Chapter 2

The OSI Model and the TCP/IP Protocol Suite

Objectives

Upon completion you will be able to:

- *Understand the architecture of the OSI model*
- *Understand the layers of the OSI model and their functions*
- *Understand the architecture of the TCP/IP Protocol Suite*
- *Differentiate between the OSI model and the TCP/IP Suite*
- *Differentiate between the three types of Internet addresses*

2.1 The 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.

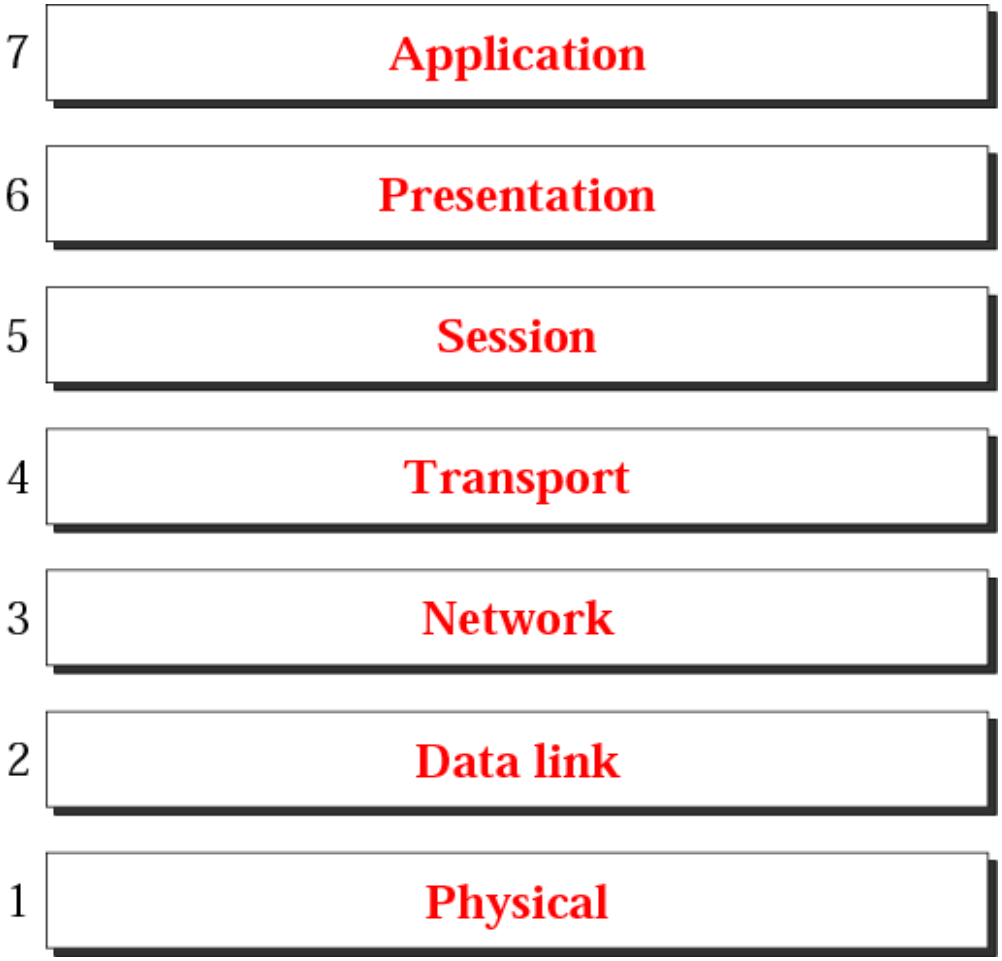
The topics discussed in this section include:

Layered Architecture
Peer-to-Peer Processes
Encapsulation

Note:

ISO is the organization.
OSI is the model

Figure 2.1 *The OSI model*



The OSI model

Layered Architecture

Fig. Shows layers involved when message travels from A to B.

Networking functions with related uses are collected into discrete groups that become the layers.

OSI Layers allows complete interoperability between incompatible systems.

Layer x on one machine communicate with layer x on other machine.

The OSI model

Peer to peer processes:

At physical layer communication is direct.

Each layer adds its own information to the message.

Interfaces between layers:

Each interface defines what information and services a layer must provide for the layer above it.

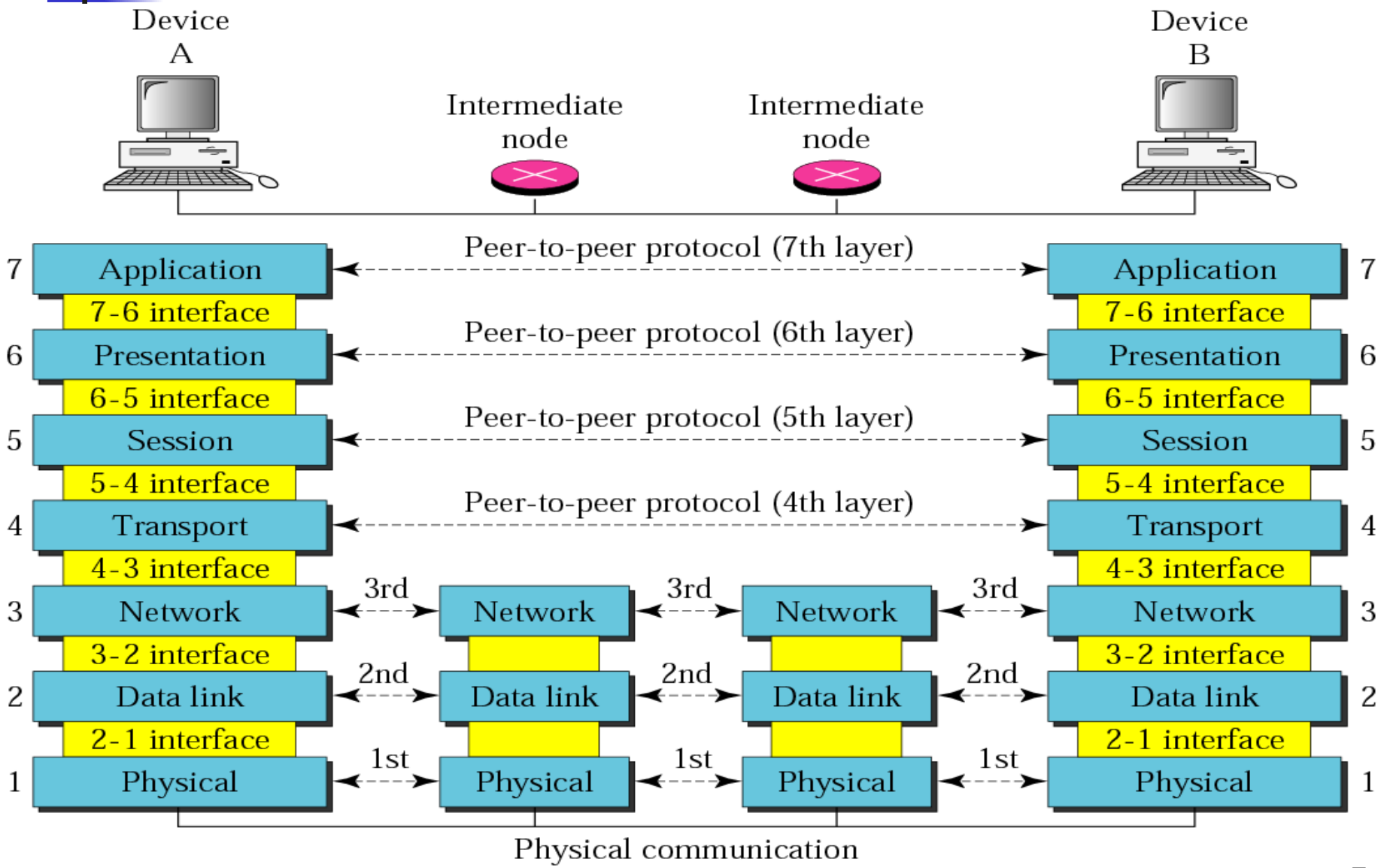
Organization of layers:

Three subgroups: Layer 1,2 and 3 are *network support* layers, deal with physical aspects.

