Chapter 2

Network Models
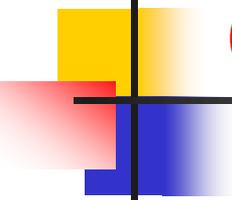
Chapter 2: Outline
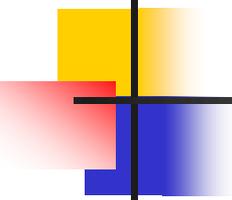
2.1 *Protocol Layering*

2.2 *TCP/IP Protocol Suite*

2.3 *OSI Model*

2-1   PROTOCOL LAYERING

A word we hear all the time when we talk about the Internet is protocol. A protocol defines the rules that both the sender and receiver and all intermediate devices need to follow to be able to communicate effectively. When communication is simple, we may need only one simple protocol; when the communication is complex, we need a protocol at each layer, or protocol layering.

2.1.1 Scenarios

Let us develop two simple scenarios to better understand the need for protocol layering.
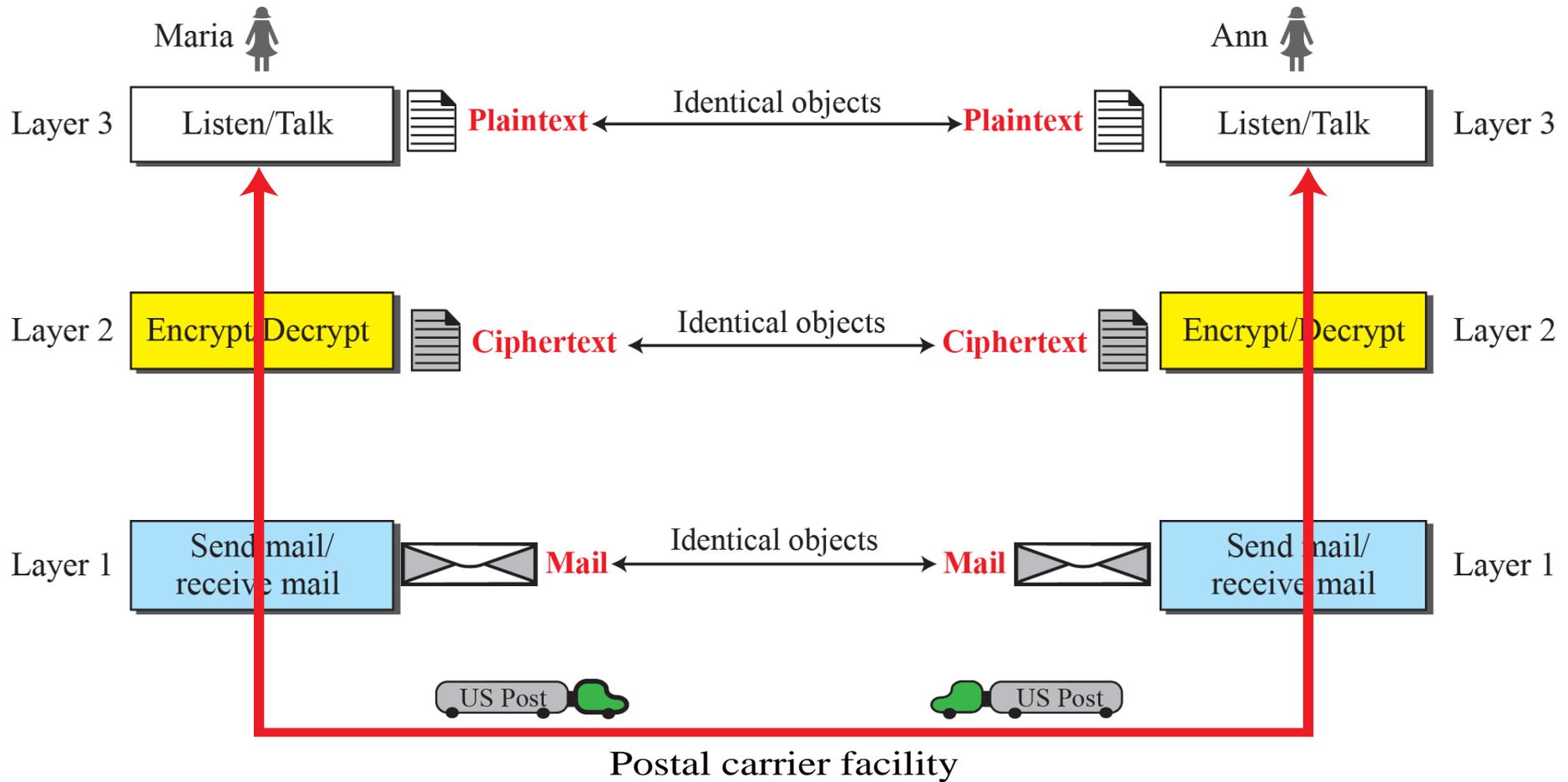
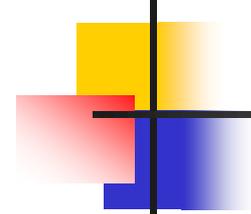*In the first scenario, communication is so simple that it can occur in only one layer.*

In the second, the communication between Maria and Ann takes place in three layers.

Figure 2.1: A single-layer protocol

Maria

Ann

Layer 1 | Listen/Talk

Listen/Talk | Layer 1

Air

Figure 2.2: *A three-layer protocol*

Maria

Ann

| Layer 3 | Listen/Talk | | **Plaintext** ← Identical objects → **Plaintext** | | Listen/Talk | Layer 3 |

| Layer 2 | Encrypt/Decrypt | | **Ciphertext** ← Identical objects → **Ciphertext** | | Encrypt/Decrypt | Layer 2 |

| Layer 1 | Send mail/ receive mail | | **Mail** ← Identical objects → **Mail** | | Send mail/ receive mail | Layer 1 |

US Post   US Post

Postal carrier facility

2.1.2 Principles of Protocol Layering

Let us discuss two principles of protocol layering.

The first principle dictates that if we want bidirectional communication, we need to make each layer so that it is able to perform two opposite tasks, one in each direction.

The second principle that we need to follow in protocol layering is that the two objects under each layer at both sites should be identical.
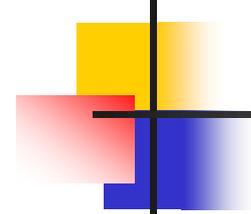
2-2   TCP/IP PROTOCOL SUITE

A word we hear all the time when we talk about the Internet is protocol. A protocol defines the rules that both the sender and receiver and all intermediate devices need to follow to be able to communicate effectively. When communication is simple, we may need only one simple protocol; when the communication is complex, we need a protocol at each layer, or protocol layering.

