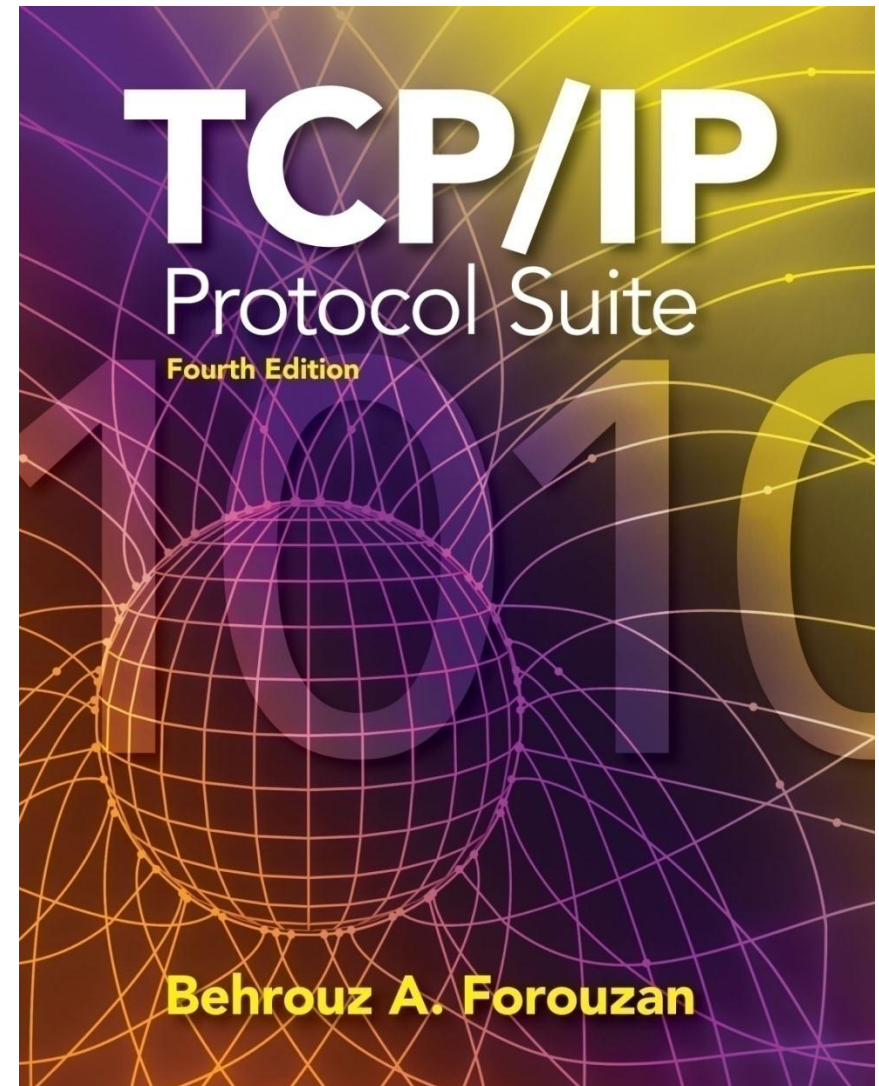


# The OSI Model and the TCP/IP Protocol Suite



# OBJECTIVES:

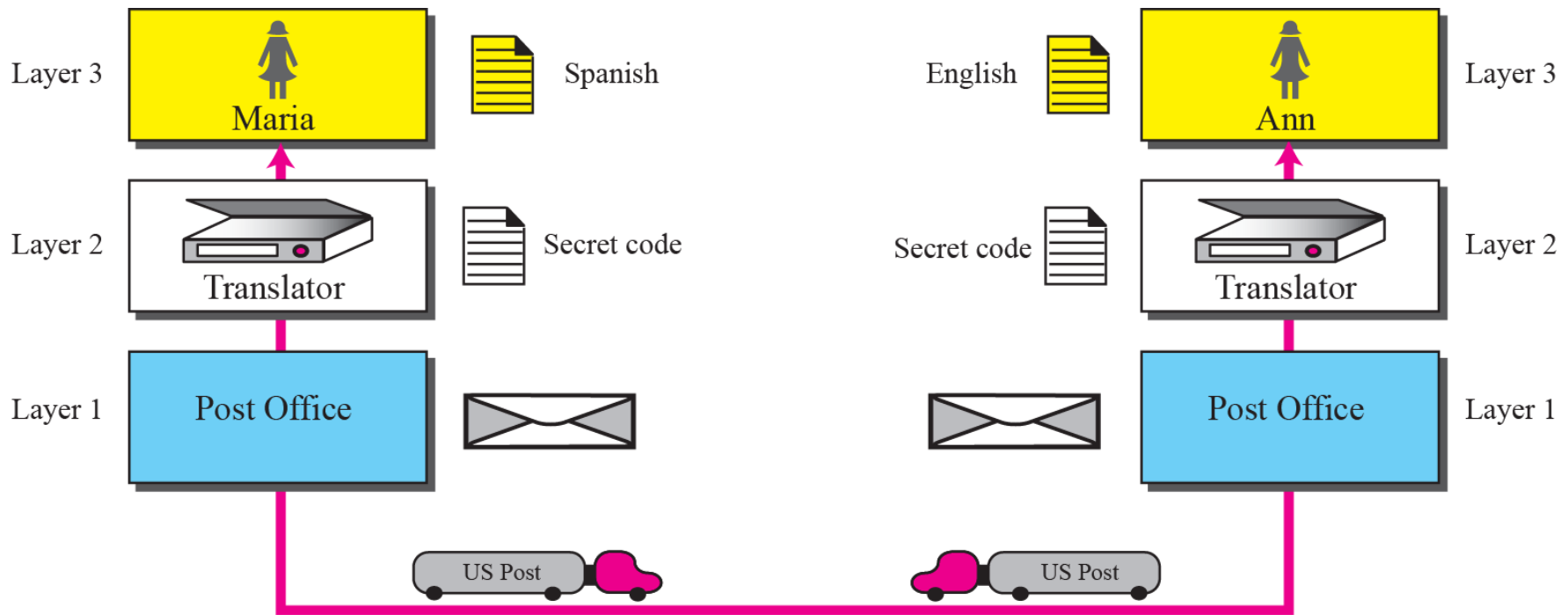
- ❑ **To discuss the idea of multiple layering in data communication and networking and the interrelationship between layers.**
- ❑ **To discuss the OSI model and its layer architecture and to show the interface between the layers.**
- ❑ **To briefly discuss the functions of each layer in the OSI model.**
- ❑ **To introduce the TCP/IP protocol suite and compare its layers with the ones in the OSI model.**
- ❑ **To show the functionality of each layer in the TCP/IP protocol with some examples.**
- ❑ **To discuss the addressing mechanism used in some layers of the TCP/IP protocol suite for the delivery of a message from the source to the destination.**

## *Example*



Assume Maria and Ann are neighbors with a lot of common ideas. However, Maria speaks only Spanish, and Ann speaks only English. Since both have learned the sign language in their childhood, they enjoy meeting in a cafe a couple of days per week and exchange their ideas using signs. Occasionally, they also use a bilingual dictionary. Communication is face to face and Happens in one layer as shown in Fig.

## Example



Now assume that Ann has to move to another town because of her job. Before she moves, the two meet for the last time in the same cafe. Although both are sad, Maria surprises Ann when she opens a packet that contains two small machines. The first machine can scan and transform a letter in English to a secret code or vice versa. The other machine can scan and translate a letter in Spanish to the same secret code or vice versa. Ann takes the first machine; Maria keeps the second one. The two friends can still communicate using the secret code, as shown in Fig.

# THE OSI MODEL

Established in 1947, the *International Standards Organization (ISO)* is a multinational body dedicated to worldwide agreement on international standards. Almost three-fourths of countries in the world are represented in the ISO. 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.

# *Topics Discussed in the Section*

- ✓ **Layered Architecture**
- ✓ **Layer-to-layer Communication**
- ✓ **Encapsulation**
- ✓ **Layers in the OSI Model**