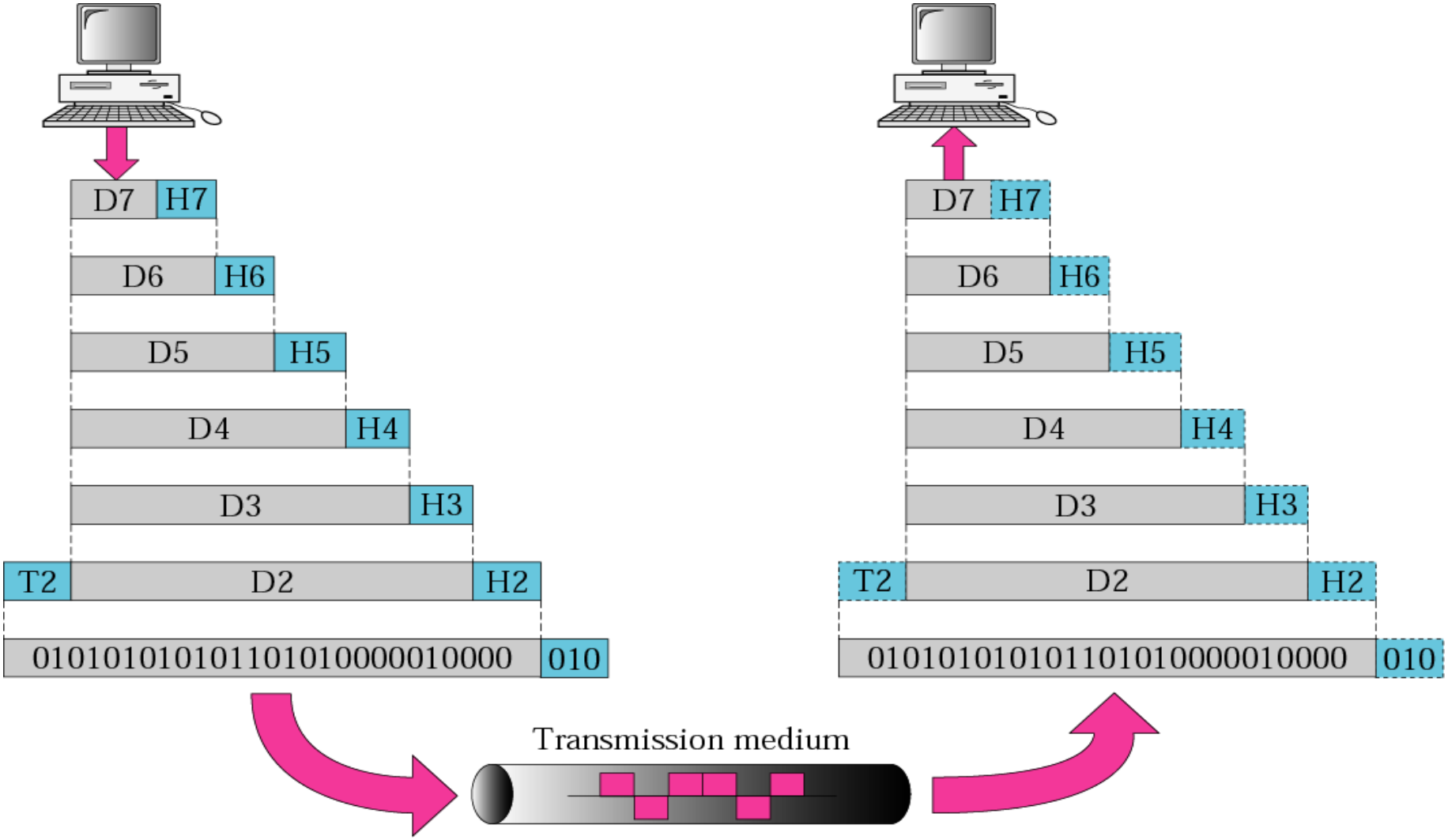
Layer 5,6,7 are *user support* layers. Allow interoperability among unrelated software systems.

Layer 4: Links two subgroups.

Figure 2.2 *OSI layers*



An exchange using the OSI model, Encapsulation



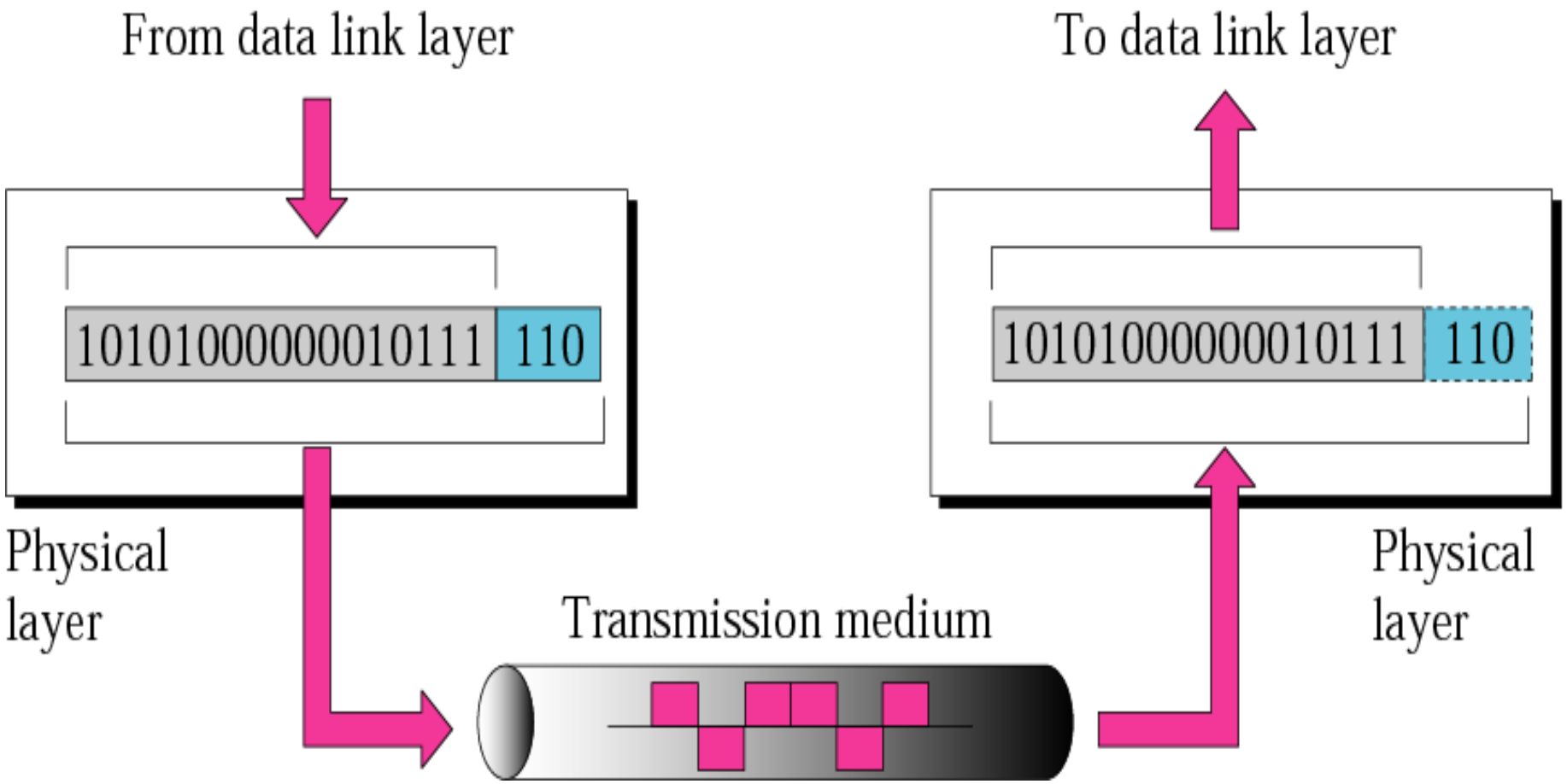
2.2 Layers in the OSI Model

The functions of each layer in the OSI model is briefly described.

The topics discussed in this section include:

Physical Layer
Data Link Layer
Network Layer
Transport Layer
Session Layer
Presentation Layer
Application Layer
Summary of Layers

Physical layer



The Physical Layer

1.Physical characteristics of interfaces and media
2.Representation of bits
3.Data rate
4.Synchronization of bits
5.Line Configuration:-
- *Point to point* – Connected together through dedicated link
- *Multipoint* – share link between several devices

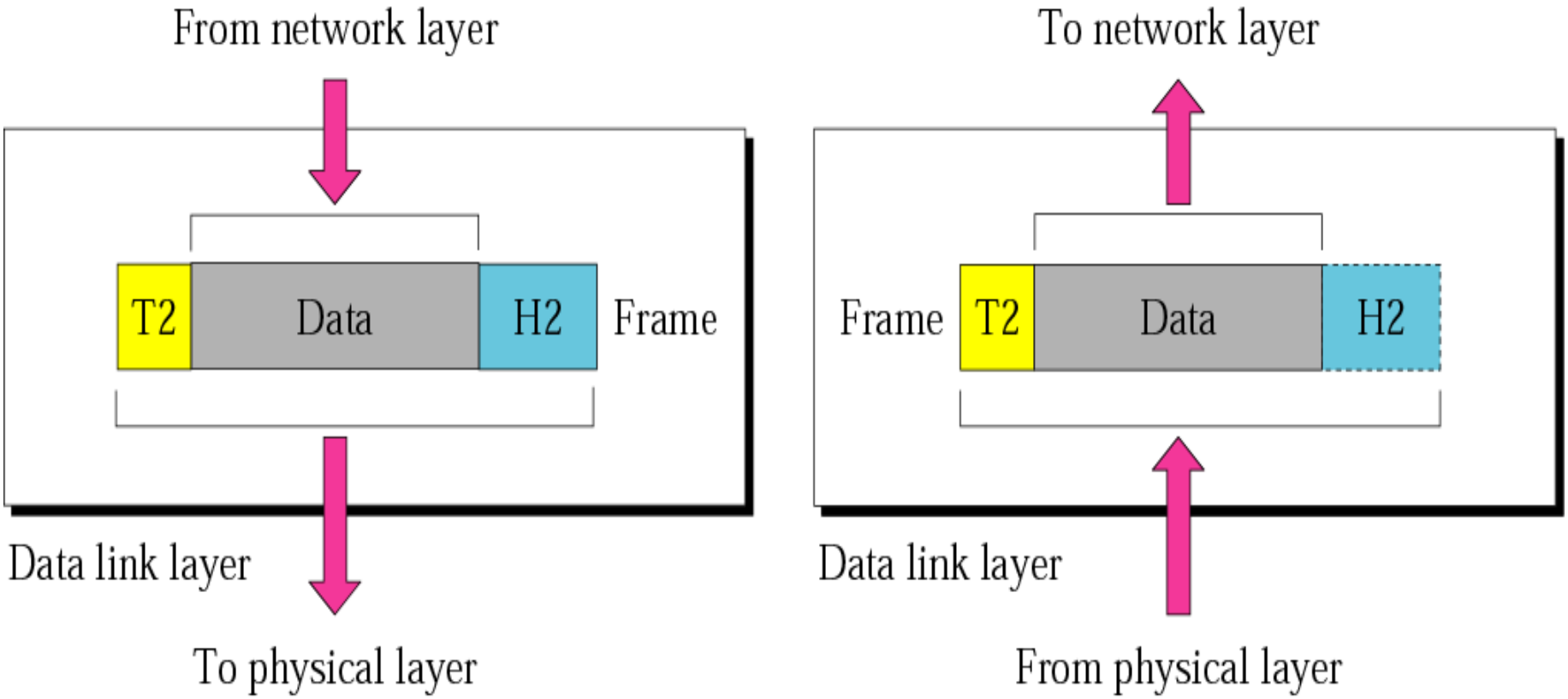
6.Physical topology:-
- *Mesh* – Every device connected to every other device
- *Star* – devices connected through central device
- *Ring* – each device connected to next device
- *Bus* – Every device on common link

7.Transmission Mode:-
- *Simplex* – Only one device can send
- *Half-duplex* – two devices can send & receive not at same time
- *full duplex* – Send and receive at same time

Note:

The physical layer is responsible for the movement of individual bits from one hop (node) to the next.

