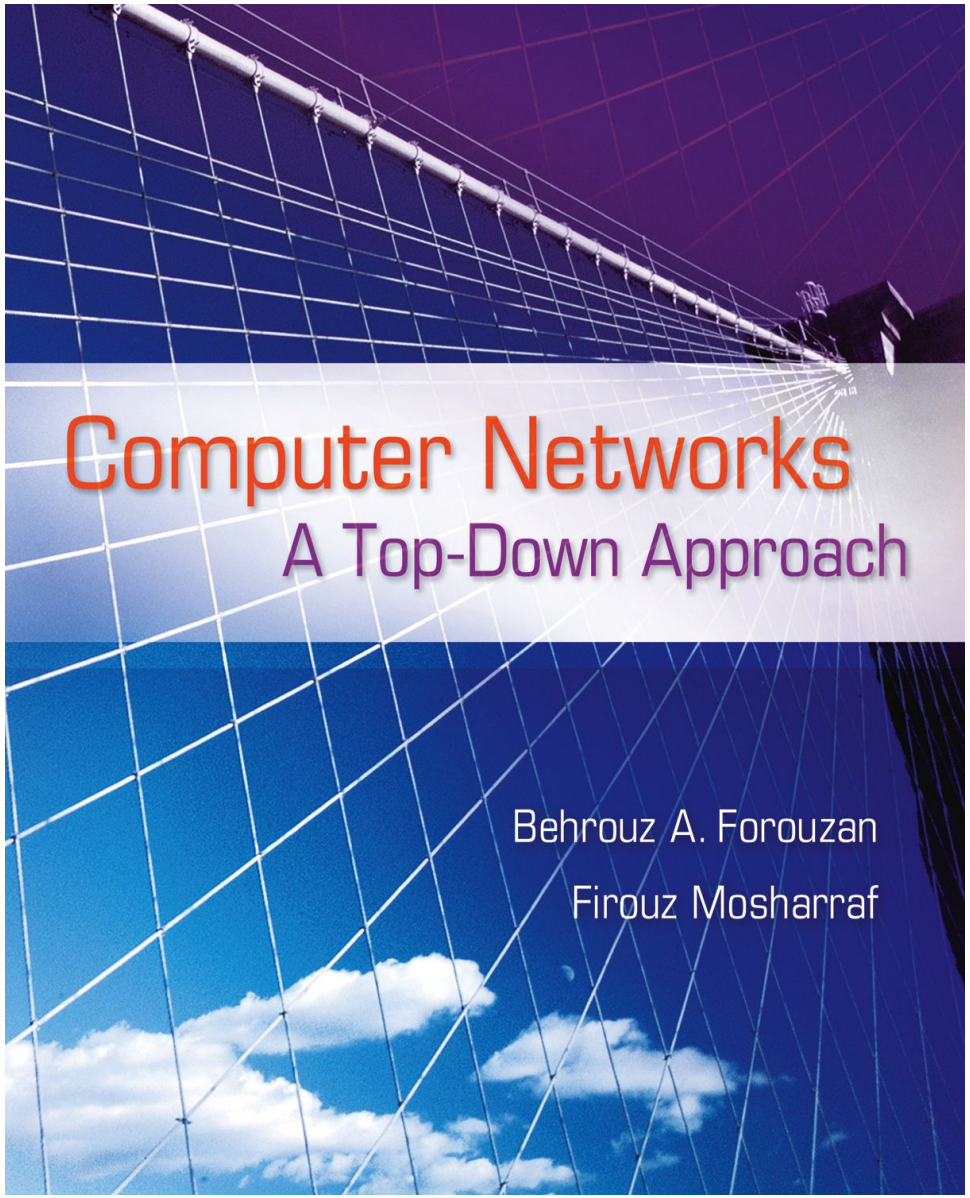
Chapter 1

Introduction



Chapter 1: Outline

1.1 Overview of the Internet

1.2 Protocol Layering

1.3 Internet History

1.4 Standards and Administration

Chapter 1: Objective

- *We introduce local area networks (LANs) and wide area networks (WANs) and show that an internet or the Internet is a combination of these networks.*
- *We introduce the concept of protocol layering to show how the task to be done by the Internet is divided into smaller tasks. We also discuss TCP/IP protocol suite and show the duty of each layer.*
- *We give a brief history of the Internet.*
- *We introduce the administration of the Internet and define the standards and their lifetime.*

1-1 OVERVIEW OF THE INTERNET

We start our journey by first defining a network. We then show how we can connect networks to create small internetworks. Finally, we show the structure of the Internet and open the gate to study the Internet in the next ten chapters.

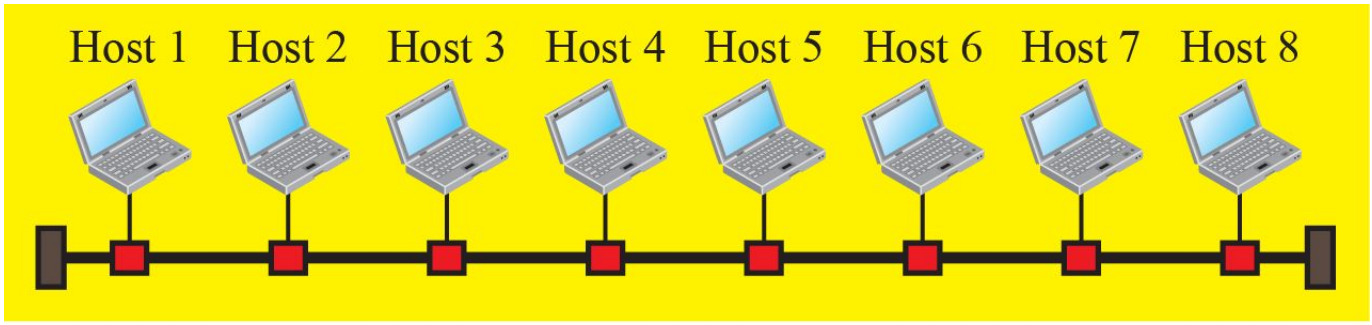
1.1.1 Networks

A network is the interconnection of a set of devices capable of communication. In this definition, a device can be a host such as a large computer, desktop, laptop, workstation, cellular phone, or security system. A device in this definition can also be a connecting device such as a router a switch, a modem that changes the form of data, and so on.

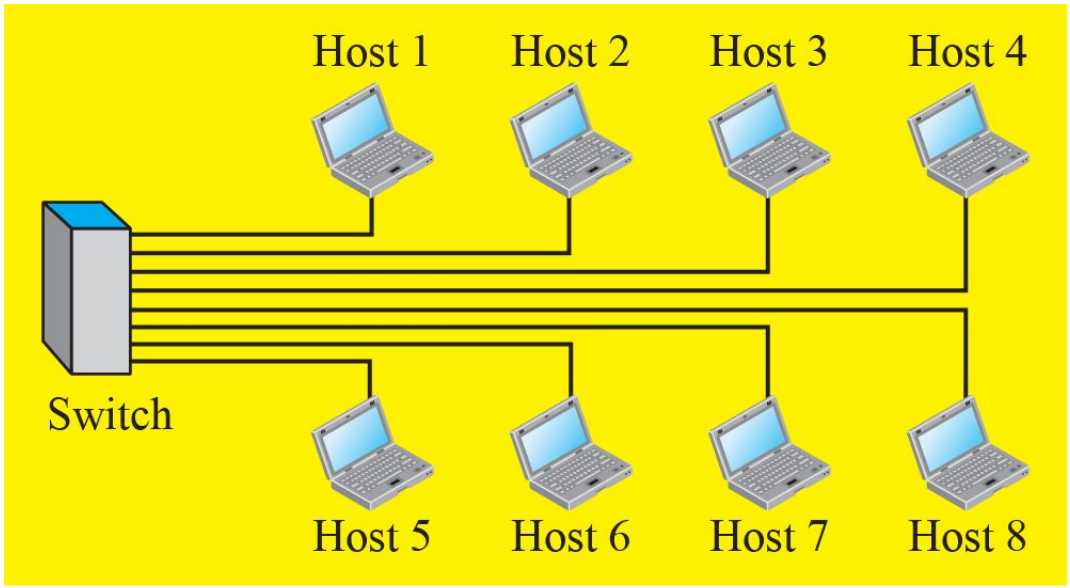
1.1.1 Networks (Continued)

- *Local Area Networks*
- *Wide Area Networks*
  - *Point-to-Point WANs*
  - *Switched WANs*
- *Internetwork*

Figure 1.1: An Isolated LAN in the past and today



a. LAN with a common cable (past)



b. LAN with a switch (today)