*Note*

***ISO is the organization;  
OSI is the model.***



## *The OSI model*

Layer 7 Application

Layer 6 **Presentation**

Layer 5 **Session**

Layer 4 Transport

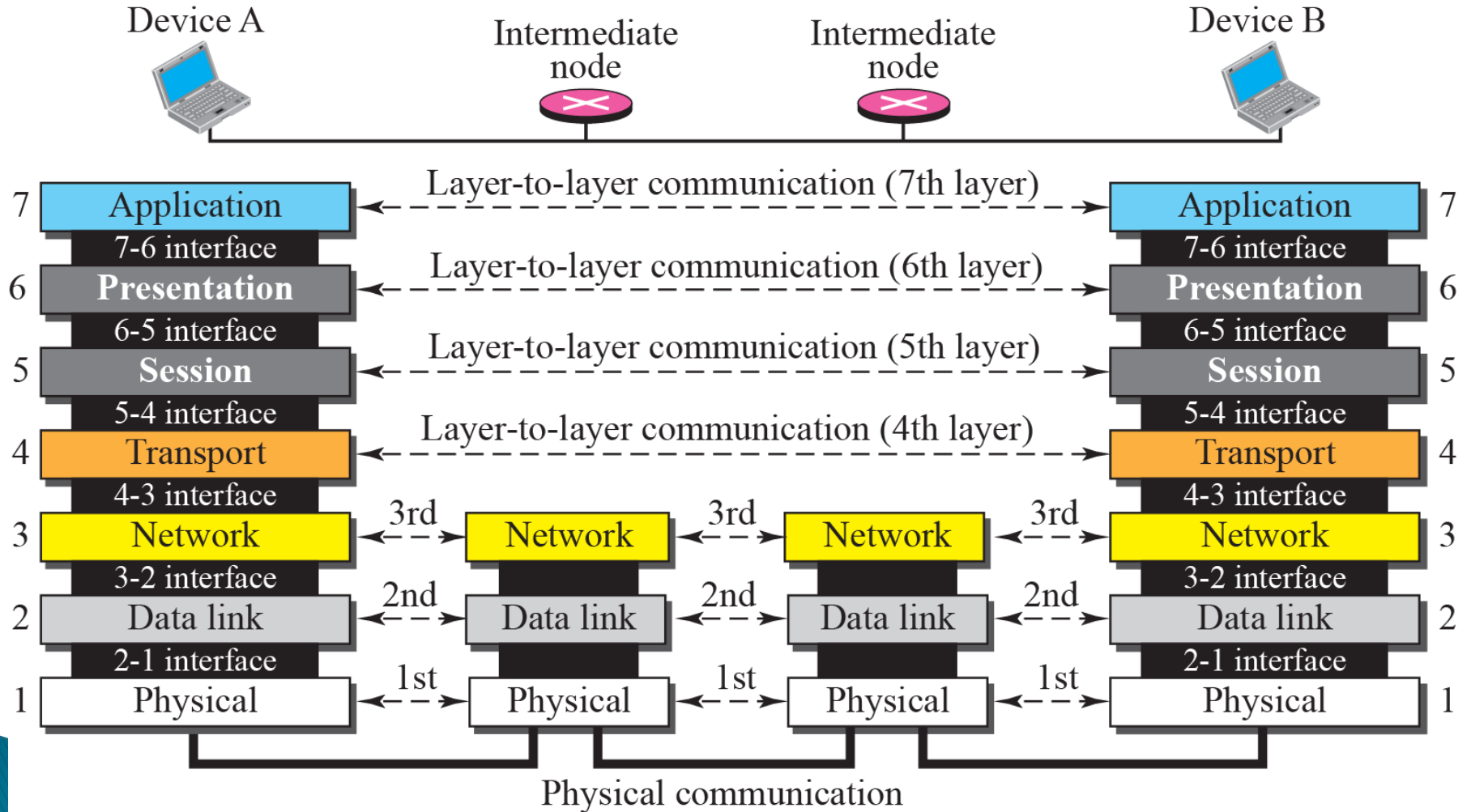
Layer 3 Network

Layer 2 Data link

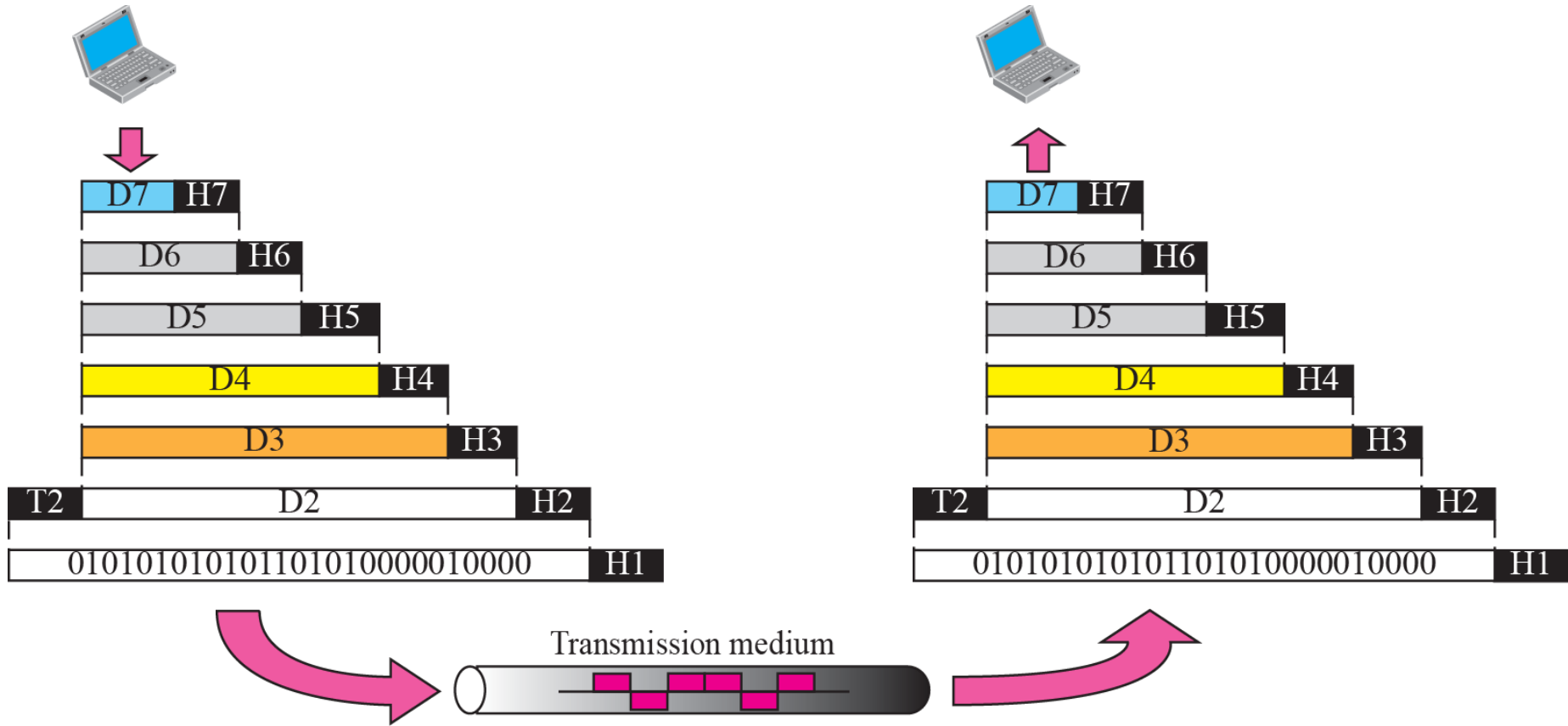
Layer 1 Physical



# OSI layers



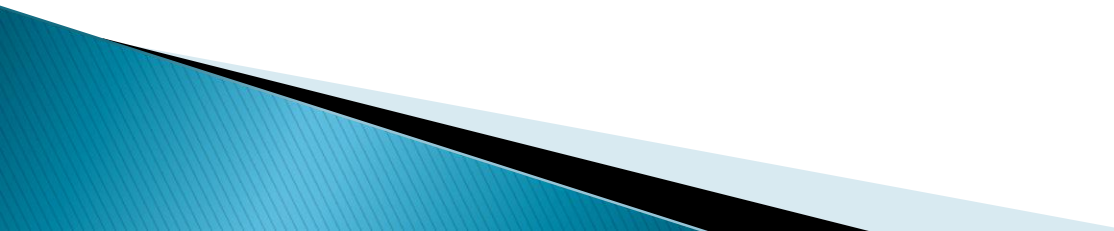
# An exchange using the OSI model





*Note*

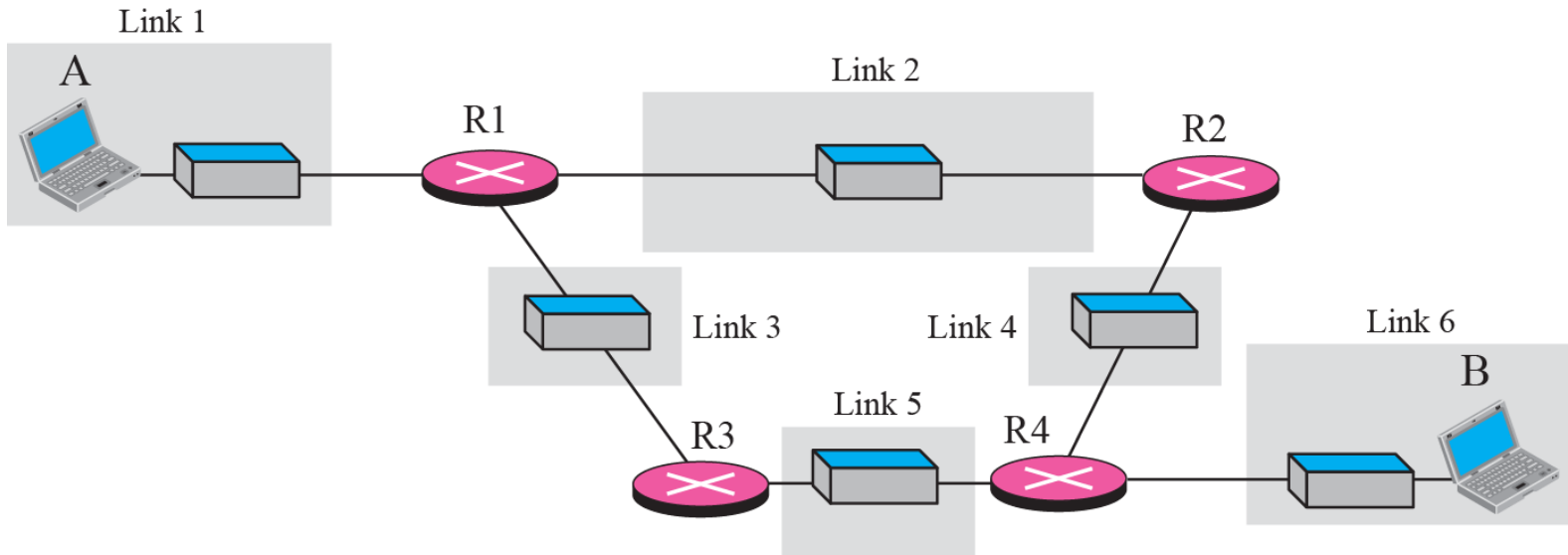
*The physical layer is responsible for moving individual bits from one (node) to the next.*



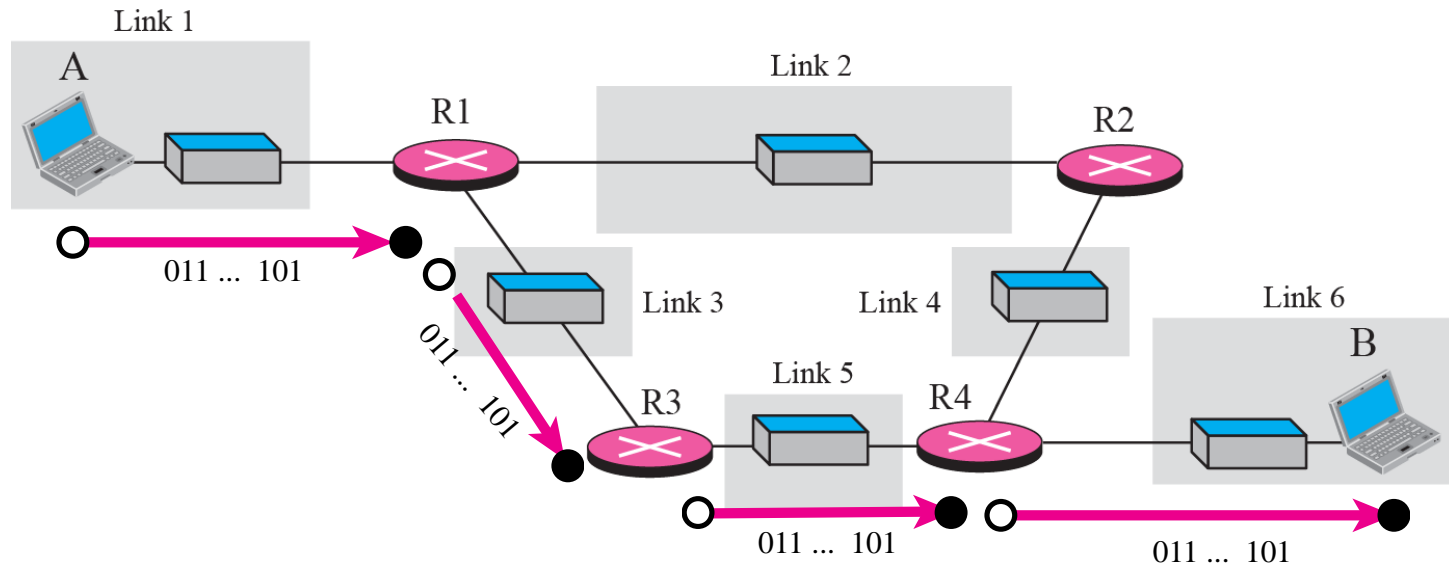
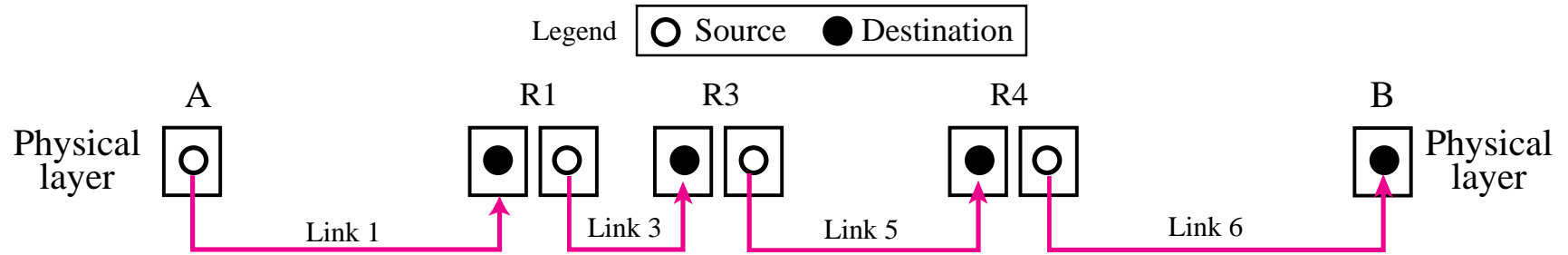
## Summary of OSI Layers

Application	To allow access to network resources	7
Presentation	To translate, encrypt, and compress data	6
Session	To establish, manage, and terminate sessions	5
Transport	To provide reliable process-to-process message delivery and error recovery	4
Network	To move packets from source to destination; to provide internetworking	3
Data link	To organize bits into frames; to provide hop-to-hop delivery	2
Physical	To transmit bits over a medium; to provide mechanical and electrical specifications	1

