CHAPTER 2

Project 1: Making Your Computers Talk to Each Other
In Chapter 1, “Understanding Basic Networking,” we touched on wired and wireless networks and some of the features of each. In this chapter we will begin to build a network solution that we will use as the basis for the rest of the projects in this book. Before we dive in, let’s take a look at both wired and wireless solutions in a bit more detail. When you know more about what each solution offers, you will be better equipped to decide which is the best solution for your environment.

Understanding Network Speeds

When network optimization is discussed, you often hear terms relating to the speed of the network, in bits per second. For example, 10Mbps, which is the entry-level Ethernet network speed, refers to the network being capable of transferring information at the rate of 10 megabits per second, or 10 million bits per second. So what does this really mean to you?

Let’s consider something that you might typically work with on a daily basis, such as a document written in Microsoft Word. A single-page Word document is about 20KB to 25KB in size. (A kilobyte roughly translates to 1,000 bytes.) We have a measurement mismatch here: We speak of network speeds in terms of megabits, but files are referred to in terms of kilobytes and sometimes megabytes. The basic difference here is that we are speaking of bits in one case and bytes in the other.

Bits and Bytes

Let’s make sure we are clear about what each of these relatively obscure terms—bits and bytes—refers to:

- A bit is a single binary representation of information in electronic terms. A bit has one of two possible states: either a one (1) or a zero (0). The bit is either on (1) or off (0), sort of like a light switch.
- A byte, on the other hand, is a collection of 8 bits and can have one of 256 possible values.

Let’s revisit that Word document again. That file, expressed in bits, is 20 bytes × 8 bits per byte = 160 bits. Simple math shows that this file takes but a fraction of a second to be transferred across a 10Mbps connection.

Let’s look at another example. A digital photograph takes about 500 kilobytes of storage, depending on the resolution; the higher the quality of the picture, the more storage space required. This file represents 4000Kb, or 4Mb, of data. This file will take just under half of a second to transfer across a 10Mbps connection.

This should give you a good idea of how to relate the terms you see thrown about when talking about network speeds. As long as all the computers on your network share the same connection speed, you have a reliable standard by which to judge connectivity.

Your connection to the Internet will typically be quite a bit slower than your local home network speed. DSL, cable, and satellite Internet connections run at speeds up to 1.5Mbps. For Web surfing, email, and file downloads, this speed is fine for most networks. As a matter of fact, you can stream audio and
video with this type of Internet connection. You get the idea by now: Things really don’t take that long to move across the network.

Next, let’s turn our attention to the details of the various network types you’ll typically use in a home environment.

**Wired Ethernet Networking**

Ethernet technologies are by far the most popular for home and small-business solutions. There are a number of Ethernet solutions from which you can choose. The only real drawback to Ethernet is the need to run wires between all the computers that will participate in the network and the hub or switch that is used to connect the computers to each other. Ethernet wires are referred to as Category 5 (CAT5 or CAT5e) cables and have been specified as a standard by Electronics Industries Alliance (EIA) /Telecommunications Industry Association (TIA). (CAT5 is also known as the EIA/TIA 568 standard.) If you’re interested in more detail, you can visit http://wikipedia.org and search for Category 5 cable or EIA/TIA.

**Choosing Your Ethernet Cables**

Various cable types can be used to connect computers to each other with varying speeds. CAT5 cables are designed to provide reliable data communications for Ethernet networks up to 100Mbps. The maximum distance that data can be transmitted reliably with a CAT5 cable is 100 meters, or just about 330 feet. CAT5e cables are designed to provide reliable data communications for Ethernet networks up 1000Mbps (referred to as Gigabit Ethernet). The

While Ethernet is king in terms of networking these days, it was not always so. Much the same as the battle between the Sony Beta and the JVC VHS video recorder formats. In years past Ethernet was considered inferior to a technology introduced by IBM called Token Ring. Before Token Ring, there was ARCDATA which was developed by Datapoint Corporation. The feature that endeared the Token Ring and ARCNET to the geeks of the time was their deterministic nature. There was a very orderly process and each computer on the network was guaranteed a time when it could transmit. Until a computer had the floor (so to speak) all it could do was listen. This guaranteed that there would be no traffic jams since only one computer could transmit at a time. Ethernet by contrast is what is called a multiple access medium and is prone to communications collisions. It is this nature that requires Ethernet to create a way to detect when multiple computers have attempted a transmission, detect the condition, and recover from it.
maximum distance that data can be transmitted reliably with a CAT5e cable is 100 meters, assuming a gigabit network. CAT5e cables can also be used in 100Mbps Ethernet networks, where the advantage they offer is a maximum distance of 350 meters, as opposed to 100 meters offered by CAT5 cables.