Data link layer



The Data Link Layer

- *Framing* : Divides stream of bits into frames.
- *Physical Addressing :* Adds a header to the frame to define receiver
- *Flow control :* To prevent overwhelming the receiver.
- *Error Control: adds reliability to physical layer. Also detects duplicate Frames.*
- *Access Control: Determines which device has control over the link at any given time.*

Note:

The data link layer is responsible for moving frames from one hop (node) to the next.

Figure 2.6 *Hop-to-hop delivery*

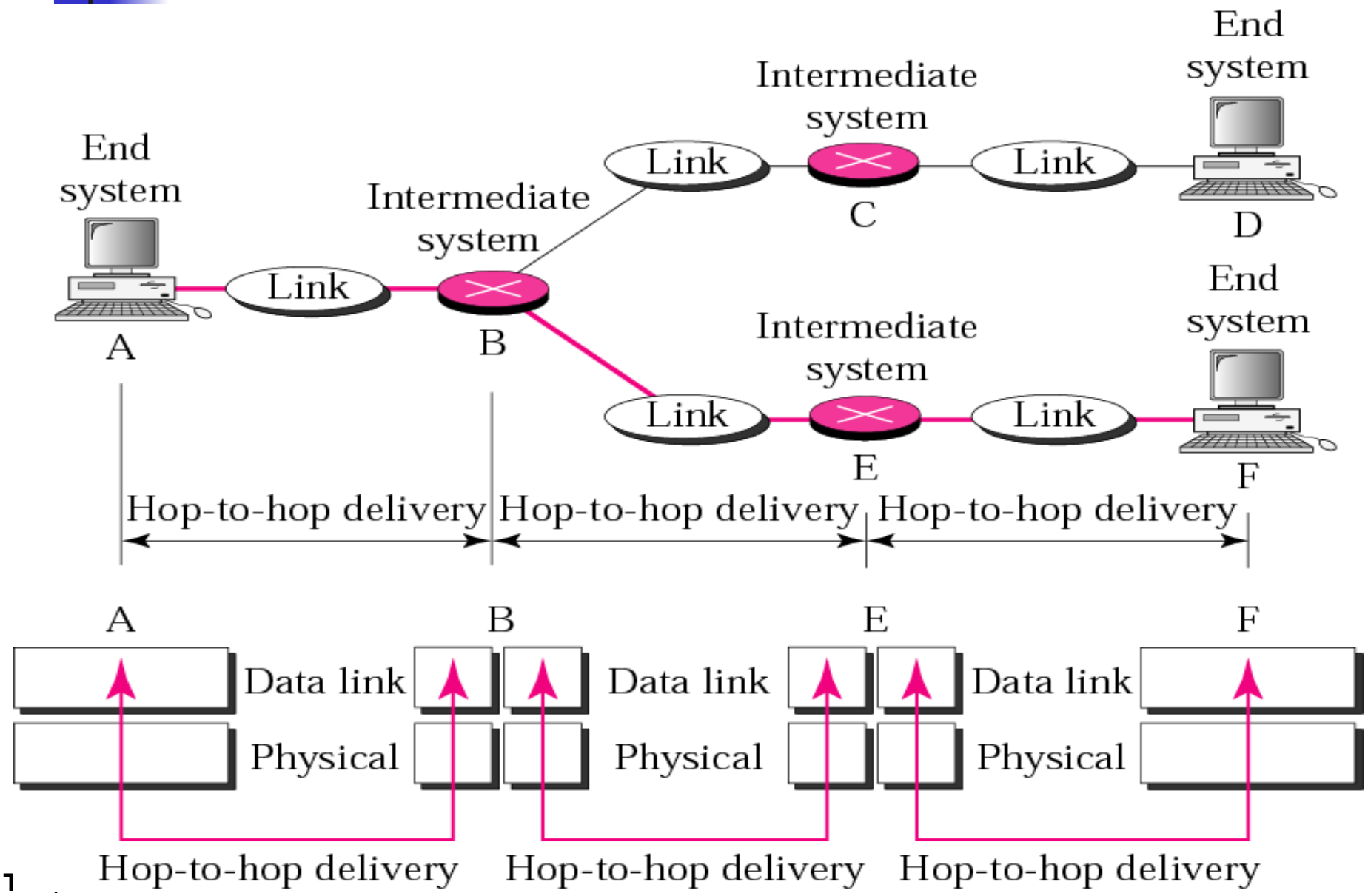
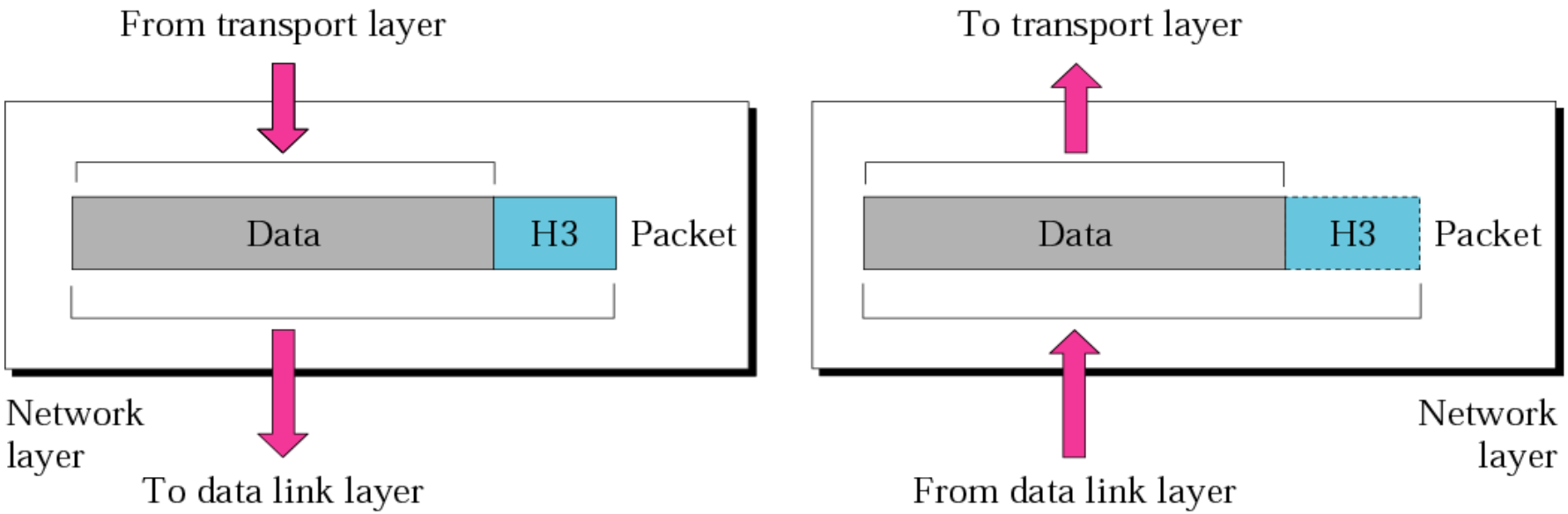


Figure 2.7 *Network layer*



Network Layer

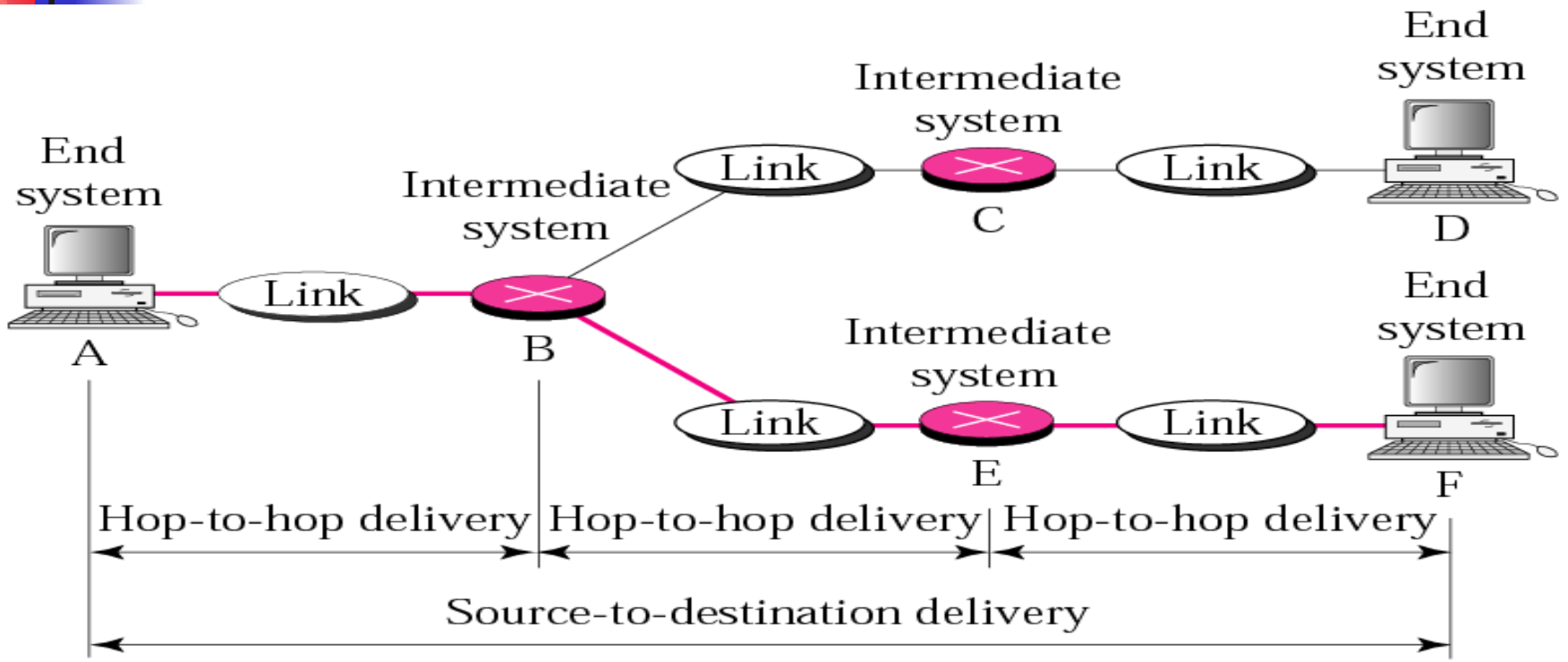
- *Source to destination delivery of packet across multiple networks.*
- *If the same link, no need of network layer.*