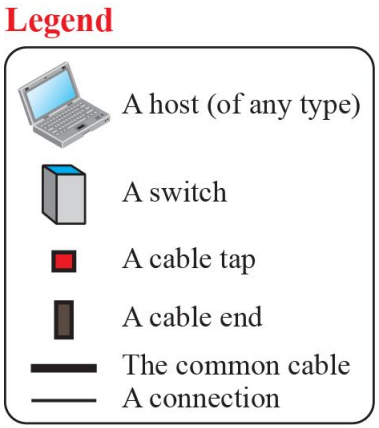


Figure 1.2: A Point-to-Point WAN

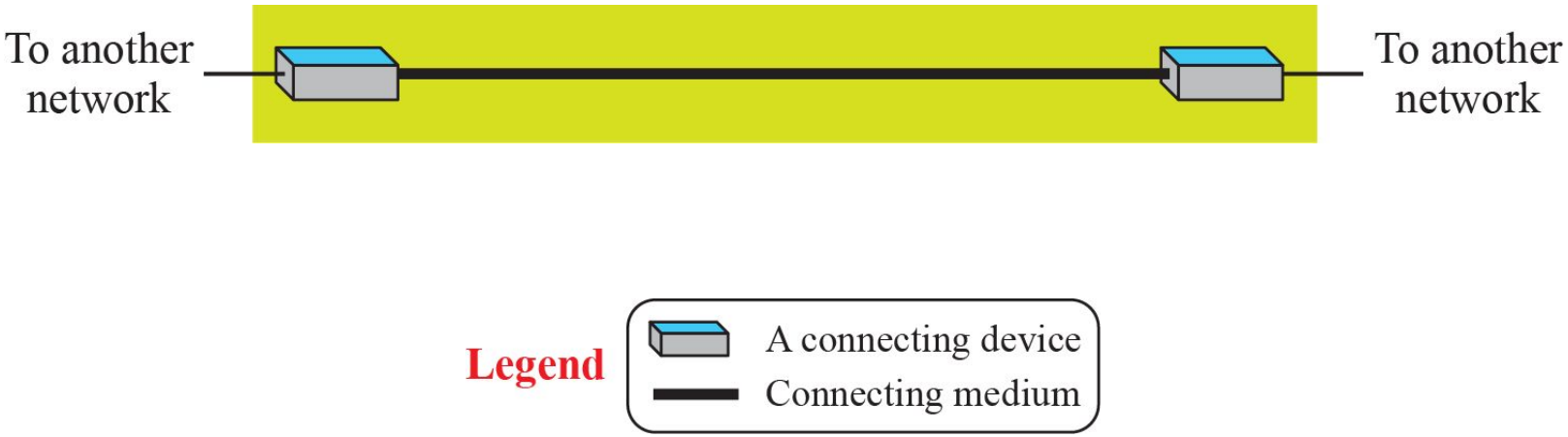


Figure 1.3: A Switched WAN

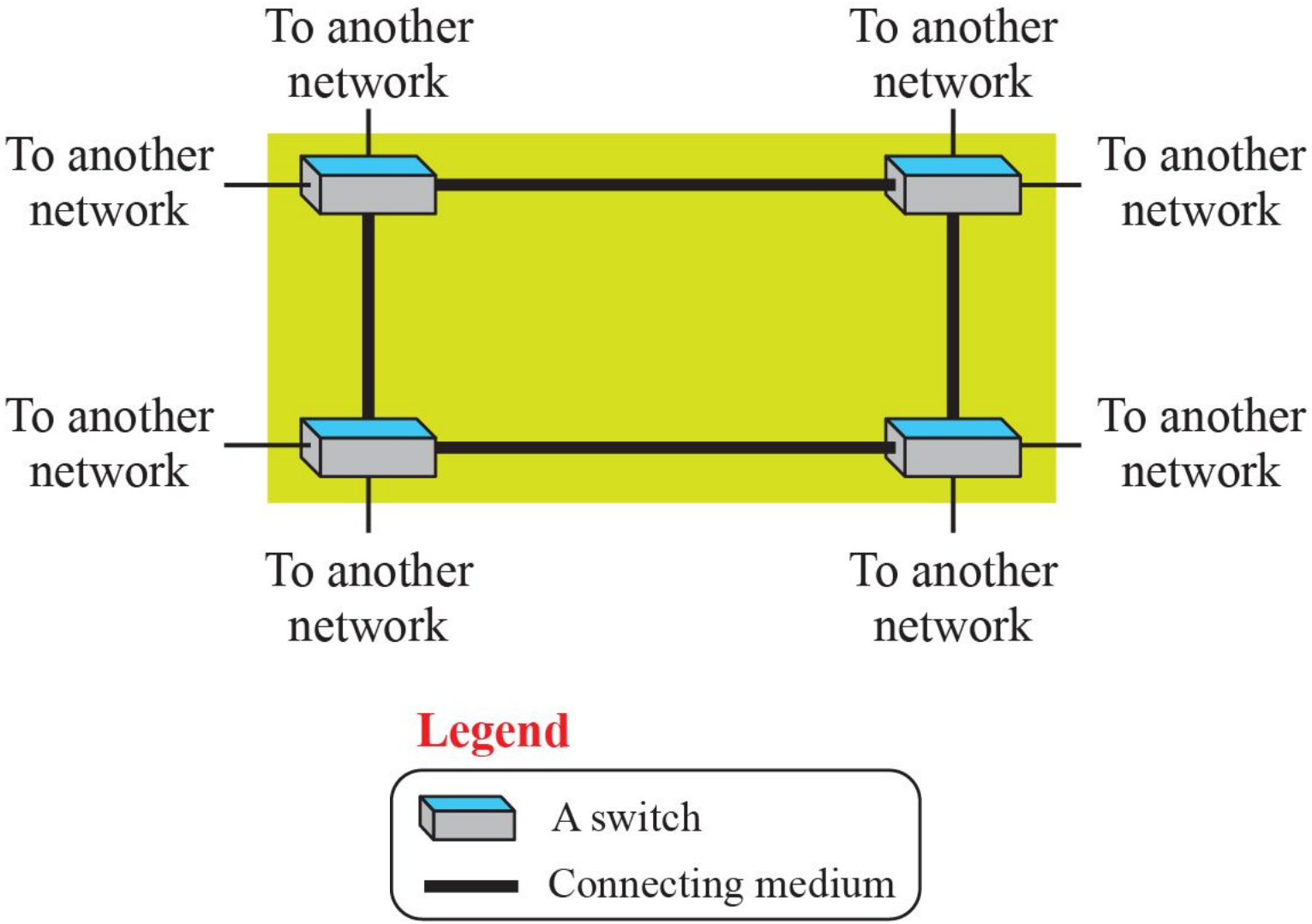


Figure 1.4: An internetwork made of two LANs and one WAN

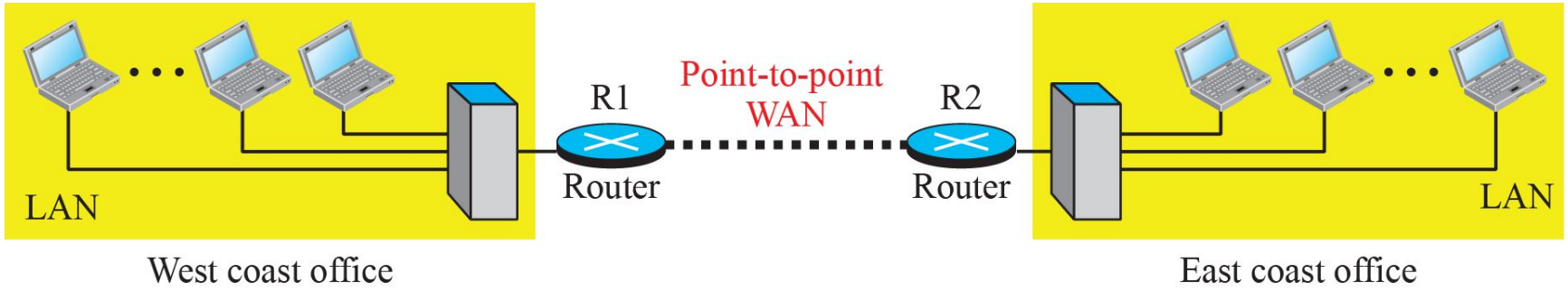
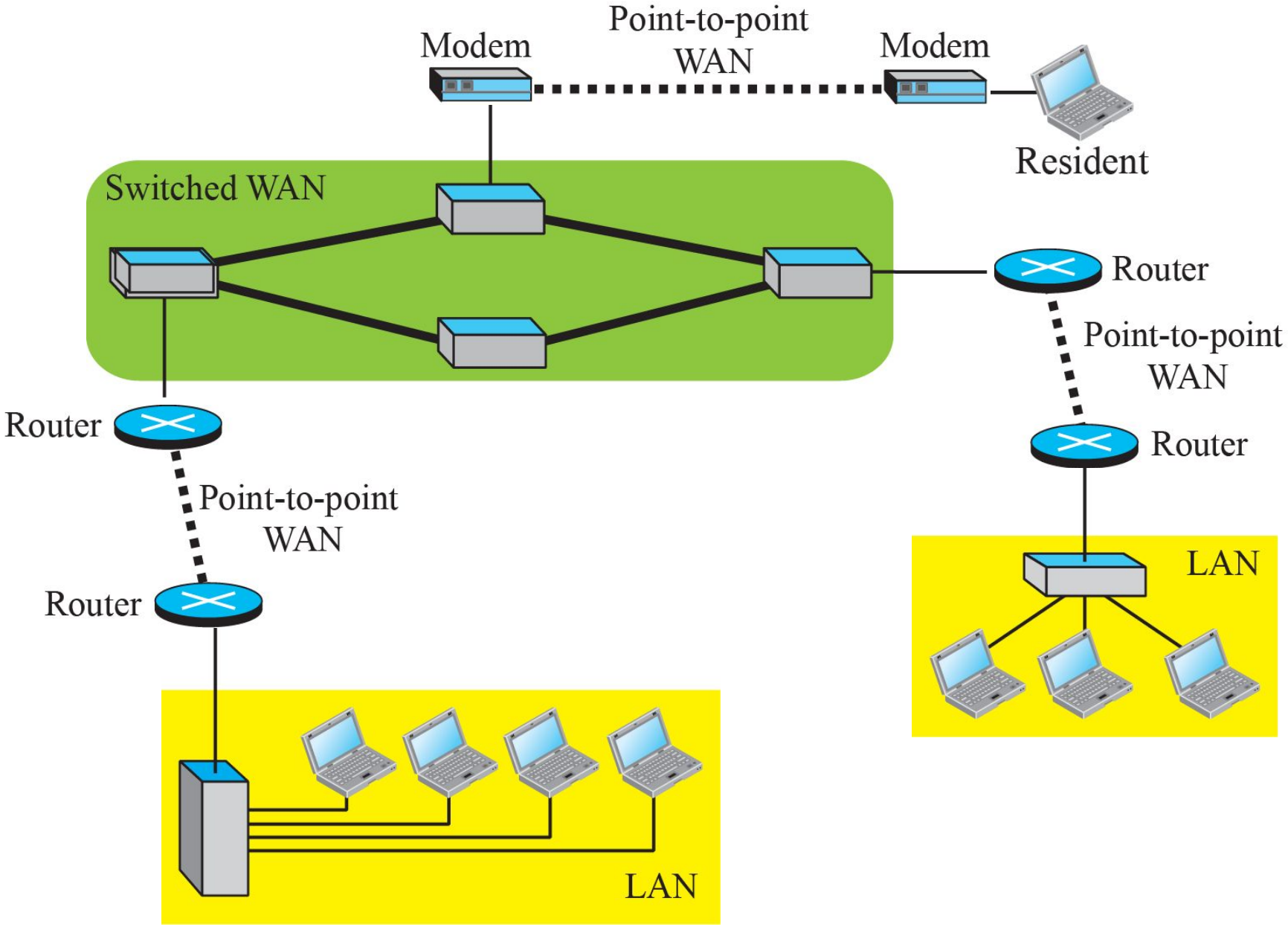