**NOTE**

You might want to be aware of the CAT3 standard, although chances are that you will have little need for it from this point on. The CAT3 specification defines a cable that is used for data transmission on 10Mbps networks over a maximum distance of 100 meters. EIA and TIA are the organizations responsible for these standards.

A central device called the *hub* or *switch* is used as the communications command center for each computer. The difference between a hub and switch has to do with whether the speed of the connection is shared or dedicated to a single computer:

- A *hub* shares the bandwidth of the connection among all the computers connected to it. For example, if you have five computers connected to a 10Mbps hub, they are all sharing that 10Mbps bandwidth. What’s more, all those computers contend with each other for access to the medium because the rules of the Ethernet protocol define only one sender at a time.

- A *switch* provides dedicated bandwidth to each computer connected to it. The advantage is that a switch doesn’t impose the limitation of a single computer transmitting at one time. Each computer is able to utilize the full bandwidth available, without concern for whether any of the other computers are transmitting data.

The original Ethernet specification was intended to be implemented by using a hub and a data transmission rate of 10Mbps. CAT3 cables were used back then. The 100Mbps Ethernet implementation is called Fast Ethernet, and, as we have already discussed, it is intended to be run over CAT5 cables. Chances are that if you have a recent computer, you will only need to concern yourself with Fast Ethernet and possibly Gigabit Ethernet speeds. This makes your choice a lot easier in terms of hub or switch selection.

While it is possible to buy a Fast Ethernet hub, it really makes no practical or financial sense to do so. The speed difference you gain is worth the nominal price increase you will pay for a switch versus a hub.

The single greatest factor influencing your home networking decision may rest on where your computers will be located and/or whether your home is already wired for computer networking. You may also want to consider running wires behind walls yourself or having them run for you by a qualified technician. These latter two options can be either time-consuming or costly, depending on the number of computers and difficulty running the wires.

If all your computers will be located in a single room, wired Ethernet may be the most economical choice. If, however, your computers consist of laptops that will move from room to room, you might want to consider wireless networking as an alternative.
Wireless Networking

If your home network is not contained within a single room, or if wiring is not a viable option for you, then one of the available wireless networking solutions is the way to go. The drawbacks to wireless networking are that the cost is somewhat higher than that of wired Ethernet solutions and that the configuration can be a bit more time-consuming. Security is also a concern with wireless networks. Keep in mind that your data is traveling across radio frequencies, which are available to anyone with the right equipment to receive those signals.

Wireless Networking Hardware

To create a wireless home network, you need to consider two types of hardware: a WAP and network interface cards (NICs).

WAPs

For any type of wireless network, you need to purchase a wireless access point (WAP). WAPs, which are the wireless equivalent of hubs and switches in a wired environment, come in many different varieties. You need to consider whether to buy a WAP that also includes routing features (very common these days), which is a great benefit when you’re connecting a home network to the Internet through an ISP. One of the great benefits of WAPs these days is that you can simply plug them in to your ISP connection and then make simple configurations on your home computers to enable networking. Because of this ease of use, the projects in this book implement wireless networking.

WAPs vary in their capabilities, and you will certainly want to read the manual for the WAP that you choose for your network. In general, you should look for what is called a wireless router, which you can usually buy for less than $100. A wireless router includes WAP functionality along with an Ethernet switch that accommodates speeds of 10Mbps and 100Mbps, usually with four ports, and a separate connection for linking to your ISP connection.

Wireless NICs

To build a wireless network, you also need a wireless NIC for each of your computers. Each notebook or laptop type of device needs a PC card device or a USB wireless NIC, and each desktop can use either an internally installed NIC or a USB wireless NIC. Wireless NICs are fairly inexpensive; you can buy most for less than $50, and there are quite a few you can buy for around $25. Many manufacturers of both laptops and desktops include NICs in their systems. So you may not have to purchase one when you decide to put together your network.