# A private internet



# Communication at the physical layer





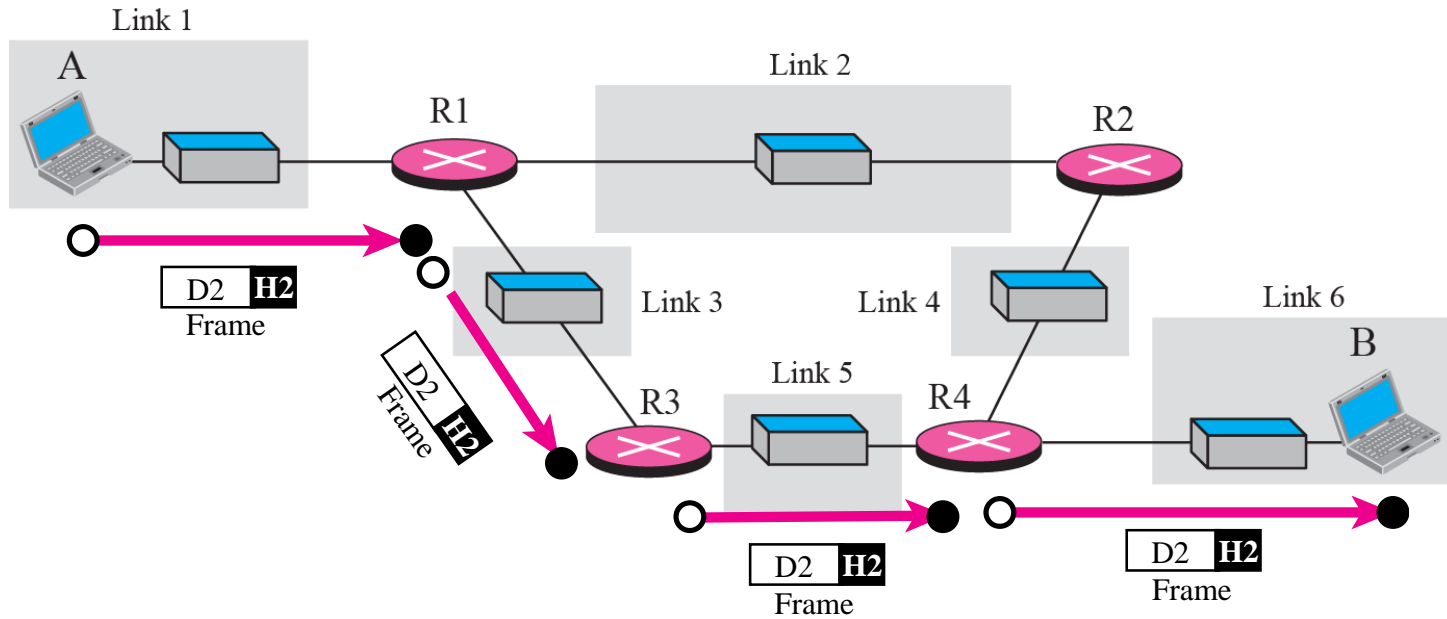
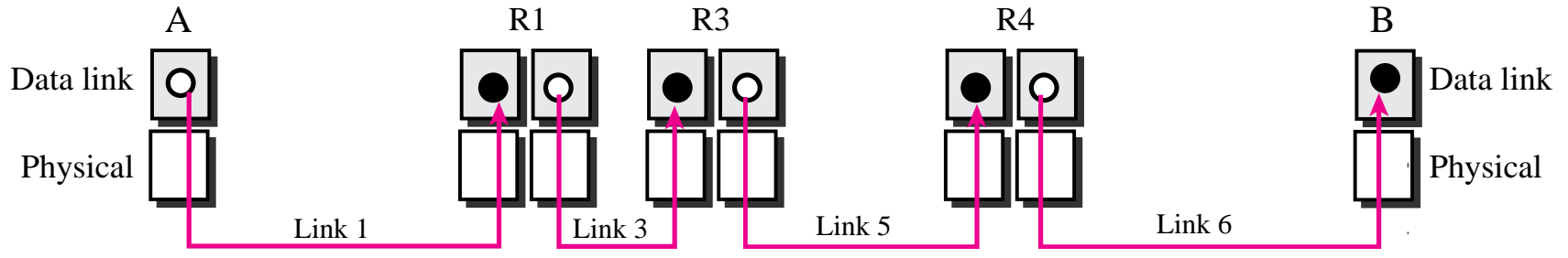
*Note*

***The unit of communication at the physical layer is a bit.***



# Communication at the data link layer

Legend ○ Source ● Destination D Data H Header







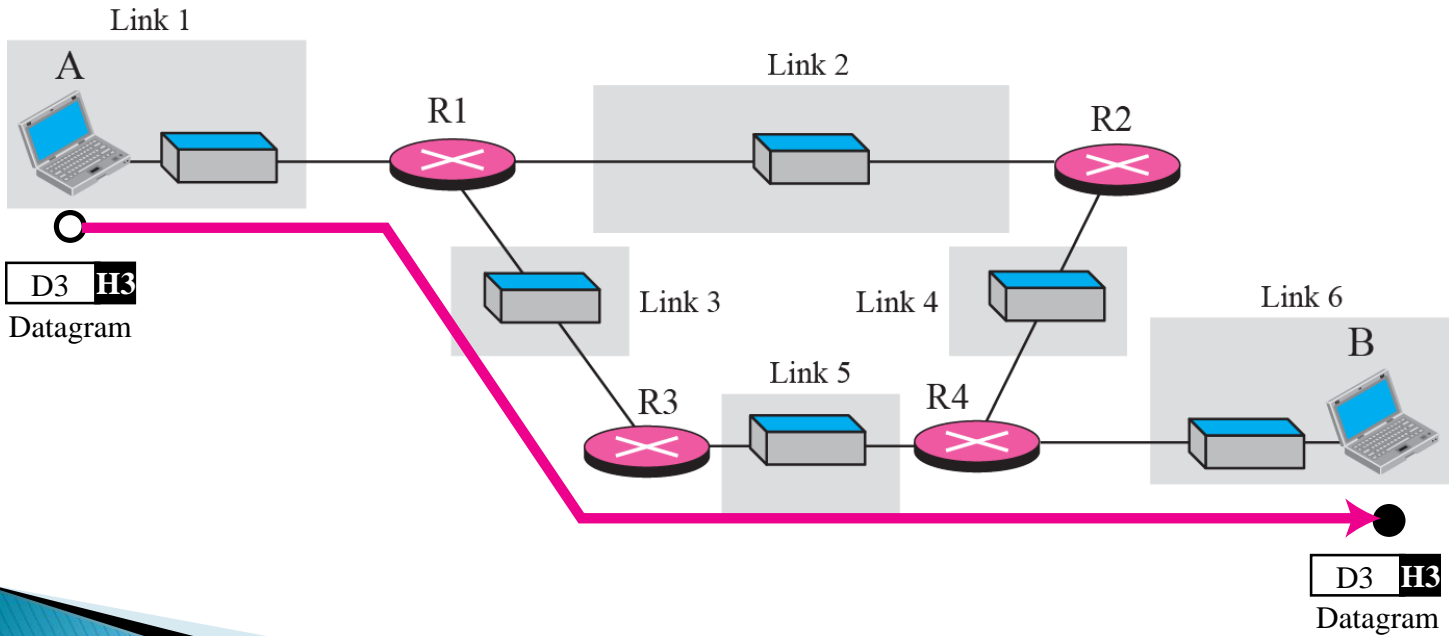
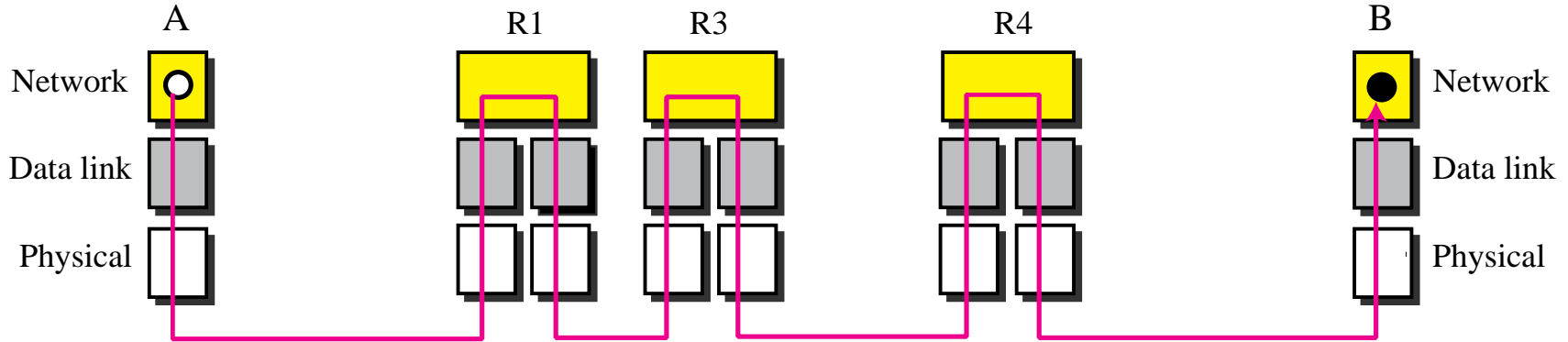
*Note*

***The unit of communication at the data link layer is a frame.***



# Communication at the network layer

Legend ○ Source ● Destination D Data H Header



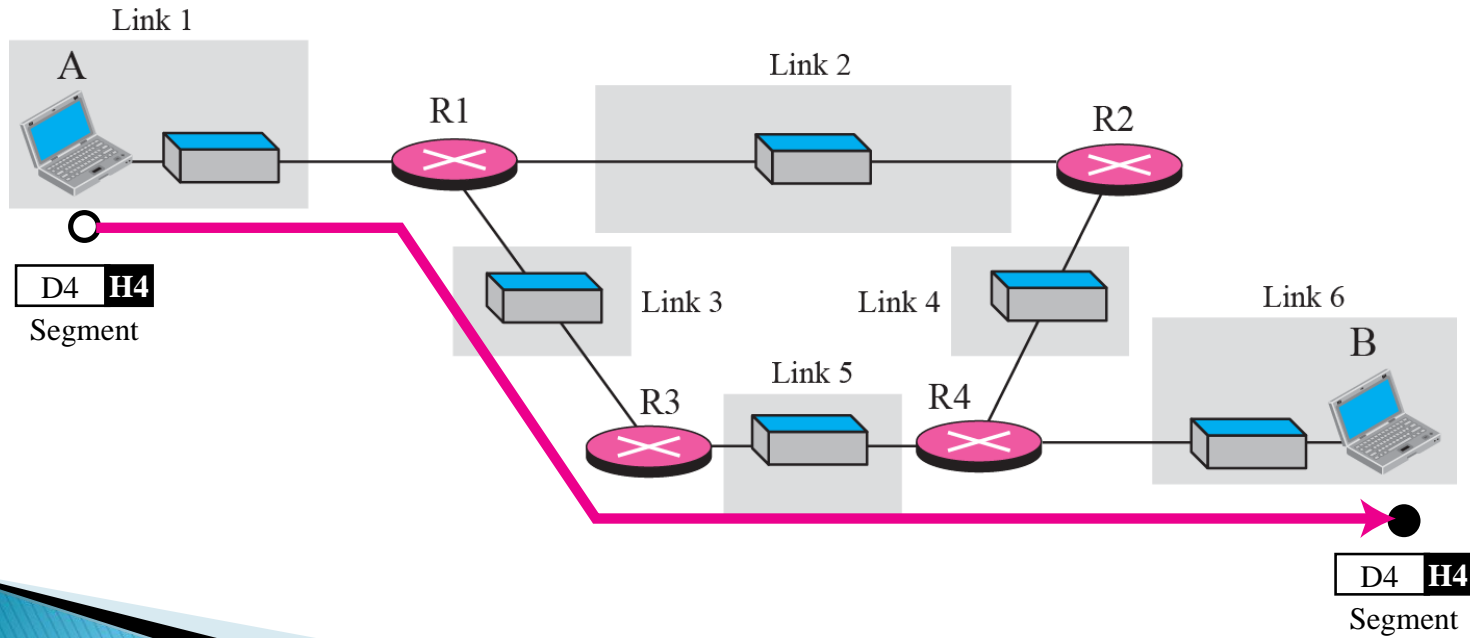
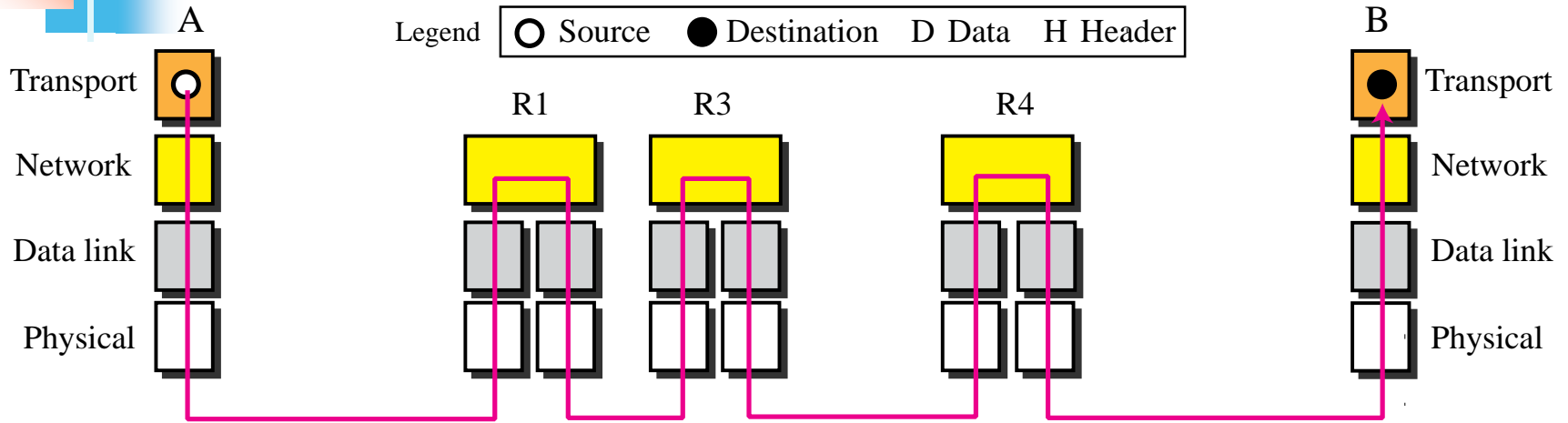


