Joe Casad

Sixth Edition

Sams Teach Yourself

TCP/IP in 24 Hours

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Cable Broadband

Demand for Internet services, and the ever-increasing capacity of computer systems, caused the industry to look for alternatives to the once-popular technique of connecting to the Internet through a slow and finicky phone modem. (You'll learn about phone connections later in this hour.) Rather than undertaking the huge expense of providing a whole new cabling infrastructure for every home that wanted access, service vendors looked for ways to provide Internet services over existing wires.

One form of residential cabling that has proved quite capable of supporting Internet services is the cable television network. Cable-based broadband is now common in many parts of the world. A typical cable modem connection is shown in Figure 9.1.

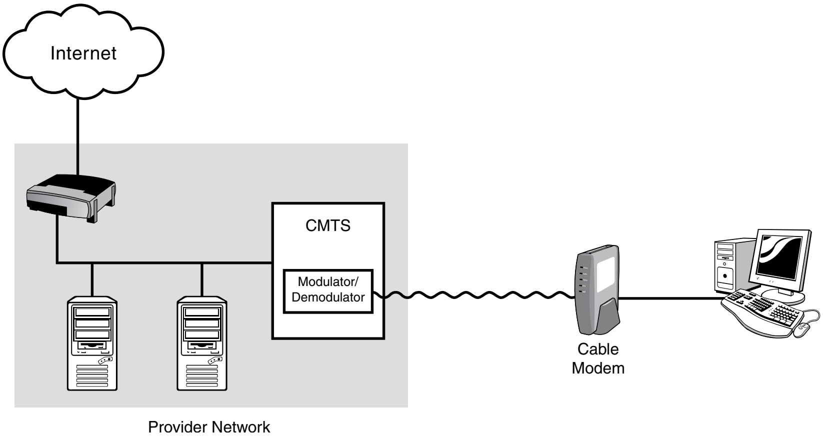

FIGURE 9.1
A typical cable modem configuration.

The cable modem connects directly to a coaxial cable that is connected to the cable TV service network. The modem typically has a single ethernet port, which is connected either to a single PC or to a switch or router attached to a small local network.

The term *modem* is short for modulator/demodulator. A cable modem, like a phone modem, modulates digital network transmissions to and from analog form to pass the data efficiently along the cable connection.

Another device called a **cable modem termination system (CMTS)** receives the signal from the cable modem and converts it back to digital form at the interface with the cable provider's network. The provider, in turn, leases bandwidth from an upstream Internet service provider (ISP), and a router on the provider's network connects the user with the rest of the Internet. The provider might also offer other support services, such as a Dynamic Host Configuration Protocol (DHCP) server to assign dynamic IP addresses to users on the network.

Although the cable modem does serve as an interface between two different transmission media, it is not actually a router but is, instead, more like a network bridge (which you learn about later in this hour). The cable modem filters traffic by the physical (Media Access Control [MAC]) address at the Network Access layer. In recent years, however, some manufacturers have begun building a cable modem into some residential router devices, so you might come across a combination device that serves as both a router and a cable modem.

Early cable modem vendors each had their own proprietary standards for managing communication over the cable medium. In the late 1990s, several cable companies developed the **Data Over Cable Service Interface Specification (DOCSIS)** as a standard for cable modem networks. As long as the CMTS and the cable modem are both DOCSIS compliant, the connection can occur without any special effort from the user, although, as a precaution against stolen services, cable companies typically require the user to preregister the MAC address of the cable modem to participate in the network.

Digital Subscriber Line

The other promising candidate for a home broadband transmission medium is the telephone network. Of course, the conventional telephone modem already uses the phone network, but telephone companies thought they could get better performance if they used a different approach. The result of this effort is a communications form known as a **digital subscriber line (DSL)**.

In fact, the twisted-pair cabling used in telephone networks has much more capacity than is typically used for voice communication. The DSL transceiver, which acts as an interface from the local network to the telephone network, operates in a frequency range that doesn't interfere with voice communication over the line. Consequently, DSL can operate continuously without tying up the line or interfering with phone service.

Like a cable network, a DSL network requires a device at the other end of the line that receives the signal and interfaces with the Internet through the provider's network. A device known as a **digital subscriber line access multiplexer (DSLAM)** serves as the other endpoint for the DSL connection (see Figure 9.2). Unlike on a cable network, where the medium is essentially shared by users on the segment, each DSL customer has a dedicated line from the transceiver to the DSLAM, which means that performance is less susceptible to degradation with increased traffic. You might say that, whereas a cable network is similar to a LAN, a DSL line is more like a point-to-point telephone connection.

