People communicate. One way or another, they exchange some information among themselves all the times. In the past several decades, many electronic technologies have been invented to aid this process of exchanging information in an efficient and creative way. Among these are the creation of fixed telephone networks, the broadcasting of television and radio, the advent of computers, the rise of the Internet, and the emergence of wireless sensation. Originally, these technologies existed and operated independently, serving their very own purposes. Not until recently that these technological wonders have started to converge, and it is a well-known fact that a computer communication network is a result of this convergence.

This chapter presents an overview of computer communication networks and the basics of simulation of such a network. Section 1.1 introduces a computer network along with the reference model which is used for describing the architecture of a computer communication network. A brief discussion on designing and modeling a complex system such as a computer network is then given in Sect. 1.2. In Sect. 1.3, the basics of computer network simulation are discussed. Section 1.4 presents one of the most common type of network simulation, namely, the time-dependent simulation. An example simulation is given in Sect. 1.5. Finally, Sect. 1.6 summarizes the chapter.

1.1 Computer Networks and the Layering Concept

A computer network is usually defined as a collection of computers interconnected for gathering, processing, and distributing information. Computer is used as a broad term here to include devices such as workstations, servers, routers, modems, base stations, and wireless extension points. These computers are connected by communication links such as copper cables, fiber optic cables, and microwave/satellite/radio links. A computer network can be built as a nesting and/or interconnection of several networks. The Internet is a good example of computer
networks. In fact, it is a network of networks, within which tens of thousands of networks interconnect millions of computers worldwide.

### 1.1.1 Layering Concept

A computer network is a complex system. To facilitate design and flexible implementation of such a system, the concept of *layering* is introduced. Using a layered structure, the functionalities of a computer network can be organized as a stack of layers.

Logically, each layer communicates to its peer (a logical entity on the same layer) on the other communication node. However, the actual data transmission occurs through the lowest layer, namely, the physical layer. Therefore, data at the source node always move down the layers until reaching the physical layer. Then, it is transmitted via a physical link to a neighboring node or the destination node. At the destination node, the data are passed to the layers until reaching the corresponding peer.

Representing a well-defined and specific part of the system, each layer provides certain *services* to the above layer. When performing a task (e.g., transmit a packet), an upper layer asks its lower layer to do more specific job. Accessible (by the upper layers) through so-called interfaces, these services usually define *what* should be done in terms of network operations or primitives, but do not specifically define *how* such things are implemented. The details of how a service is implemented are defined in a so-called protocol.

A protocol is a set of rules that *multiple* peers comply with when communicating to each other.\(^1\) As long as the peers abide to a protocol, the communication performance would be consistent and predictable. As an example, consider an error detection protocol. When a transmitter sends out a data packet, it may wait for an acknowledgment from the receiver. The receiver, on the other hand, may be responsible for acknowledging to the transmitter that the transmitted packets are received successfully.

The beauty of this layering concept is the layer independency. That is, a change in a protocol of a certain layer does not affect the rest of the system as long as the interfaces remain unchanged. Here, we highlight the words *services, protocol,* and *interface* to emphasize that it is the interaction among these components that makes up the layering concept.

Figure 1.1 graphically shows an overall view of the layering concept used for communication between two computer hosts: a source host and a destination host. In this figure, the functionality of each computer host is divided into four

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\(^1\)Unlike a protocol, an algorithm is a set of steps to get things done (either with or without communications).