*Note*

***The unit of communication at the network layer is a datagram.***



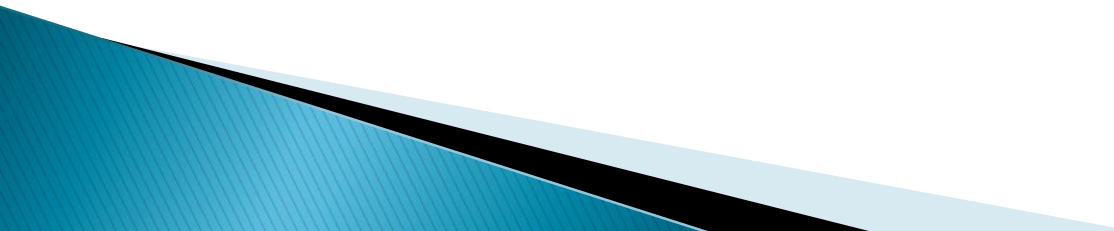
# Communication at transport layer



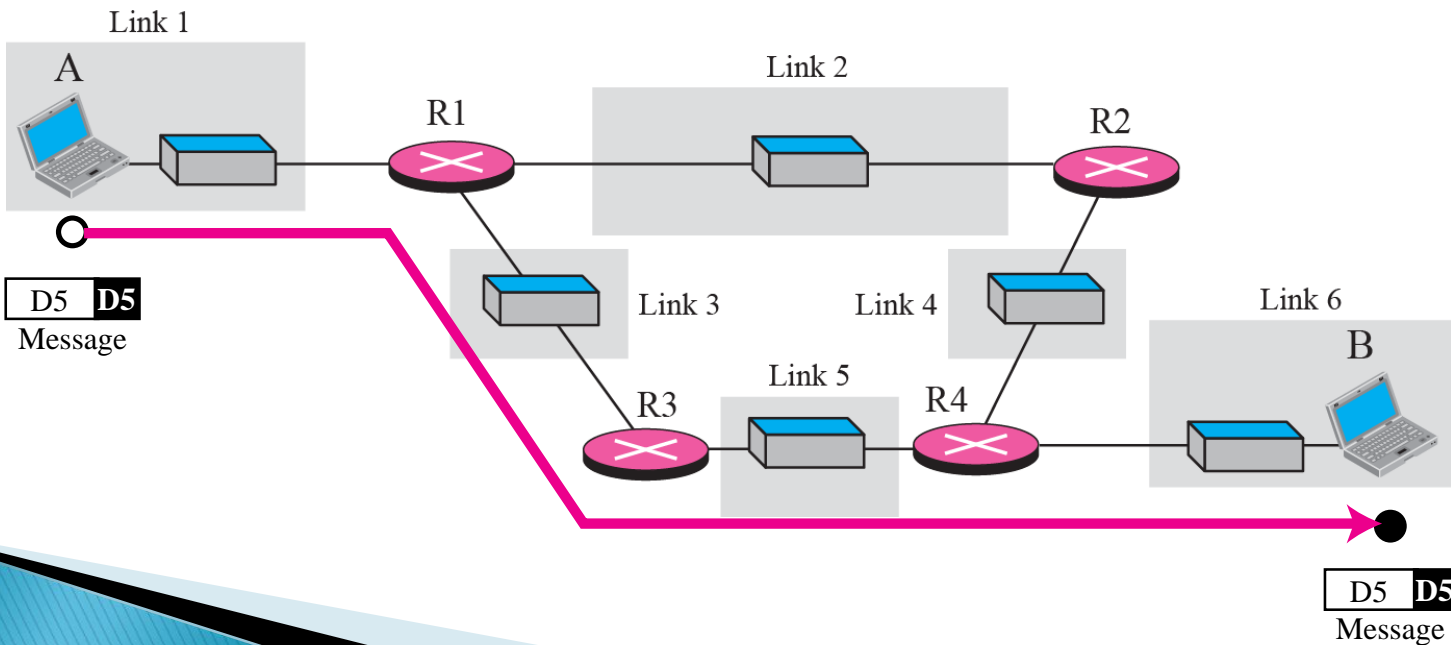
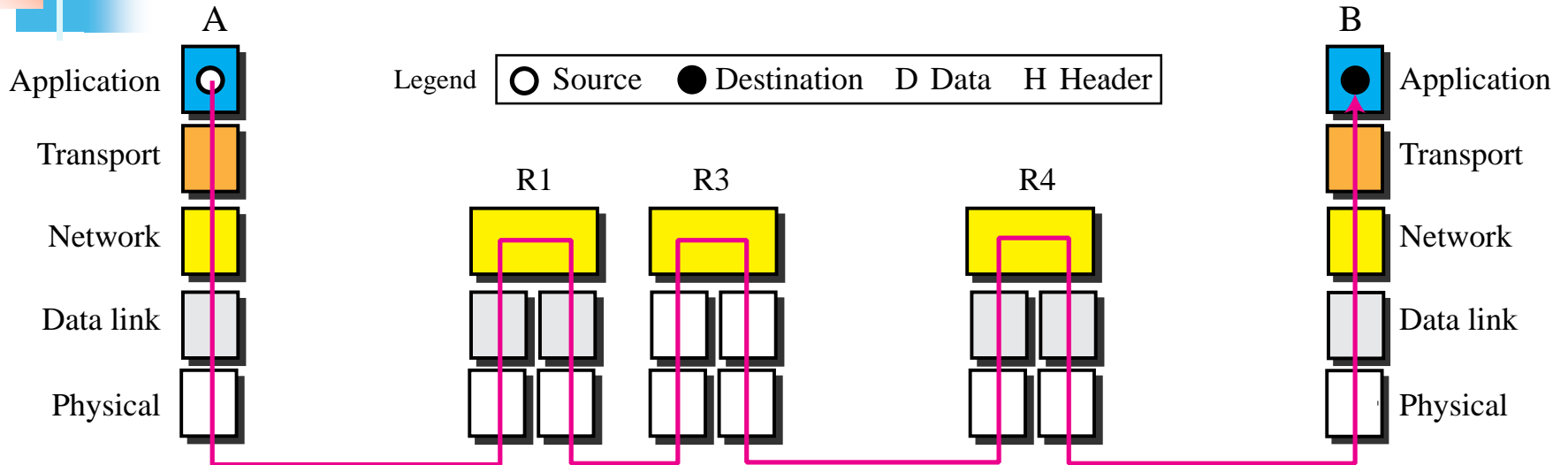


*Note*

***The unit of communication at the transport layer is a segment, user datagram, or a packet, depending on the specific protocol used in this layer.***



# Communication at application layer





*Note*

***The unit of communication at the application layer is a message.***

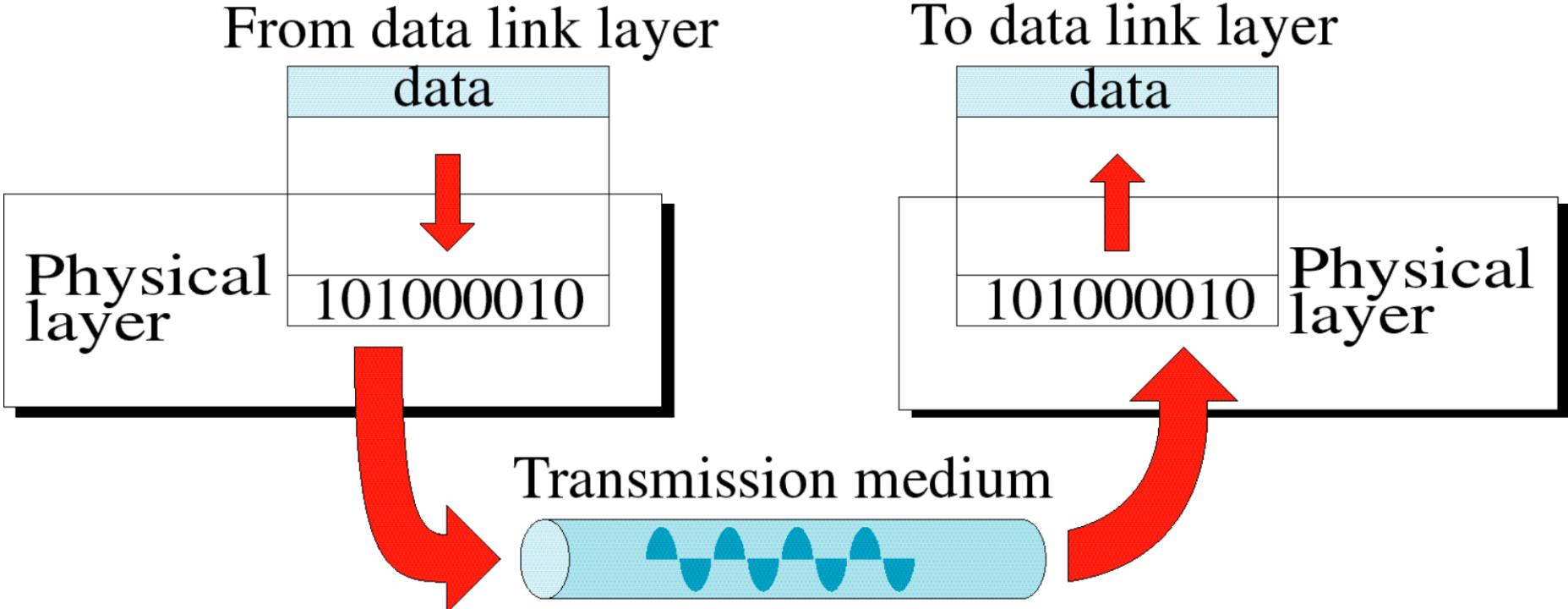


# Physical Layer

- Responsible for movement of data from one node to another node.
- Concerned with
  - Physical Characteristics of the medium
  - Representation of bits– Electrical, Electromagnetic, Optical
  - Data rate
  - Line Configuration
  - Synchronization
  - Physical Topology
  - Transmission Mode– Simplex, Duplex, Half Duplex



# Physical Layer

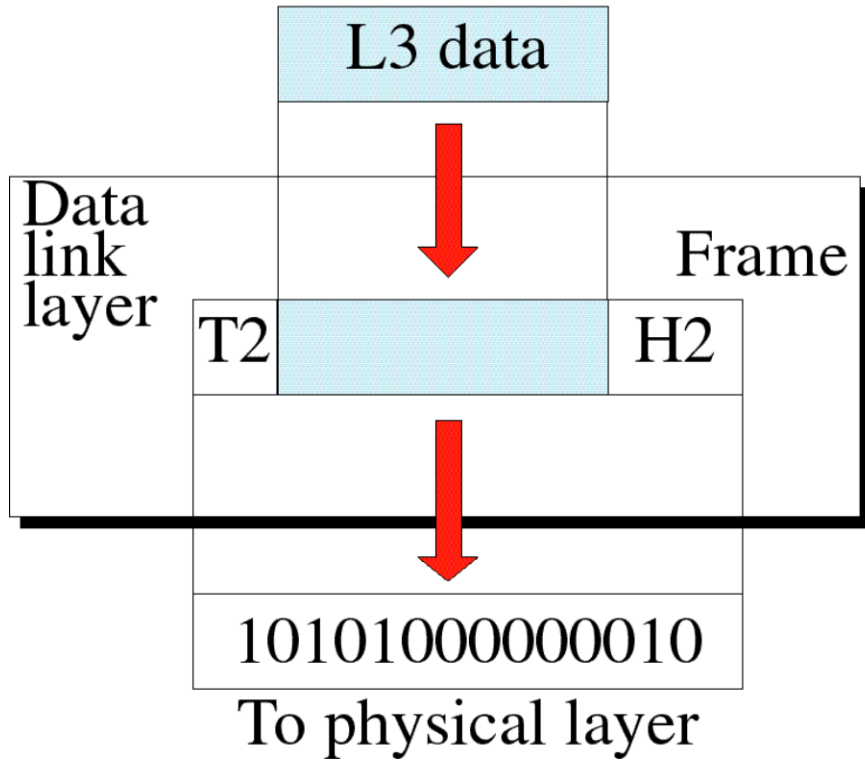


# Data Link Layer

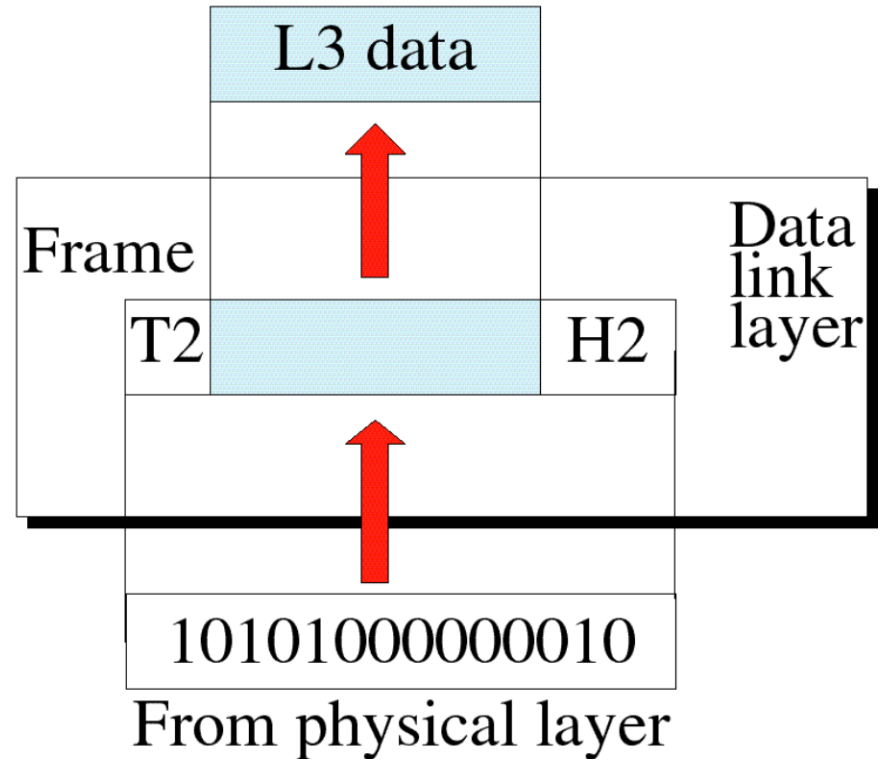
- ▶ Responsible for moving frames from one node to the other– Next hop delivery
- ▶ Framing– divides the data from N/W layer into frames
- ▶ Physical Addressing– Sender and Rx if the Rx is within the N/W, otherwise next hop addressing.
- ▶ Data Flow Control on the sender
- ▶ Error detection/control with the use of trailer
- ▶ Access control– in case of Multi Link system

# Data Link Layer

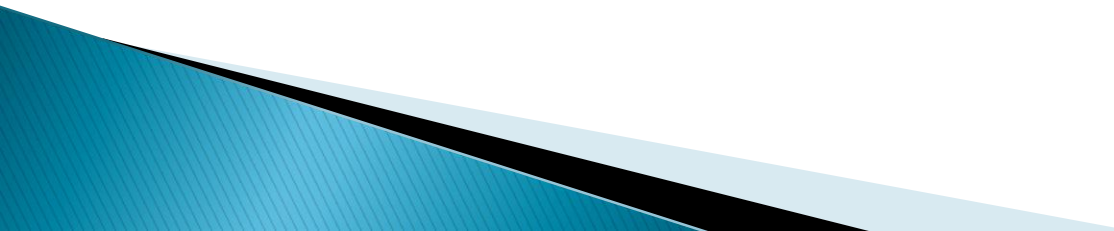
From network layer



To network layer

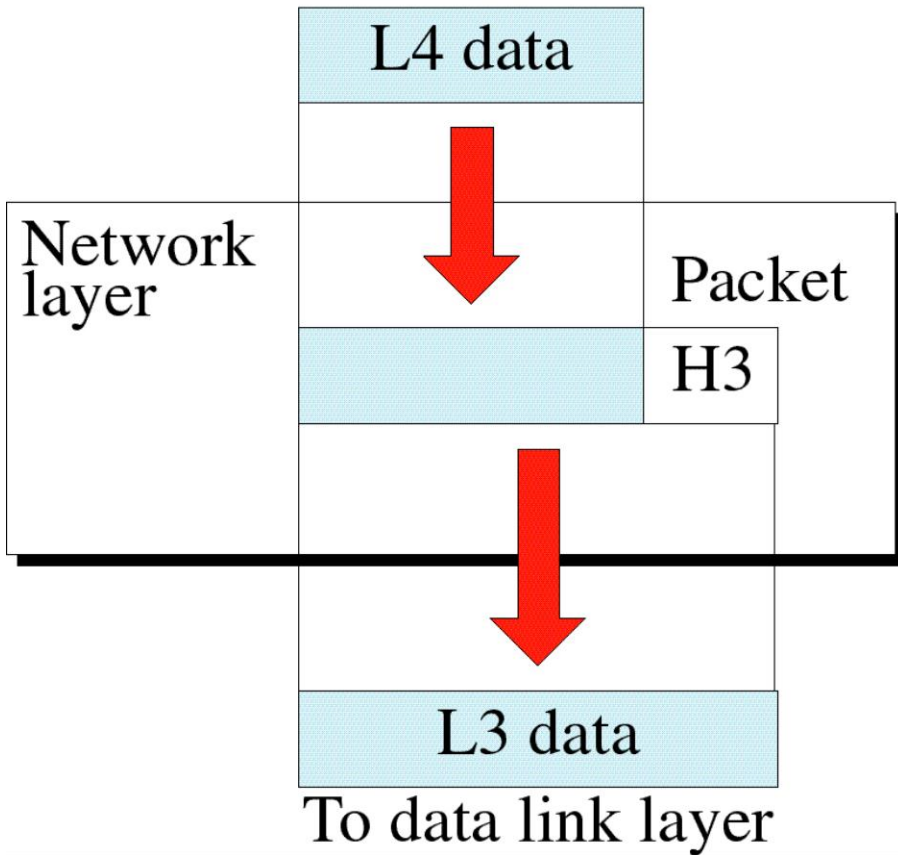


# Network Layer

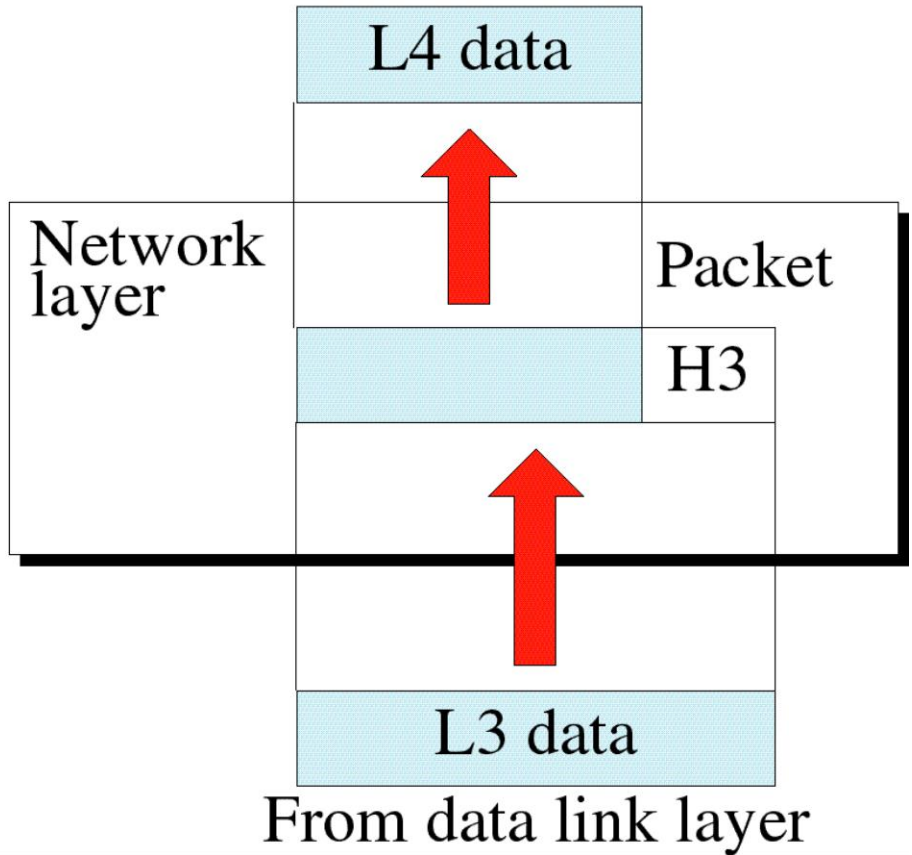
- ▶ Source to Destination Delivery of Packets
  - ▶ Not required in peer-to-peer delivery
  - ▶ Adds Logical addresses of sender and Rx.
  - ▶ Routing for internetwork communication.
- 

# Network Layer

From transport layer



To transport layer



**A**



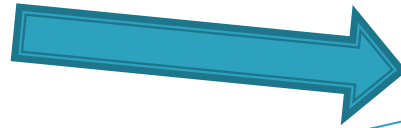
**10**

**B**



**85**

**Medium**



**99**



**20**



**N**

**33**



**66**

**G**



**45**



**P**



**95**



**Medium**

**M**



**77**

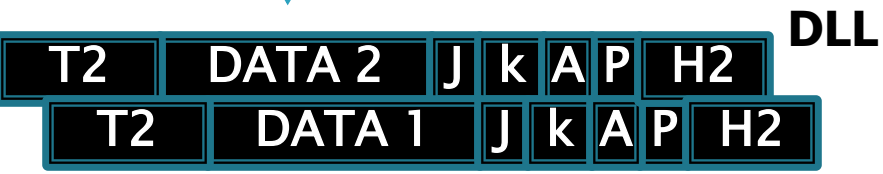
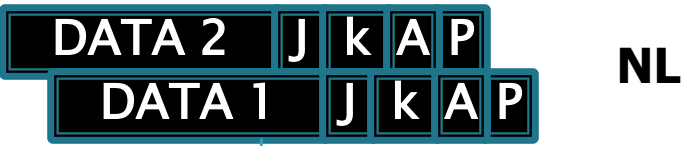
# Transport Layer

- ▶ Process to Process Delivery of message b/w Tx & Rx
- ▶ Create connection b/w two end ports for sake of security.
- ▶ Service Point or Port Addressing – Yahoo Messenger
- ▶ Segmentation and Reassembly– Divide the message received from Session layer in to Segments and number them to make a sequence for reassembly at the receiving side
- ▶ Flow Control
  - ▶ End to End rather than across a link.
  - ▶ Controls duplication of message
- ▶ Connection Control
  - Connection Oriented Transport Layer, like Telephone
  - Connectionless Transport Layer, like E-Mail
- ▶ Error Control
  - ▶ End to End rather than across a link.
  - ▶ Sending transport layer makes ensure that the entire message arrives at the receiving transport layer without error.