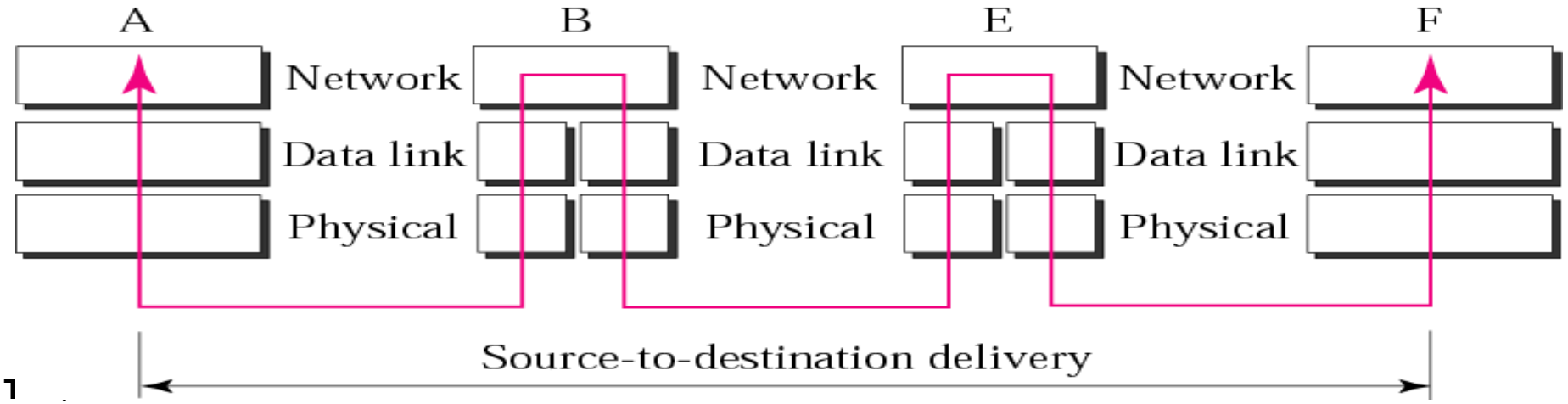
- *Responsibilities of Network Layer*
  - *Logical Addressing*
  - *Routing: connecting devices route or switch to their final destination.*

Note:

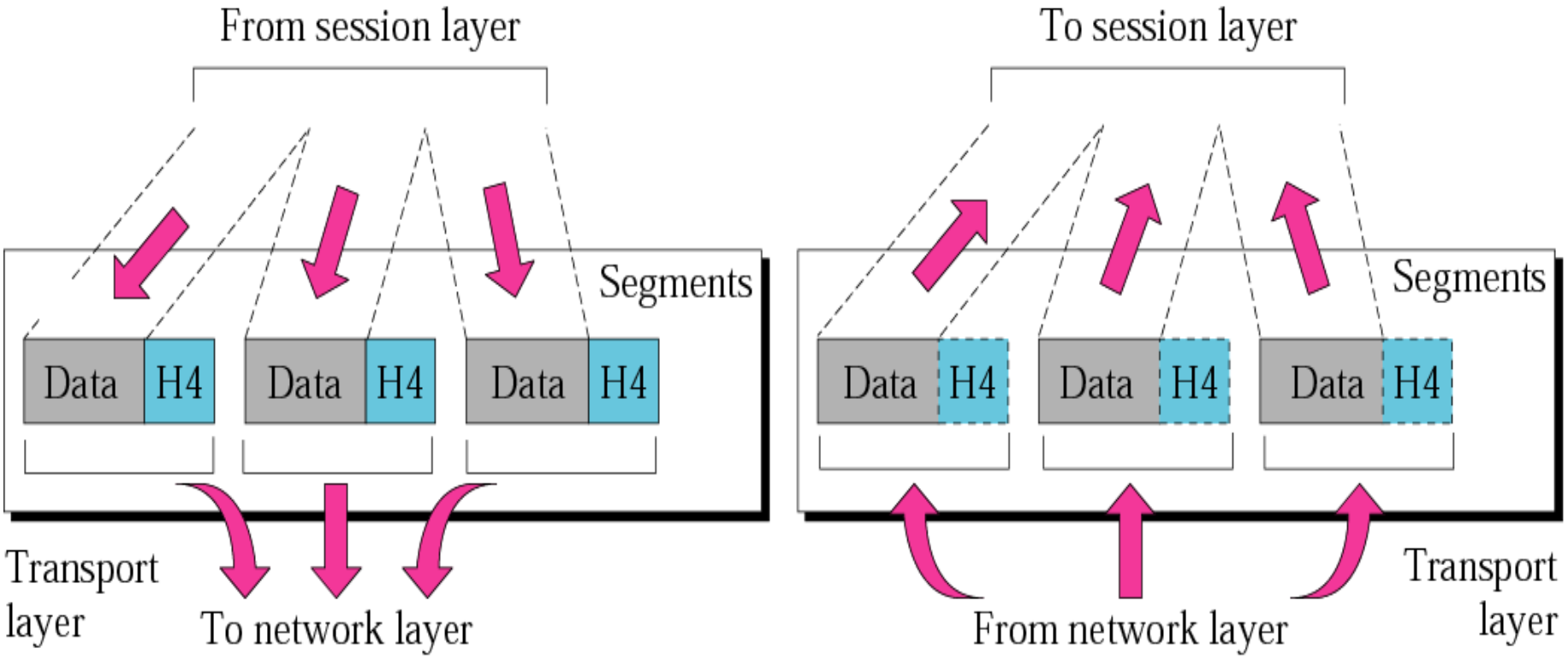
The network layer is responsible for the delivery of individual packets from the source host to the destination host.

Source-to-destination delivery of network layer





Transport layer



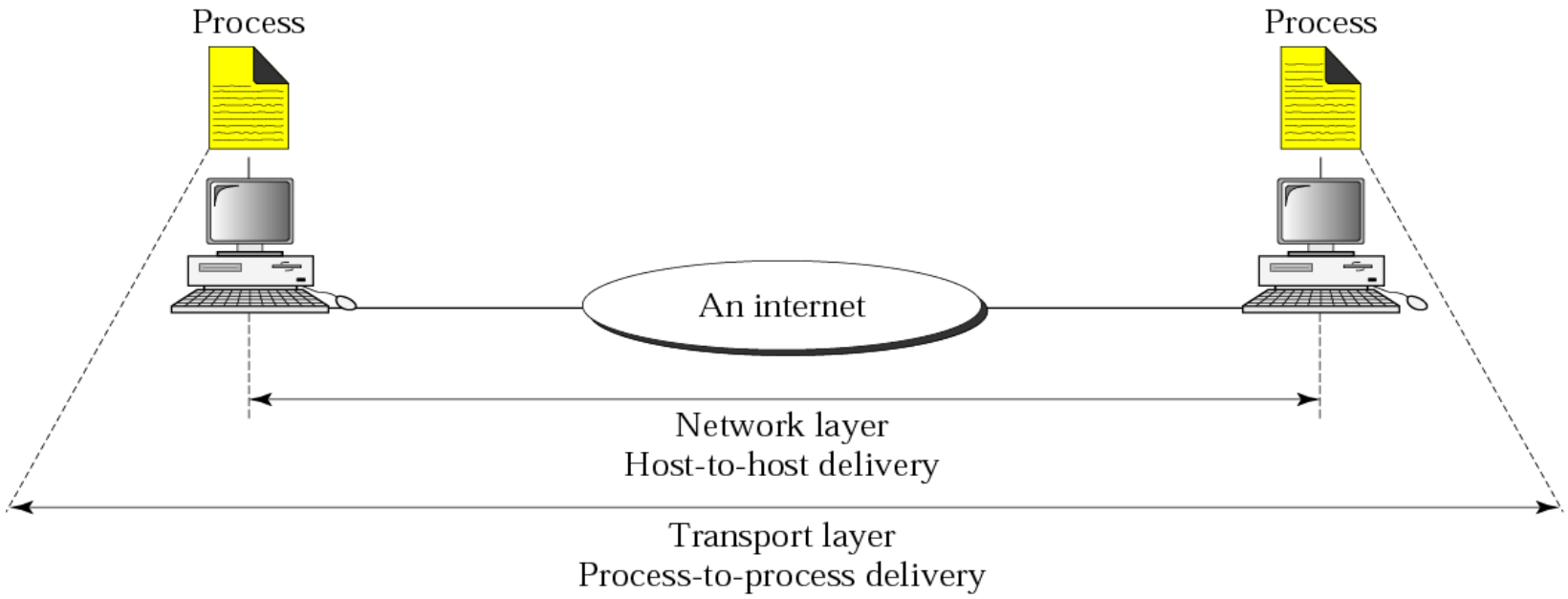
Transport Layer

- *Responsible for process-to-process delivery.*
- *Ensures that whole message arrives intact and in order.*
- *Responsibilities of Transport Layer*
  - *Service Point Addressing :* port addresses
  - *Segmentation and Reassembly: segments with sequence numbers*
  - *Connection Control: Connectionless or connection oriented.*
  - *Flow Control: End to end flow control*
  - *Error Control: process to process, through retransmission.*