The layers in the TCP/IP protocol suite is made of five layers: physical, data link, network, transport, and application.

|	
5	Application
4	Transport
3	Network
2	Data link
1	Physical
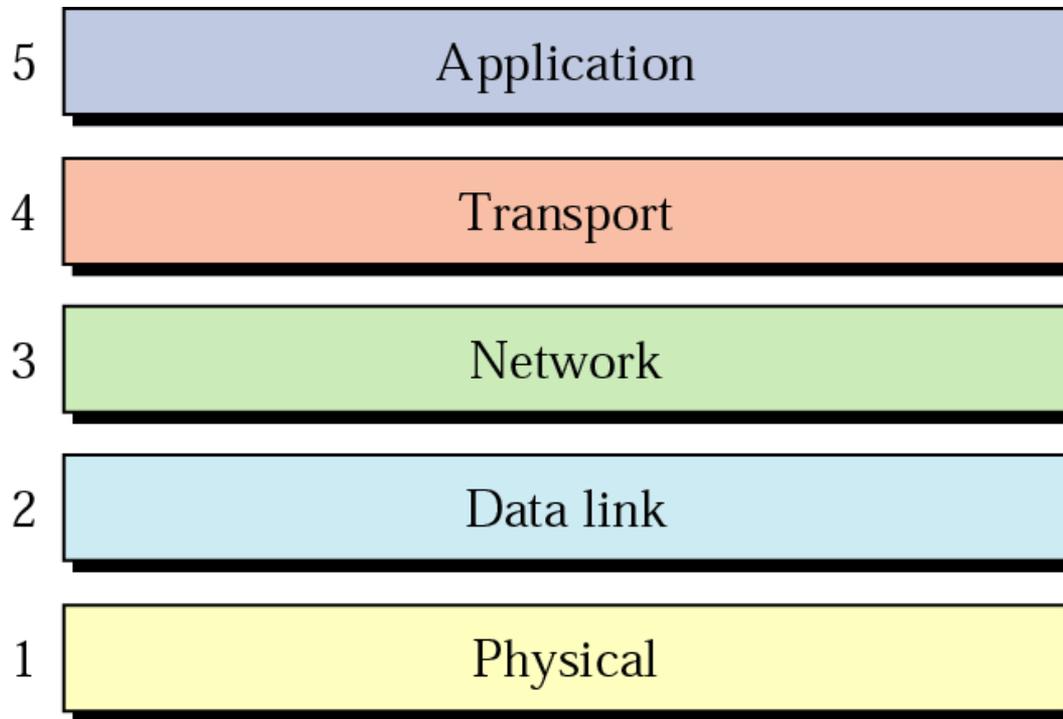
Layer: *A grouping of related tasks involving the transfer of information .Each layer addresses an essential networking tasks*

2.2.1 Layered Architecture

To show how the layers in the TCP/IP protocol suite are involved in communication between two hosts, we assume that we want to use the suite in a small internet made up of three LANs (links), each with a link-layer switch. We also assume that the links are connected by one router, as shown in Figure 2.5.

Figure 2.5: Communication through an internet
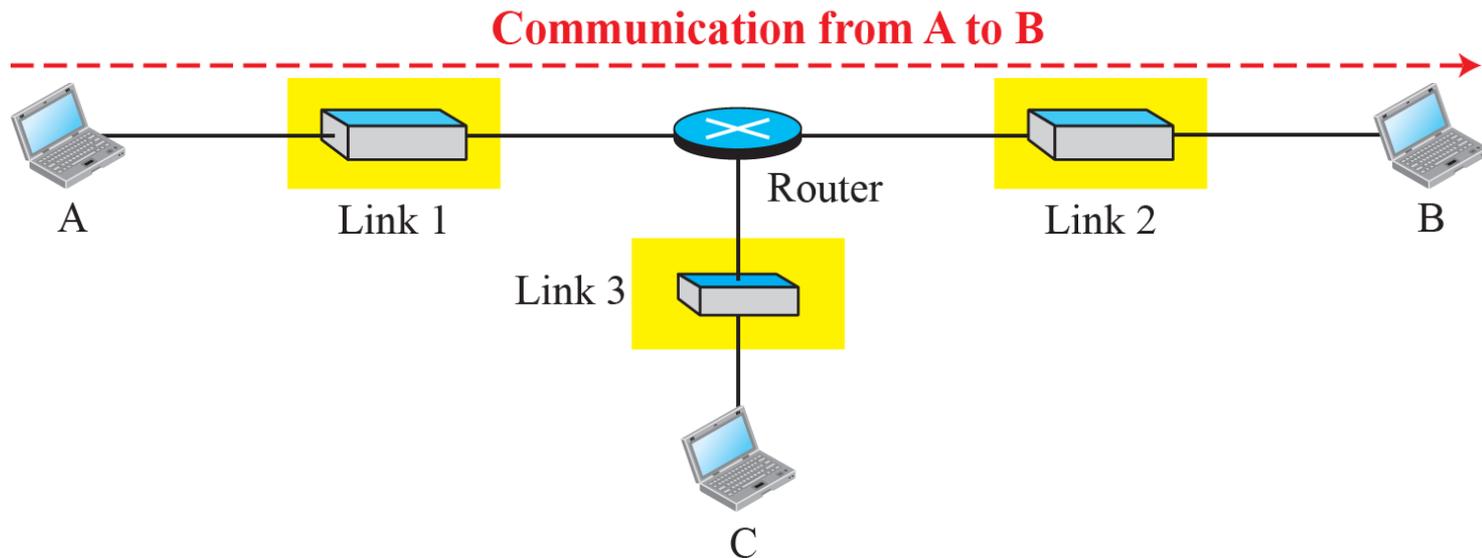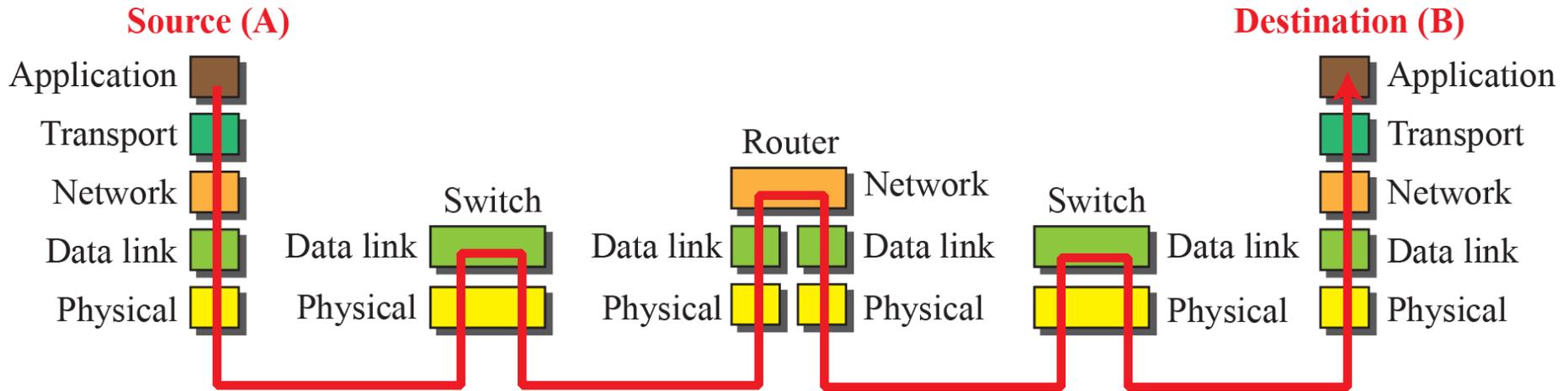
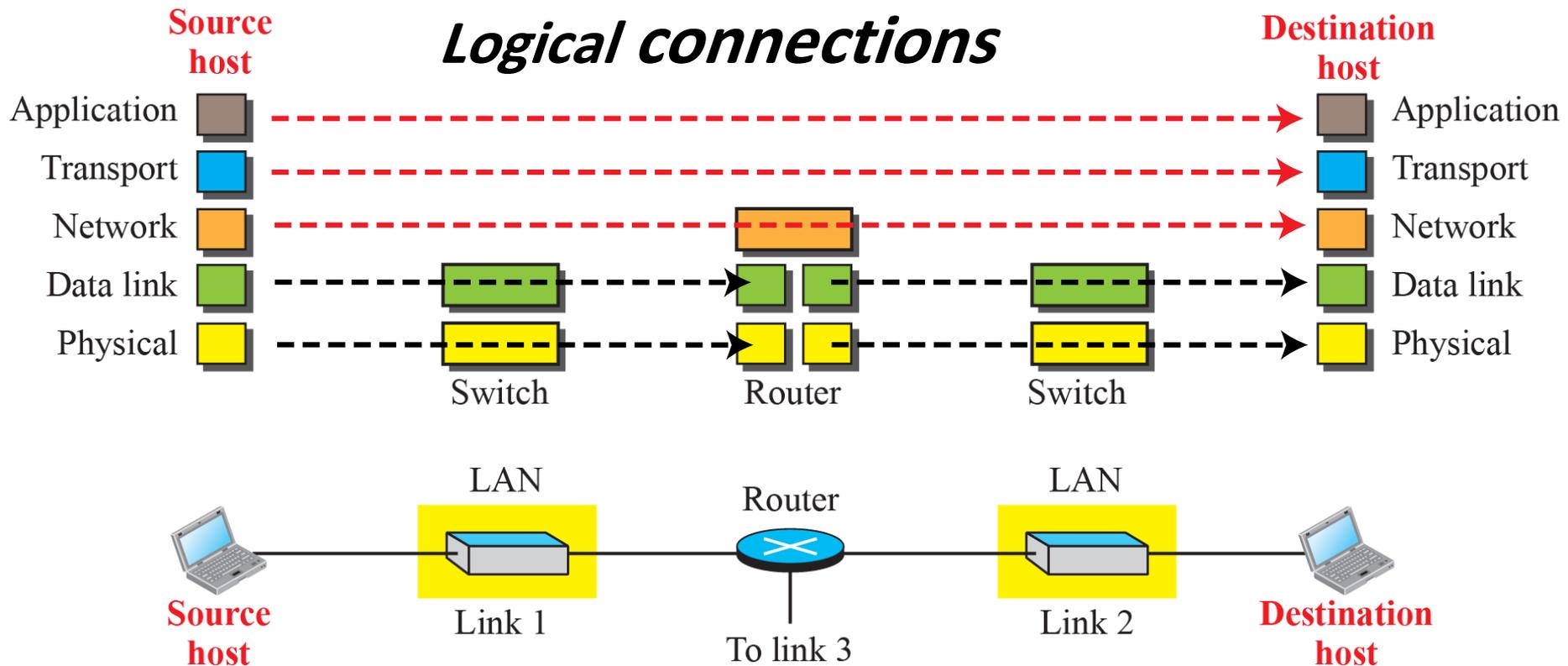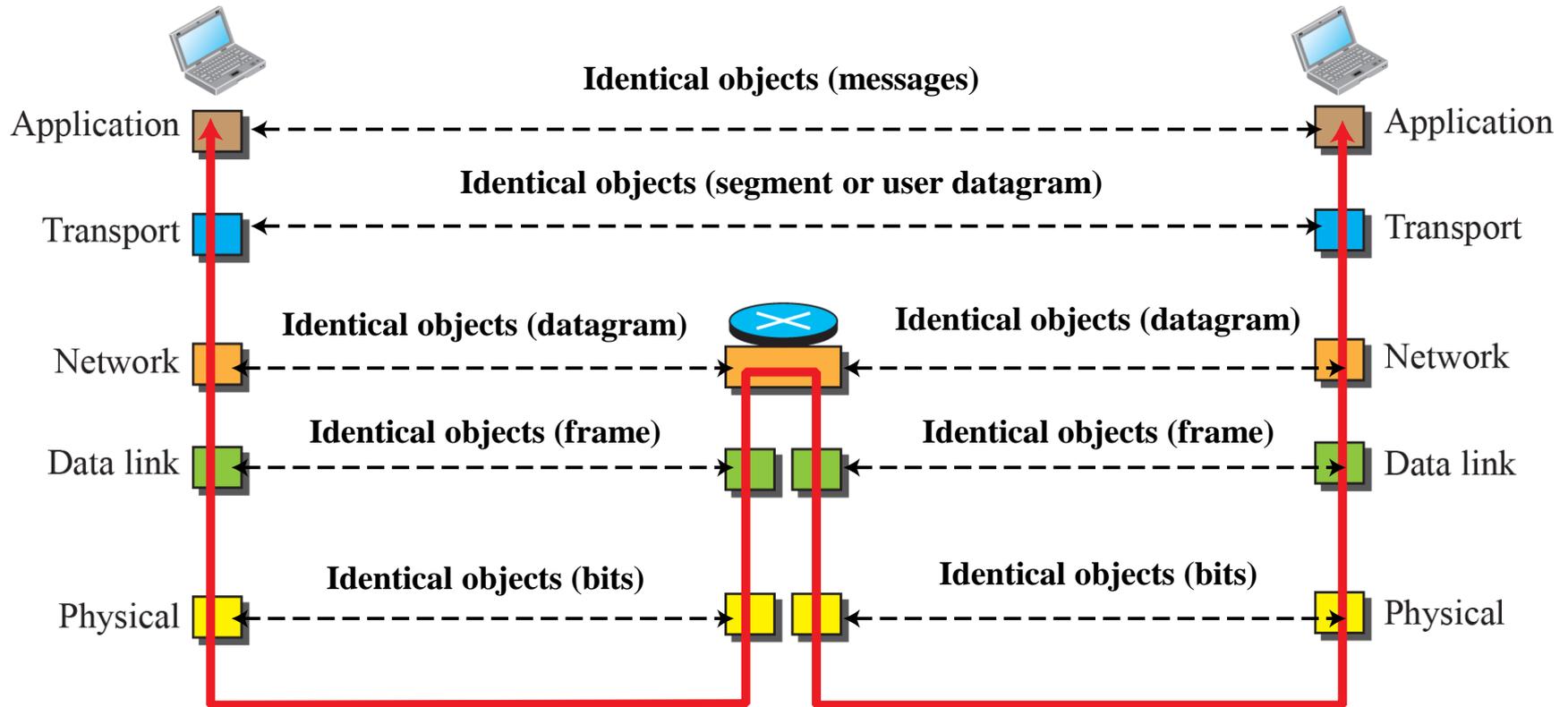*To better understand the duties of each layer, we need to think about the logical connections between layers.*

Figure 2.7: *Identical objects in the TCP/IP protocol suite*

Notes: We have not shown switches because they don't change objects.