**A**

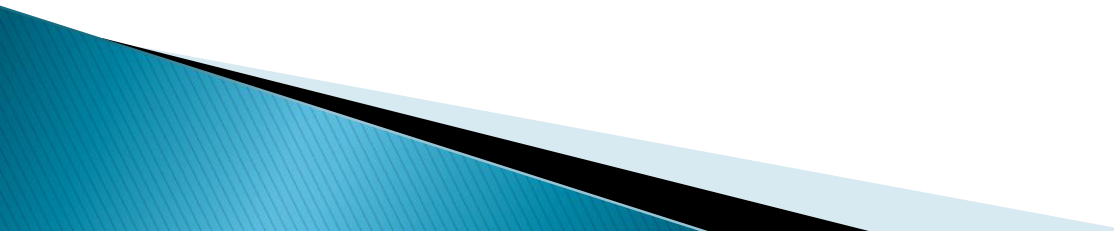


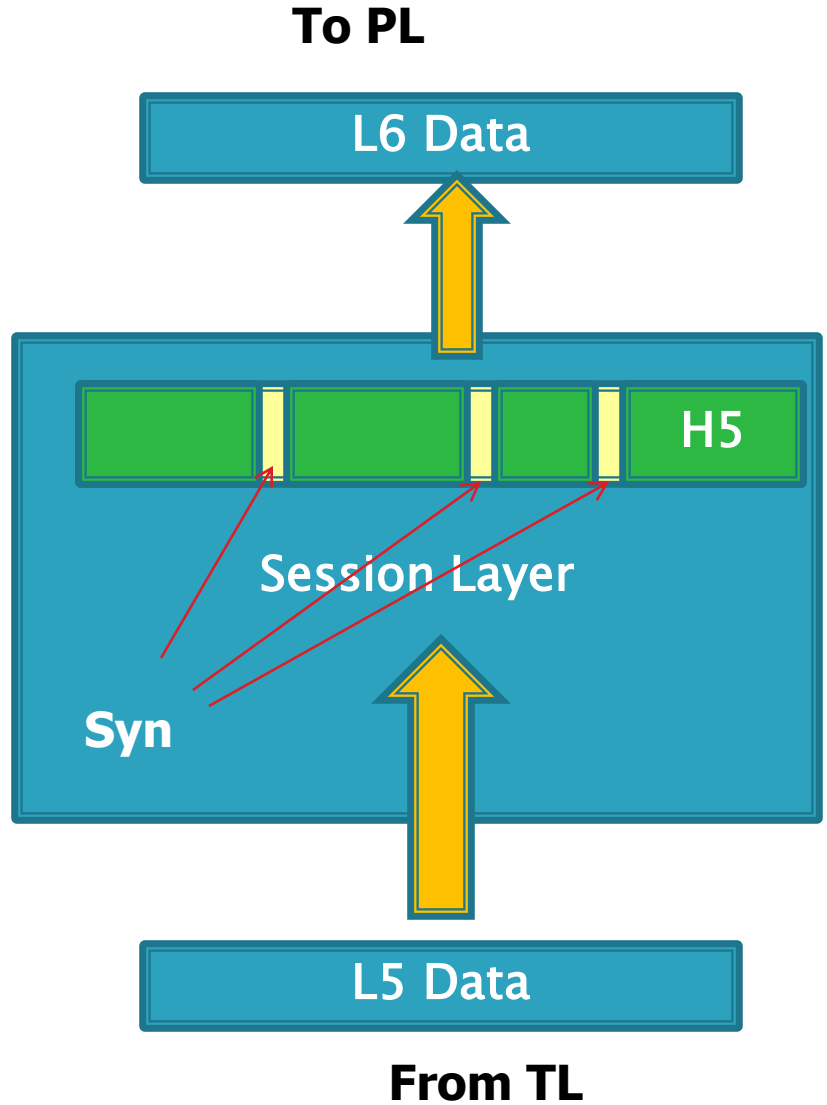
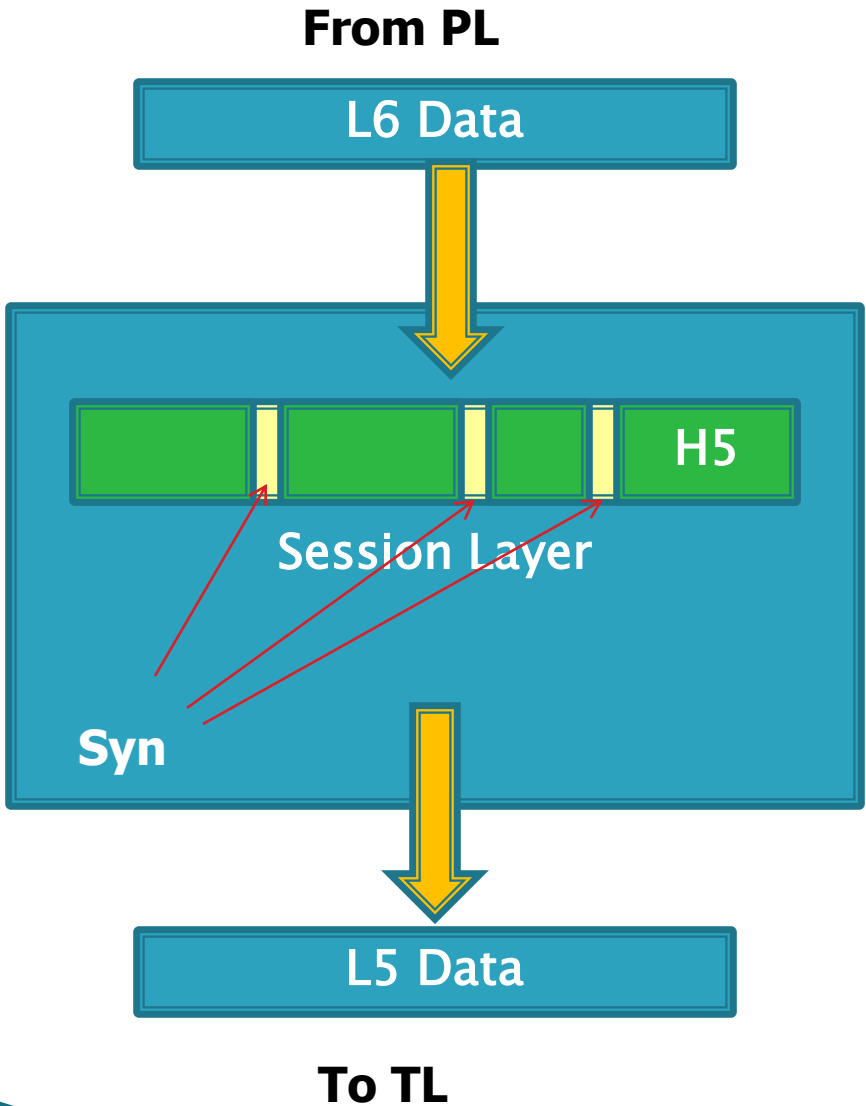
**P**



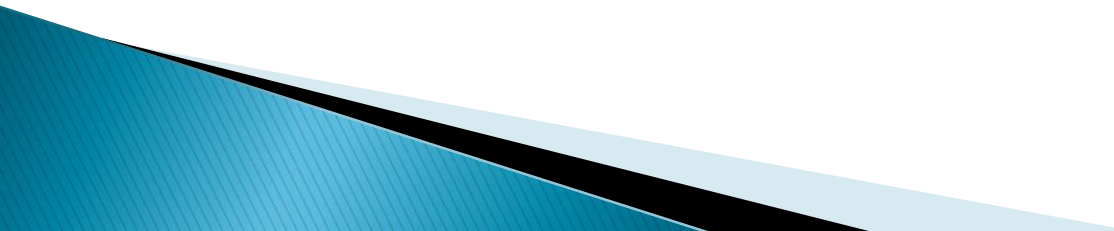


# Session Layer

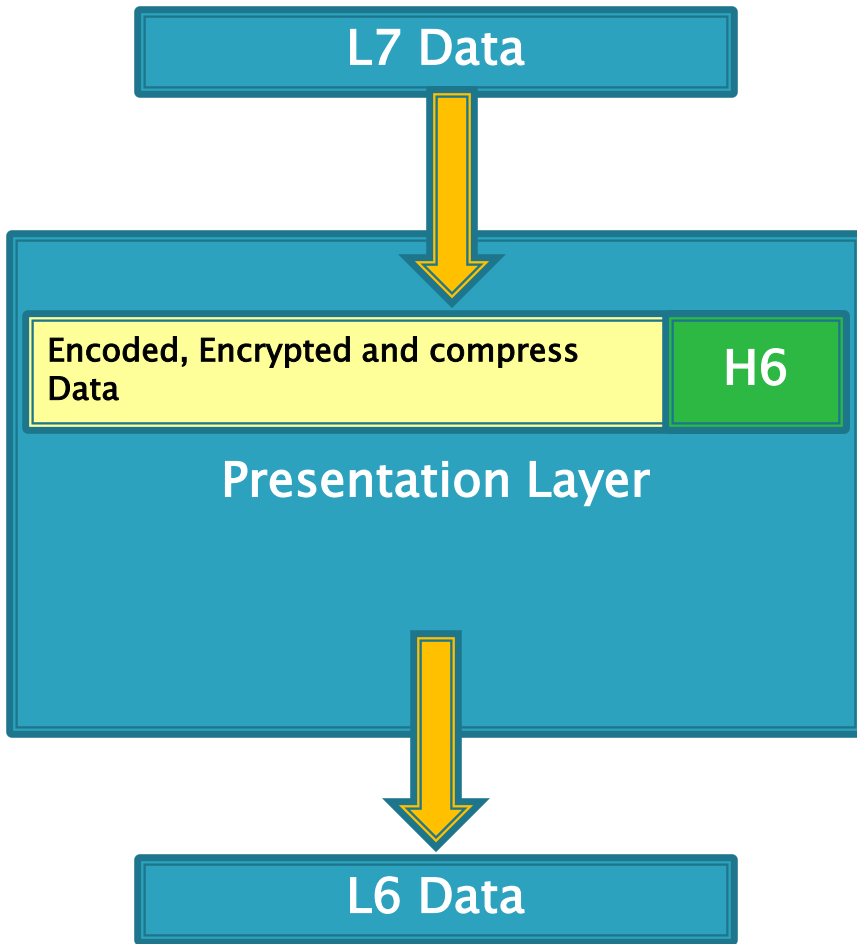
- ▶ Network dialog controller. Establishes, maintains and Synchronizes interaction b/w comm. systems
  - ▶ Dialog Controlling – Half Duplex or Full Duplex
  - ▶ Synchronization – Allows a process to add checkpoints to a stream of data
- 