Figure 1.5: *A heterogeneous network made of WANs and LANs*



1.1.2 Switching

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

- *Circuit-Switched Network*
- *Packet-Switched Network*

Figure 1.6: A circuit-switched network

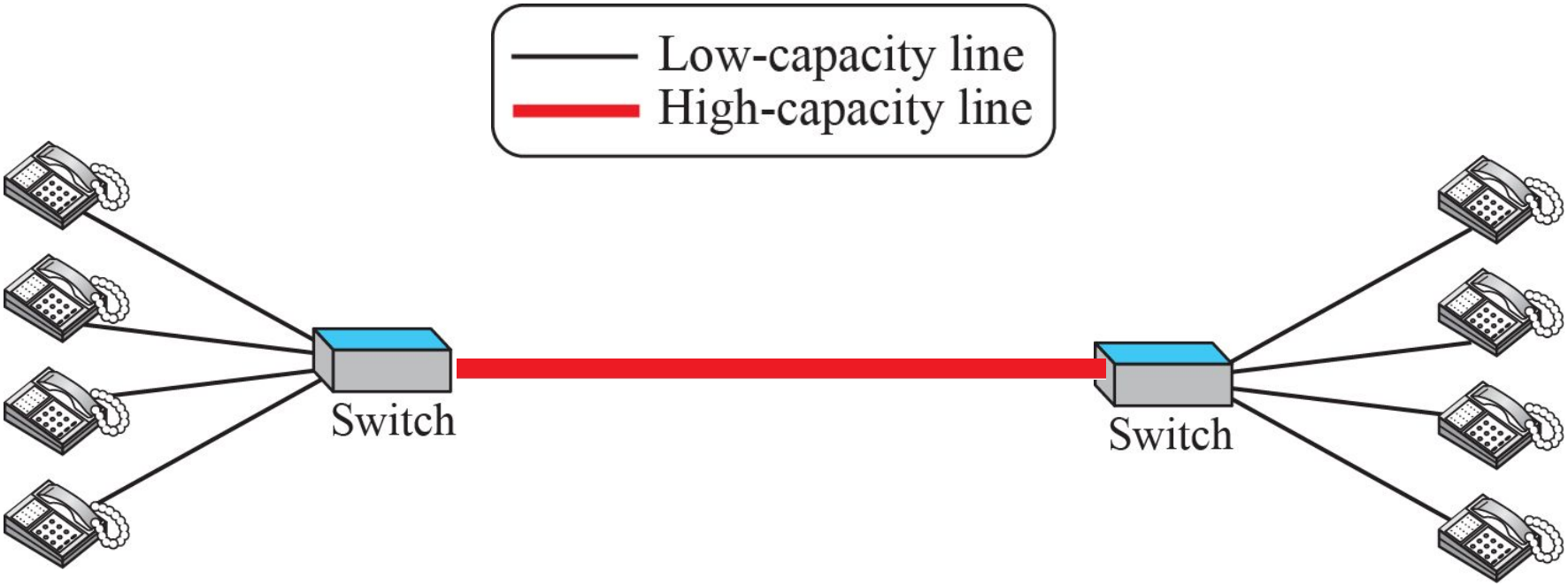
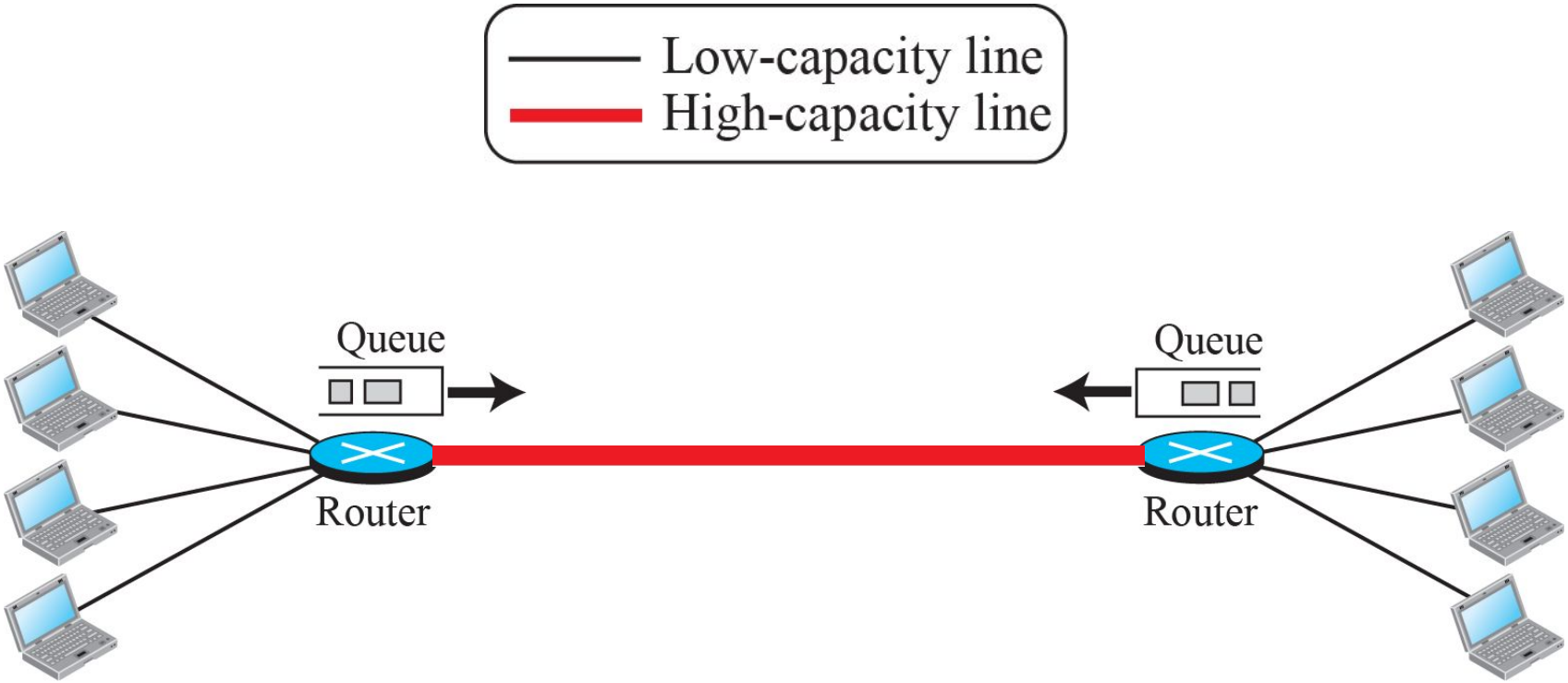


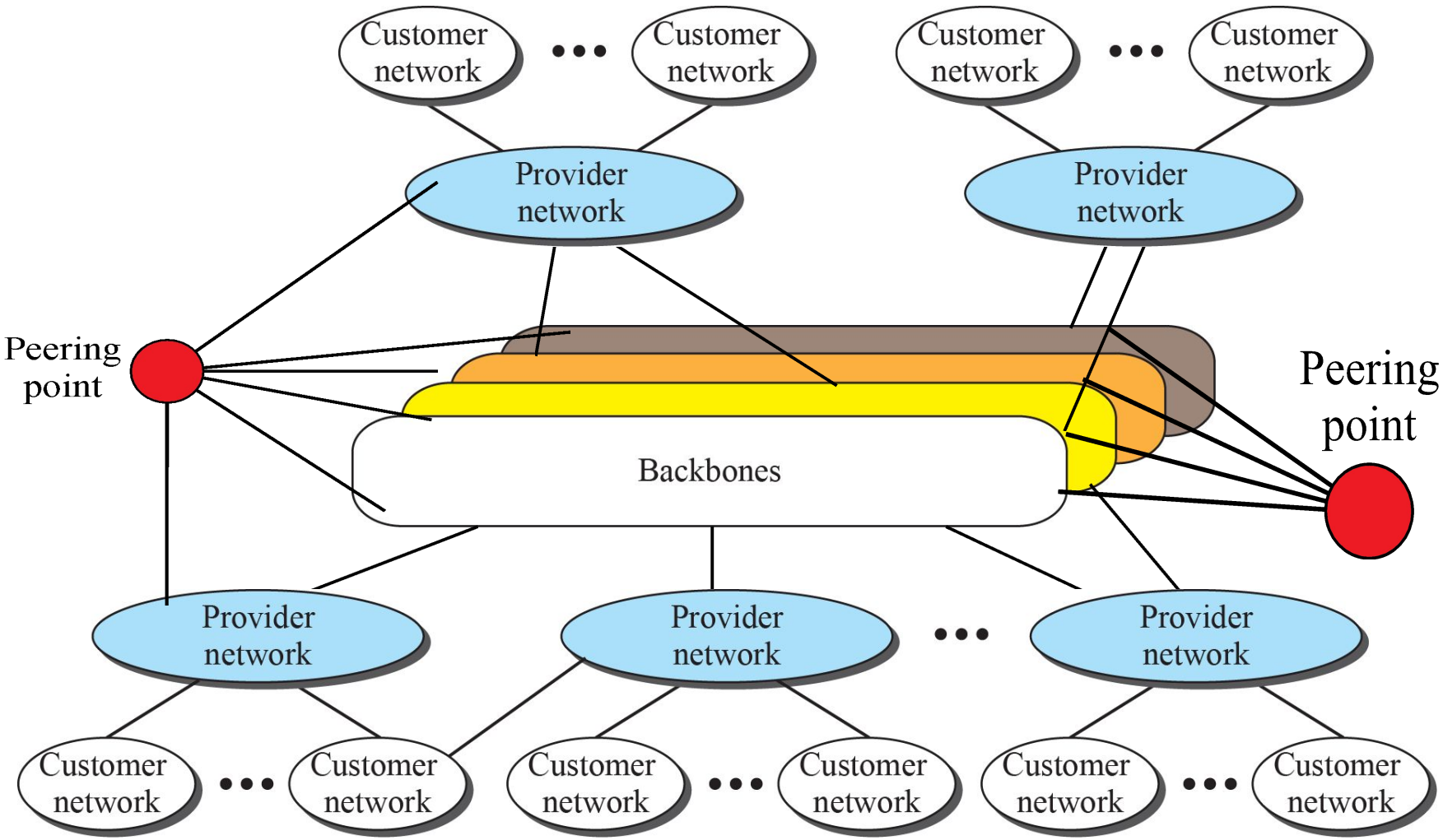
Figure 1.7: A packet-switched network



1.1.3 The Internet

The most notable internet is called the Internet and is composed of thousands of interconnected networks. Figure-1.8 shows a conceptual (not geographical) view of the Internet.

Figure 1.8: The Internet today



1.1.4 Accessing the Internet

The Internet today is an internetwork that allows any user to become part of it. The user, however, needs to be physically connected to an ISP. The physical connection is normally done through a point-to-point WAN. In this section, we briefly describe how this can happen, but we postpone the technical details of the connection until Chapters 6 and 7.