NOTE
USB NICs are a bit slower than built-in NICs.

Wireless Networking Standards

When people talk about wireless networking, they are referring to what is commonly known as the 802.11 standard, which is specified by the Institute of Electrical and Electronics Engineers (IEEE). You can obtain exhaustive
information on the various 802.11 wireless specifications from the IEEE website, at http://standards.ieee.org/wireless. As with many things relating to computers and networking, it is important to understand the terminology related to wireless networking. The following sections describe the three most common 802.11 standards: 802.11b, 802.11a, and 802.11g.

The 802.11b Wireless Standard
The first 802.11 standard to be implemented was 802.11b. The data communications speed expectation of 802.11b is 11Mbps; however, the actual speed is influenced by the amount of interference the signal encounters. 802.11b wireless networks operate on a radio frequency of 2.4 Gigahertz (GHz), so you will often have problems in such networks if you have cordless phones that share this frequency. You can solve this problem by either moving your wireless equipment as far from your cordless device as possible, by using 900MHz or 5.8GHz phones, or by opting for another of the wireless standards.

The 802.11a Wireless Standard
802.11a is a bit odd in the lexicon of wireless networking history. It is an upgrade to the 802.11b technology, even though sequentially you would think it was the first to be released. However, it is a mutually exclusive upgrade in that you can’t run both 802.11b and 802.11a on the same network. The advantage offered by 802.11a is speed; it is capable of data transmission at 54Mbps, which is a five-fold increase over the speed offered by 802.11b. WAPs and NICs in the 802.11a environment also operate on radio frequency technology, but they work in the GHZ range, so
CHOOSING A NETWORK TYPE

interference with cordless phones is a problem only if you use 5.8GHz phones.

The 802.11g Wireless Standard

802.11g offers a true upgrade over the other wireless standards in that you can mix 802.11b devices with 802.11g devices. As with the 802.11a standard, speed is the primary reason for moving to 802.11g, where data is transmitted at 54Mbps. The advantage of moving from 802.11b to 802.11g, of course, is that you are not required to perform a wholesale upgrade of all devices on the network. The most important consideration is that your WAP can accommodate the fastest wireless NIC on the network. So by installing an 802.11g WAP, you are able to mix the NICs in your computers. The 802.11b devices will be able to transmit at 11Mbps, and the 802.11g devices will be able to transmit at 54Mbps, all on the same network. 802.11g devices operate on the 2.4GHz frequency, so your wireless interference issues are the same as with 802.11b devices. You will likely only encounter 802.11g wireless networking if you control the creation of your wireless network. If some of your computer equipment is a little older, you may have to make provisions for slower-speed devices.

Choosing a Network Type

So far in this chapter, we have covered wired Ethernet solutions and what you can expect by creating and using one. We have also covered wireless solutions and what you can expect by choosing one of them. Table 2.1 summarizes the various technologies we have discussed.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Speed</th>
<th>Wireless</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet 10</td>
<td>10Mbps</td>
<td>No</td>
</tr>
<tr>
<td>Ethernet 100</td>
<td>100Mbps</td>
<td>No</td>
</tr>
<tr>
<td>Gigabit Ethernet</td>
<td>1000Mbps</td>
<td>No</td>
</tr>
<tr>
<td>802.11b</td>
<td>11Mbps</td>
<td>Yes</td>
</tr>
<tr>
<td>802.11a</td>
<td>54Mbps</td>
<td>Yes</td>
</tr>
<tr>
<td>802.11g</td>
<td>54Mbps</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Ease-of-use and installation are usually the prime decision-making factors in setting up a home network, so this book shows how to implement a wireless network. Specifically, it shows how to use 802.11g devices.

Remember that laptops can use PC card or USB NICs, while desktop computers use USB NICs for wireless networking. So the first order of business in setting up your network is getting everything set up so that your computers can communicate. At this point we will start delving into our projects, which detail the steps required to configure the computers in your home network. In these projects, you will connect your home network to the Internet through a wireless router. You will plug this device into your ISP connection through a port designated for your Internet connection. (You need to refer to your manufacturer’s instructions for specific details on how to do this.) It is important that you place the wireless router as close to the middle of your home network as possible, and you need to place it as high as you can.
Configuring Your Computers for Wireless Access

The following sections walk through how to configure your computers for wireless access. In this solution, you will install a wireless router that is connected to your ISP link. You will enable WEP, and you will have to enter a key in order to be able to access the wireless network. You will learn how to configure your computers so that they can communicate with each other on your wireless network.