Identical objects (messages)

Identical objects (segment or user datagram)

Identical objects (datagram)

Identical objects (datagram)

Identical objects (frame)

Identical objects (frame)

Identical objects (bits)

Identical objects (bits)

Application

Transport

Network

Data link

Physical

Application

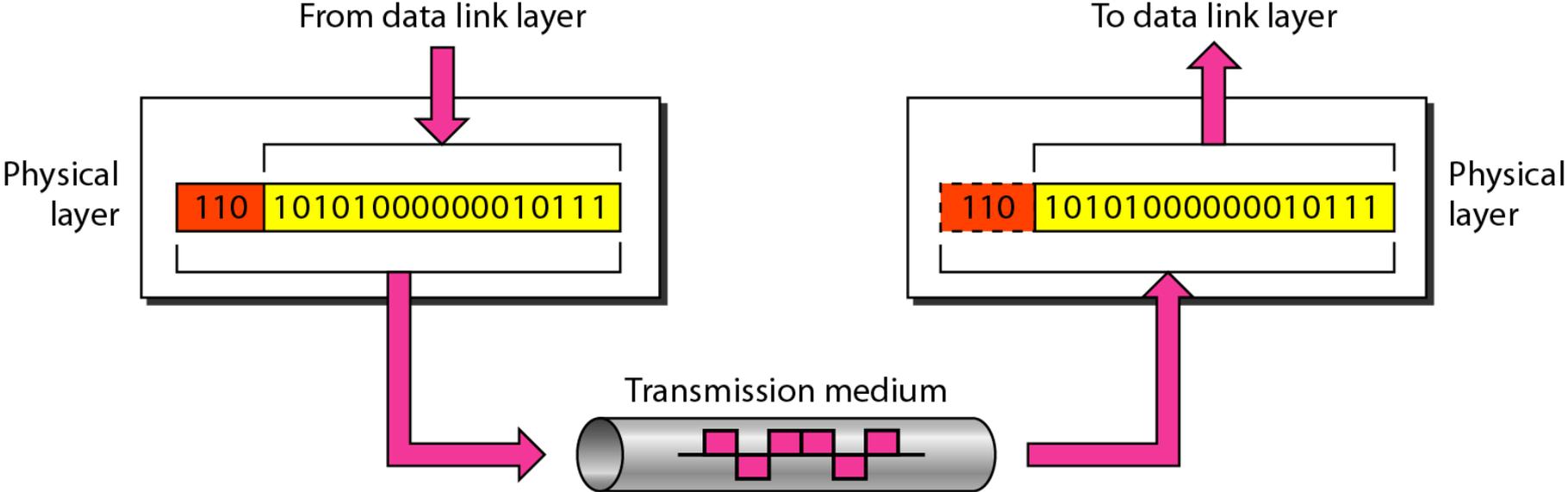Transport

Network

Data link

Physical

2.2.3 Description of Each Leyer

1. Physical layer

- **The physical layer is responsible for movements of individual bits from one hop (node) to the next.**
- **Transmission Media is another hidden layer under the Physical Layer**
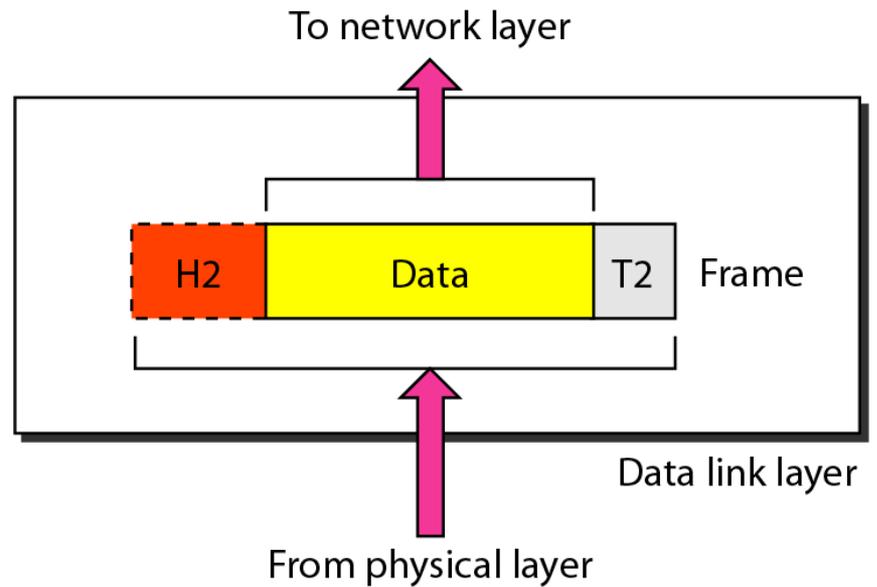
Physical layer

# 2.2.3 Description of Each Leyer

2. Data Link Layer

- *The data link layer is responsible for moving frames from one hop (node) to the next over the link.*
- *The link can be Wired LAN/WAN or Wireless LAN/WAN.*
- *Some protocols provides complete error detection and correction, some protocols provide only error correction.*
- *At the Datalink layer addresses are called MAC Address.*

Data link layer
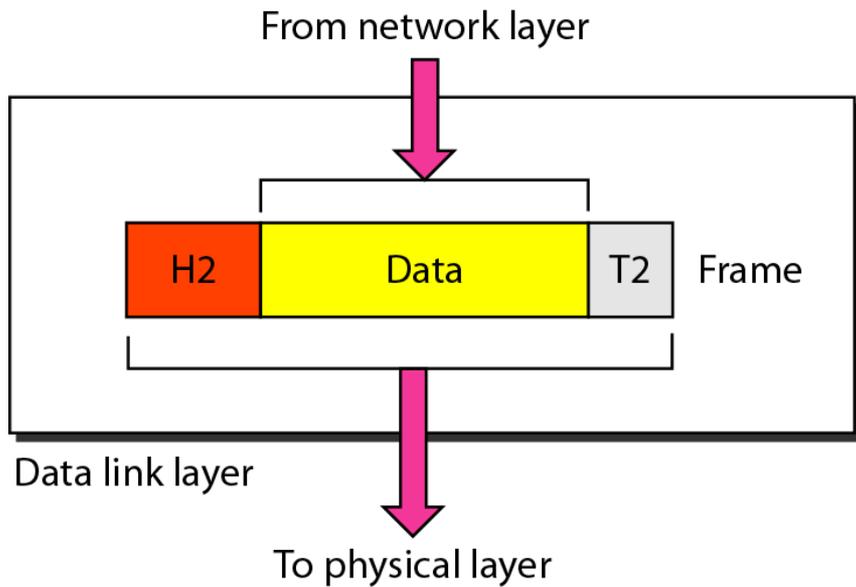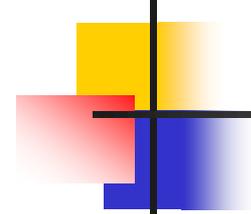
Datalink Layer

Physical address (MAC)

- **known also as the *MAC* or link address**
- **Is the address of a node as defined by its LAN or WAN**
- **It is included in the frame used by data link layer (Header)**
- **The MAC addresses are locally defined address**

3. Network Layer

- **The network layer is responsible for the delivery of individual packets from the source host to the destination host across multiple network.**
- **If two system are connected to the same link (network), no need for this layer.**
- **The network layer also response for routing the packet.**
- **IP is the main protocol of the network layer.**
- **At the Network layer addresses are called IP Address.**

Network Layer

Logical addressing (IP)

- *Network layer adds unique identifier (IP or logical address) to the packet.*

- *These unique identifier(as tel. no, each tel. has unique number) enable special devices called router to make sure the packet get to correct system.*

- *IP addresses are necessary for universal communications that are independent of physical network.*