1.1.4 Accessing the Internet (continued)

- Using Telephone Networks
  - Dial-up Service
  - DSL
- Using Cable Networks
- Using Wireless Networks
- Direct Connection

1.1.5 Hardware and Software

We have given the overview of the Internet structure. For communication to happen, we need both hardware and software. This is similar to a complex computation in which we need both a computer and a program. In the next section, we show how these combinations of hardware and software are coordinated with each other using protocol layering.

1-2 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.

1.2.1 Scenarios

Let us develop two simple scenarios to better understand the need for protocol layering.

- *First Scenario (Figure 1.9)*
- *Second Scenario (Figure 1.10)*
- *Principle of Protocol Layering*
- *Logical Connections*

Figure 1.9: A single-layer protocol

Figure 1.10: A three-layer protocol

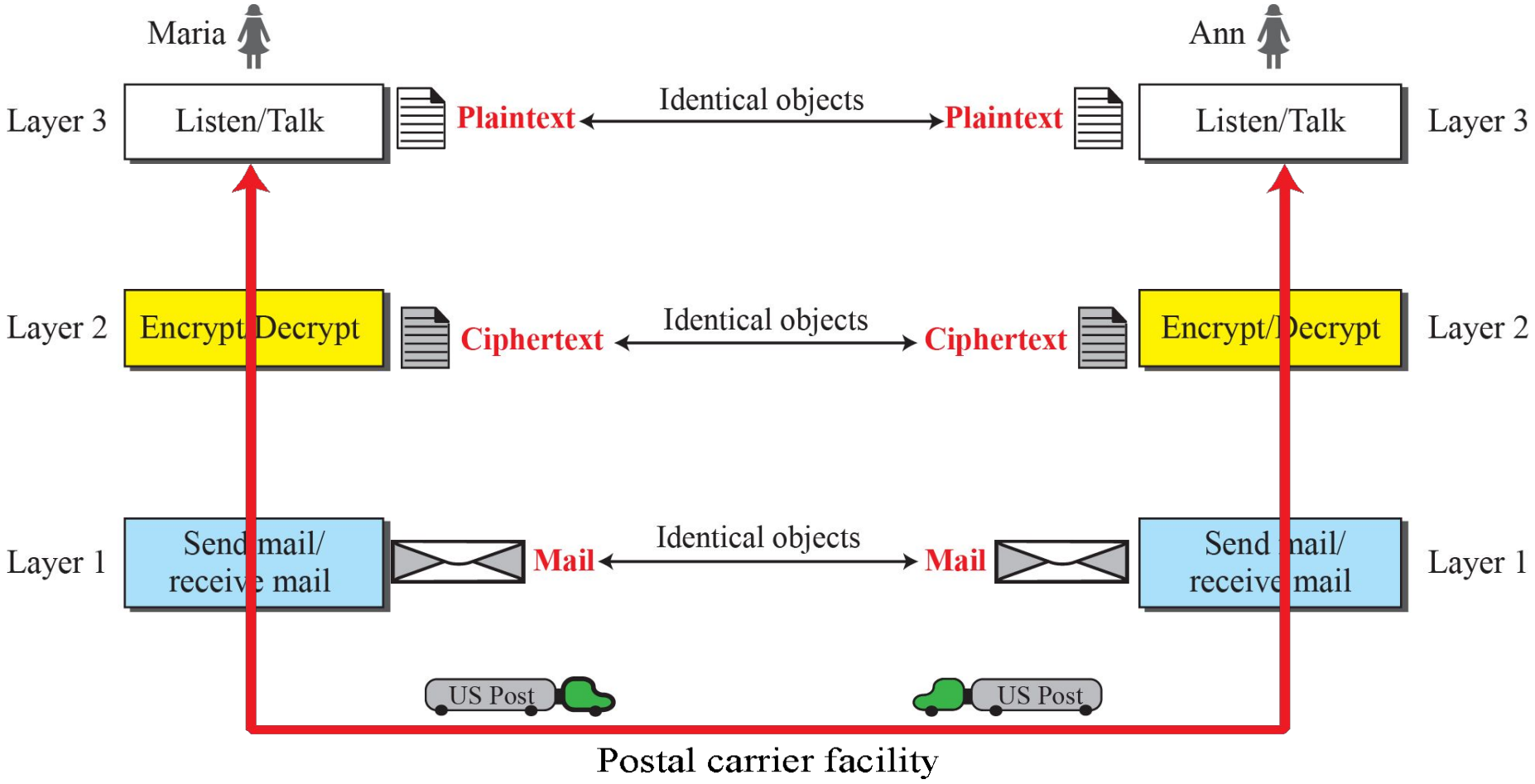
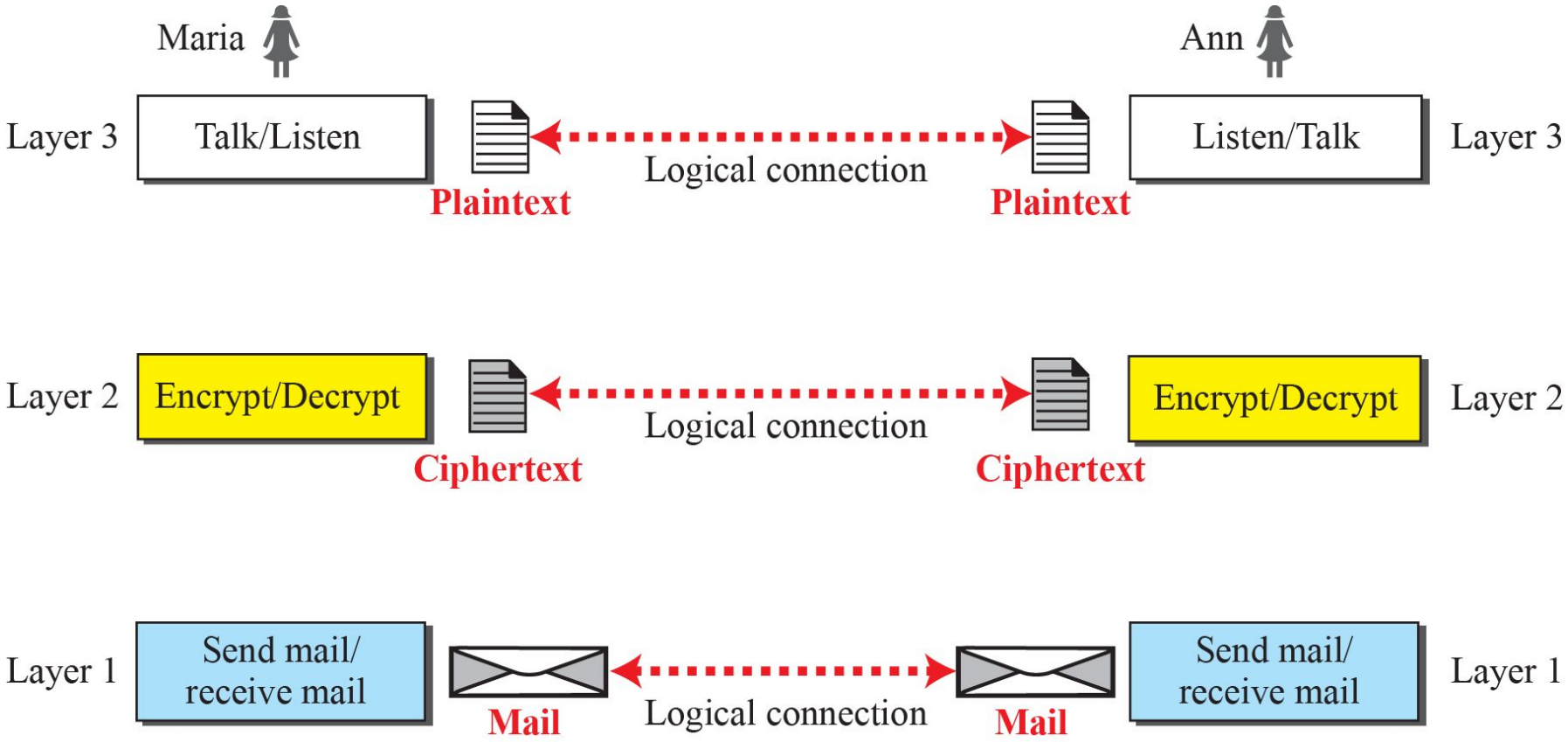


Figure 1.11: Logical connection between peer layers



1.2.2 TCP/IP Protocol Suite (continued)

- Layered Architecture
- Layered in the Suite
- Description of Each Layer
  - Application Layer
  - Transport Layer
  - Network Layer
  - Data-link Layer
  - Physical Layer

1.2.2 TCP/IP Protocol Suite

TCP/IP is a protocol suite used in the Internet today. It is a hierarchical protocol made up of interactive modules, each of which provides a specific functionality. The term hierarchical means that each upper level protocol is supported by the services provided by one or more lower level protocols. The original TCP/IP protocol suite was defined as four software layers built upon the hardware. Today, however, TCP/IP is thought of as a five-layer model.

1.2.2 TCP/IP Protocol Suite (continued)

- *Encapsulation and Decapsulation*
  - *Encapsulation at the Source Host*
  - *Decapsulation and Encapsulation at Router*
  - *Decapsulation at the Destination Host*
- *Addressing*
- *Multiplexing and Demultiplexing*

Figure 1.12: Layers in the TCP/IP protocol suite

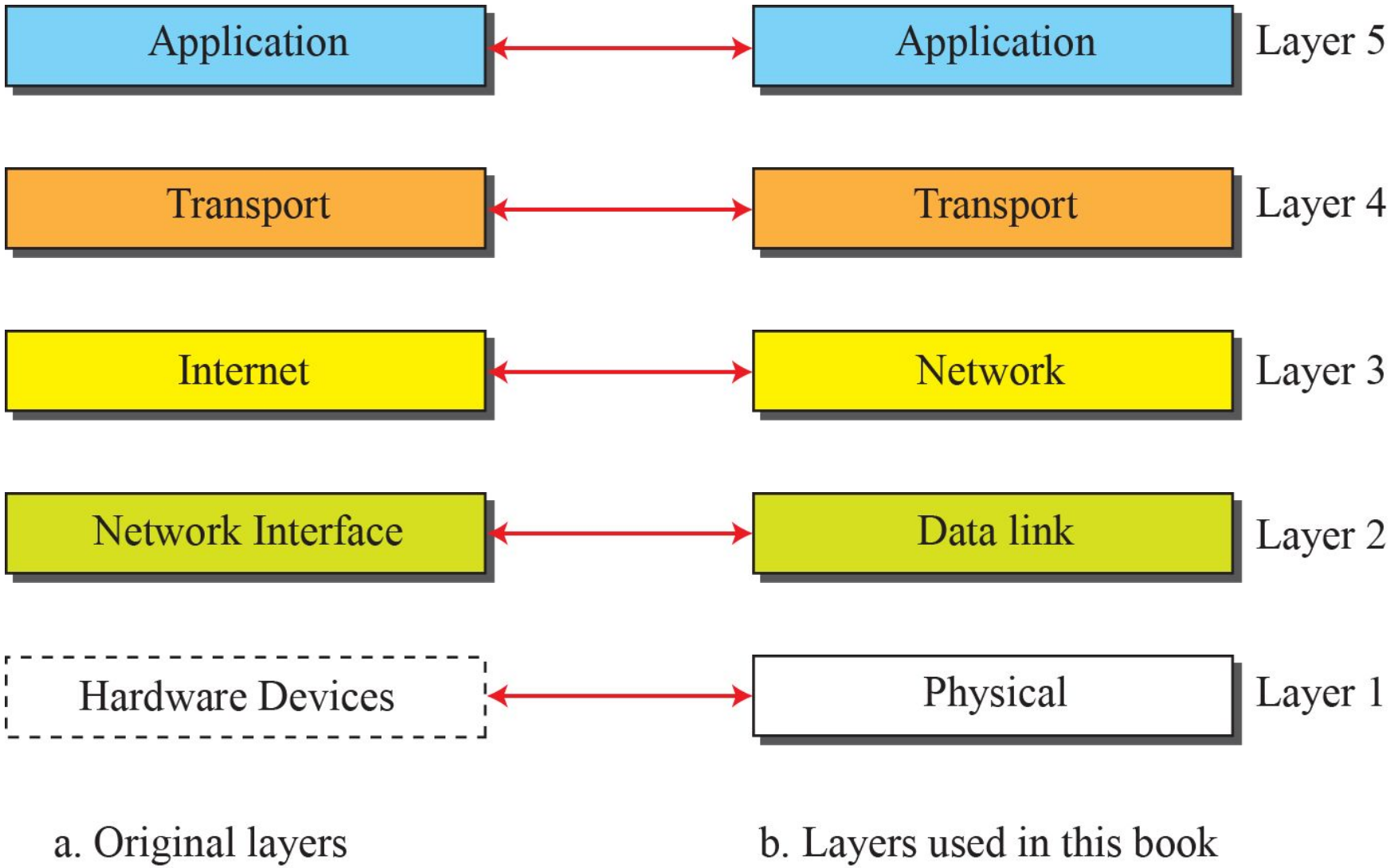


Figure 1.13: Communication through an internet

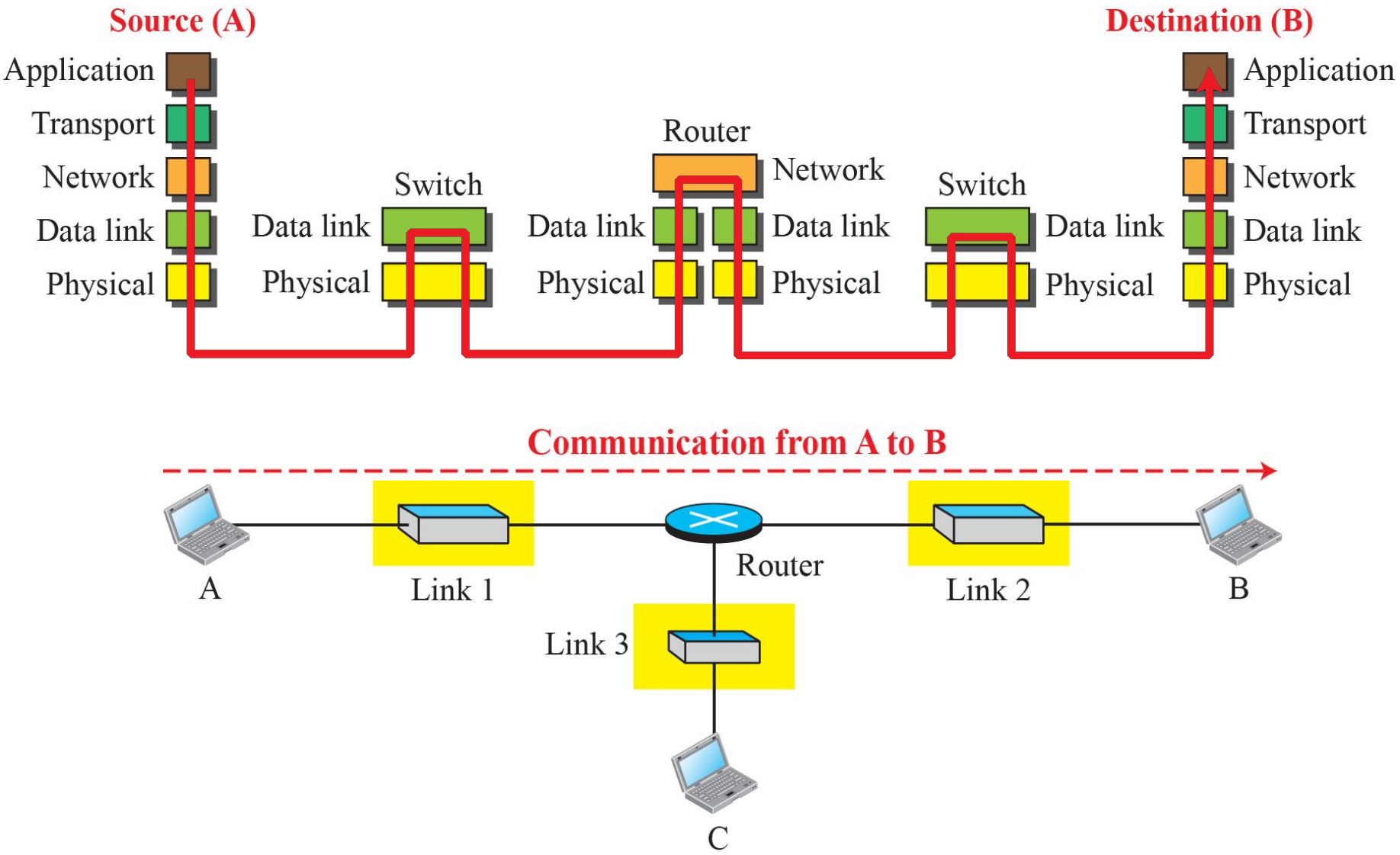


Figure 1.14: Logical connections between layers in TCP/IP

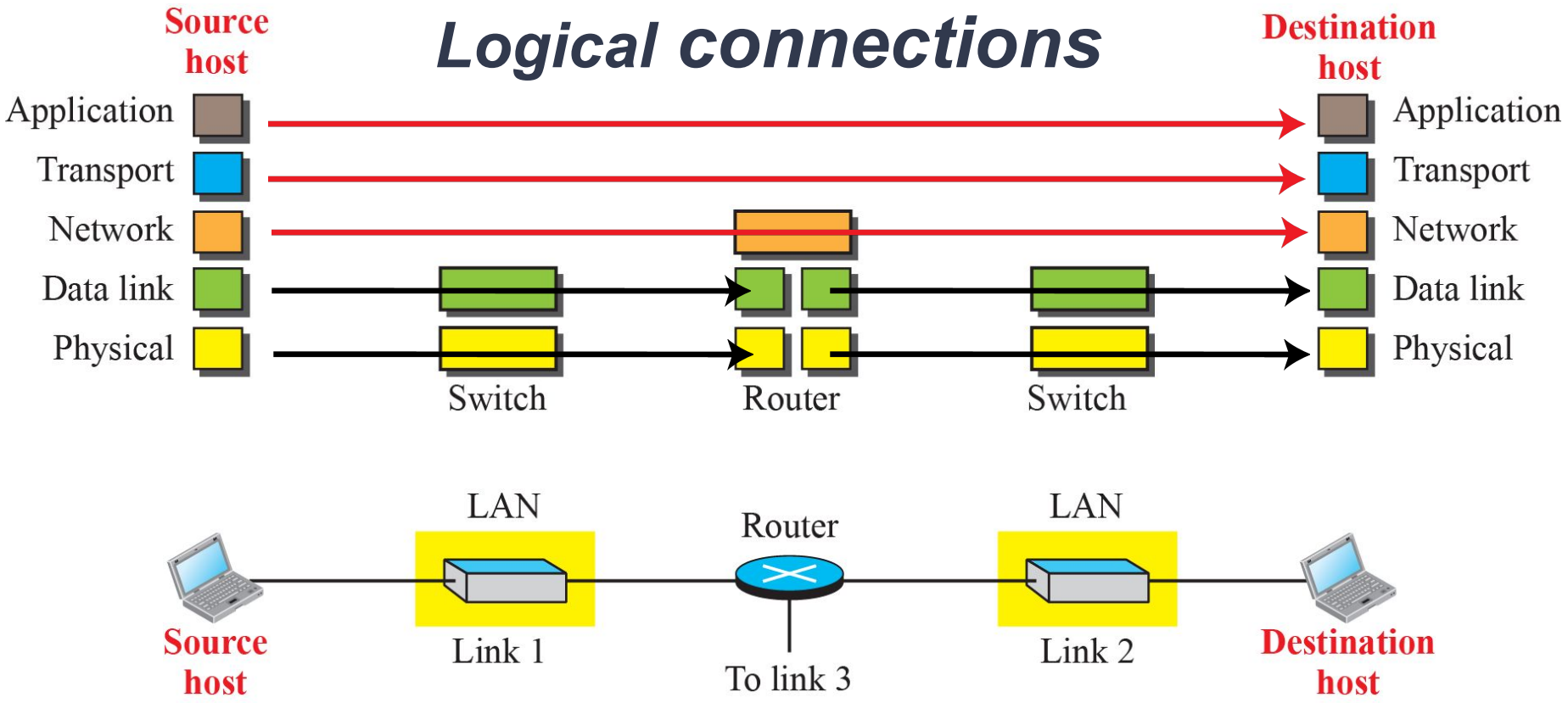


Figure 1.15: Identical objects in the TCP/IP protocol suite

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

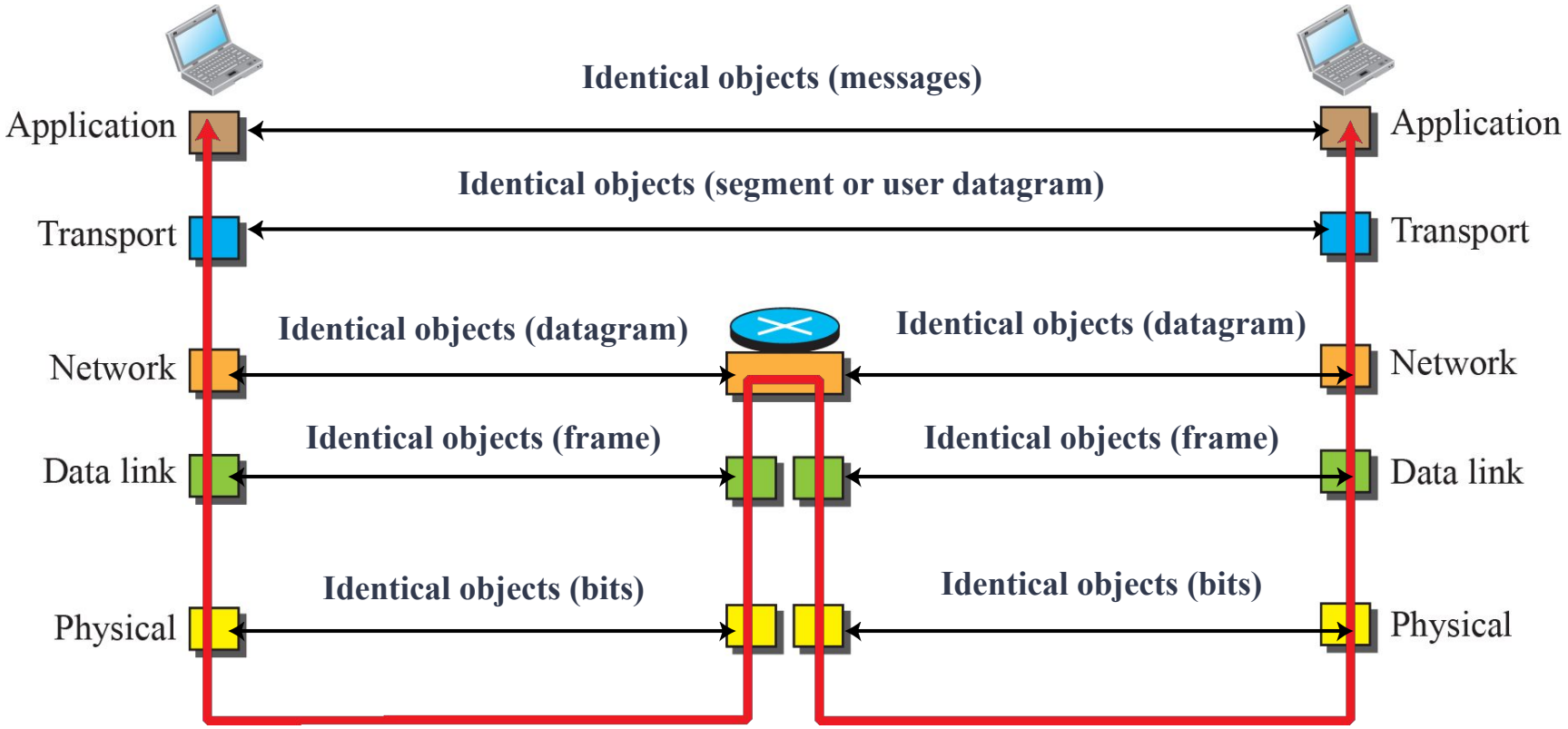


Figure 1.16: Encapsulation / Decapsulation

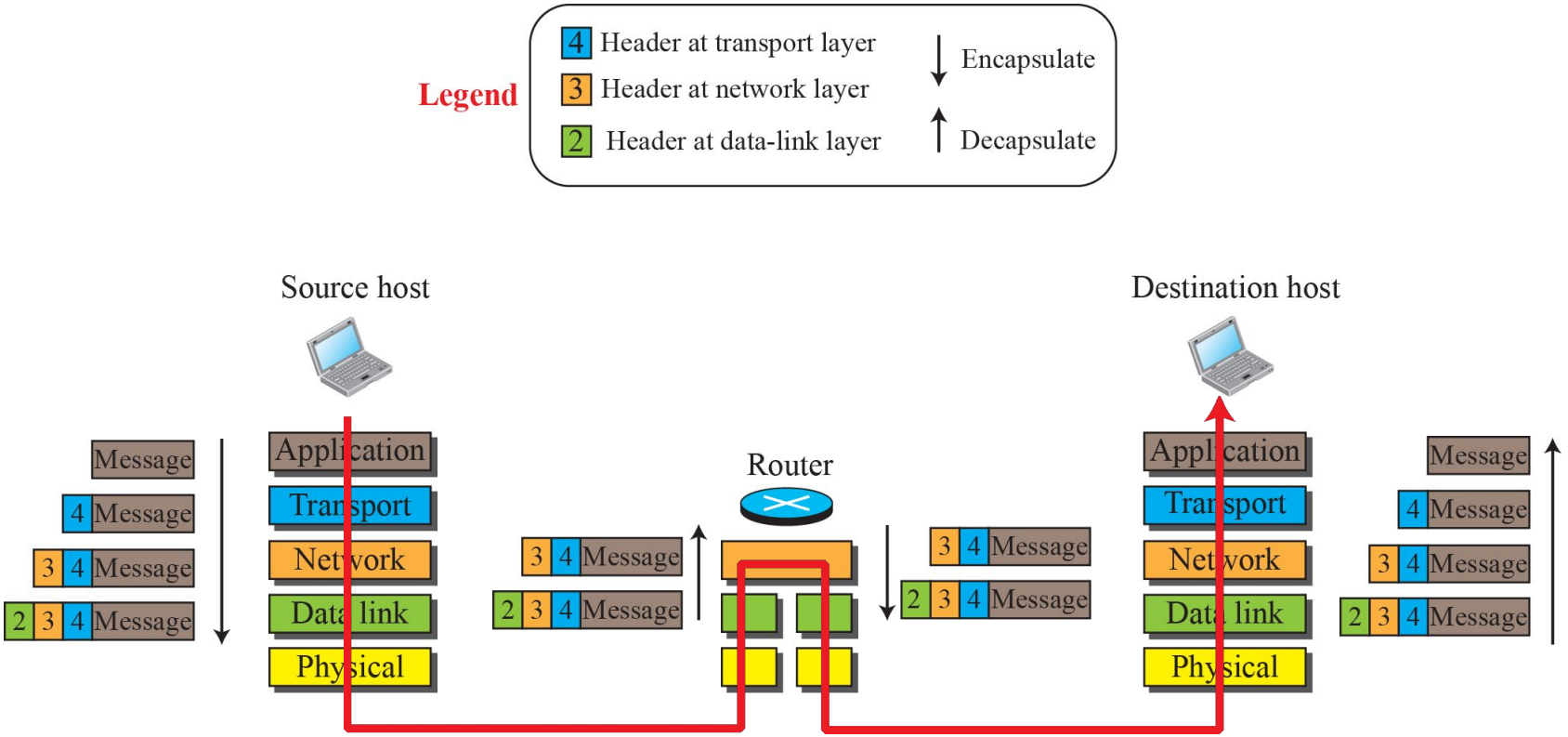


Figure 1.17: Addressing in the TCP/IP protocol suite

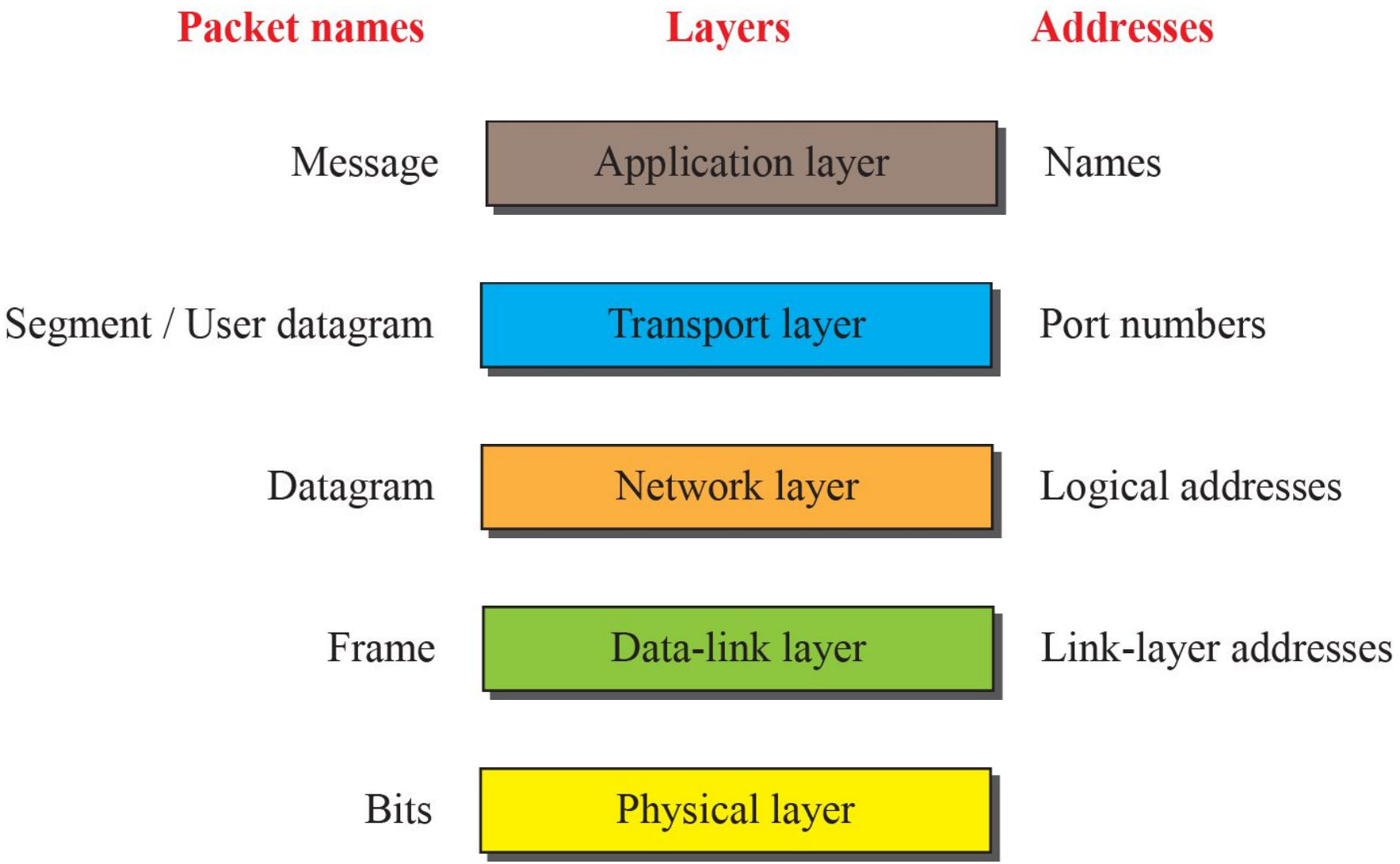
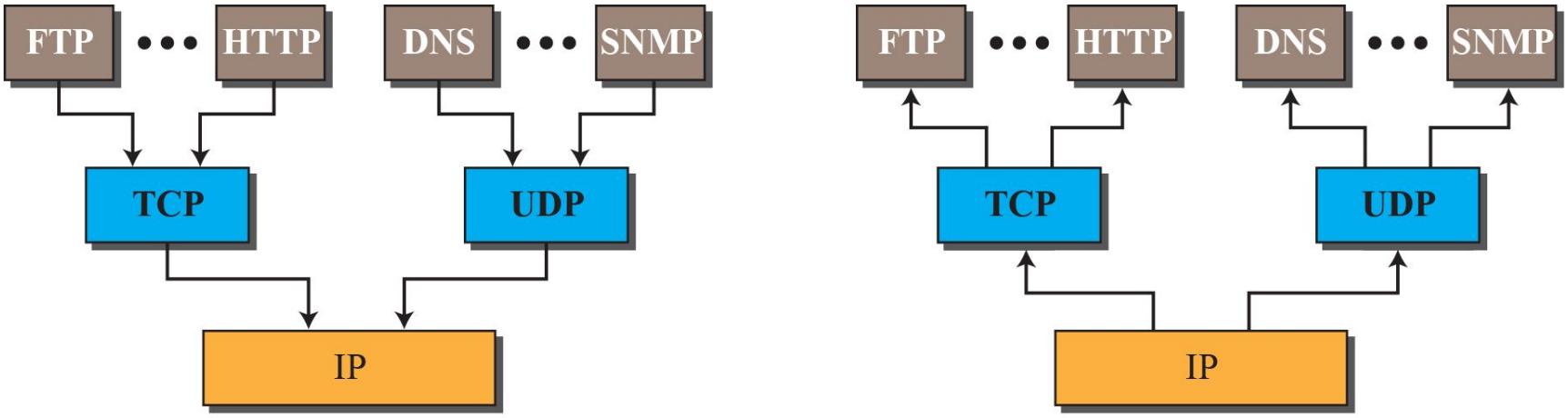


Figure 1.18: Multiplexing and demultiplexing



a. Multiplexing at source

b. Demultiplexing at destination

1.2.2 The OSI Model

Established in 1947, 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.

- *OSI versus TCP/IP*
- *Lack of OSI Model's Success*

Figure 1.19: The OSI model

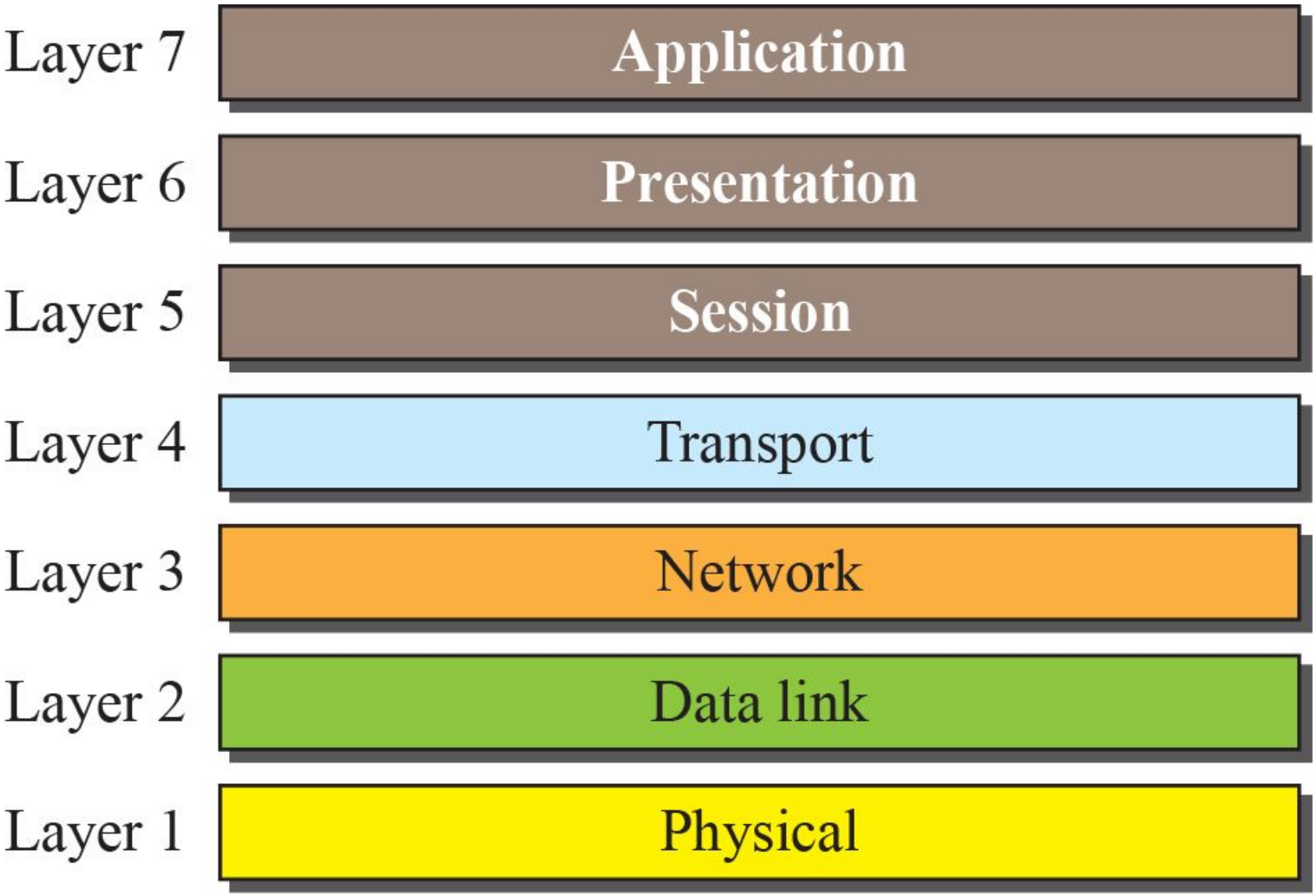
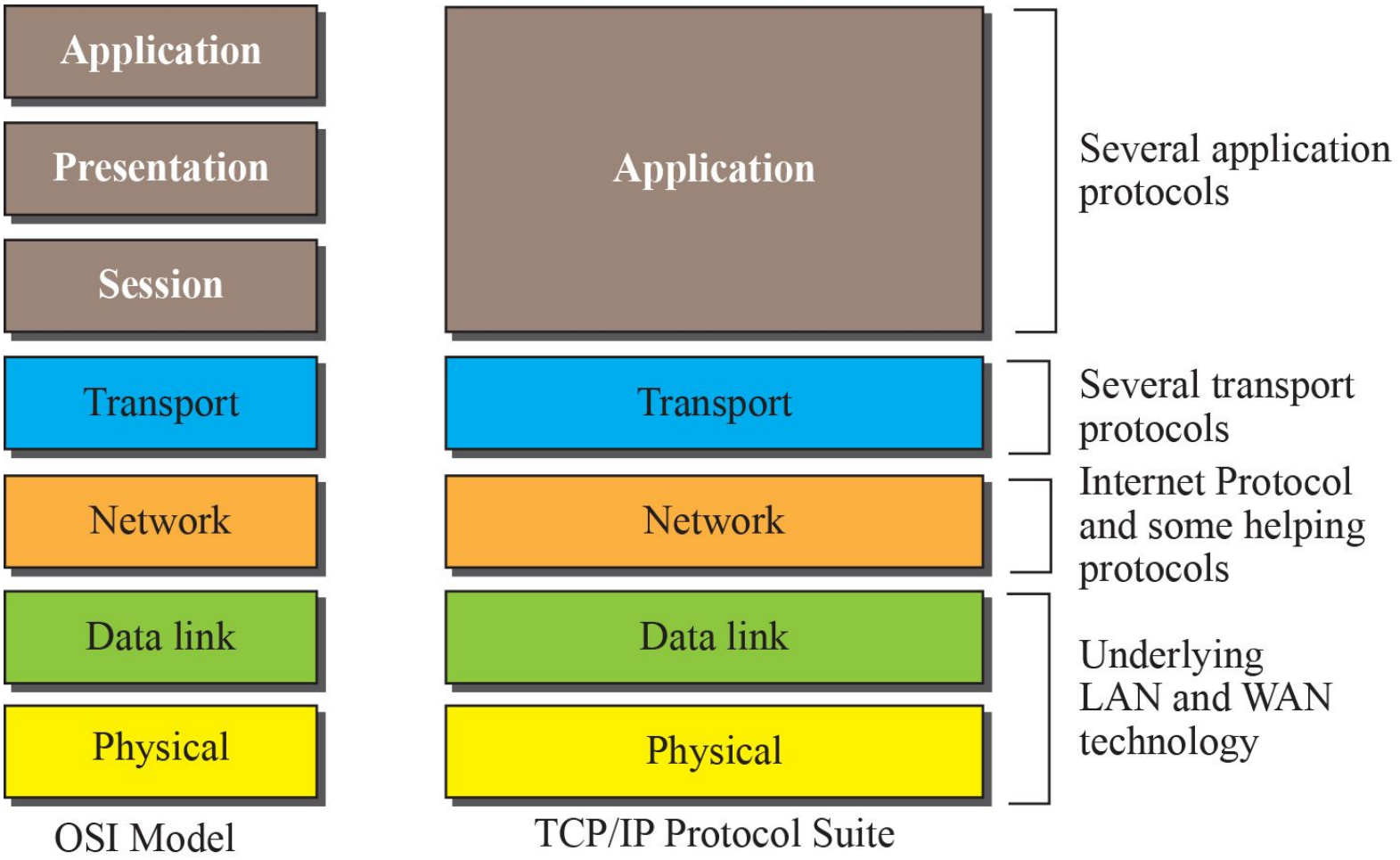


Figure 1.20: TCP/IP and OSI model



1-3 INTERNET HISTORY

Now that we have given an overview of the Internet and its protocol, let us give a brief history of the Internet. This brief history makes it clear how the Internet has evolved from a private network to a global one in less than forty years.

