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CHAPTER 9
Networking

Data communications is an essential component of every digital system. Some systems realize communications by direct interaction with the environment and some with the exchange of removable storage media such as tapes, disks, or memory modules. Many systems engage in data transfer that is more real-time in nature. When these communications begin to involve multiple end-points, high-speed transfers, and the need for reliable carriage of that data, the set of technologies that are broadly known as networking become directly relevant.

There is probably no single definition of networking that can always identify when it is or is not needed—the universe of applications is too diverse for such rigid definitions. The purpose of this chapter is to introduce mainstream networking concepts so that you can make the decision of whether a particular application demands networking or a simpler exchange of bits and bytes. Networking technologies blend hardware and software into algorithms that are implemented by either or both resources, depending on the specific context. Because of limitations of space and scope, this chapter concentrates on the hardware aspect of networking and how hardware is used to support the formats, protocols, and algorithms that make networking the flexible technology that it is.

The discussion begins with protocol layers to understand the separate logical functions that compose a network. Ethernet is frequently used as an example to further clarify networking concepts because of its ubiquity. Hardware support for networking most commonly resides at the lower layers of the protocol stack. The bulk of the chapter is concerned with transmission, recovery, and verification of data on the wire—essential tasks that serve as the foundation of data transfer. A brief presentation of Ethernet closes the chapter to provide an illustration of how networking technology functions in the real world.

9.1 PROTOCOL LAYERS ONE AND TWO

Networking systems can be highly complex and include many different hardware and software components. To facilitate the analysis and design of such systems, major functional sections are separated into *layers* whose definitions are reasonably standardized across the industry. Multiple layers are arranged from the lowest level on the bottom to the highest level on the top in a conceptual *protocol stack*. To transfer data from an application running on one computer to that on another, the data descends the stack's layers on one computer and then ascends the stack on the destination computer. The industry standard network stack definition is the *Open System Interconnection* (OSI) reference model shown in Fig. 9.1.

As with most conceptual classifications, it is important to recognize that not all networking schemes and implementations adhere strictly to the OSI seven-layer model. Some schemes may merge one or more layers together, thereby reducing the number of formally defined layers. Others