10.14 Dialup Modems

Another interesting application of modems involves the voice telephone system. Instead of using an electrical signal as a carrier, a *dialup modem* uses an audio tone. As with conventional modems, the carrier is modulated at the sending end and demodulated at the receiving end. Thus, besides the ability to place and receive telephone calls, the chief difference between dialup and conventional modems arises from the lower bandwidth of audible tones.

When dialup modems were first designed, the approach made complete sense — a dialup modem converted data into a modulated analog carrier because the telephone system transported analog signals. Ironically, the interior of a modern telephone system is digital. Thus, on the sending side, a dialup modem uses data to modulate an audible carrier, which is transmitted to the phone system. The phone system digitizes the incoming audio, transports a digital form internally, and converts the digitized version back to analog audio for delivery. The receiving modem demodulates the analog carrier, and extracts the original digital data. Figure 10.10 illustrates the ironic use of analog and digital signals by dialup modems.

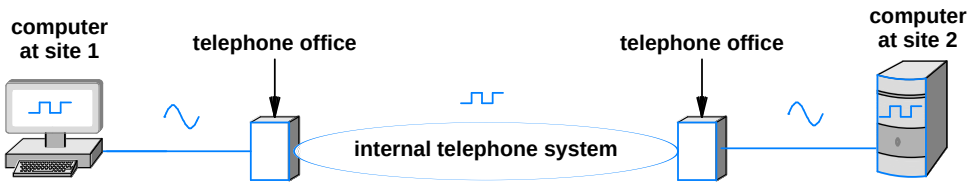

Figure 10.10 Illustration of digital and analog signals (denoted by a square wave and a sine wave) that occur when a dialup modem is used to send data from one computer to another.

As the figure indicates, a dialup modem is usually embedded in a computer. We use the term *internal modem* to denote an embedded device, and the term *external modem* to denote a separate physical device.

10.15 QAM Applied To Dialup

Quadrature Amplitude Modulation is also used with dialup modems as a way to maximize the rate at which data can be sent. To understand why, consider Figure 10.11, which shows the bandwidth available on a dialup connection. As the figure illustrates, most telephone connections transfer frequencies between 300 and 3300 Hz, but a given connection may not handle the extremes well. Thus, to guarantee better reproduction and lower noise, dialup modems use frequencies between 600 and 3000 Hz, which means the available bandwidth is 2400 Hz. A QAM scheme can increase the data rate dramatically.