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1.3.2 Early History

There were some communication networks, such as telegraph and telephone networks, before 1960. These networks were suitable for constant-rate communication at that time, which means that after a connection was made between two users, the encoded message (telegraphy) or voice (telephony) could be exchanged.

- *Birth of Packet-Switched Networks*
- *ARPANET*

1.3.3 Birth of the Internet

In 1972, Vint Cerf and Bob Kahn, both of whom were part of the core ARPANET group, collaborated on what they called the Internetting Project. They wanted to link dissimilar networks so that a host on one network could communicate with a host on another. There were many problems to overcome: diverse packet sizes, diverse interfaces, and diverse transmission rates, as well as differing reliability requirements.

1.3.3 Birth of the Internet (continued)

- *TCP/IP*
- *MILNET*
- *CSNET*
- *NSFNET*
- *ANSNET*

1.3.3 Internet Today

Today, we witness a rapid growth both in the infrastructure and new applications. The Internet today is a set of pier networks that provide services to the whole world. What has made the Internet so popular is the invention of new applications.

- *World Wide Web*
- *Multimedia*
- *Peer-to-Peer Applications*

1-4 STANDARDS AND ADMINISTRATION

In the discussion of the Internet and its protocol, we often see a reference to a standard or an administration entity. In this section, we introduce these standards and administration entities for those readers that are not familiar with them; the section can be skipped if the reader is familiar with them.

1.4.1 Internet Standards

An Internet standard is a thoroughly tested specification that is useful to and adhered to by those who work with the Internet. It is a formalized regulation that must be followed. There is a strict procedure by which a specification attains Internet standard status. A specification begins as an Internet draft.

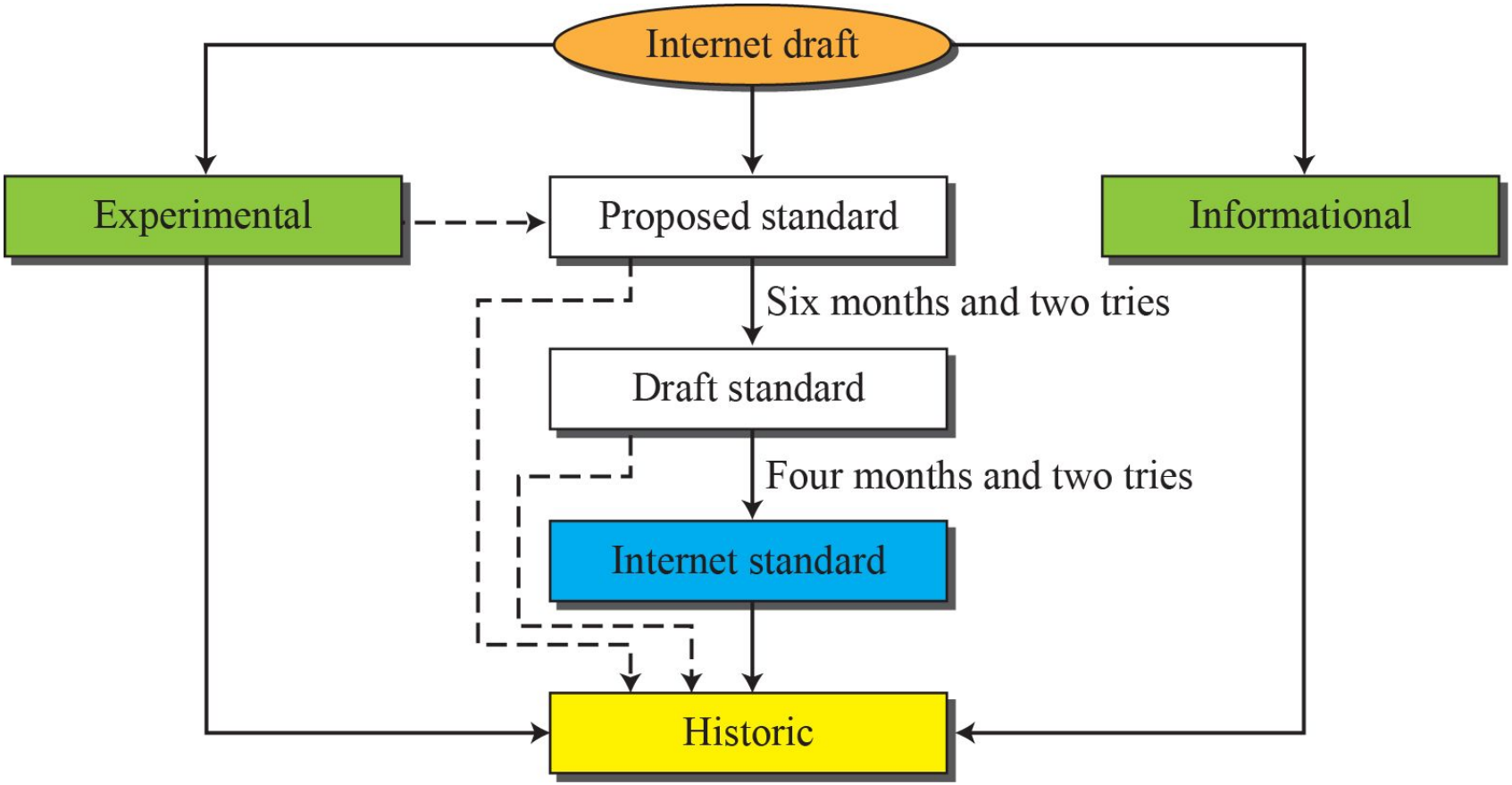
1.4.1 Internet Standards (Continued)

- **Maturity Levels**
  - Proposed Standard
  - Draft Standard
  - Internet Standard
  - Historic
  - Experimental
  - Informational

1.4.1 Internet Standards (Continued)

- **Requirement Levels**
  - Required
  - Recommended
  - Elective
  - Limited Use
  - Not Recommended

Figure 1.21: Maturity levels of an RFC



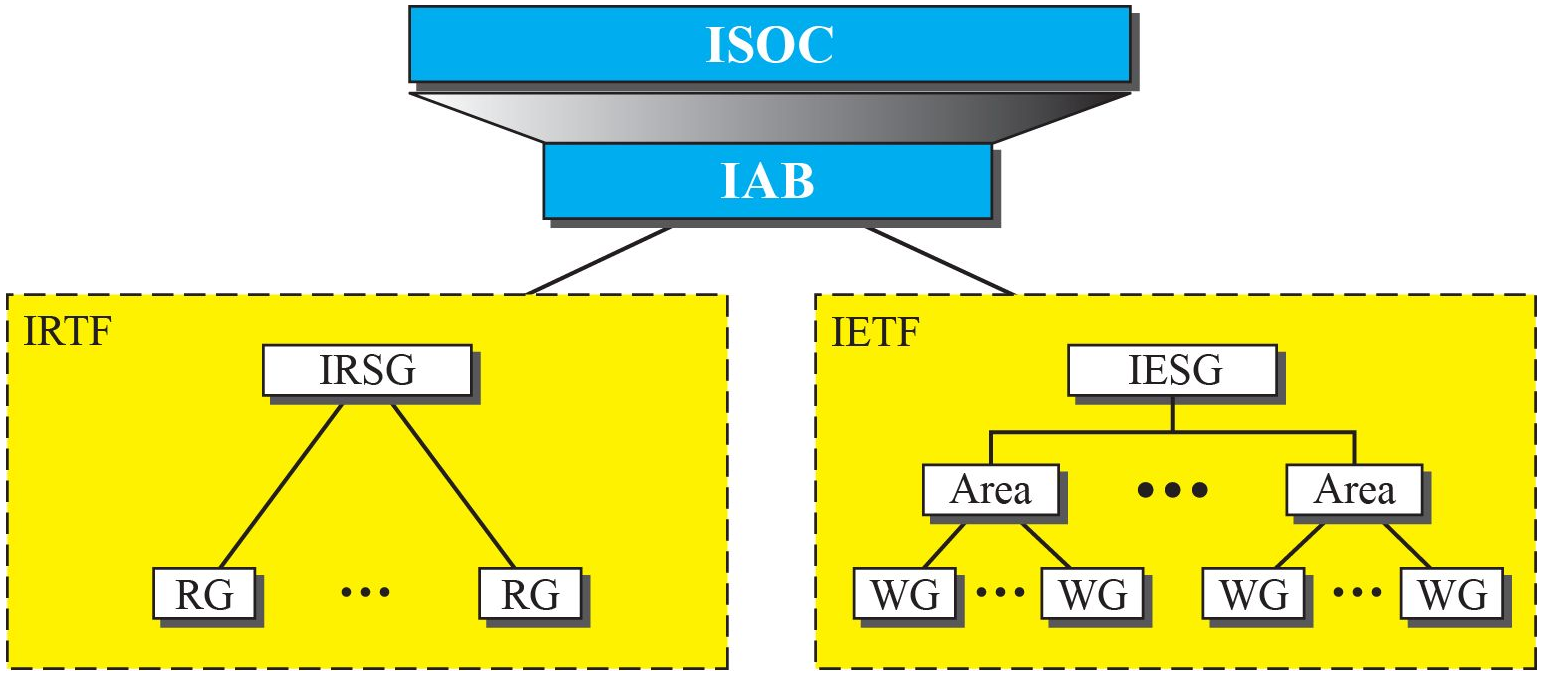
1.4.2 Internet Administration

The Internet, with its roots primarily in the research domain, has evolved and gained a broader user base with significant commercial activity. Various groups that coordinate Internet issues have guided this growth and development. Appendix D gives the addresses, e-mail addresses, and telephone numbers for some of these groups.

1.4.2 Internet Administration (continued)

- ISOC
- IAB
- IETF
- IANA and ICANN
- Network Information Center (NIC)

Figure 1.22: Internet administration



Chapter 1: Summary (continued)

- *The history of internetworking started with ARPA in the mid-1960s. The birth of the Internet can be associated with the work of Cerf and Kahn and the invention of a gateway to connect networks. The Internet administration has evolved with the Internet. We discussed ISOC, IAB, IETF, IRTF, ICANN, and NIC.*

- *An Internet standard is a thoroughly tested specification. An Internet draft is a working document with no official status and a six-month lifetime. A draft may be published as a Request for Comment (RFC). RFCs go through maturity levels and are categorized according to their requirement level.*