Routing:

*provide the routing mechanism for the **router** which route the packet to their final destination.*

Routers : devices used when independent networks are connected to create an internetworking (network of networks)

Network layer

From transport layer

To transport layer

| H3 | Data | Packet |

Network layer

To data link layer

| H3 | Data | Packet |

Network layer
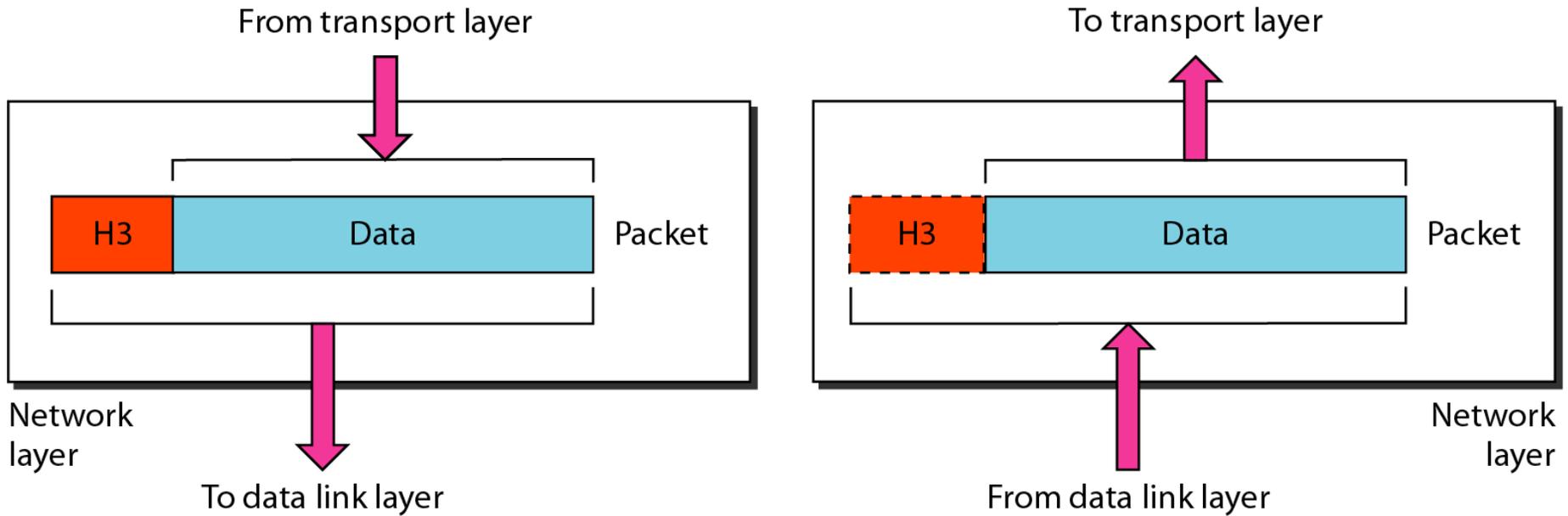
From data link layer

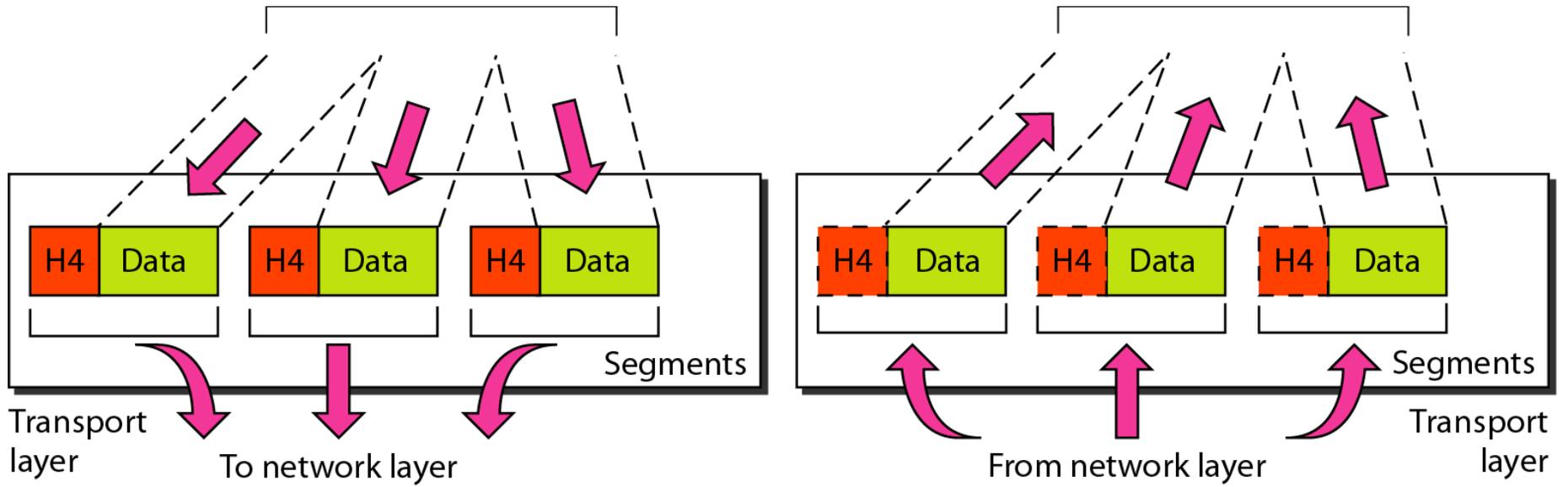*4. Transport Layer (process to process delivery)*

- **The transport layer is responsible for the delivery of a message from one process to another.**
- **At the Transport layer addresses are called Port Address.**
- **TCO/IP model defines 3 protocols :**
    - **TCP (Transmission Control Protocol)**
    - **UDP (User Datagram Protocol)**
    - **SCTP(Stream Control Transmission Protocol)**

Transport layer

H4 | Data   H4 | Data   H4 | Data

Segments

Transport layer

To network layer

H4 | Data   H4 | Data   H4 | Data

Segments

Transport layer

From network layer

Transport Layer

Port addressing (Service-point addressing)

- *Computer often run several process (running programs) at the same time, so the process to process delivery means delivery from a specific process on a computer to specific process to the other.*
- *The transport layer header must include Port address*
- *Port address**: 16-bit addresses represented by decimal number range from 0-65535 to* **choose among multiple processes on the destination host**
- *Destination port No* *is needed for* *delivery*
- *Source port N**o is needed for* *replay**.*

Transport Layer

The transport layer can be either connection less or connection oriented

1. Connection oriented protocol (TCP)

- Makes a connection with the transport layer at the destination machine first before delivering the packers.
- When the connection *established* a sequence of packets from source to the destination can be sent one after another on the same path and in sequential order.
- When all packets of message have been delivered, the connection is terminated

This makes the sending transport *layer ensure that the message arrives at the receiving transport layer without error (damage, loss or duplication*

Transport Layer

2. Connection Less Protocol (UDP)

It sends the data, but does not establish and verify a connection between hosts before sending data.

