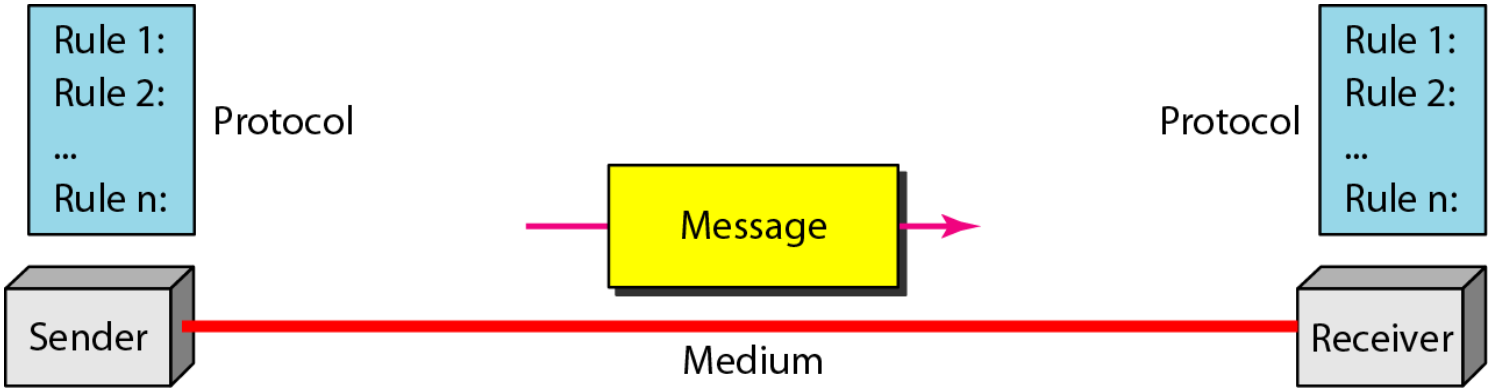
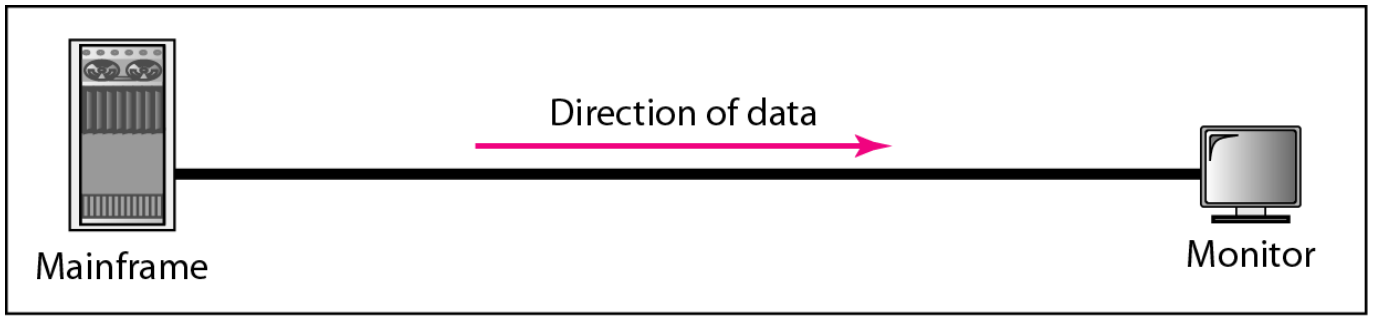
Data Communication

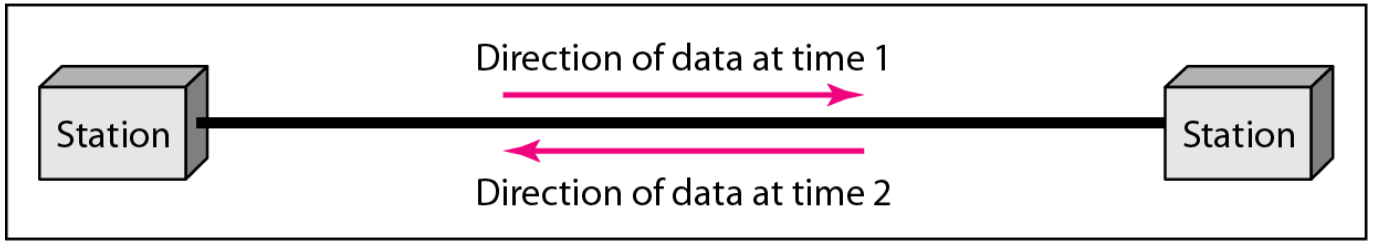
- The term telecommunication means communication at a distance.
- The word data refers to information presented in whatever form is agreed upon by the parties creating and using the data.
- **Data communications are the exchange of data between two devices via some form of transmission medium such as a wire cable.**



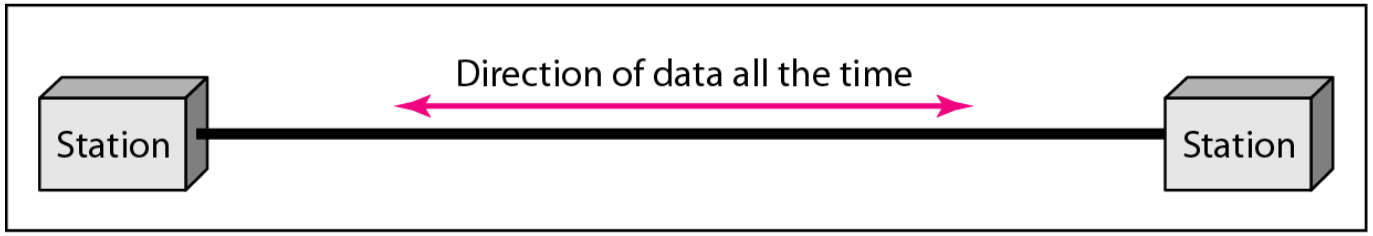
Data Flow



a. Simplex



b. Half-duplex

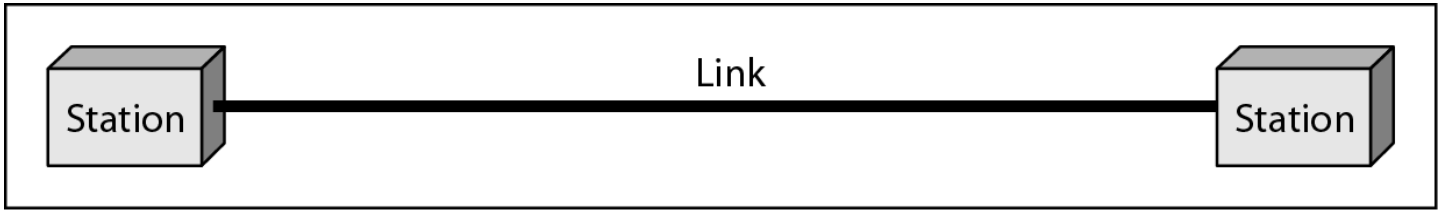


c. Full-duplex

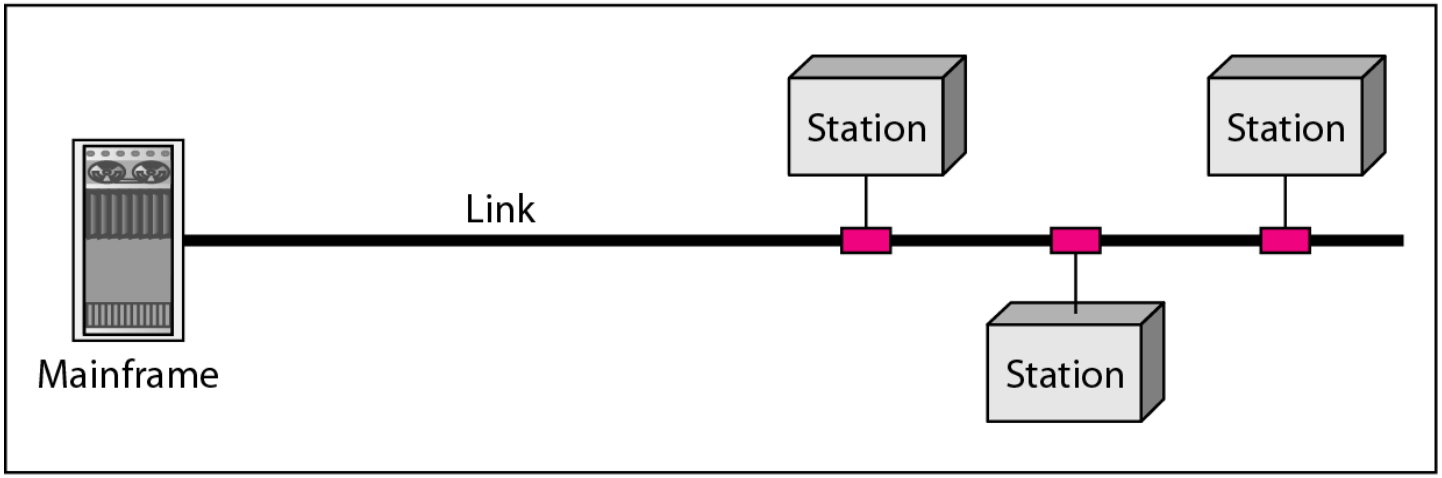
Computer Networks

*A network is a **set of devices or nodes** connected by **communication links**.*
*A node can be a computer, printer, or any other device capable of **sending and/or receiving data** generated by other nodes on the **network.***

Types of connections: point-to-point and multipoint

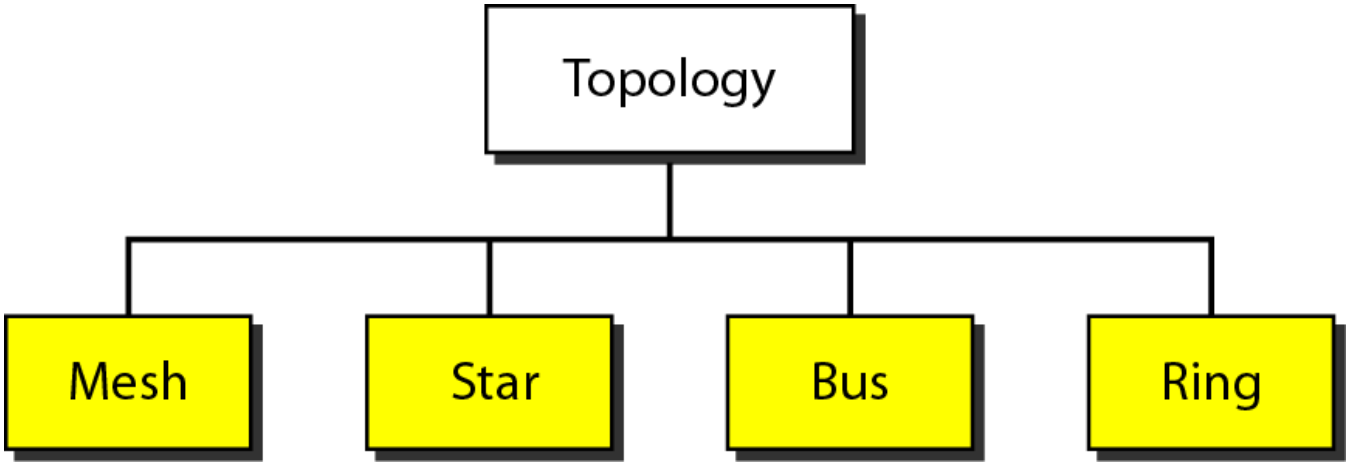


a. Point-to-point

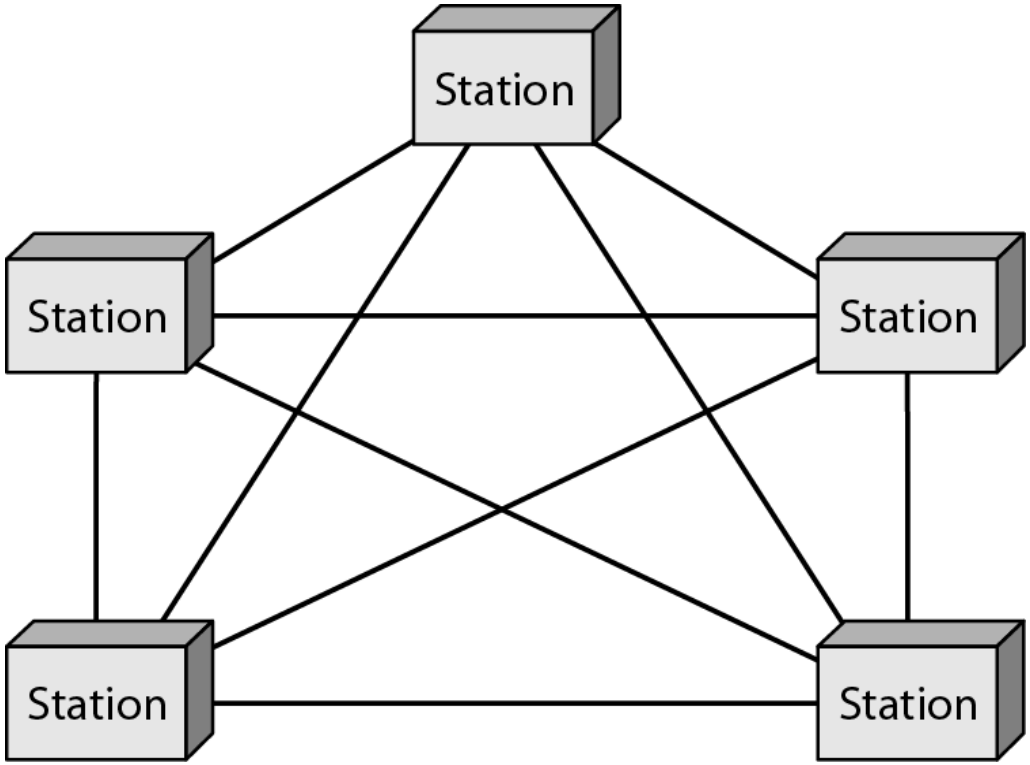


b. Multipoint

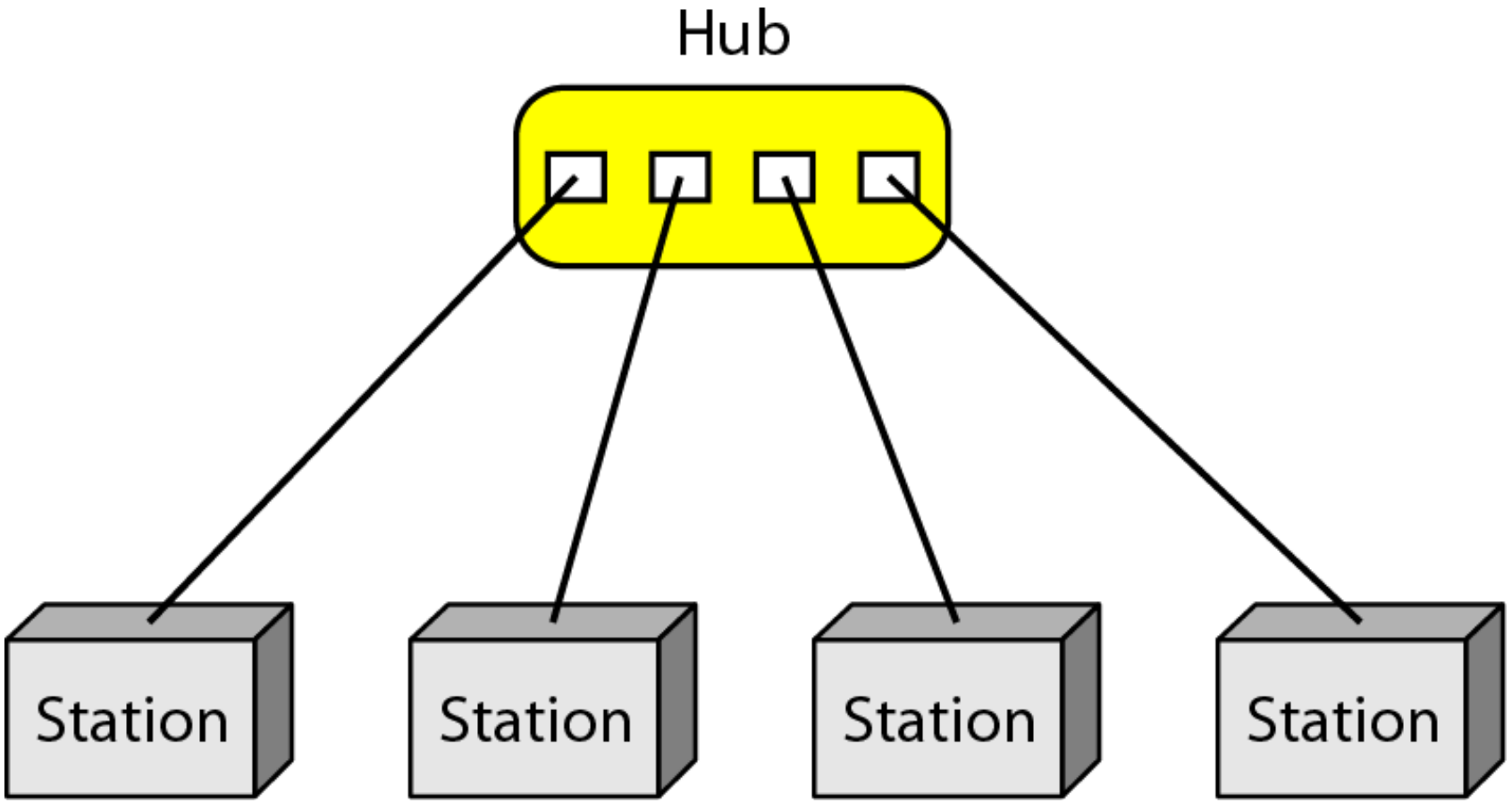
Categories of topology



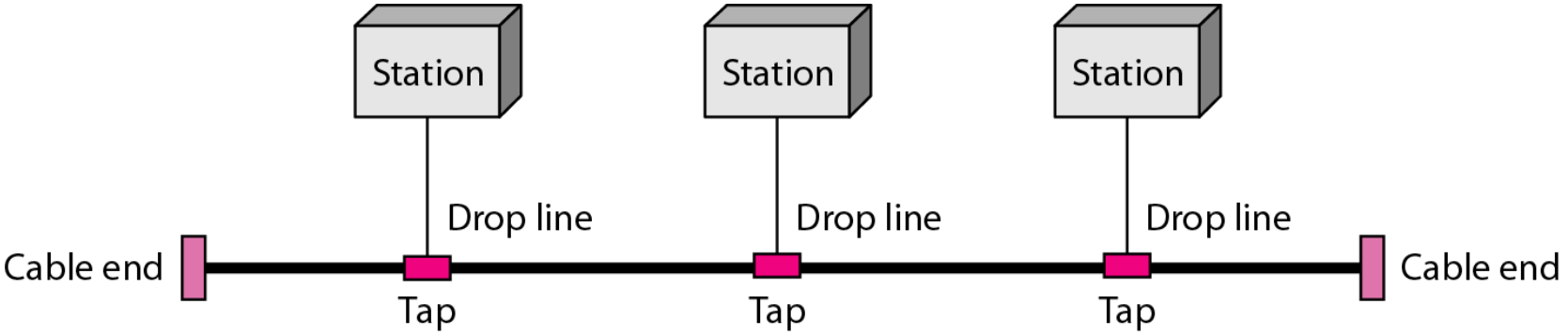
Mesh Topology (five devices)



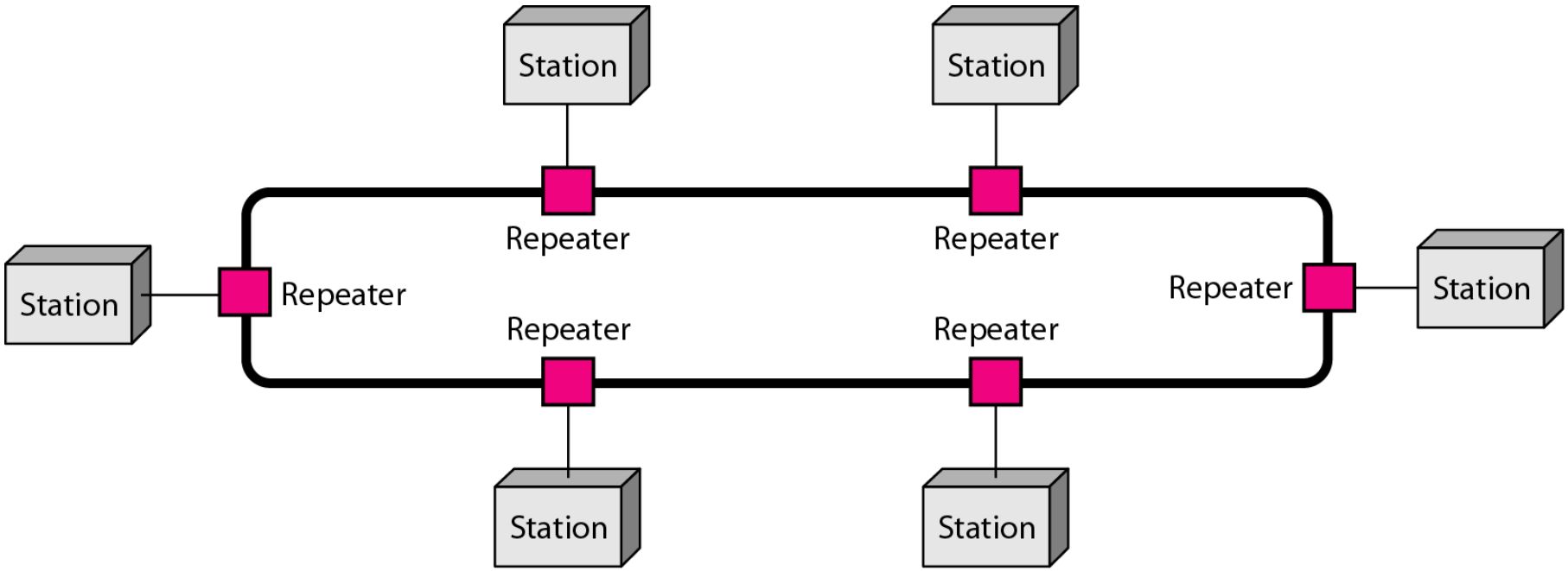
star topology connecting four stations



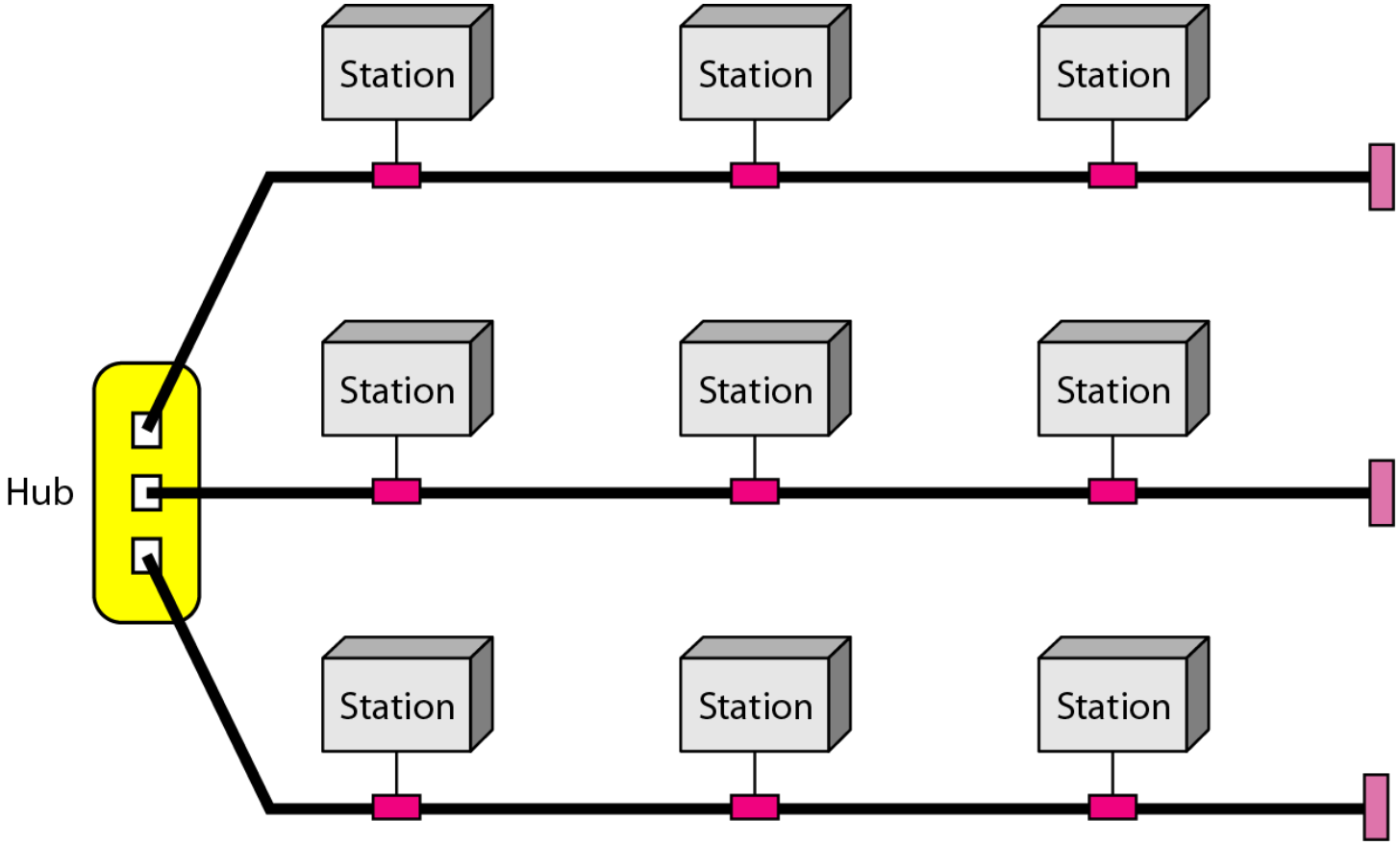
A bus topology connecting three stations



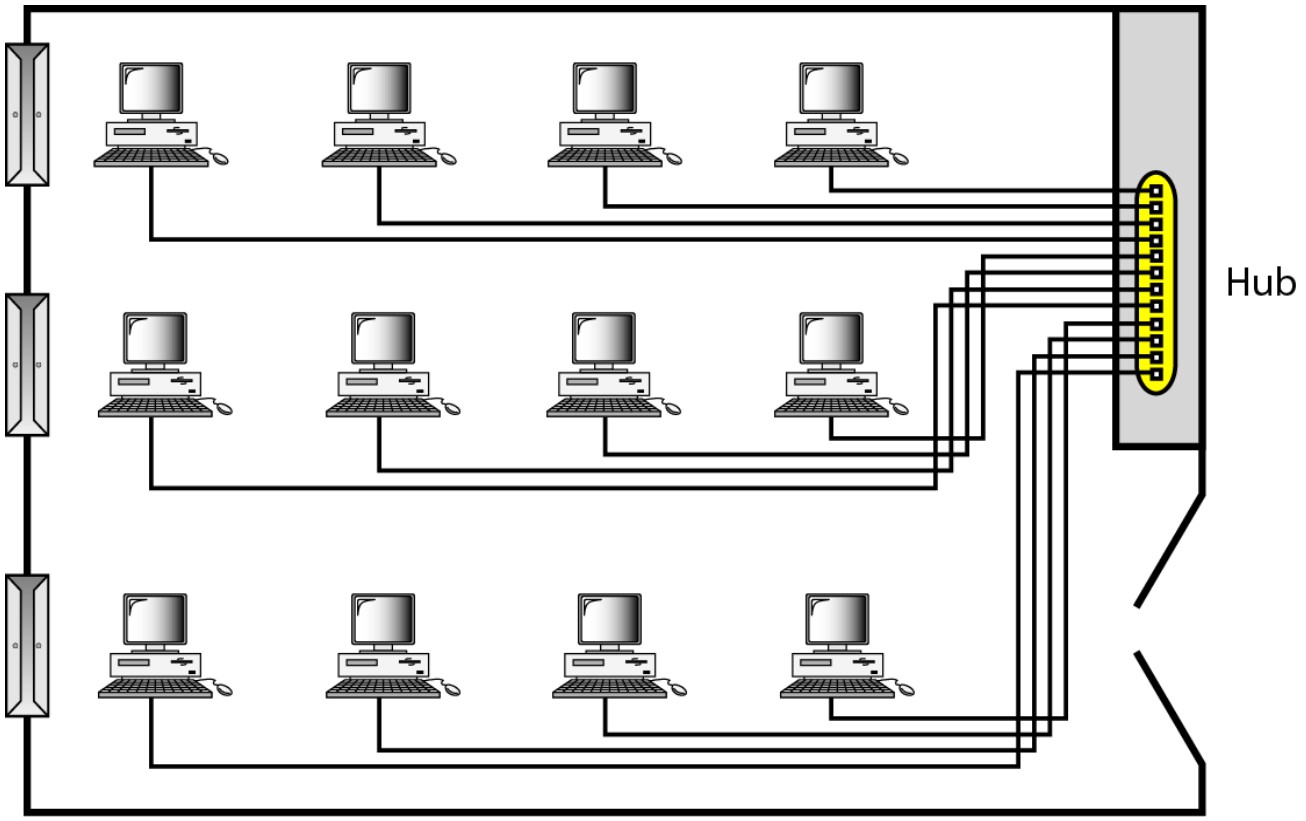
A ring topology connecting six stations



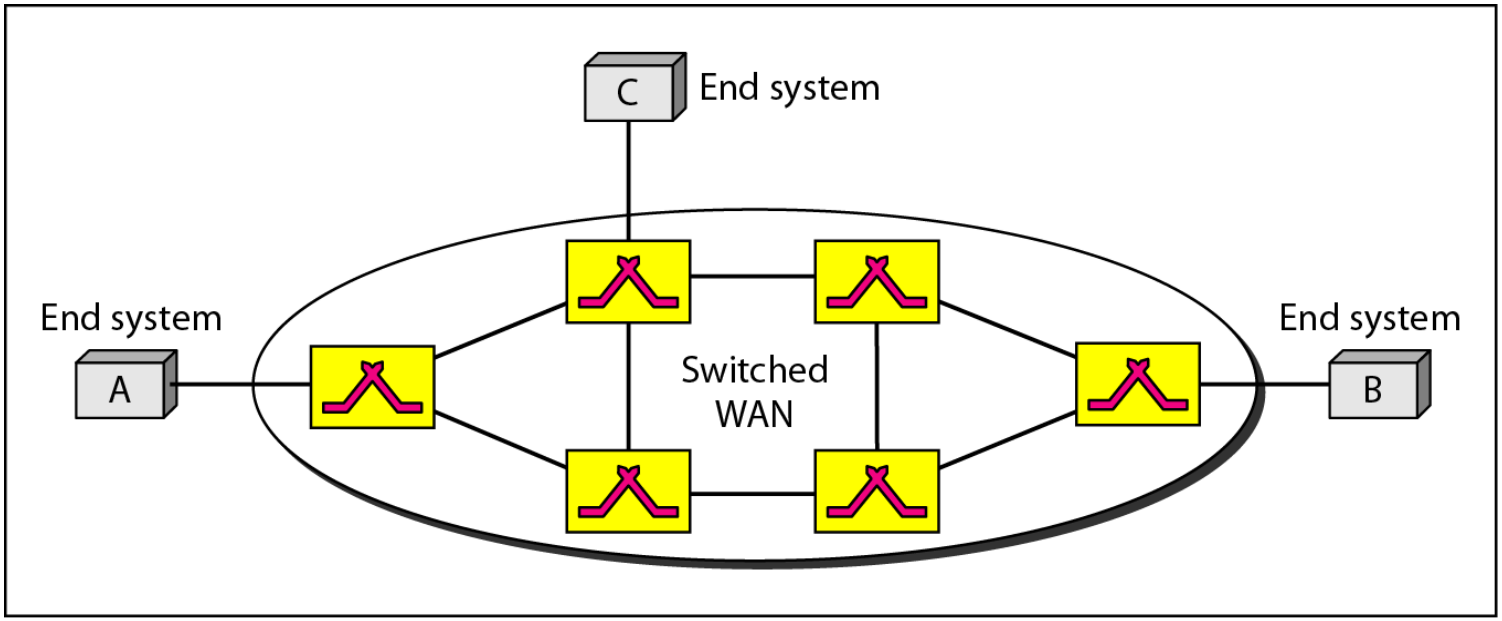
A hybrid topology



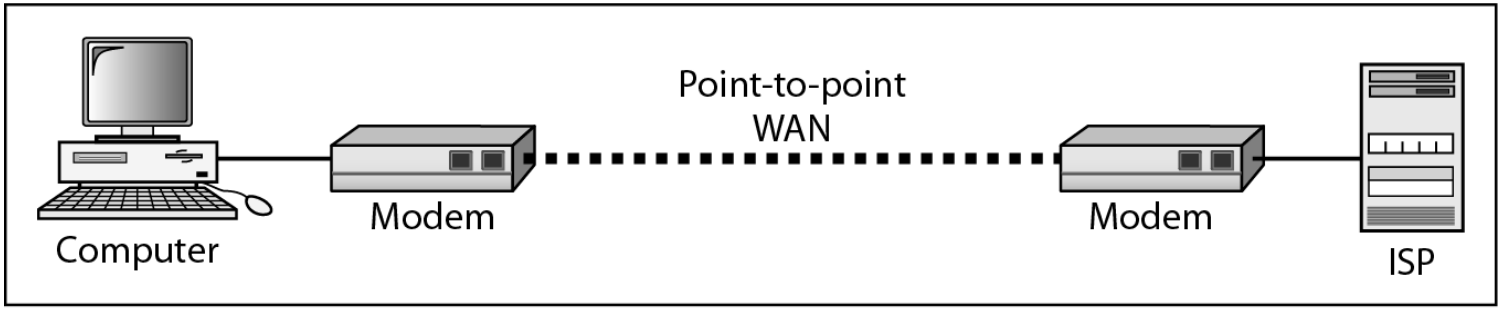
An isolated LAN connecting 12 computers to a hub in a closet



WANs: a switched WAN and a point-to-point WAN

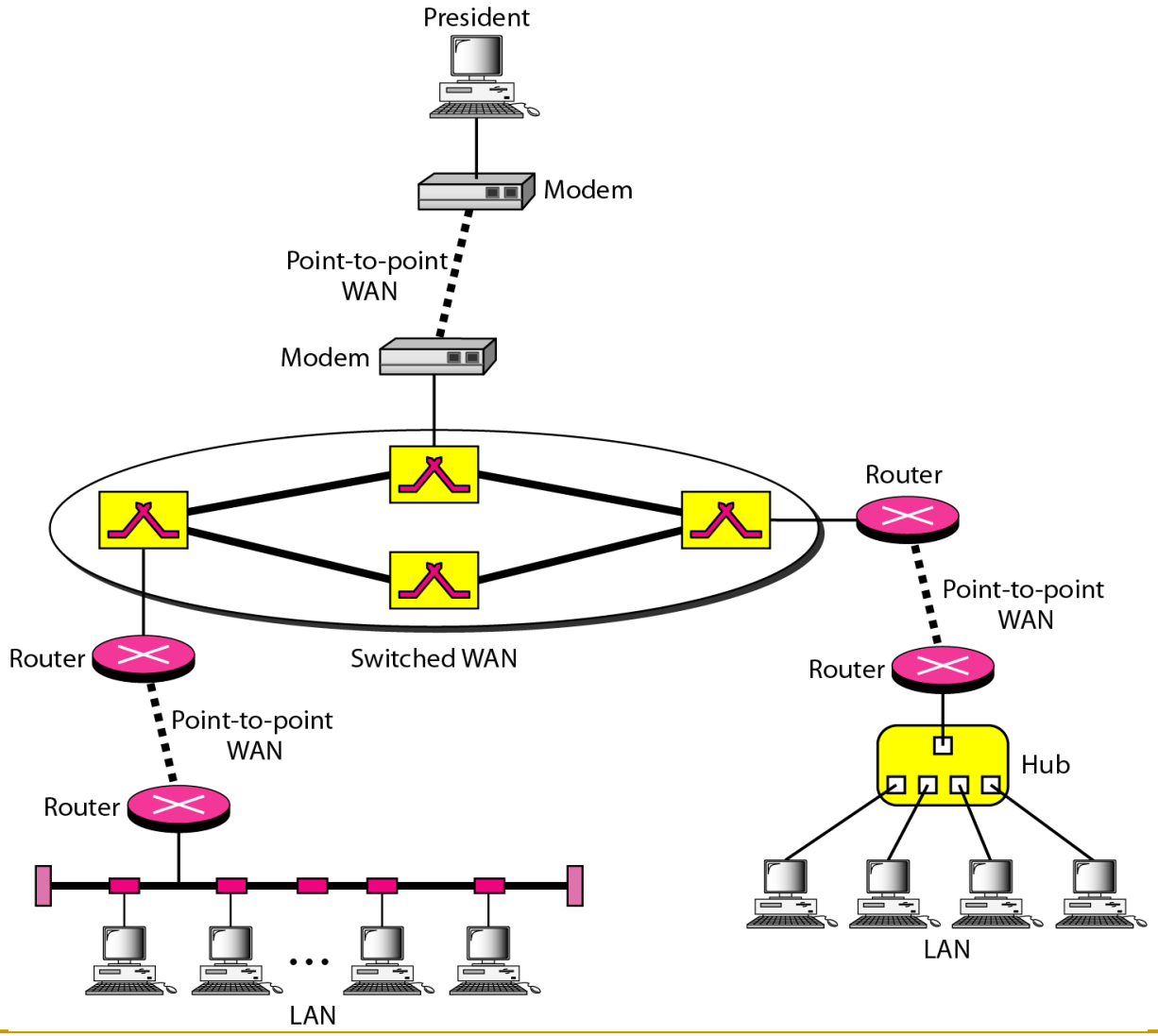


a. Switched WAN



b. Point-to-point WAN

A heterogeneous network made of four WANs and two LANs



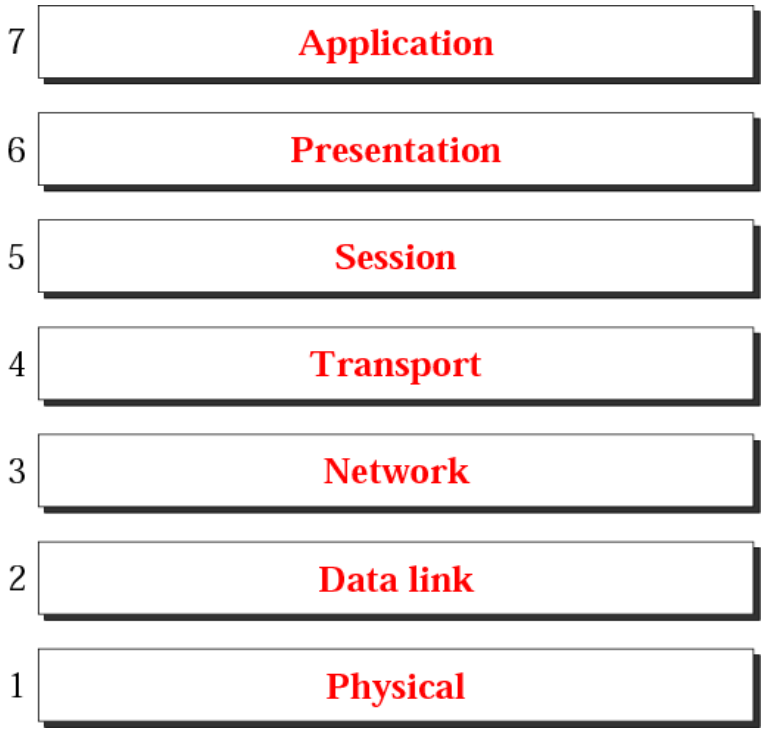
OSI Model

OSI Model

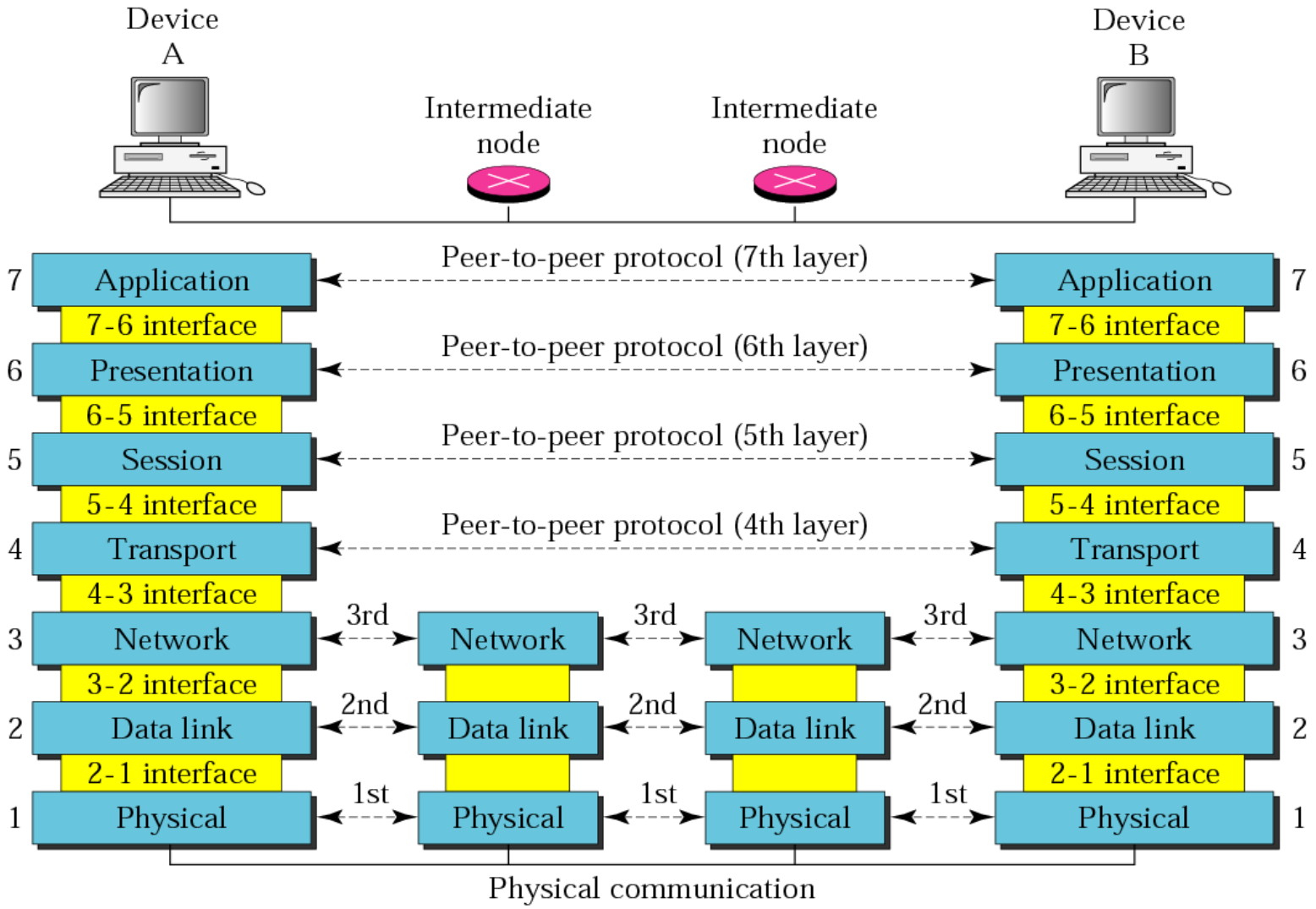
- Established in 1947, the International Standards Organization (ISO) is a multinational body dedicated to worldwide agreement on international standards.
- An ISO standard that covers all aspects of network communications is the Open Systems Interconnection (OSI) model.
- It was first introduced in the late 1970s.
- **An Open system is a set of protocol that allows any two different system to communicate regardless of their underlying architecture.**

OSI Model

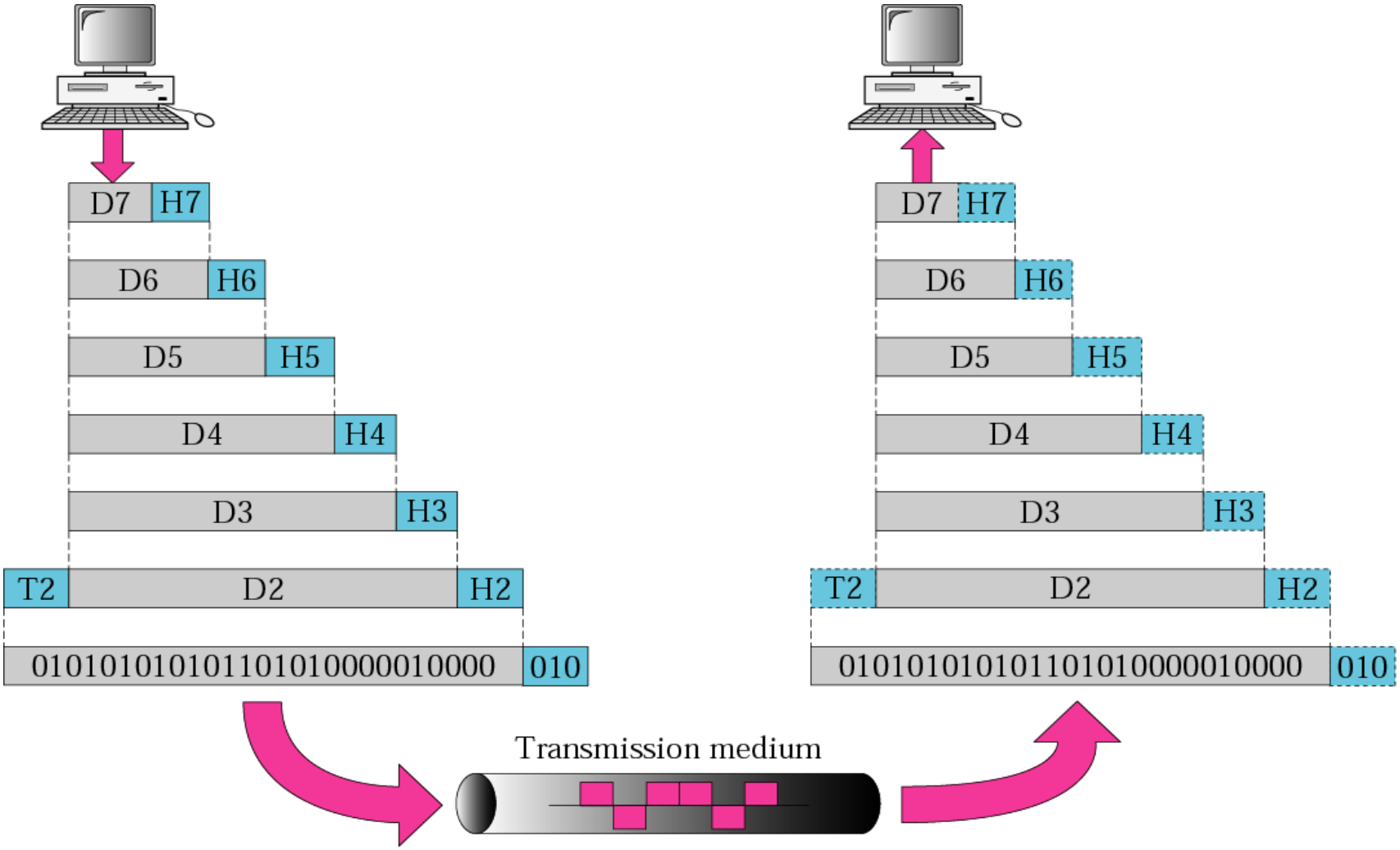
- OSI model is not protocol; It is a model for understanding and designing a network architecture that is **flexible**, **robust** and **interoperable.**
- Consist of seven separate but related layers.



Interfaces and Layered Architecture



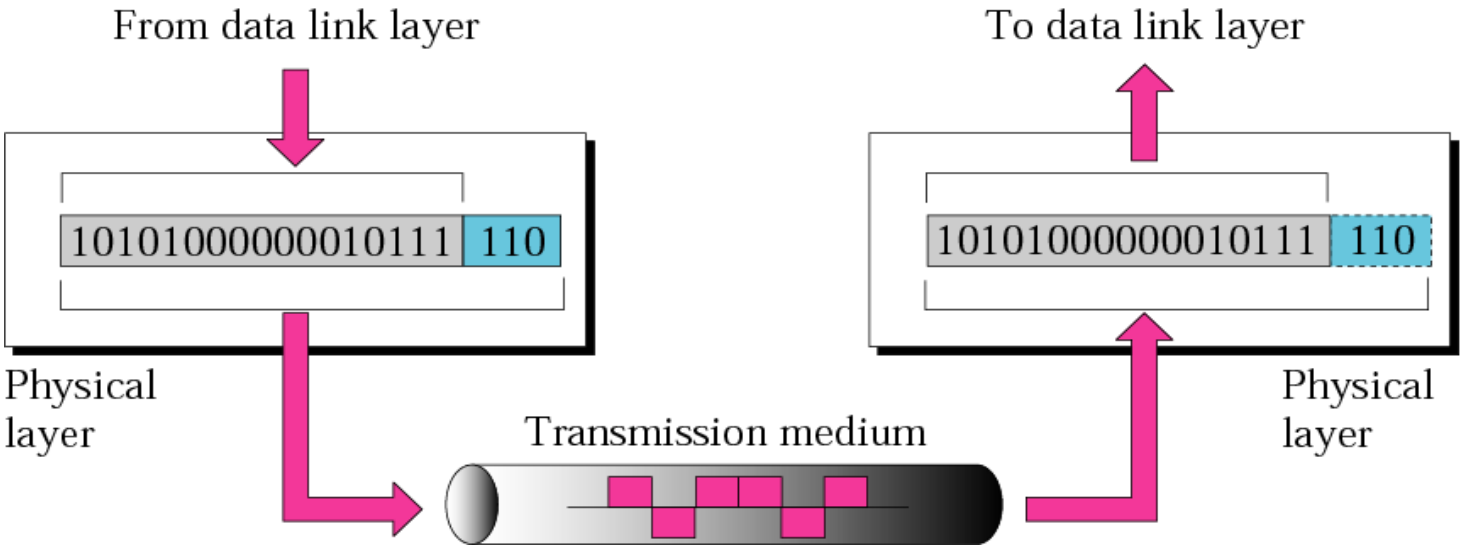
Encapsulation



Layers in the OSI Model

1. Physical Layer:

- Coordinates the functions required to carry a bit stream over a physical medium.
- Responsible for the movement of individual bits from one hop (node) to the next.



Layers in the OSI Model

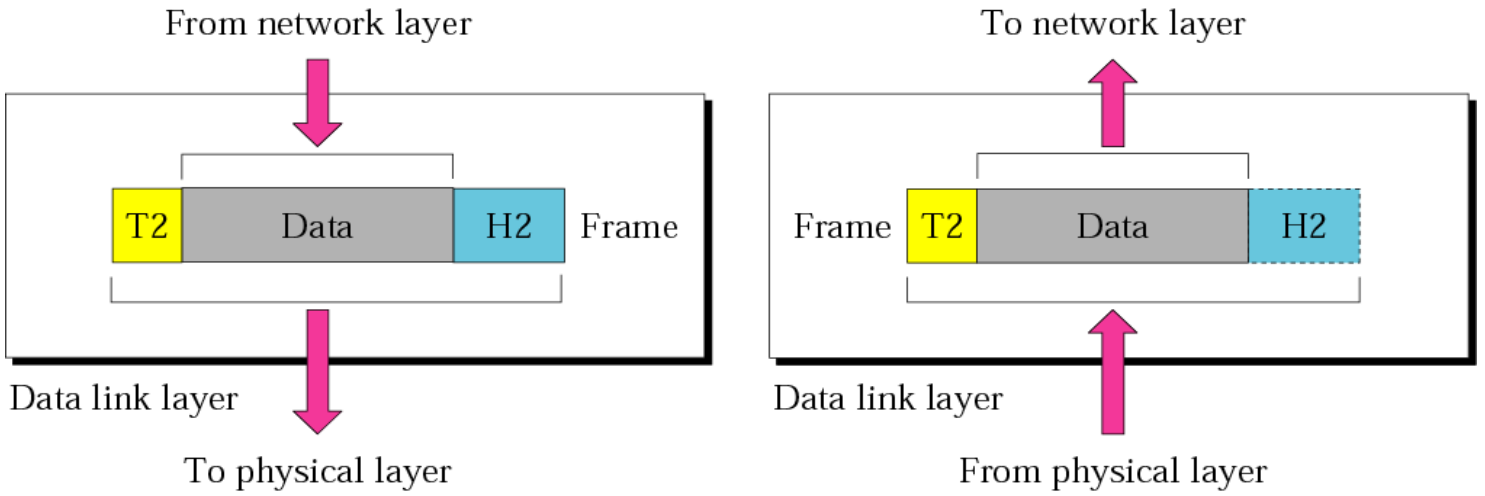
Physical Layer concerned with the following:

- Physical Characteristics of interface and media.
- Representation of bits.
- Data Rate/Transmission Rate.
- Synchronization of bits.
- Line Configuration.
- Physical Topology.
- Transmission Mode.

Layers in the OSI Model

2. Data Link Layer:

- Transform the physical layer, a raw transmission facility, to a reliable link.
- Responsible for the movement of frames from one hop (node) to the next.

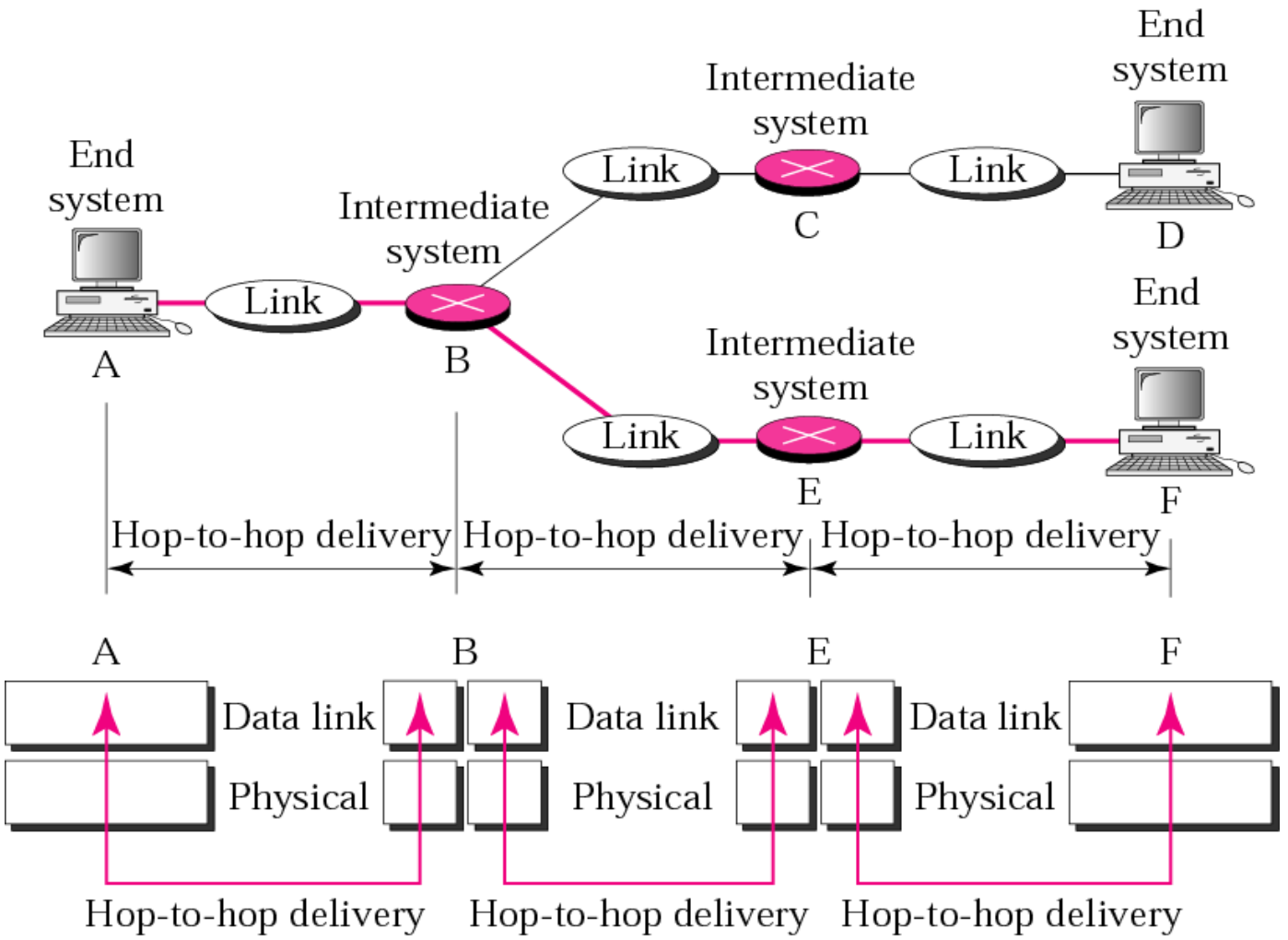


Layers in the OSI Model

Data Link Layer concerned with the following:

- Framing
- Physical Addressing
- Flow Control
- Error Control
- Access Control

Layers in the OSI Model



Layers in the OSI Model

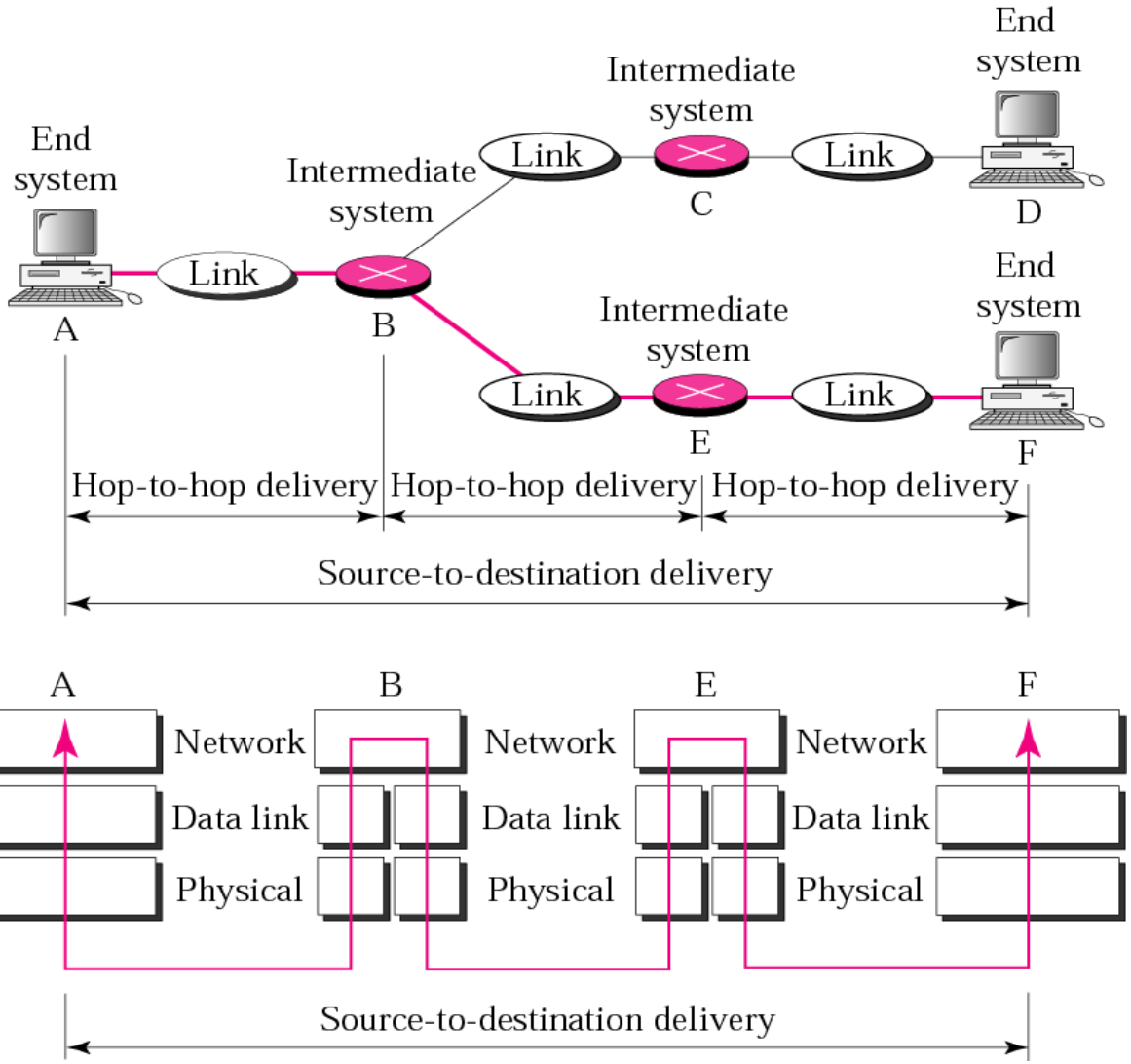
3. Network Layer:

- Ensures that each packet gets from its point of origin to its final destination.

Network Layer concerned with the following:

- Logical Addressing
- Routing

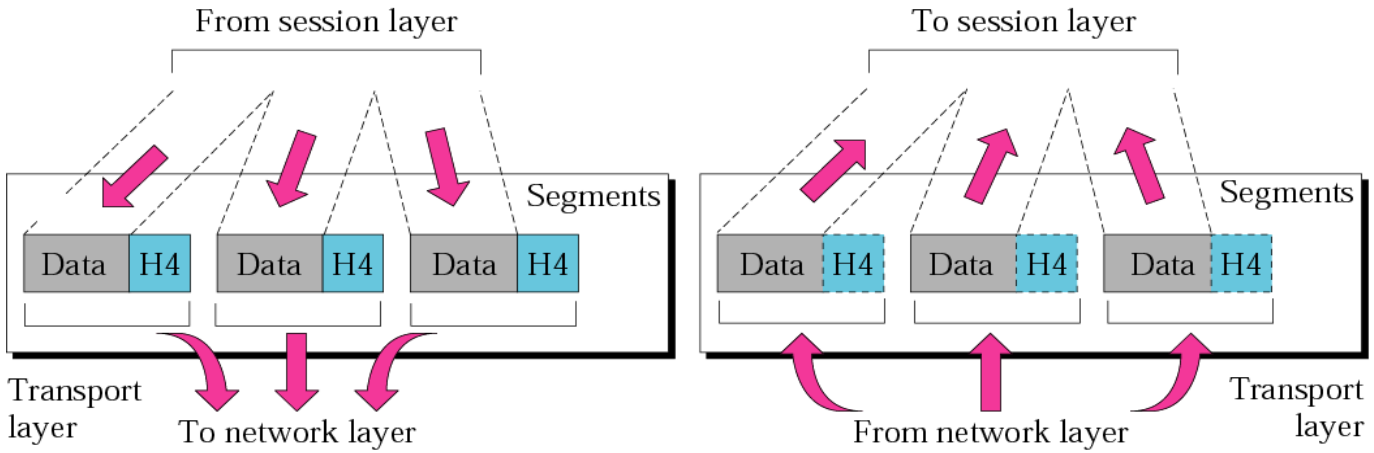
Layers in the OSI Model



Layers in the OSI Model

4. Transport Layer:

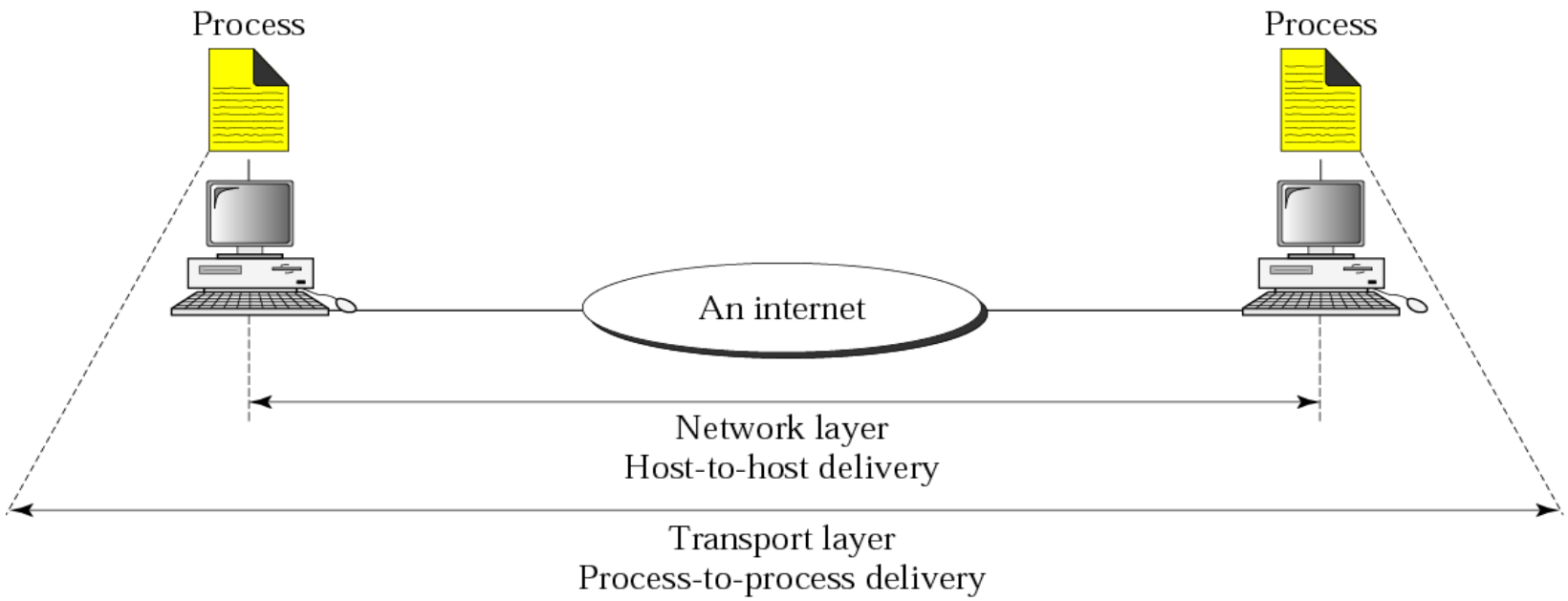
- The transport layer is responsible for the delivery of a message from one process to another.



Transport Layer concerned with the following:

Service-Point Addressing, Segmentation and Reassembly, Connection Control, Flow Control, Error Control

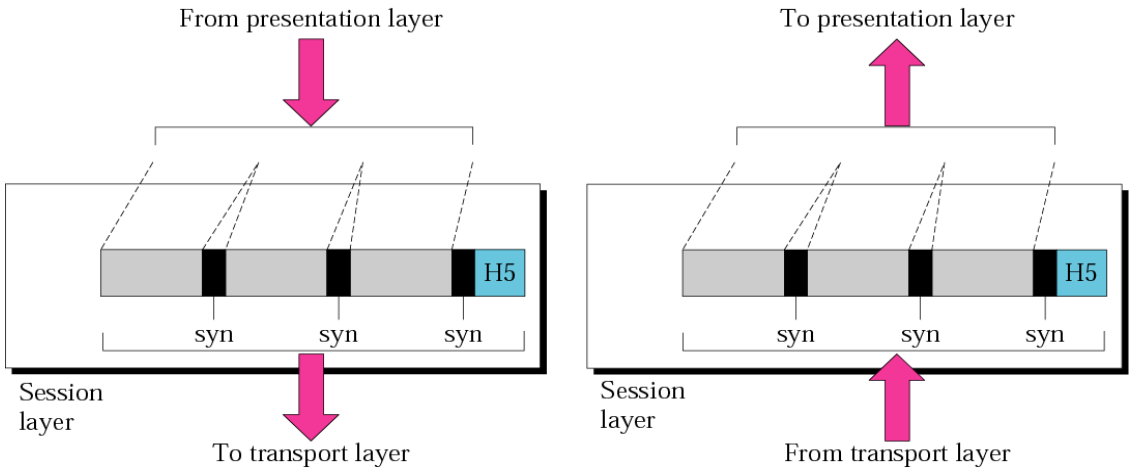
Layers in the OSI Model



Layers in the OSI Model

5. Session Layer:

- The session layer establishes, maintains and synchronizes the interaction between communicating systems.



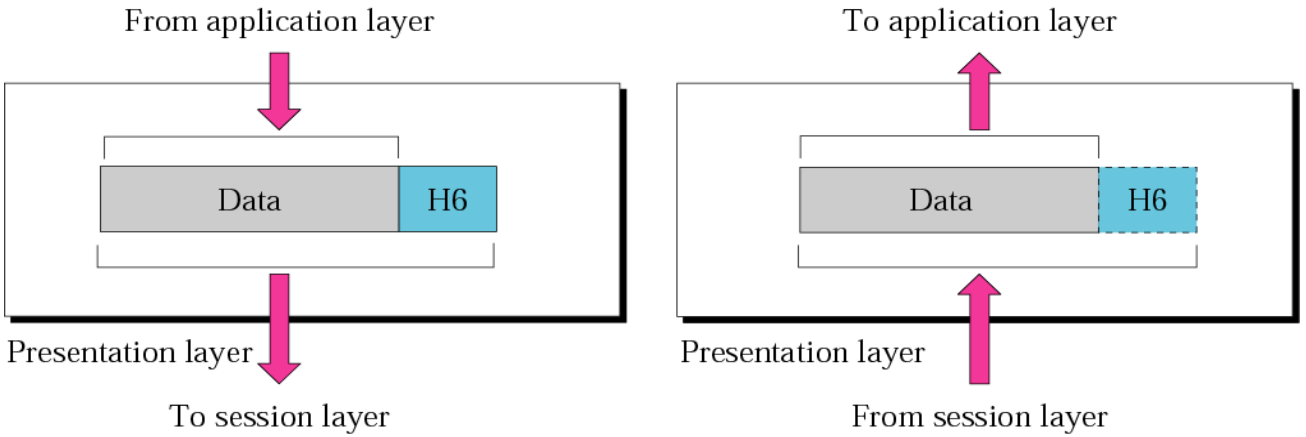
Session layer concerned with the following:

- Dialog Control
- Synchronization

Layers in the OSI Model

6. Presentation Layer:

- Concerned with the syntax and semantics of the information exchanged between two systems.



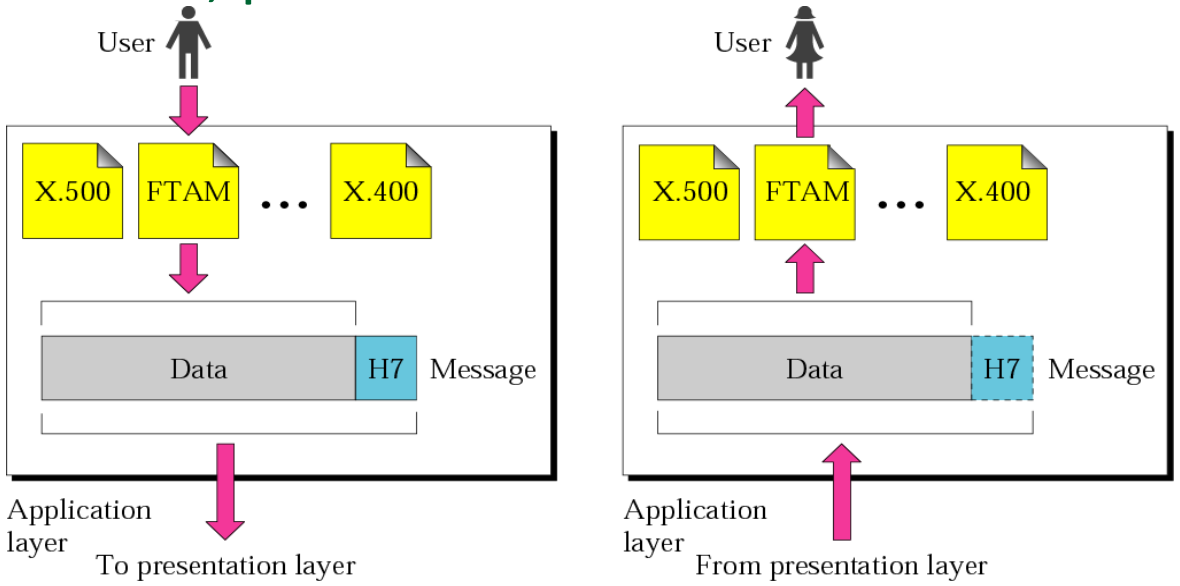
Presentation layer concerned with the following:

- Translation
- Encryption
- Compression

Layers in the OSI Model

6. Application Layer:

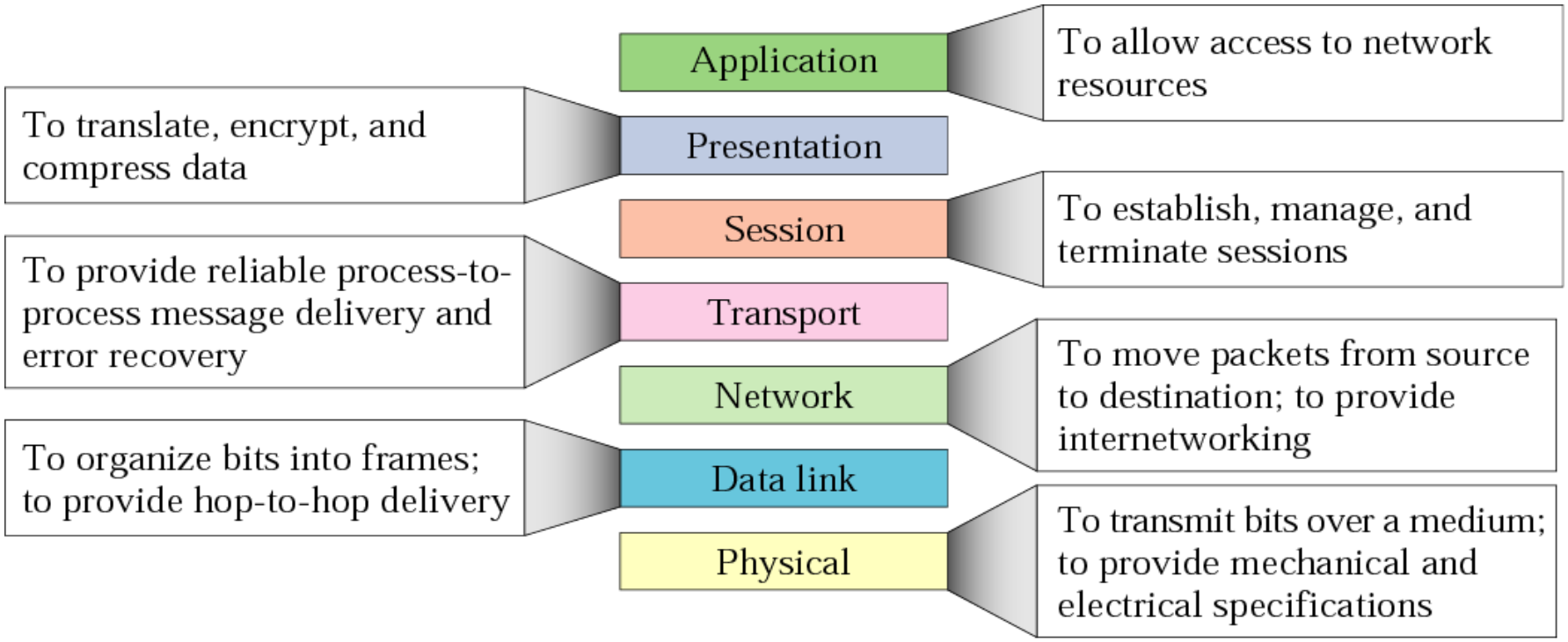
- Enables the user, whether human or network, to access the network, provide user interface.



Application layer provides the following services:

Network Virtual Terminal, E-mail Services, File Transfer, Access and Management (FTAM), Directory Services

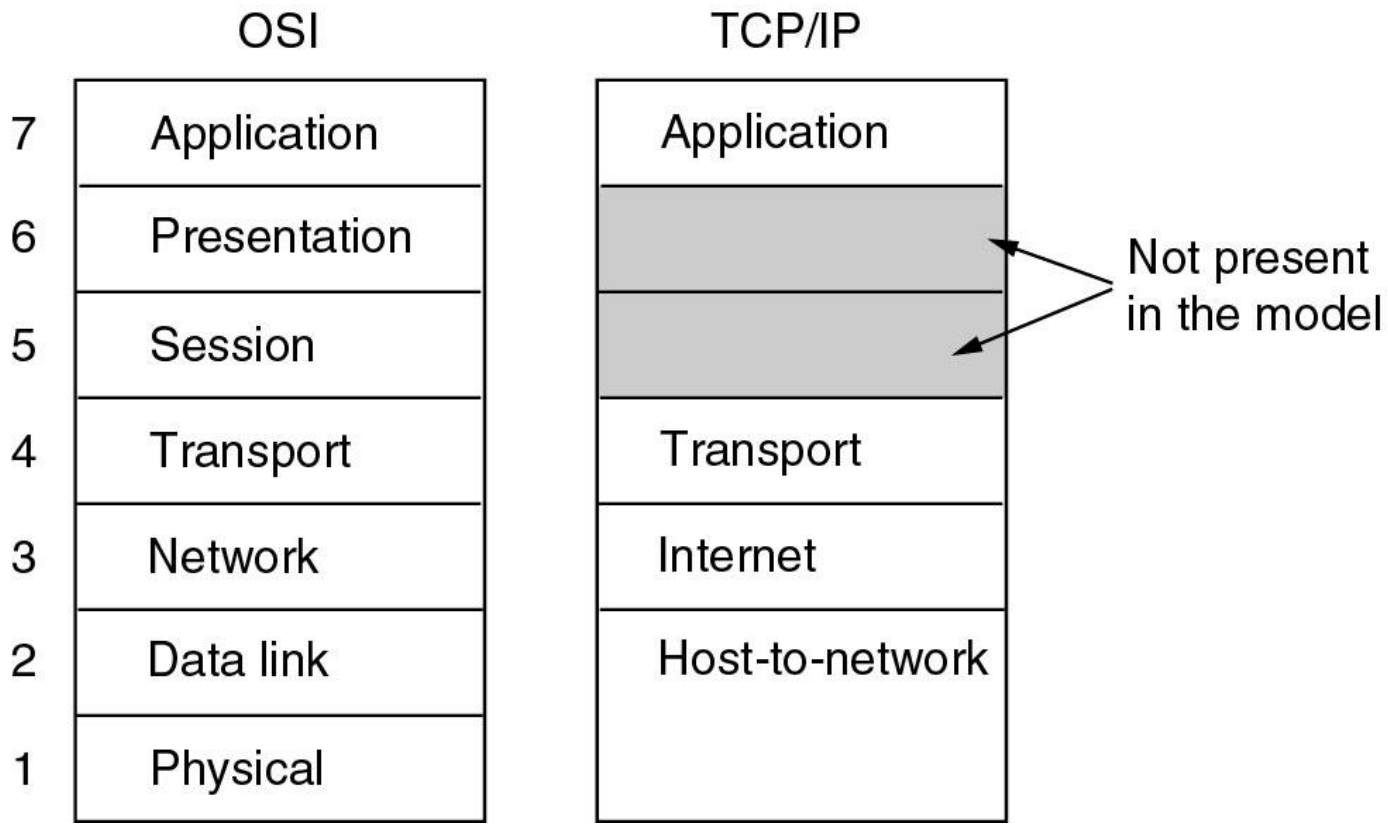
Summary of layers



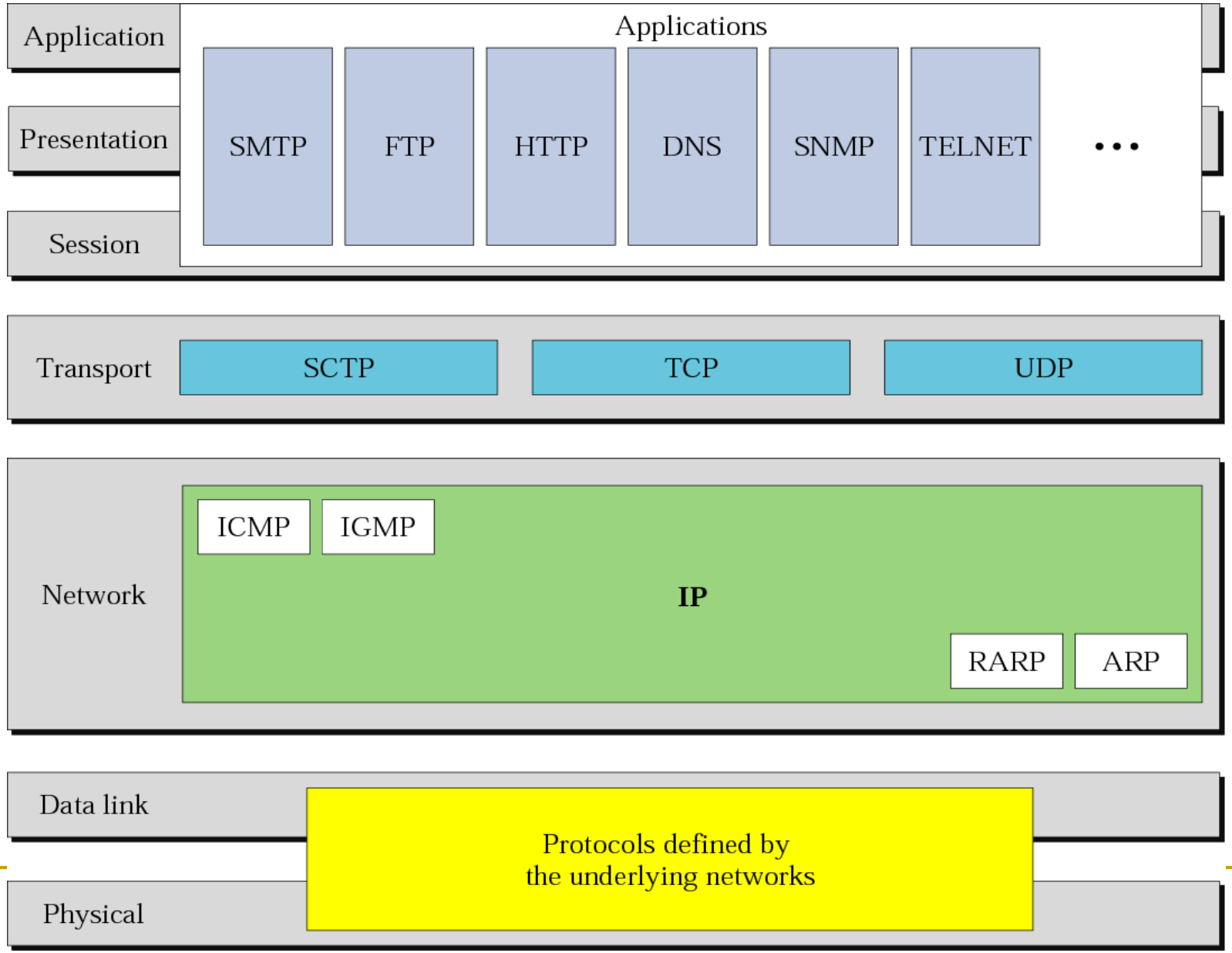
TCP/IP Model

TCP/IP model

Developed prior to OSI Model.



TCP/IP model


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

Comparison between OSI and TCP/IP Model

Similarities:

1. Stack of independent protocols.
2. Roughly similar functionalities.
3. Layers above transport layer are application oriented.

Differences:

Three concepts are central to OSI Model:

1. Services
2. Interfaces
3. Protocols

OSI Model makes distinction between them explicitly.

Comparison between OSI and TCP/IP Model

1. **Services**

   Each layer some service s for the layer above it.

   Defines what layer does.

   Not how entities above it access it or how layers works?

2. **Interfaces**:

   Tells the processes above it how to access it.

   Defines parameters and results.

3. **Protocols:**

   Provides the offered services by any protocol.

   Should not affect the functionalities of above layers.

Comparison between OSI and TCP/IP Model

- TCP/IP did not clearly distinguish between service, interface and protocols.
- The protocols in the OSI model are better hidden than in the TCP/IP model, can be replaced easily.
- The OSI reference model devised first before the corresponding protocols were invented, i.e. DLL.
- With TCP/IP, the reverse is true.
- Number of Layers.
- Connection oriented vs. connection less approach at different layers.

Comparison between OSI and TCP/IP Model

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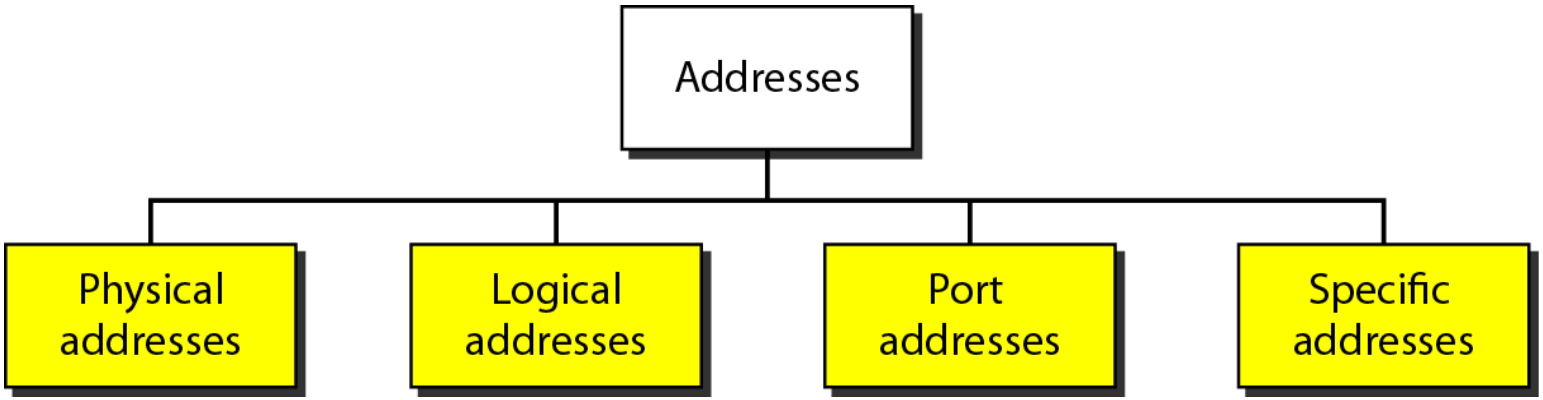
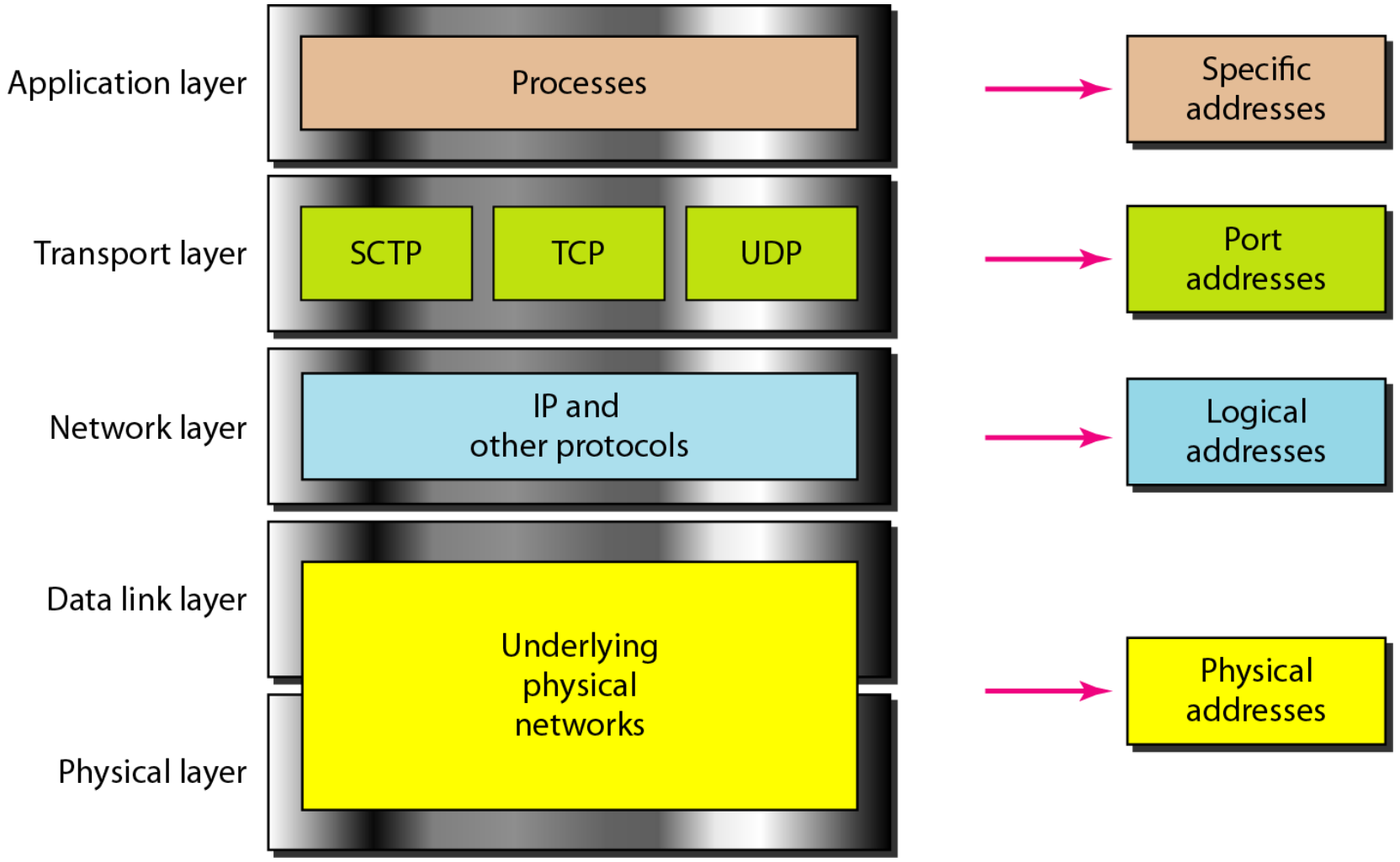
- Connection oriented vs. connection less approach at different layers.

Addressing

- Four levels of addresses are used in an internet employing the TCP/IP protocols: **Physical, Logical, Port, and Specific.**



Addressing


Application layer
Processes
Specific addresses
Transport layer
SCTP
TCP
UDP
Port addresses
Network layer
IP and other protocols
Logical addresses
Data link layer
Underlying physical networks
Physical addresses
Physical layer

Addressing

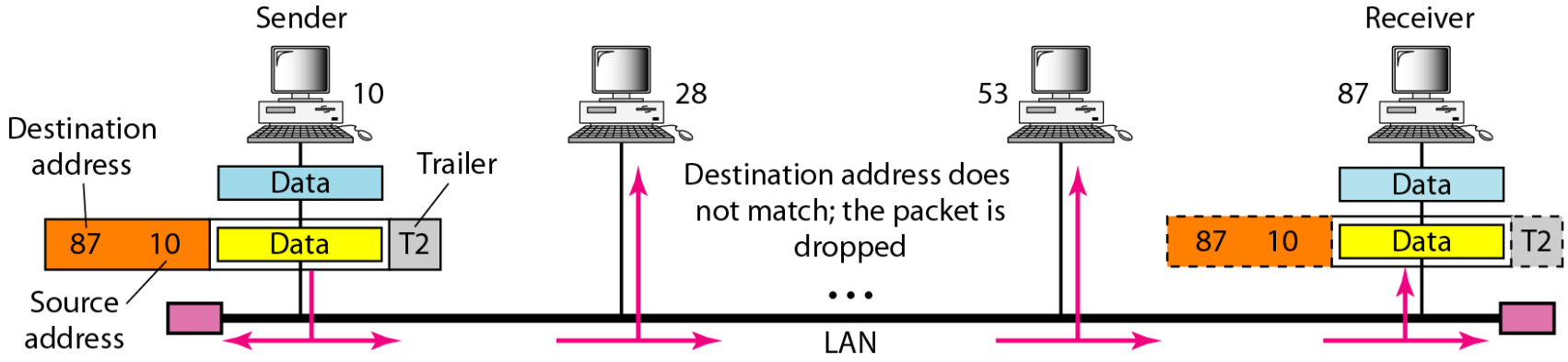
1. **Physical Address:**
   - Address of a node as defined by its LAN or WAN.
   - Included in the Frame used by Data Link Layer.
   - Lowest Level Address
   - Ethernet uses 6-byte (48 bits) physical Address imprinted on the NIC.
   - LocalTalk has a 1-byte dynamic address.

Addressing

1. Physical Address:

Example:

A node with physical address 10 sends a frame to a node with physical address 87. The two nodes are connected by a link (bus topology LAN).



Addressing

1. **Physical Address:**

   Example:

   Most local-area networks use a 48-bit (6-byte) physical address written as 12 hexadecimal digits; every byte (2 hexadecimal digits) is separated by a colon, as shown below:

07:01:02:01:2C:4B

A 6-byte (12 hexadecimal digits) physical address.

Unicast, Multicast and Broadcast Physical Addresses

Addressing

2. **Logical Address:**
   - Necessary for universal communications that are independent of physical networks.
   - 32-bits address with IPv4.
   - No two publically addressed and visible hosts on the Internet can have the same IP address.

Addressing

2. **logical Address:**

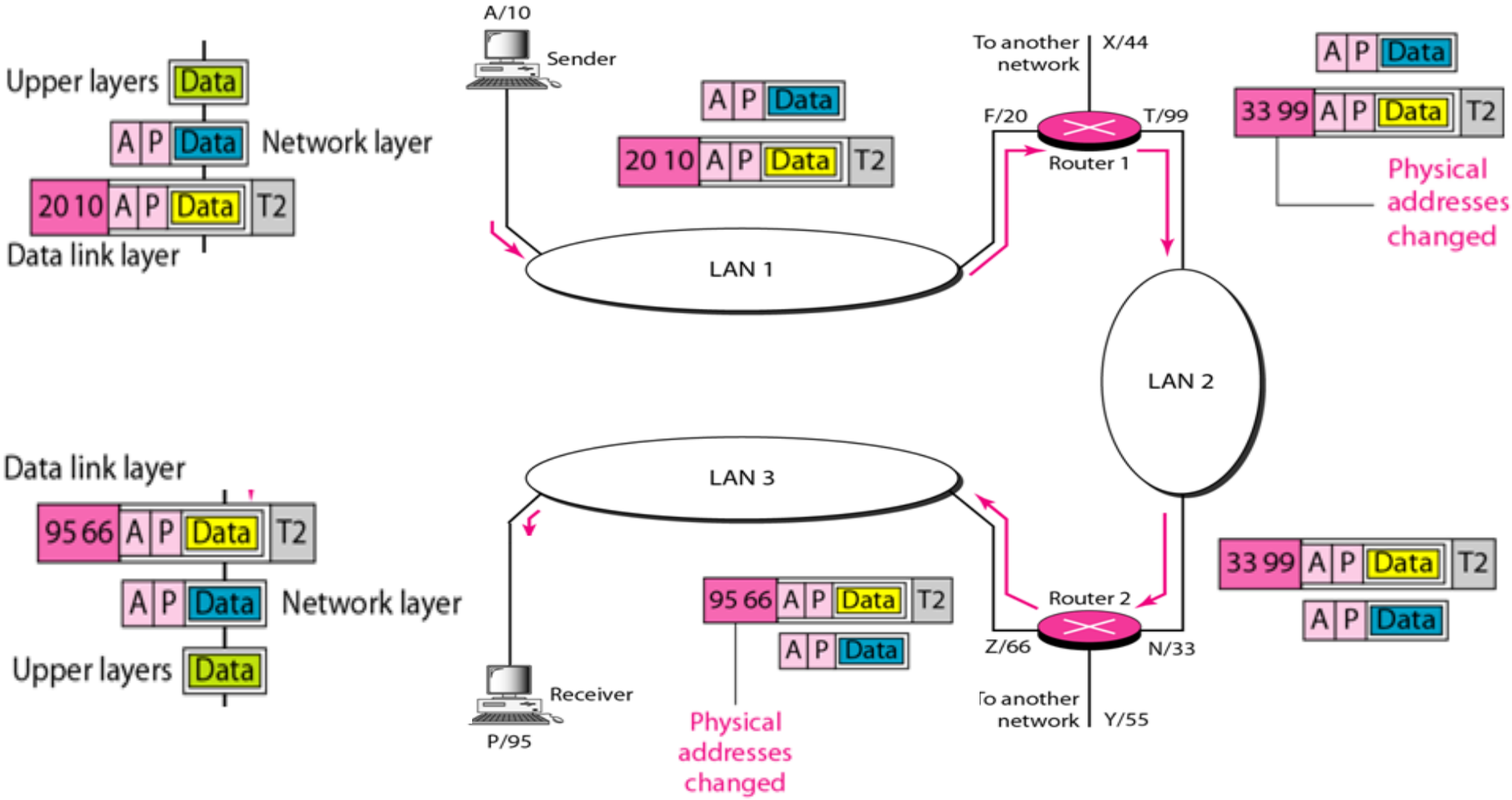
Example:

An internet with two routers connecting three LANs is shown in the next diagram.

Each device (computer or router) has a pair of addresses (logical and physical) for each connection.

Each router, is connected to three networks. So, each router has three pairs of addresses, one for each connection.

Addressing



Unicast, Multicast and Broadcast Physical Addresses

Addressing

3. **Port Address:**
   - IP and Physical address are required for data travel from source to destination host.
   - The end objective of any communication is to deliver the data to right process.
   - Port address unequally identifies the process running on node.
   - 16 bits in length.

Addressing

3. Port Address:

Example

Next diagram shows two computers communicating via the Internet.

*The sending computer is running three processes at this time with port addresses **a, b, and c**.*

*The receiving computer is running two processes at this time with port addresses **j and k.***

***Process a** in the sending computer needs to communicate with **process j** in the receiving computer. Note that although physical addresses change from hop to hop, logical and port addresses remain the same from the source to destination.*

Addressing

3. Port Address:

Example