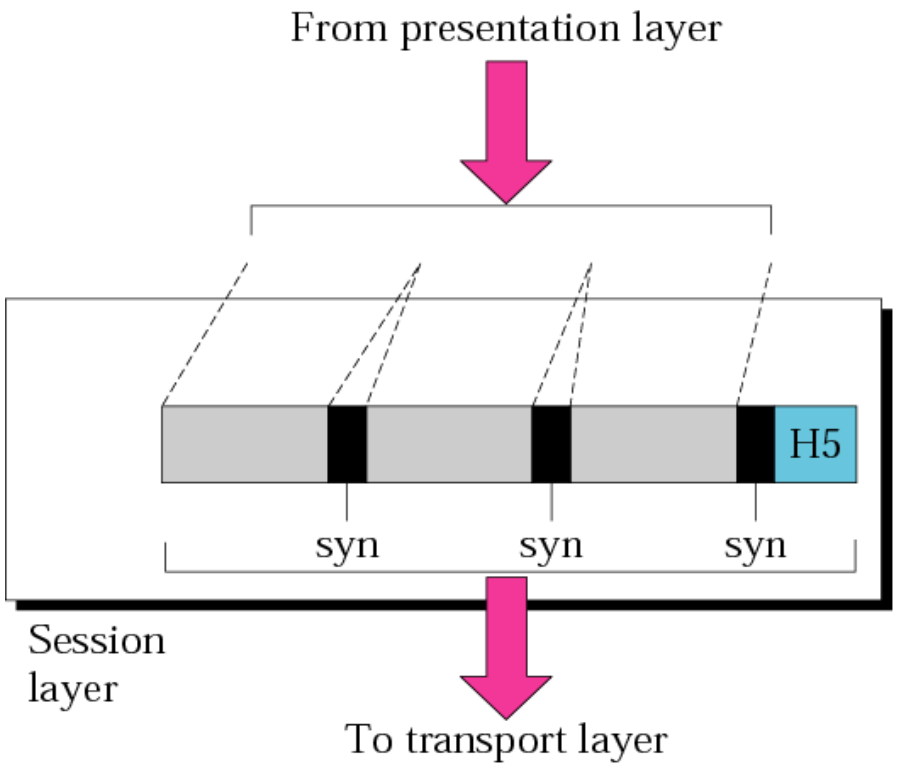
Note:

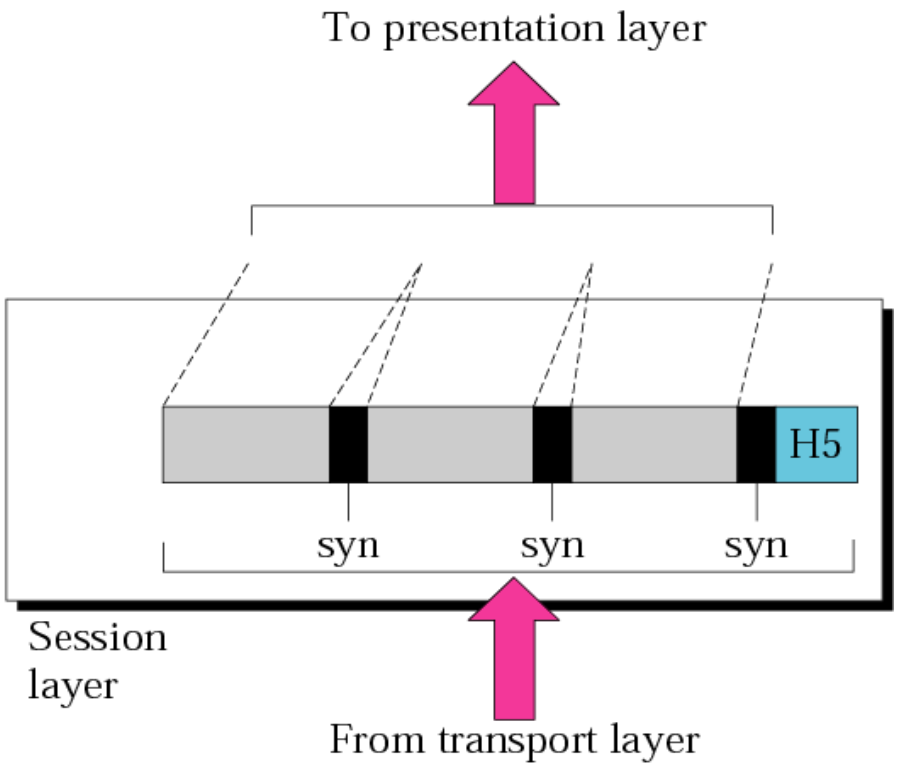
The transport layer is responsible for the delivery of a message from one process to another.

Reliable process-to-process delivery of a message



Session layer



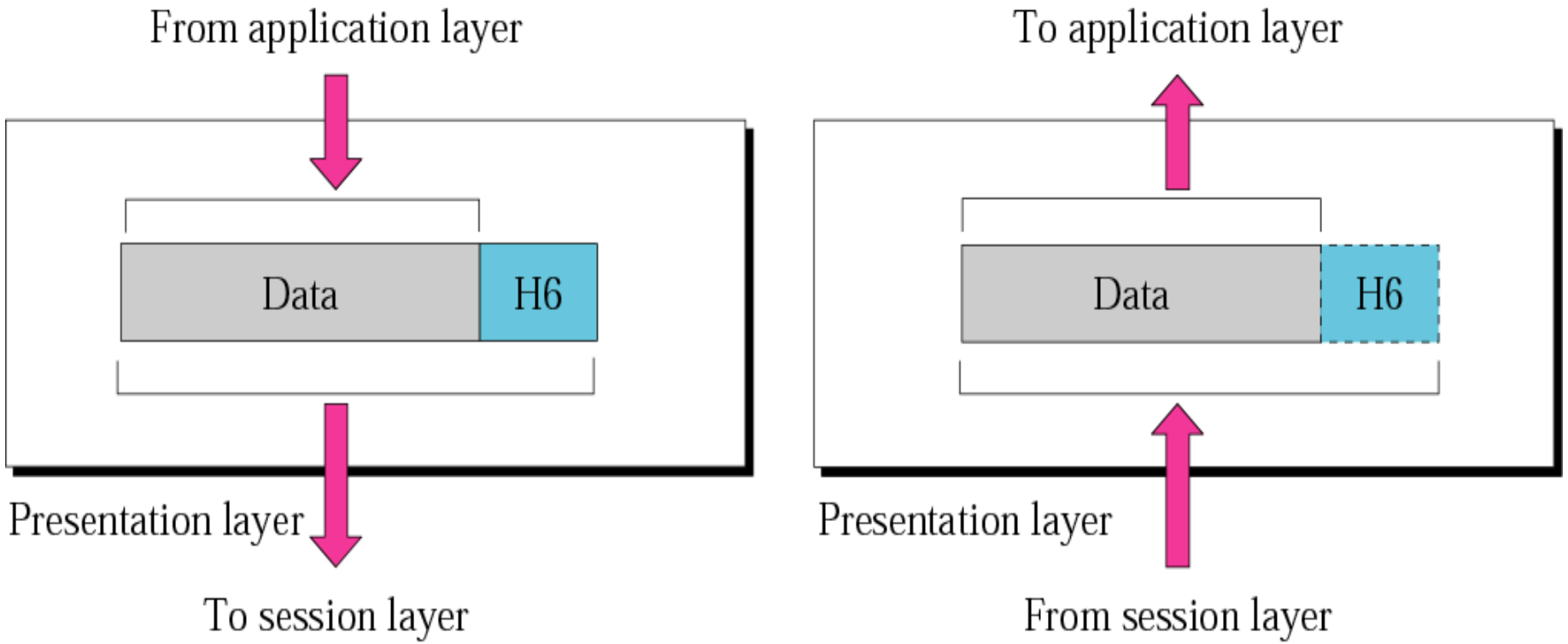


Session Layer

- *Session layer is network dialog controller.*
- *Establishes, maintains and synchronizes interaction between communicating systems.*

- *Responsibilities of Session Layer*
  - *Dialog Control :* allows communication between two processes to take place.
  - *Synchronization: adds checkpoints into the stream of data.*