To configure your computers for wireless networking, follow these steps:

1. Select Start, Control Panel and then double-click Network Connections. The Network Connections page appears (see Figure 2.1).

2. On the Network Connections page, right-click your wireless network connection and then click Properties.

3. On the Wireless Network Connection Properties page, select the Wireless Networks tab (see Figure 2.2) and then click Properties.

Because you are using a wireless networking solution, you will need to be sure that you understand the security implications. If you set up your wireless router by plugging it in directly out of the box, it will certainly work. However, with that configuration, your network is available to anyone who has a wireless networking device and happens to be within range of your wireless signal. While this may not seem to be a big problem, you need to realize that this means that people may have access to your network, which means the information on your computers is vulnerable to attack.

You have a couple choices when looking at wireless security: Wired Equivalent Privacy (WEP) and Wi-Fi Protected Access (WPA). WEP provides you with a modicum of security, and it is fairly easy to break for someone who really wants to get into your wireless network. Using WEP is somewhat like locking your windows: Someone will be less likely to try tampering with your WEP-protected network than with one with no protection whatsoever. WPA is really the state-of-the-art as far as wireless security is concerned. The steps outlined in this book show you how to configure your network for WEP security as a compatibility precaution. Some wireless network cards do not support WPA, so you should check your equipment. For detailed background information on WPA, refer to www.wi-fi.org.

As background for the projects in this book, you should read the manual that came with your wireless router to ensure that you have configured it in the fashion recommended by the manufacturer.

NOTE

If your wireless network does not appear under Preferred Networks, click View Wireless Networks. If your network still does not appear, click Refresh Network List, select your wireless network from the list, and then click Change Advanced Settings. At this point, retry step 3. If your network name still does not appear, review the instructions that came with your network devices to ensure that you have configured the equipment as required.
4. Complete the page as follows:
   - Set Network Authentication to Open.
   - Set Data Encryption to WEP.
   - Set Network Key to the key entered when the wireless router was configured for WEP.

   When you are done with these settings, click OK twice and close the Network Connections page.

   If you choose to use WPA security in your wireless network, you need to read the Microsoft Knowledge Base article on WPA support for Windows XP, at http://support.microsoft.com/?kbid=815485.

F I G U R E 2.1
The Network Connections page.

F I G U R E 2.2
The Wireless Network Connection Properties page.
Testing Your Computers’ Connectivity

At this point, your computers should be able to communicate with each other. To verify that they can, try the following connectivity test:

1. Select Start, Run, type **CMD**, and then click OK.
2. In the command window, type **ipconfig /all** and then press Enter.
3. Note the default gateway and DHCP server IP addresses.
4. Type **ping w.x.y.z**, where *w.x.y.z* is the IP addresses noted in step 3. You also need to use the IP address of another computer on your network. You should see four almost-identical lines, starting with Reply from *w.x.y.z*.

1. Open your web browser by selecting Start, Internet Explorer. You should see a web page displayed on your screen at this point.
2. If you have trouble seeing an Internet page, verify your ISP link by contacting your ISP’s technical support group. (Because the variety of Internet connections is wide, it is beyond the scope of this book to cover troubleshooting of every type of problem.)

Summary

This chapter expands your basic knowledge for home networking. You have seen the various solutions available and walked through how to configure your computers to get them communicating with each other. Chapter 3, “Project 2: Sharing Files, Printers, and Other Stuff on Your Network,” looks at how to start sharing things between your computers. Now that you have a good foundation for your network, it will be up and running very shortly.

NOTE

If you are having trouble establishing a connection at this point, you should refer to the troubleshooting topics in Chapter 7, “When Your Network Doesn’t Work the Way It Should.”

You have now confirmed that your home network computers have basic connectivity.

Testing Your Internet Connectivity

You need to make sure that your computers can access the Internet. To verify this, follow these steps: