used with a battery-operated device, such as a smart phone, that uses lower voltages to reduce power consumption.

To a programmer, the most important abstractions are the items visible to software: the representations used for data and programs. The next sections consider data representation, and discuss how it is visible to programs; later sections describe how instructions are represented.

## 3.3 Definitions Of Bit And Byte

All data representation builds on digital logic. We use the abstraction *binary digit* (*bit*) to describe a digital entity that can have two possible values, and assign the mathematical names *0* and *1* for the two values.

Multiple bits are used to represent more complex data items. For example, each computer system defines a *byte* to be the smallest data item larger than a bit that the hardware can manipulate.

How big is a byte? The size of a byte is not standard across all computer systems. Instead, the size is chosen by the architect who designs the computer. Early computer designers experimented with a variety of byte sizes, and some special-purpose computers still use unusual byte sizes. For example, an early computer manufactured by CDC corporation used a six-bit byte, and a computer designed at BB&N used a ten-bit byte. However, most modern computer systems define a byte to contain eight bits — the size has become so widely accepted that engineers usually assume a byte size equal to eight bits, unless told otherwise. The point is:

> *Although computers have been designed with other size bytes, current computer industry practice defines a byte to contain eight bits.*

## 3.4 Byte Size And Possible Values

The number of bits per byte is especially important to programmers because memory is organized as a sequence of bytes. The size of the byte determines the maximum numerical value that can be stored in one byte. A byte that contains k bits can represent one of $2^k$ values (i.e., exactly $2^k$ unique strings of 1s and 0s exist that have length k). Thus, a six-bit byte can represent 64 possible values, and an eight-bit byte can represent 256 possible values. As an example, consider the eight possible combinations that can be achieved with three bits. Figure 3.1 illustrates the combinations.

```
000     010     100     110
001     011     101     111
```

**Figure 3.1** The eight unique combinations that can be assigned to three bits.