# Presentation Layer

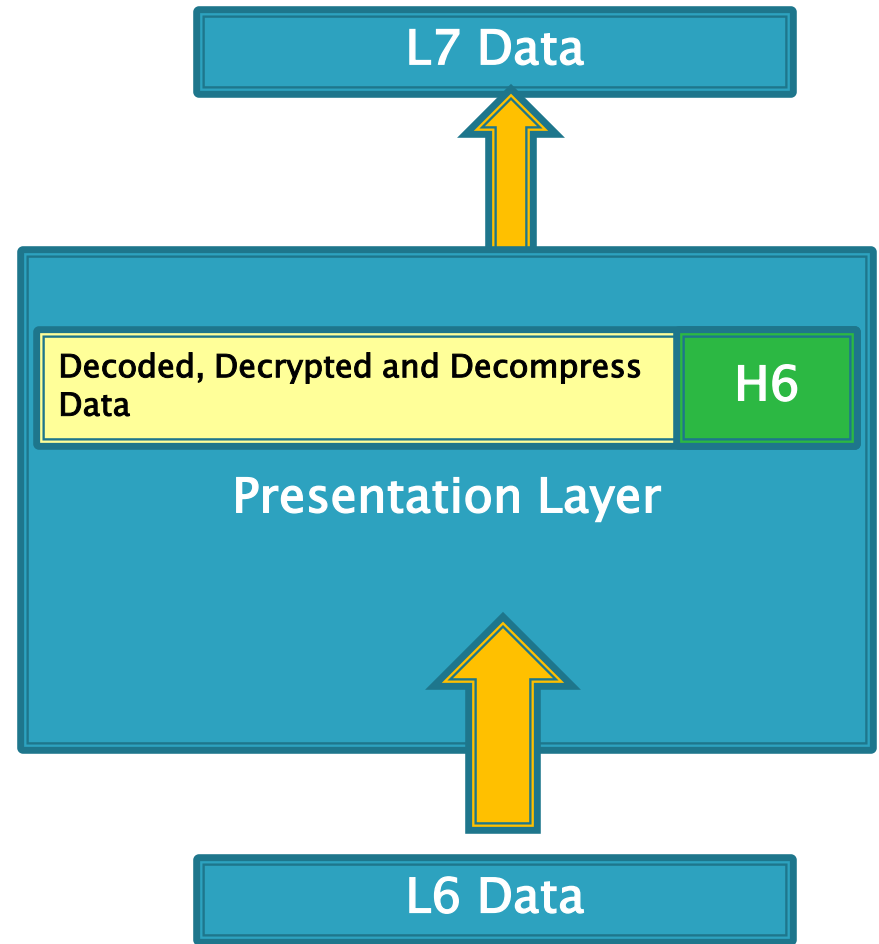
- ▶ Concerned with Syntax and Semantics of the information exchanged b/w the two communication systems
  - ▶ Translation – Encoding and Decoding
    - Sender to Common format on Sending side
    - Common to Receiving format on Rx side
  - ▶ Encryption – for security and privacy purpose
  - ▶ Compression – reducing the number of bits to sent over network.
- 

**From AL**



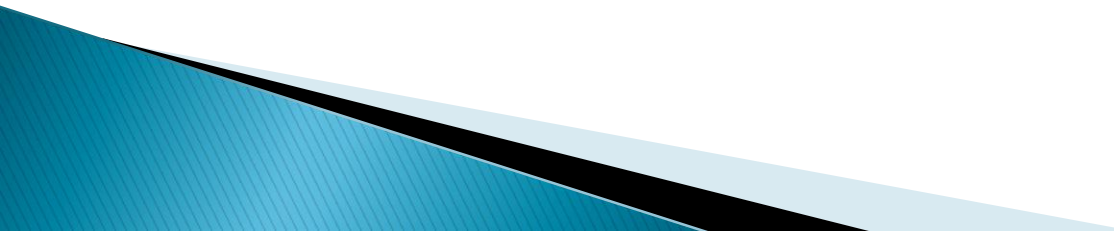
**To SL**

**To AL**

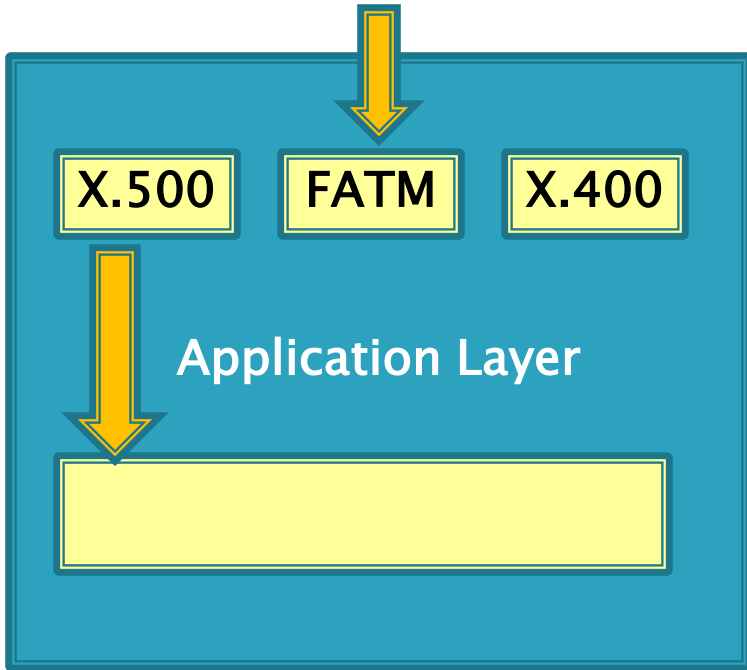


**From SL**

# Application Layer

- ▶ Provides User interfaces and support for Services, like e-mail, file transfer.
  - ▶ Network Virtual terminal
  - ▶ File Transfer Access, and Management(FATM)
  - ▶ Mail Services
  - ▶ Directory Services
- 

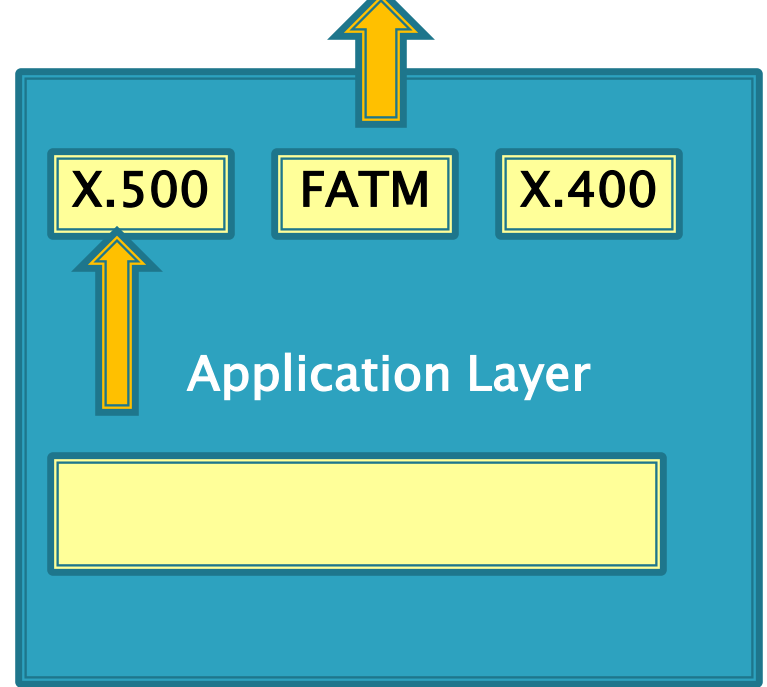
**User A**



**L7 Data**

**To PL**

**User B**



**L7 Data**

**From PL**

## 2-4 ADDRESSING

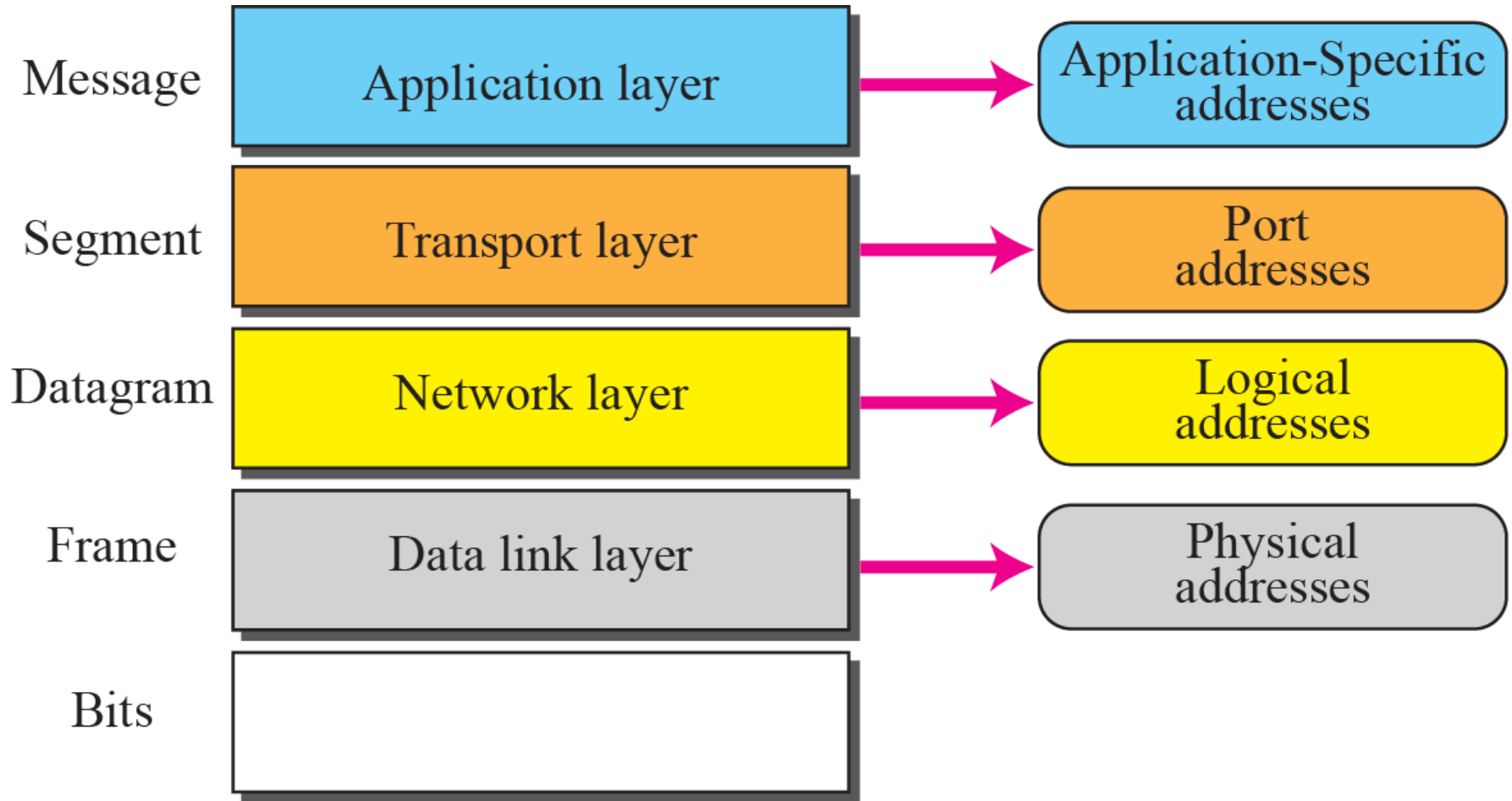
Four levels of addresses are used in an internet employing the TCP/IP protocols: physical address, logical address, port address, and application-specific address. Each address is related to a one layer in the TCP/IP architecture, as shown in Figure 2.15.

# *Topics Discussed in the Section*

- ✓ **Physical Addresses**
- ✓ **Logical Addresses**
- ✓ **Port Addresses**
- ✓ **Application-Specific Addresses**



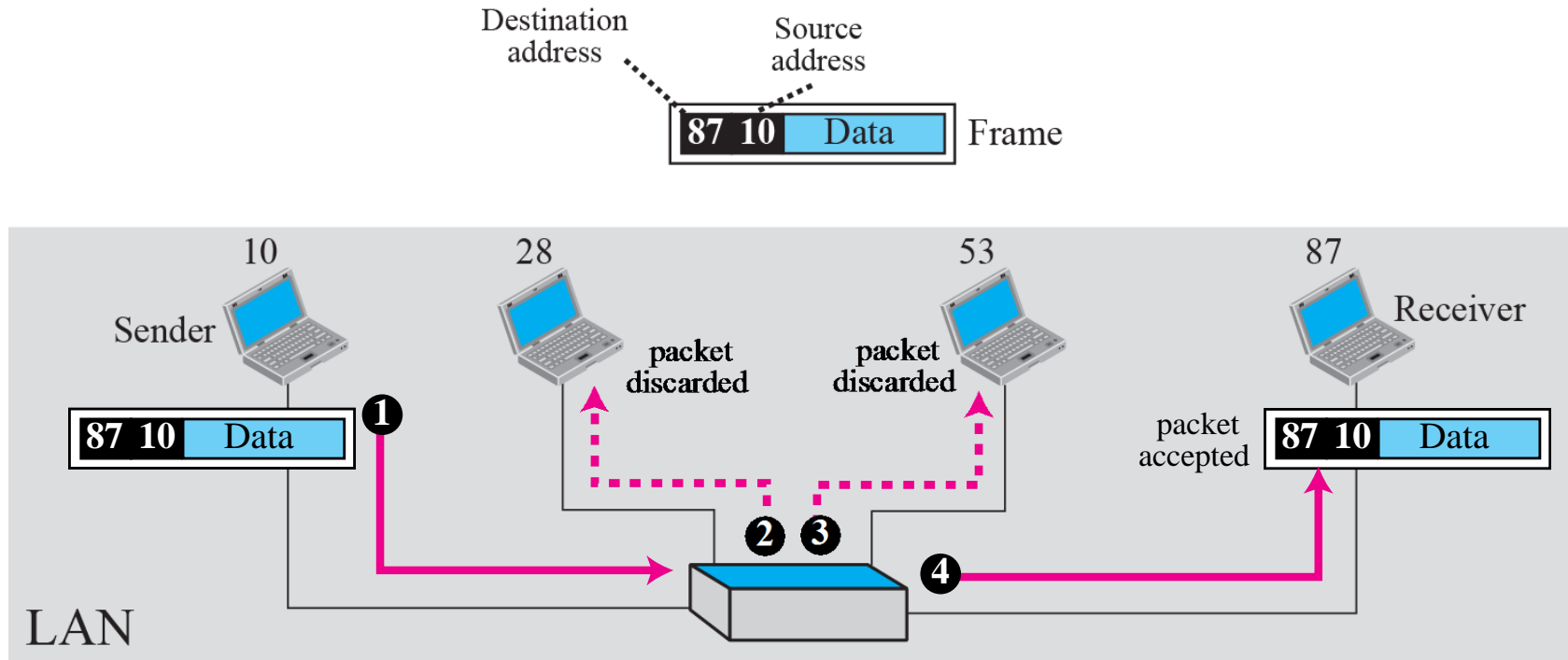
**Figure 2.15** *Addresses in the TCP/IP protocol suite*