- Treats each packet independently, the packets in a message may or may not travel the same path to their destination.
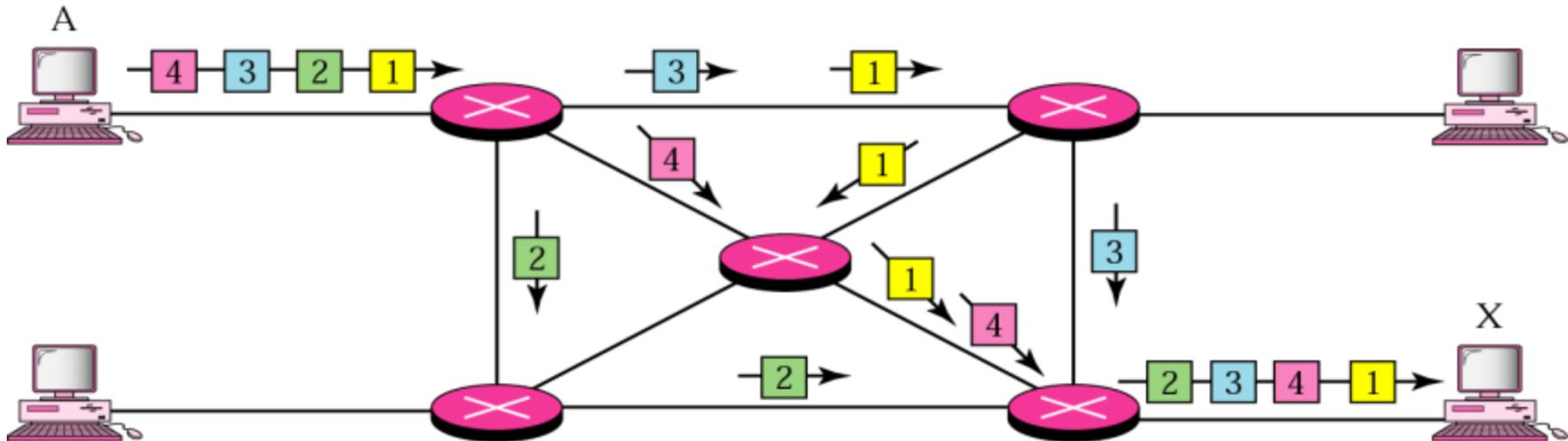
5 . Application Layer

- **The application layer exchange messages between each other.**
- **TCP/IP model defines the following protocols:**
  - **FTP:File transfer protocol is used for transferring files from one host to another .**
  - **Telnet: A service that enables users on the internet to log onto remote systems from their own host system.**
  - **HTTP: Hyper text transfer protocol used for network file transfers in WWW environment**
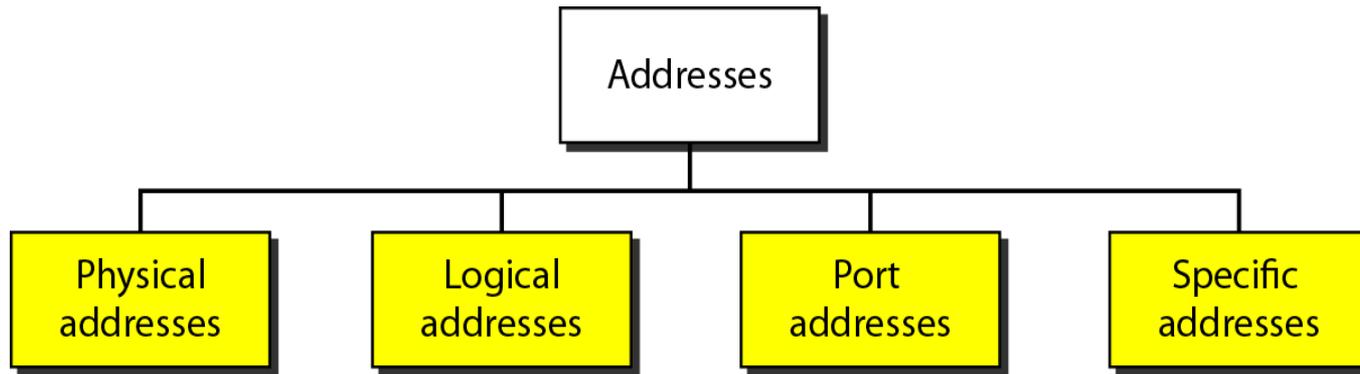 - **SMTP: Simple mail transfer protocol used to send electronic mail on the internet.**

One of the important concepts in protocol layering in the Internet is encapsulation/ decapsulation.
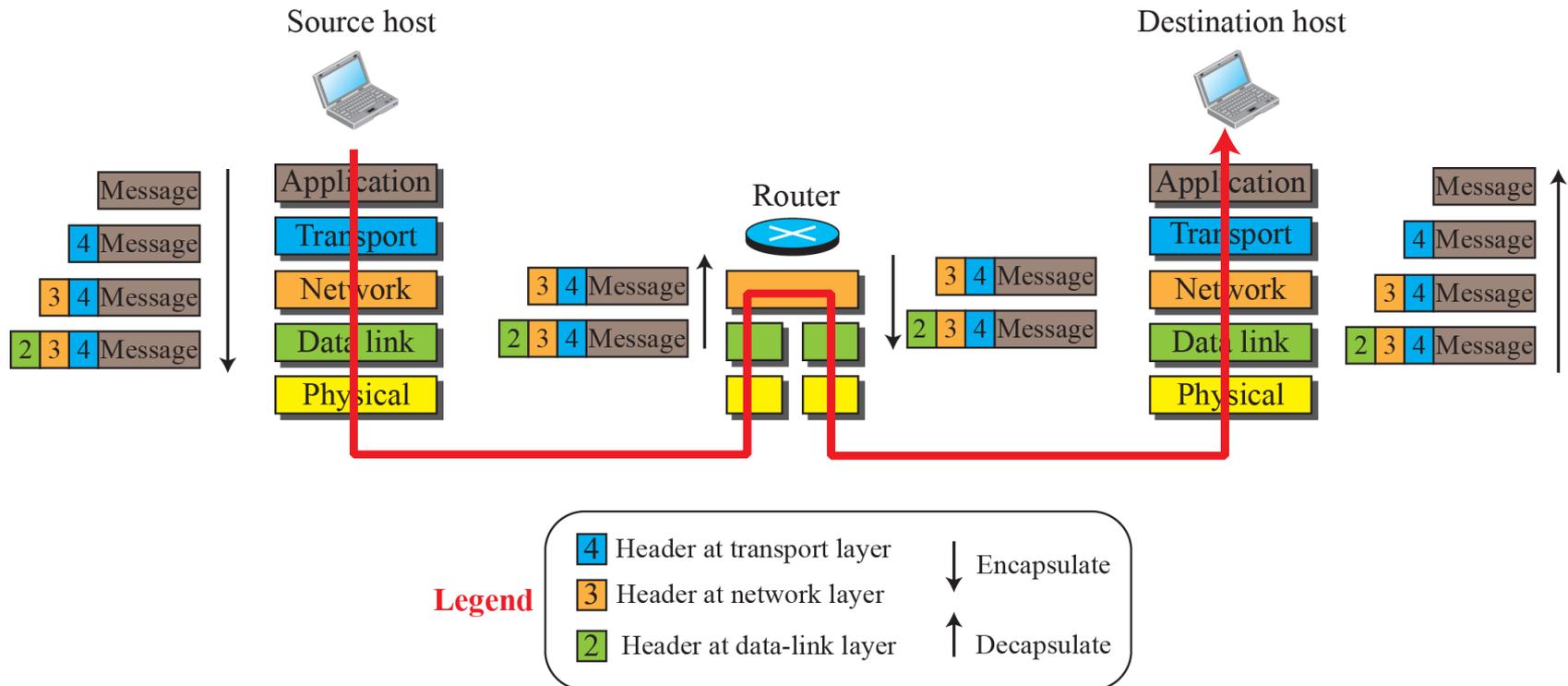
2.2.5 Addressing