Presentation layer

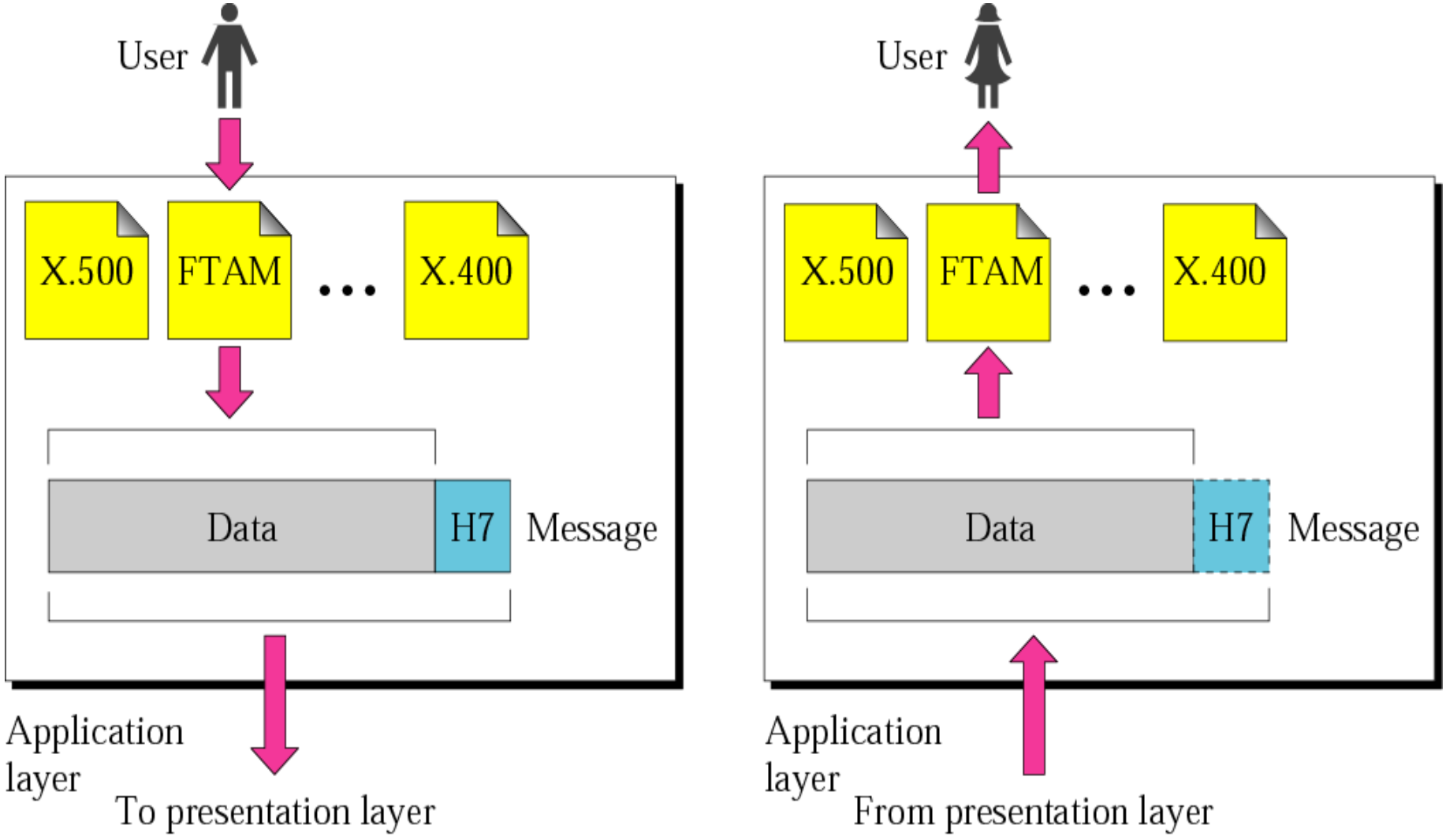


Presentation Layer

- *Concerns with Syntax and Semantics of information exchanged.*

- *Responsibilities of Presentation Layer*
  - *Translation :* translation of data to bits streams, change information from sender dependent to common format.
  - *Encryption:*
  - *Compression:* *important for text, audio, video.*

Application layer

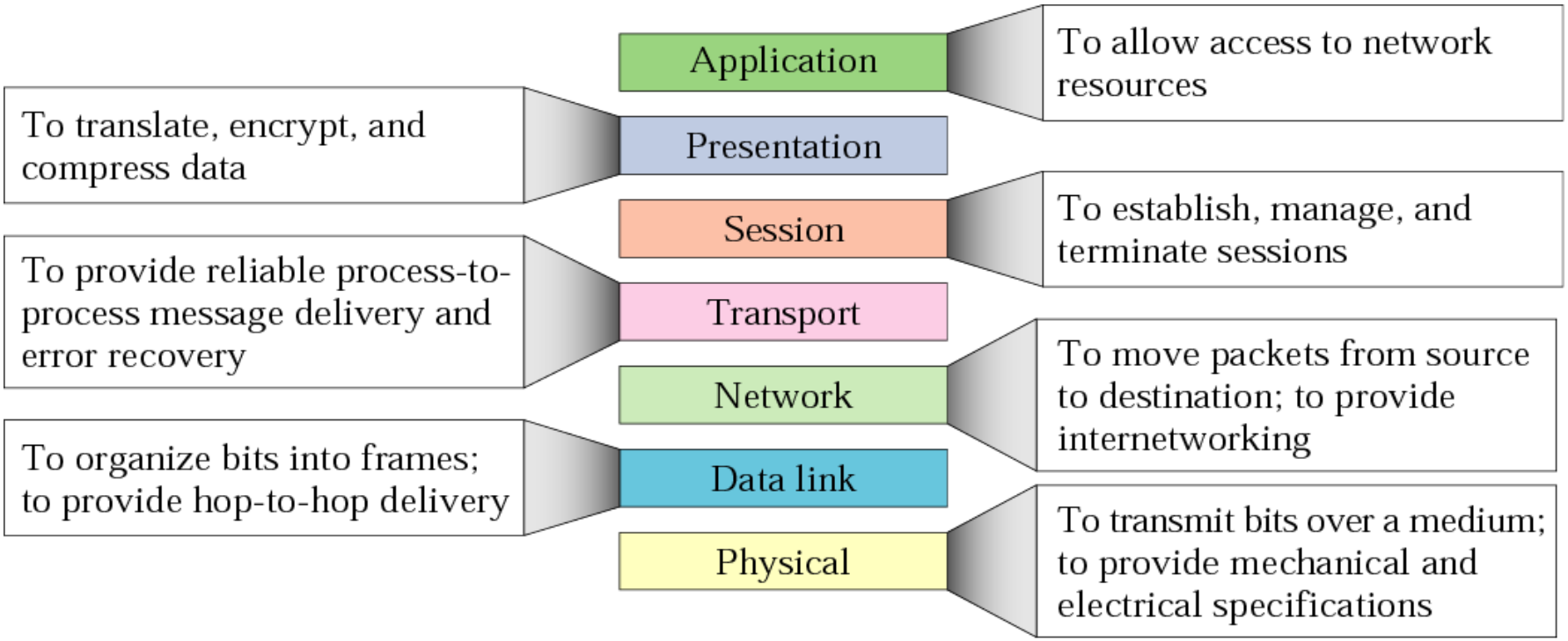


Application Layer

- *Provide user interface and support for services.*

- *Responsibilities of Application Layer*
  - *Network virtual terminal :* allows remote login.
  - *File transfer, access and management (FTAM):* *access files, retrieve files in remote host.*
  - *Mail services: email forwarding and storage.*
  - *Directory services: distributed database sources*

Summary of layers



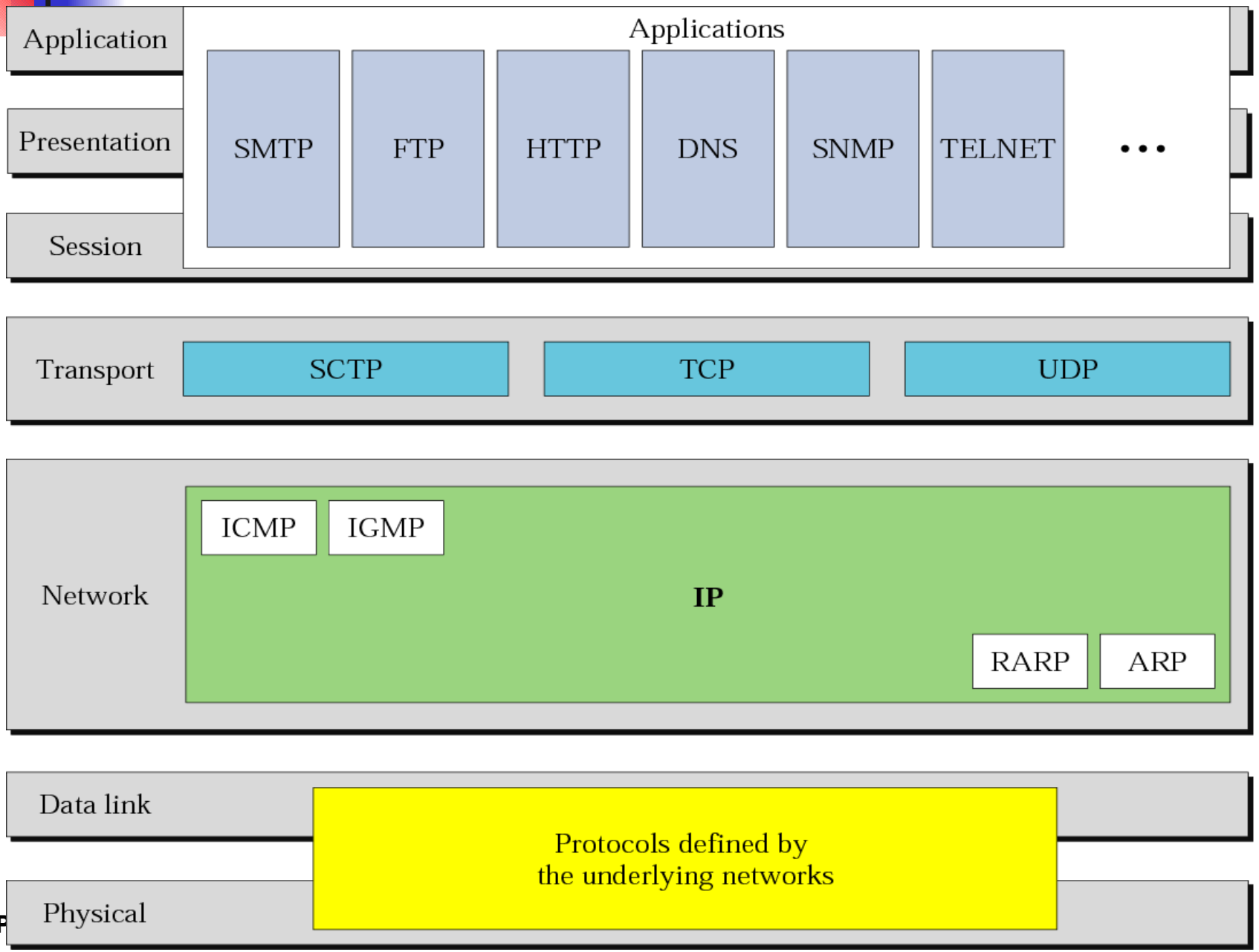
2.3 TCP/IP Protocol Suite

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

TCP/IP and OSI model



Network Layer

- *Internetworking Protocol (IP)*
  - *Best-effort delivery*
  - *Datagram- different routes, out of seq.*
  - *No error checking or tracking*
- *Address Resolution Protocol (ARP)*
  - *Associate IP with Physical address.*
  - *On NIC*
- *Internet Control Message Protocol (ICMP)*
  - *Notification of datagram problems*
  - *Query and error reporting messages*
- *Internet Group Message Protocol (IGMP)*
  - *Simultaneous transmission to group of receipients.*