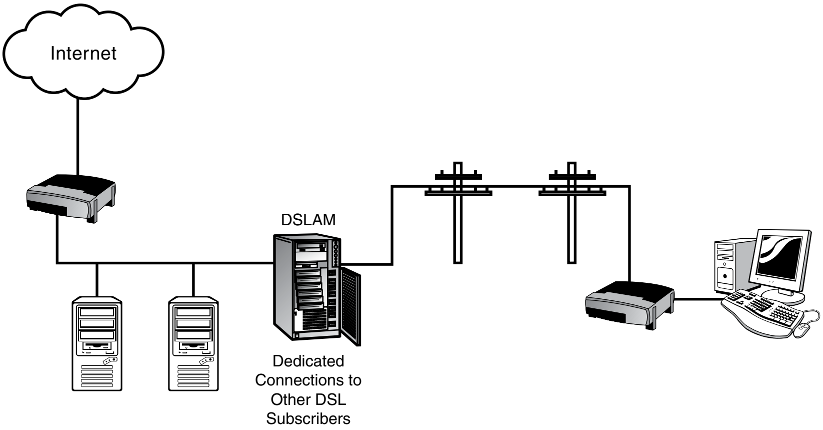

FIGURE 9.2
Connecting to the Internet with DSL.

DSL comes in several forms, including ADSL (asynchronous DSL, the most popular variant for small offices and homes), HDSL (high bit-rate DSL), VDSL (very high bit-rate DSL), SDSL (symmetric DSL, in which the upstream and downstream bandwidths are equal), and IDSL (ISDN over DSL). The view of DSL from the protocol level varies depending on the equipment and implementation. Some DSL devices are integrated with switches or routers. Other devices act as bridges (similar to a cable modem), filtering traffic at the Network Access layer by physical (MAC) address. DSL devices often encapsulate data in a point-to-point protocol such as PPP. The so-called PPP over ethernet protocol (PPPoE), for instance, is a popular option for DSL.

Wide Area Networks

Companies and large organizations with lots of computers require access options that aren't available through small-scale technologies such as dial-up and DSL. One crucial question is how to connect branch offices in different locations through an exclusive link that approximates a local network in privacy and provides adequate performance at high usage levels. This question gave rise to the development of the wide area network (**WAN**).

WAN technologies offer fast, high-bandwidth networking over large distances. Although WAN performance is not as fast as the performance of a LAN, it is typically much faster and more secure than using standard networking techniques to connect to a remote location over the open Internet. WAN-style connections offer a means for providing Internet access to high volume corporate networks, and, in some cases, WAN technologies form the mysterious, high-bandwidth heart of the cloud we know as the Internet itself.

A few of the many WAN options are

- Frame Relay
- Integrated Services Digital Network (ISDN)
- High-Level Data Link Control (HDLC)
- Asynchronous Transfer Mode (ATM)

Although these technologies might seem vastly complex and intimidating (and they are), they are also just another form of physical network specification managed through protocols operating at the TCP/IP Network Access layer. (WAN protocols are almost always centered on the OSI model, so keep in mind that the Network Access layer is equivalent to OSI's Physical and Data Link layers, also known as Layers 1 and 2.)

A typical WAN scenario is shown in Figure 9.3. A service provider operates a WAN with access to the Internet and access to the customer's branch office. A local loop connects the provider's office with the demarcation point, which is the point at which the customer connects to the network. The customer provides the router or other specialized equipment necessary to connect the local network to the WAN.

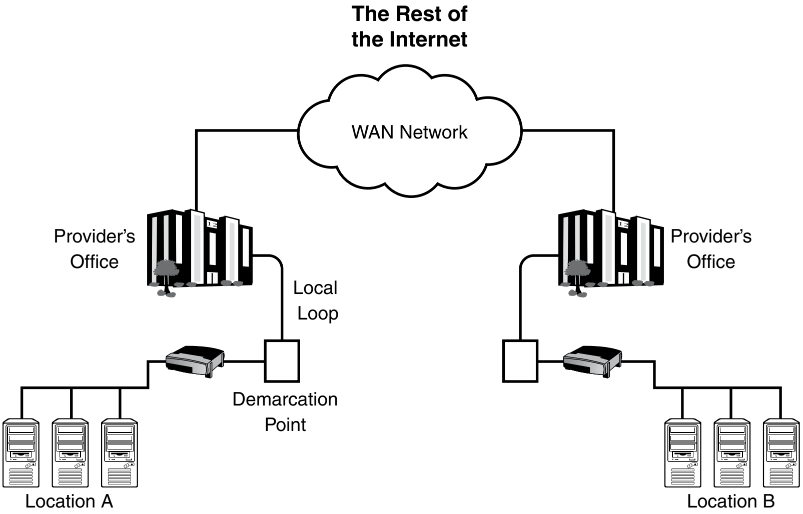

FIGURE 9.3
A typical WAN scenario.