**Four levels of addresses are used in an internet employing the TCP/IP protocols**

```
                    ┌─────────────┐
                    │  Addresses  │
                    └─────────────┘
        ┌──────────────┬──────┴───────┬──────────────┐
  ┌──────────┐   ┌──────────┐   ┌──────────┐   ┌──────────┐
  │ Physical │   │ Logical  │   │   Port   │   │ Specific │
  │addresses │   │addresses │   │addresses │   │addresses │
  └──────────┘   └──────────┘   └──────────┘   └──────────┘
```

Examples for Specific addresses:

• **e-mail addresses** (Lhajr@yahoo.com) to define the recipient of an e-mail

• **URL addresses** (www.ksu.com) to find a document on the world wide web

The addresses get changed to the corresponding port and logical addresses by the sending computer

> **Logical address (IP) The physical addresses will change from hop to hop, but the logical addresses remain the same.**
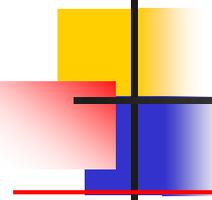
Example2:

The following figure 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 *(only two are shown in the figure).* So each router has three pairs *of addresses, one for each connection.*

Example2:
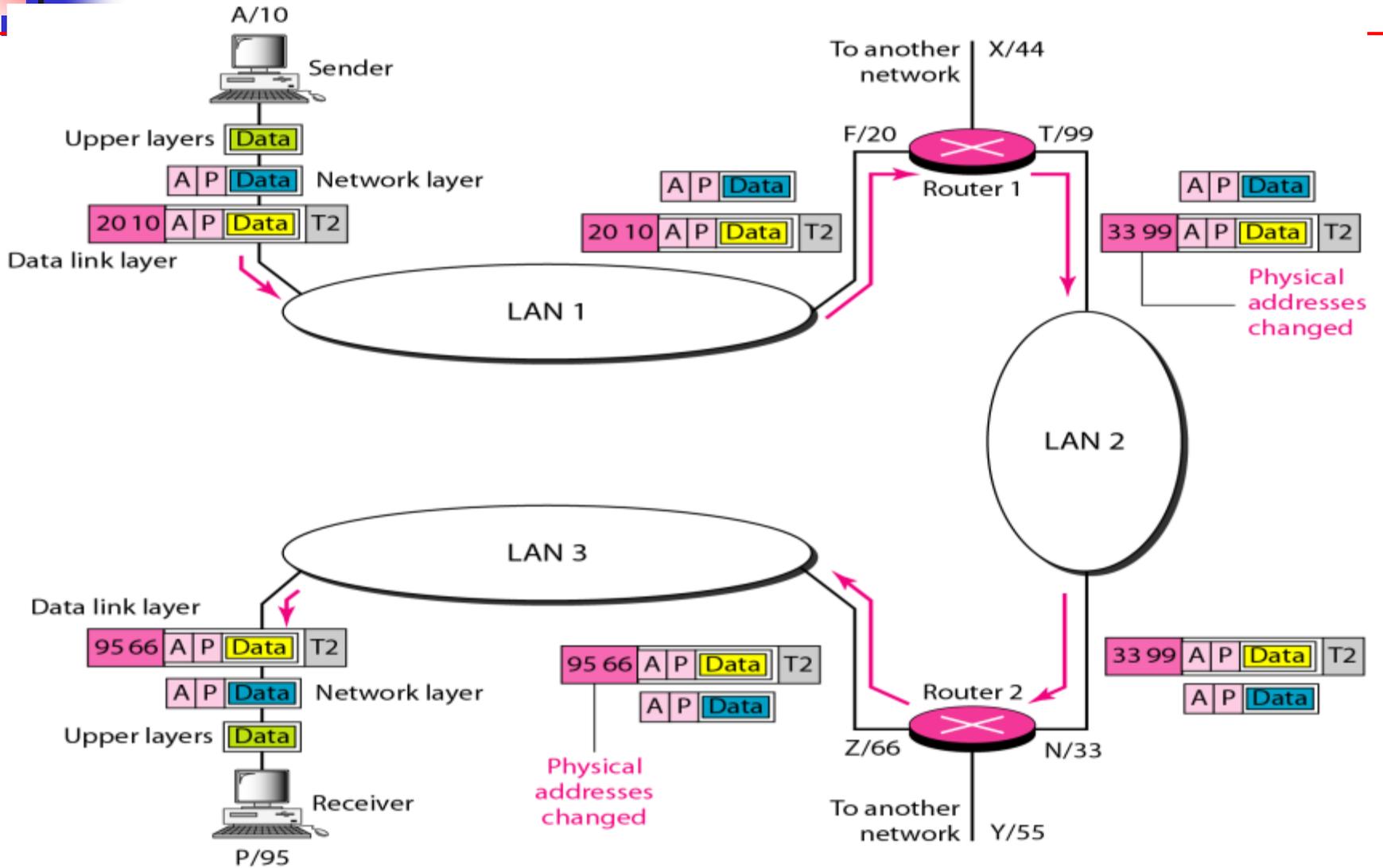
# Relationship of layers and addresses in TCP/IP
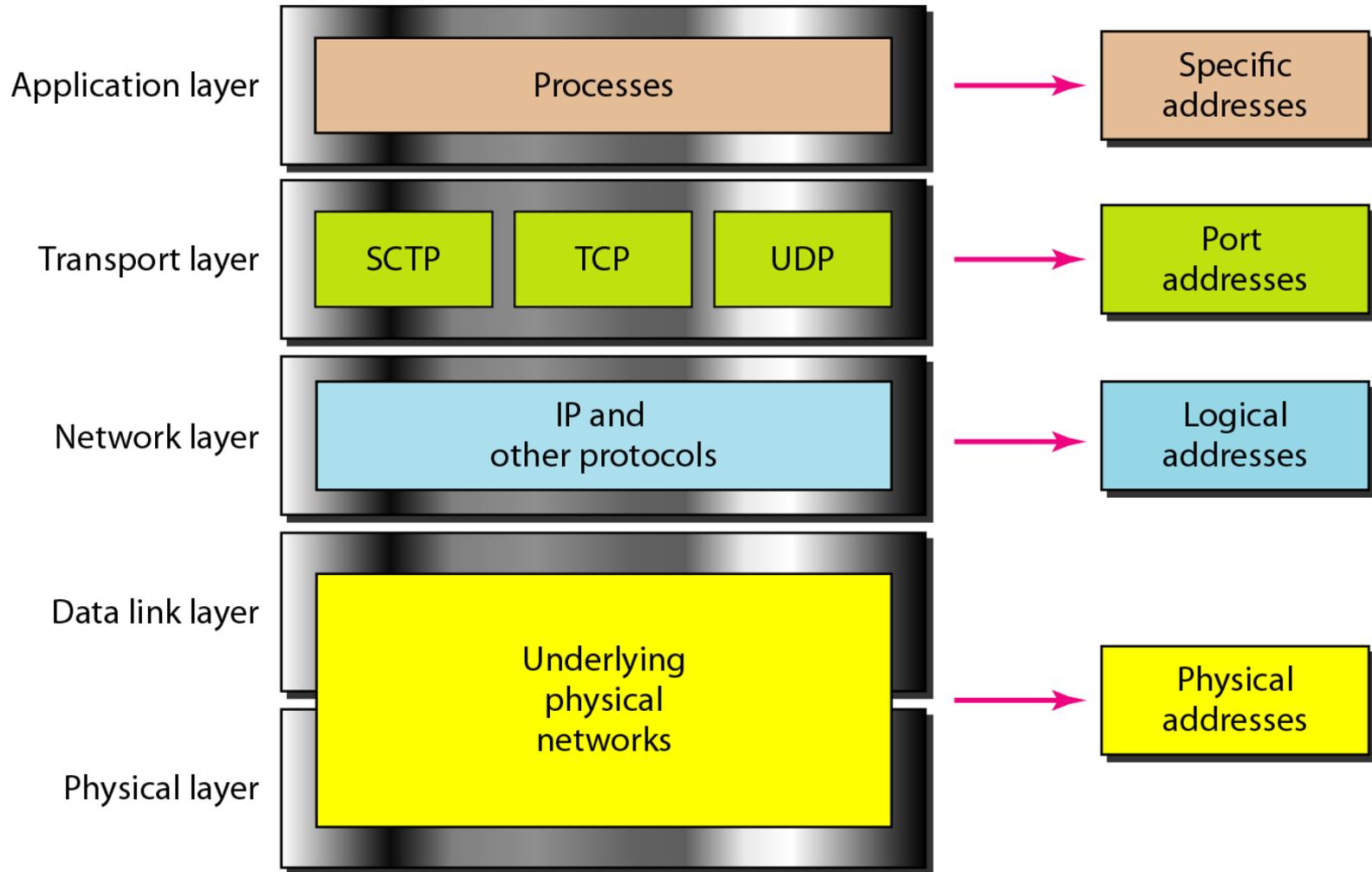
2-3   OSI MODEL