Transport Layer

- *User datagram Protocol (UDP)*
  - *Adds only port addresses*
  - *Checksum error control*
  - *Length information*
- *Transmission control Protocol (TCP)*
  - *Reliable connection oriented*
  - *Segments with sequence number*
- *Stream control transmission Protocol (SCTP)*
  - *Supports IP telephony*
  - *Combines good features of UDP and TCP.*

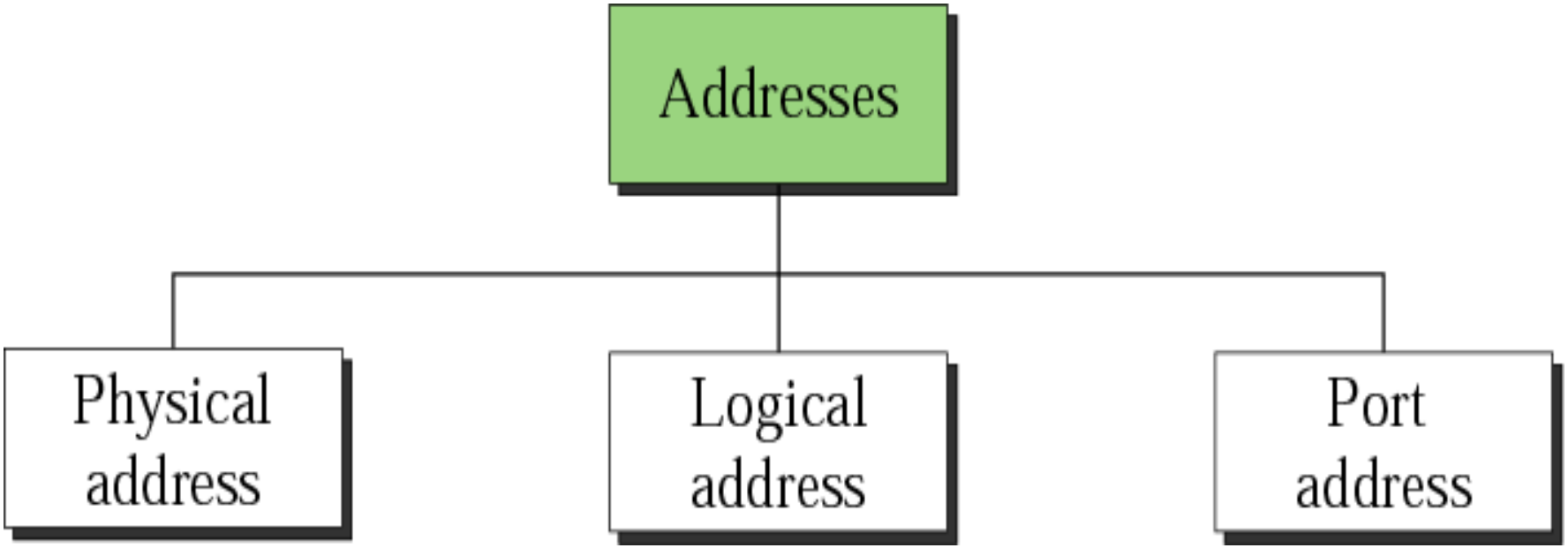
2.4 Addressing

Three different levels of addresses are used in an internet using the TCP/IP protocols: physical (link) address, logical (IP) address, and port address.

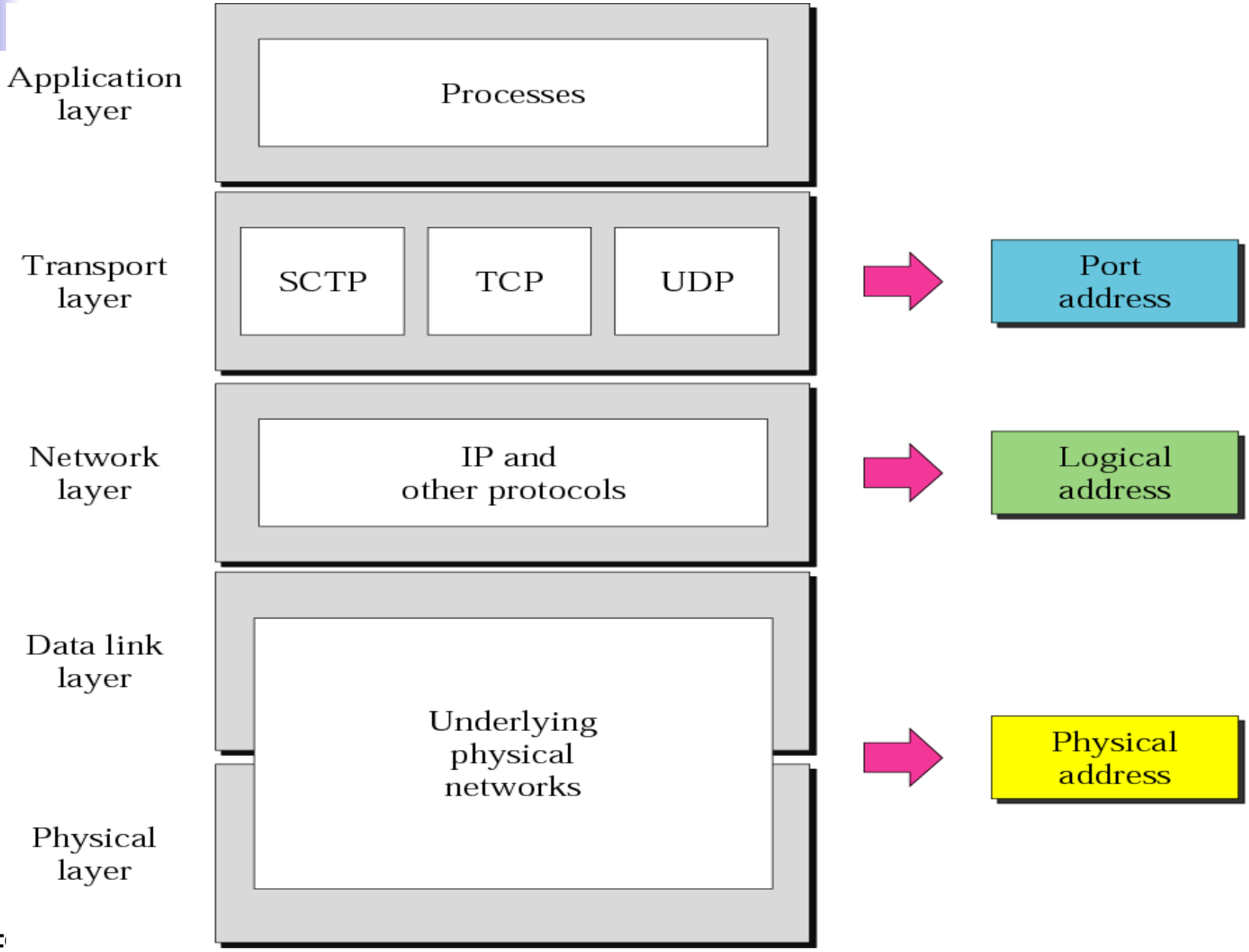
The topics discussed in this section include:

Physical Address
Logical Address
Port Address

Addresses in TCP/IP



Relationship of layers and addresses in TCP/IP

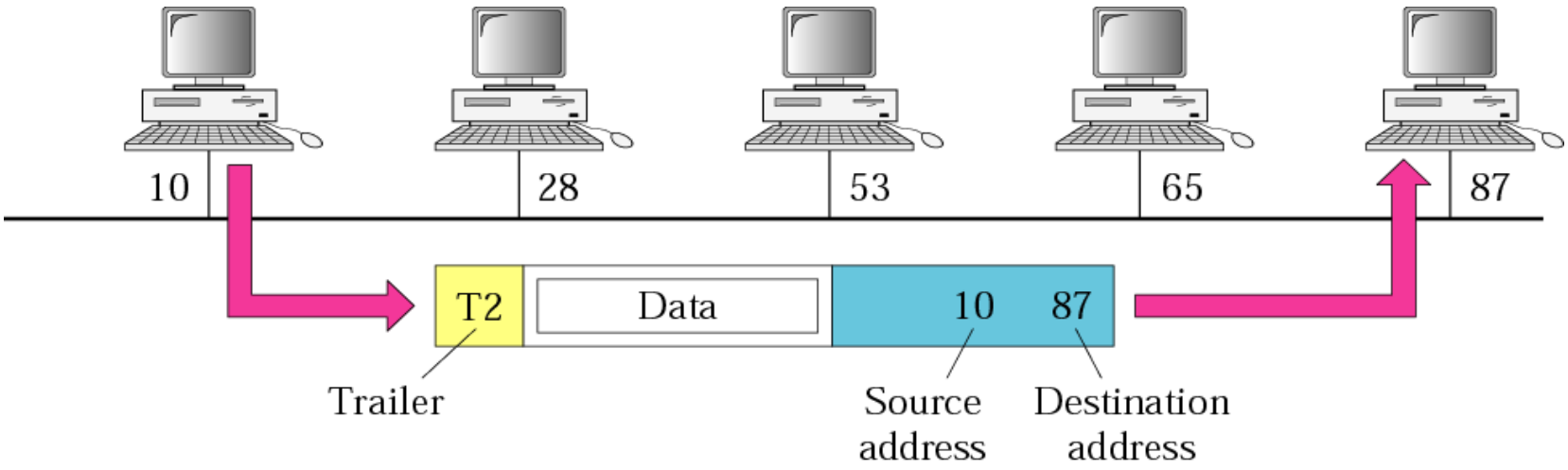


Example 1

In Figure 2.18 a node with physical address 10 sends a frame to a node with physical address 87. The two nodes are connected by a link. At the data link level this frame contains physical (link) addresses in the header. These are the only addresses needed. The rest of the header contains other information needed at this level. The trailer usually contains extra bits needed for error detection.