The provider guarantees a specified bandwidth and level of service starting from the demarcation point. Service arrangements vary. WAN service can consist of a dedicated leased line or a pay-for-what-you-use arrangement based on circuit or packet switching.

Wireless Networking

Technology has now reached the point where vendors and users are both wondering whether the continual task of running cables and connecting computers through ethernet ports is even worth the effort. A number of standards are designed to integrate wireless networking with TCP/IP. The following sections describe some of those technologies, including the following:

- 802.11 networks
- Mobile IP
- Bluetooth

Many of the details for how these technologies are incorporated into products and services depend on the vendor. The following sections introduce you to some of the concepts.

802.11 Networks

As you learned in Hour 3, "The Network Access Layer," the details of the physical network reside at the Network Access layer of the TCP/IP protocol stack. The easiest way to imagine a wireless TCP/IP network is simply as an ordinary network with a wireless architecture at the Network Access layer. The popular **IEEE 802.11** specifications provide a model for wireless networking at the Network Access layer.

The 802.11 protocol stack is shown in Figure 9.4. The wireless components at the Network Access layers are equivalent to the other network architectures you learned about in previous hours. In fact, the 802.11 standard is often called wireless ethernet because of its similarity and compatibility with the IEEE 802.3 ethernet standard.

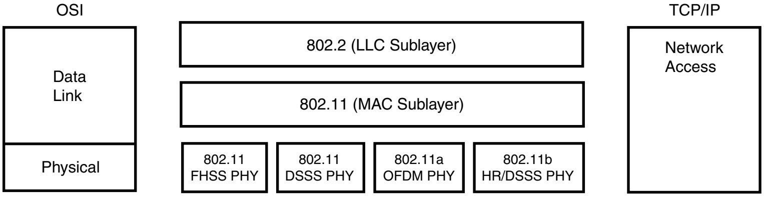

FIGURE 9.4
The 802.11 protocols reside at the TCP/IP Network Access layer.

In Figure 9.4, note that the 802.11 specification occupies the MAC sublayer of the OSI reference model. The MAC sublayer is part of the OSI Data Link layer. Recall from Hour 2, "How TCP/IP Works," that the OSI Data Link and Physical layers correspond to the TCP/IP Network Access layer. The various options for the Physical layer represent different wireless broadcast formats, including frequency-hopping spread spectrum (FHSS), direct-sequence spread spectrum (DSSS), orthogonal frequency-division multiplexing (OFDM), and high-rate direct-sequence spread spectrum multiplexing (HR/DSSS).

One quality that distinguishes wireless networks from their wired counterparts is that the nodes are mobile. In other words, the network must be capable of responding to changes in the locations of the participating devices. As you learned in earlier hours, the original delivery system for TCP/IP networks is built around the assumption that each device is in some fixed location. Indeed, if a computer is moved to a different network segment, it must be configured with a different address or it won't even work. By contrast, devices on a wireless network move about constantly. And, although many of the conventions of ethernet are preserved in this environment, the situation is certainly more complicated and calls for some new and different strategies.

BY THE WAY

802.11 Family

802.11 is actually the collective name for a series of standards. The original (1997) 802.11 standard provided transmission speeds of up to 2Mbps in the 2.4GHz frequency range. The 802.11a standard offers speeds of up to 54Mbps in the 5GHz range. The 802.11b standard provides transmissions at 5.5Mbps and 11Mbps in the 2.4GHz range. Later standards include 802.11g (adopted in 2003) and 802.11n (2009), as well as several other variants. 802.11ac is gaining popularity as a high-speed alternative.

Independent and Infrastructure Networks

The simplest form of wireless network consists of two or more devices with wireless network cards communicating with each other directly (see Figure 9.5). This type of network, which is officially called an **independent basic service set (independent BSS, or IBSS)**, is more commonly known as an ad hoc network. An independent BSS is often adequate for small collections of computers in a compact space. A classic example of an independent BSS is a laptop computer that networks temporarily with a home PC when the owner returns from a road trip and transfers files through a wireless connection. Independent BSS networks sometimes occur spontaneously at workshops or sales meetings when participants around a table link through a wireless network to share information. The independent BSS network is somewhat limited, because it depends on the proximity of the participating computers, provides no infrastructure for managing connections, and offers no means of linking with bigger networks such as the local LAN or the Internet.

Another form of wireless network, called an **infrastructure basic service set (infrastructure BSS)**, is more common on corporate networks and other institutional settings—and it is now quite popular as an option for the home and coffee shop due to a new generation of inexpensive wireless routing devices. An infrastructure BSS depends on a fixed device called an **access point** to facilitate communication among the wireless devices (see Figure 9.6). An access point communicates with the wireless network through wireless broadcasts and is wired to an ordinary ethernet network through a conventional connection. Wireless devices communicate through the access point. If a wireless device wants to communicate with other wireless devices in the