## Example 2.3

In Figure 2.16 a node with physical address 10 sends a frame to a node with physical address 87. The two nodes are connected by a link (a LAN). At the data link layer, 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. As the figure shows, the computer with physical address 10 is the sender, and the computer with physical address 87 is the receiver. The data link layer at the sender receives data from an upper layer. It encapsulates the data in a frame. The frame is propagated through the LAN. Each station with a physical address other than 87 drops the frame because the destination address in the frame does not match its own physical address. The intended destination computer, however, finds a match between the destination address in the frame and its own physical address.

**Figure 2.16** *Example 2.3: physical addresses*



## Example 2.4

As we will see in Chapter 3, 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:

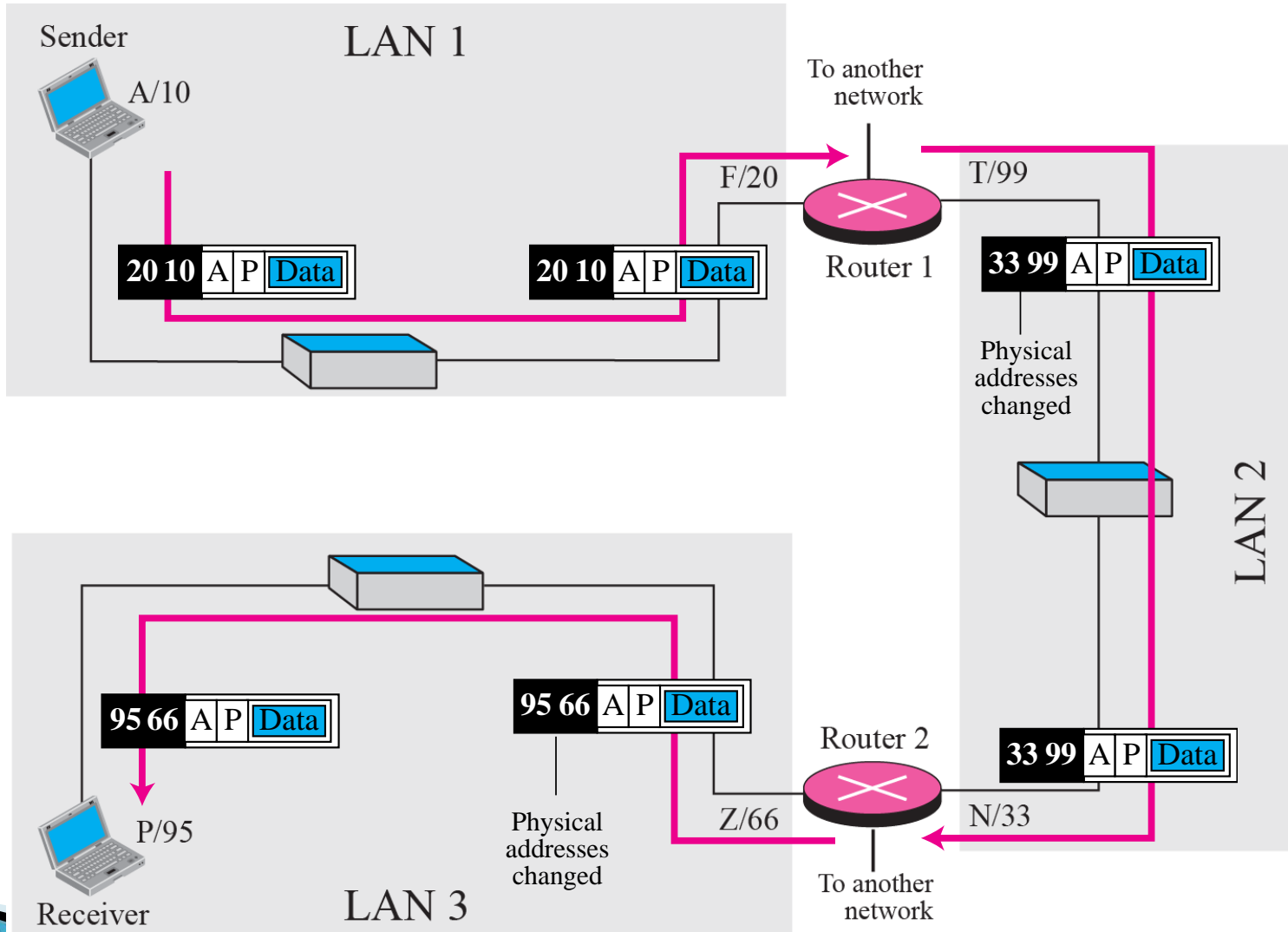
**07:01:02:01:2C:4B**

A 6-byte (12 hexadecimal digits) physical address

## Example 2.5

Figure 2.17 shows a part of an internet with two routers connecting three LANs. Each device (computer or router) has a pair of addresses (logical and physical) for each connection. In this case, each computer is connected to only one link and therefore has only one pair of addresses. Each router, however, is connected to three networks. So each router has three pairs of addresses, one for each connection. Although it may be obvious that each router must have a separate physical address for each connection, it may not be obvious why it needs a logical address for each connection. We discuss these issues in Chapters 11 and 12 when we discuss routing. The computer with logical address A and physical address 10 needs to send a packet to the computer with logical address P and physical address 95. We use letters to show the logical addresses and numbers for physical addresses, but note that both are actually numbers, as we will see in later chapters.

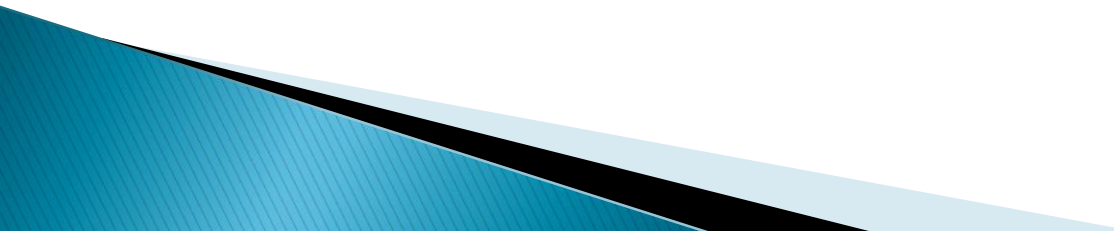
**Figure 2.17** *Example 2.5: logical addresses*





*Note*

***The physical addresses will change from hop to hop, but the logical addresses remain the same.***

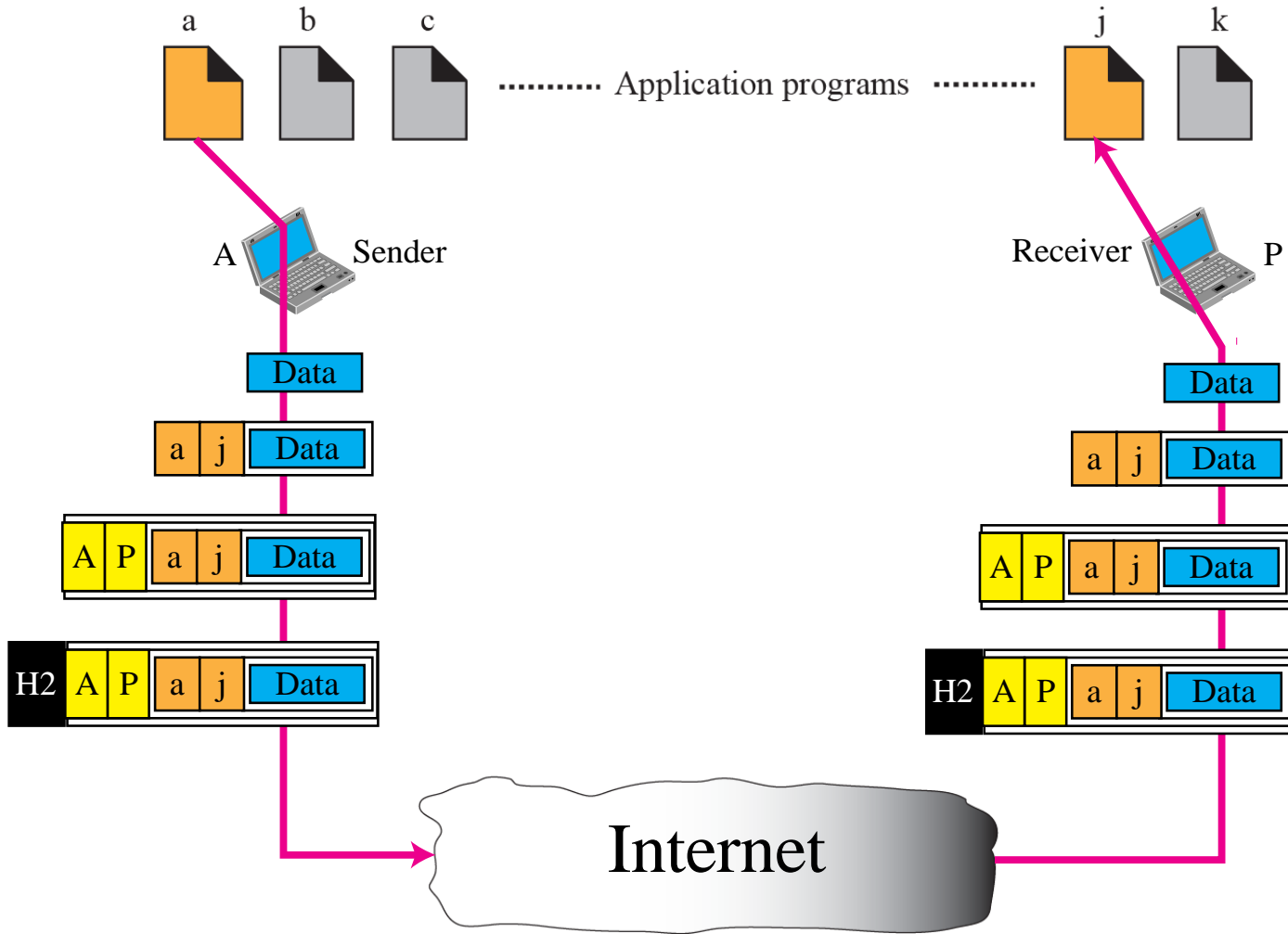


## Example 2.6

Figure 2.18 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 both computers are using the same application, FTP, for example, the port addresses are different because one is a client program and the other is a server program, as we will see in Chapter 17.



**Figure 2.18** *Example 2.6: port numbers*





*Note*

***The physical addresses change from hop to hop, but the logical and port addresses usually remain the same.***



## Example 2.7

As we will see in future chapters, a port address is a 16-bit address represented by one decimal number as shown.

753

A 16-bit port address represented as one single number