See Next Slide

Figure 2.18 *Physical addresses*



Example 2

As we will see in Chapter 3, most local area networks use a 48-bit (6 bytes) physical address written as 12 hexadecimal digits, with every 2 bytes separated by a colon as shown below:

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

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

Example 3

In Figure 2.19 we want to send data from a node with network address A and physical address 10, located on one LAN, to a node with a network address P and physical address 95, located on another LAN. Because the two devices are located on different networks, we cannot use link addresses only; the link addresses have only local jurisdiction. What we need here are universal addresses that can pass through the LAN boundaries. The network (logical) addresses have this characteristic.

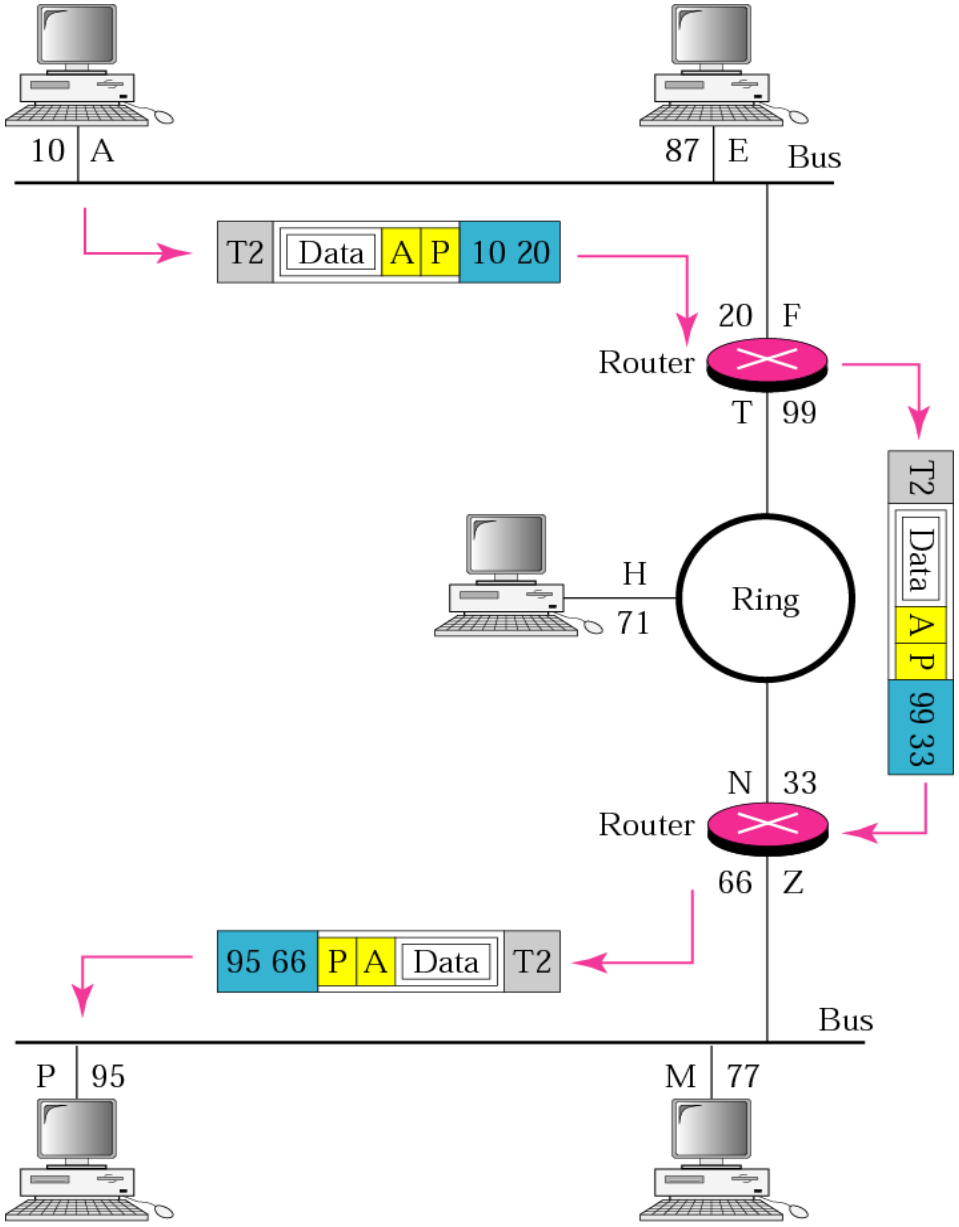
See Next Slide

Example 3 *(Continued)*

The packet at the network layer contains the logical addresses, which remain the same from the original source to the final destination (A and P, respectively, in the figure). They will not change when we go from network to network. However, the physical addresses will change as the packet moves from one network to another. The boxes labeled routers are internetworking devices, which we will discuss in Chapter 3.

See Next Slide

Figure 2.19 *IP addresses*



Example 4

As we will see in Chapter 4, an Internet address (in IPv4) is 32 bits in length, normally written as four decimal numbers, with each number representing 1 byte. The numbers are separated by a dot. Below is an example of such an address.

132.24.75.9

An internet address in IPv4 in decimal numbers

Example 5

Figure 2.20 shows an example of transport layer communication. Data coming from the upperlayers have port addresses j and k (j is the address of the sending process, and k is the address of the receiving process). Since the data size is larger than the network layer can handle, the data are split into two packets, each packet retaining the service-point addresses (j and k). Then in the network layer, network addresses (A and P) are added to each packet.

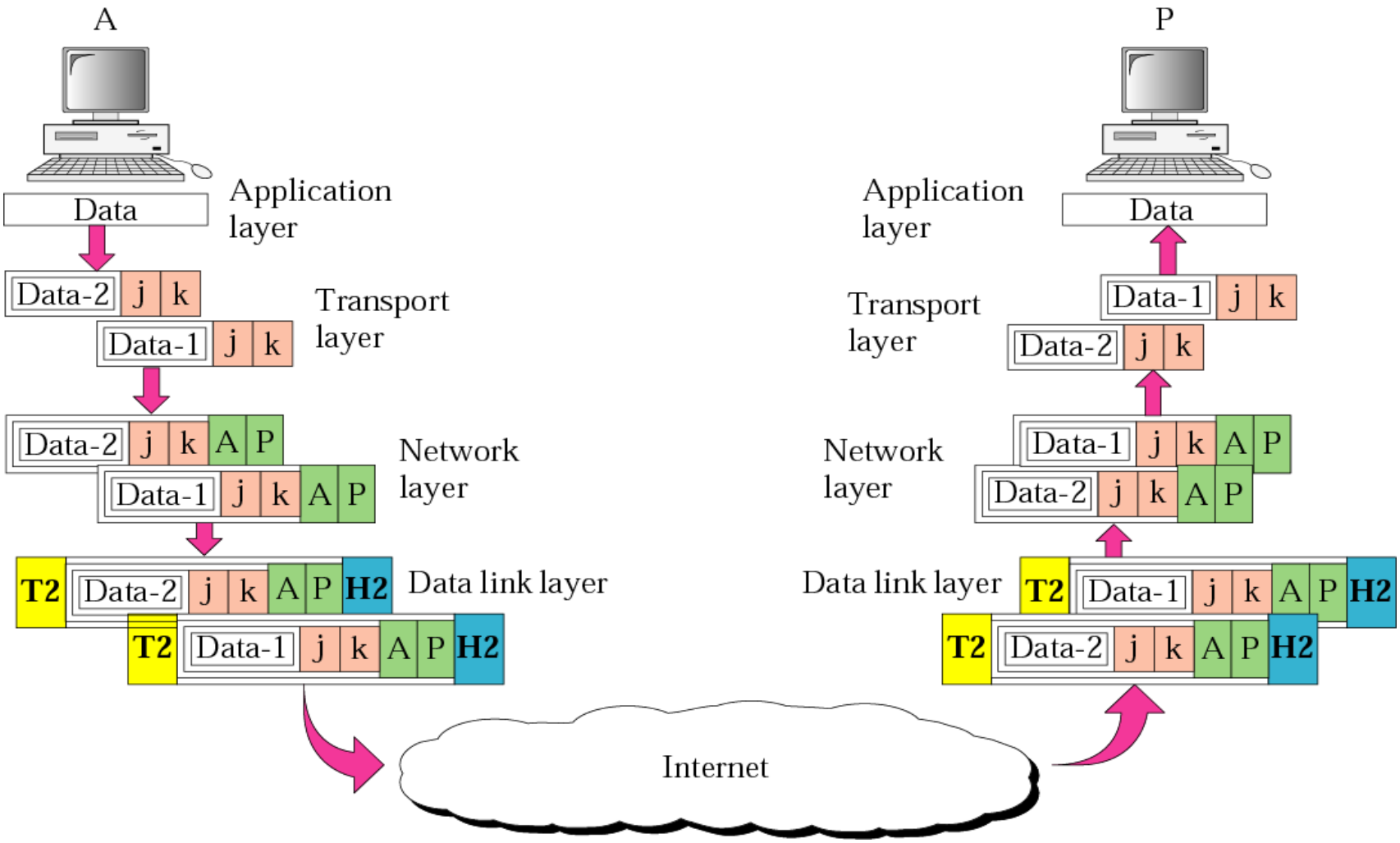
See Next Slide

Example 5 (Continued)

The packets can travel on different paths and arrive at the destination either in order or out of order. The two packets are delivered to the destination transport layer, which is responsible for removing the network layer headers and combining the two pieces of data for delivery to the upper layers.

See Next Slide

Figure 2.20 *Port addresses*



Example 6

As we will see in Chapters 11, 12, and 13, a port address is a 16-bit address represented by one decimal number as shown below.

753

A 16-bit port address represented as one single number.

2.5 IP Versions

IP became the official protocol for the Internet in 1983. As the Internet has evolved, so has IP. There have been six versions since its inception. We look at the latter three versions here.

The topics discussed in this section include:

Version 4
Version 5
Version 6