A word we hear all the time when we talk about the Internet is protocol. A protocol defines the rules that both the sender and receiver and all intermediate devices need to follow to be able to communicate effectively. When communication is simple, we may need only one simple protocol; when the communication is complex, we need a protocol at each layer, or protocol layering.

Figure 2.11: ***The OSI model***
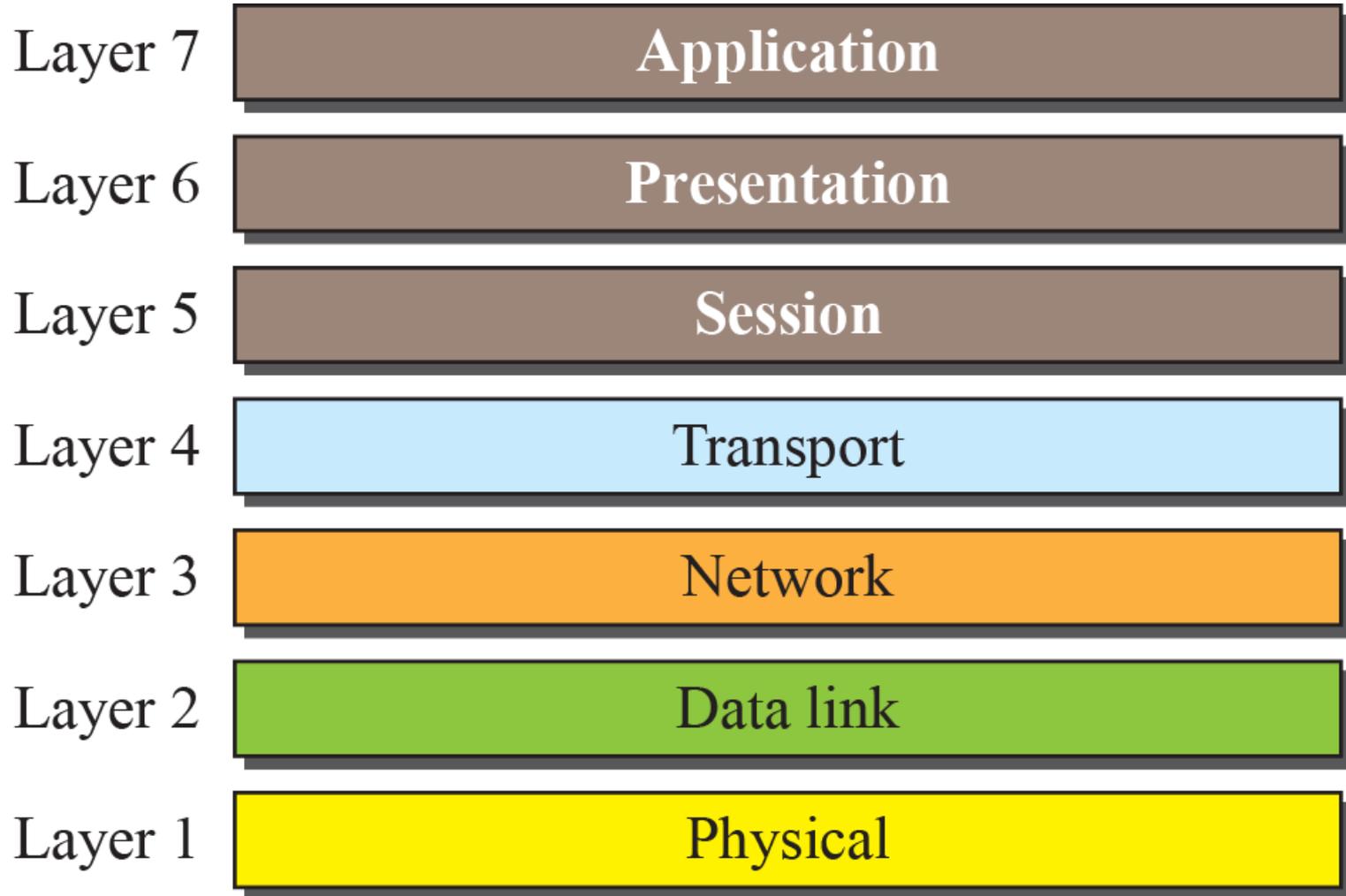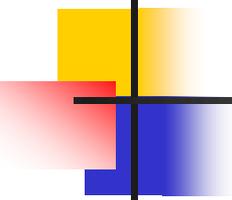
2.3.1 OSI versus TCP/IP

When we compare the two models, we find that two layers, session and presentation, are missing from the TCP/IP protocol suite. These two layers were not added to the TCP/IP protocol suite after the publication of the OSI model. The application layer in the suite is usually considered to be the combination of three layers in the OSI model, as shown in Figure 2.12.

Figure 2.12: TCP/IP and OSI model

OSI Model	TCP/IP Protocol Suite	
Application	Application	Several application protocols
Presentation		
Session		
Transport	Transport	Several transport protocols
Network	Network	Internet Protocol and some helping protocols
Data link	Data link	Underlying LAN and WAN technology
Physical	Physical	