Wireless Networking

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ABSOLUTE BEGINNER'S GUIDE

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Michael Miller

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FREE SAMPLE CHAPTER

Wireless Networking

Michael Miller

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800 East 96th Street,
Indianapolis, Indiana 46240

Wireless Networking Absolute Beginner's Guide

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About the Author

Michael Miller is a successful and prolific author with a reputation for practical advice and technical accuracy and an unerring empathy for the needs of his readers.

Mr. Miller has written more than 100 best-selling books over the past two decades. His books for Que include *Absolute Beginner's Guide to Computer Basics, Easy Computer Basics, Windows 7 Your Way, Wireless Networking with Windows Vista, Facebook for Grown-Ups, My Pinterest,* and *The Ultimate Digital Music Guide.* He is known for his casual, easy-to-read writing style and his practical, real-world advice—as well as his ability to explain a wide variety of complex topics to an everyday audience.

You can email Mr. Miller directly at abgnetworking@molehillgroup.com. His website is www.molehillgroup.com.

Dedication

To all of my Minnesota family—you're the only network that matters.

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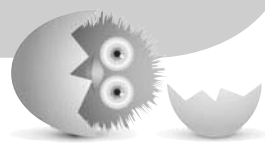
INTRODUCTION



Most homes today are networked homes. Or they should be.

That's because we all have a lot of different devices that need to connect to each other and to the Internet. It's not just desktop and notebook computers that benefit from being networked; we also have smartphones (such as the iPhone), tablets (like the iPad), videogame consoles, portable game players, and even Internet-capable TVs, Blu-ray players, audio/video receivers, and network media players. That's a lot of stuff that needs to connect.

And you need to connect them all in order to do all the things you want to do in your home. Naturally, you want to connect to the Internet, for web surfing, email checking, and social networking. But, you may also want to share files between multiple computers, view your digital photos on your living room TV, listen to your favorite music, or watch streaming movies and TV shows over the web. There's a lot you can do when all your devices are connected to a home network.

Fortunately, almost all of these devices can connect wirelessly. You don't need to run big, thick, Ethernet cable from one end of your house to the other; just install a wireless router and let all of your devices connect via Wi-Fi. (They all probably have Wi-Fi built in.)

That doesn't mean that setting up a home network is simple or even necessarily trouble proof. The complexity of today's home wireless networks can be confusing, even to the more technically adept. There are a host of questions that need answered: What kind of router should you buy? How best should you configure your network to optimize playback on all your different devices? How can you get the fastest audio and video streaming while still maintaining a decent connection on your iPhone? Should you store your music and movies on a home server or on a separate PC? Can you get your Windows and Mac computers to talk to each other? And how do you keep your neighbors from tapping into your Internet connection and home network?

That's where this book comes in. *Wireless Networking Absolute Beginner's Guide* is an easy-to-use guide for anyone installing or working with a wireless home network today. This book details how to plan, purchase, and set up a typical wireless network in your home—and then optimize that network for best performance.

Wireless Networking Absolute Beginner's Guide goes beyond simple network configuration, however. I'll show you how to connect all wireless devices to your wireless network—computers, home servers, videogames, tablets, smartphones, widescreen TVs, audio/video receivers, and the like. I'll also discuss how to get the most from these connected devices, including watching streaming audio and video over your network.

I'll also cover other types of wireless connections, both inside and outside the home, including Wi-Fi hotspots, Bluetooth in your car, and your mobile-phone carrier's cellular data service. There's even advice on how to troubleshoot network problems—because, like it or not, problems do pop up from time to time.

In short, *Wireless Networking Absolute Beginner's Guide* should give you everything you need to know to guarantee hassle-free wireless connections on all manner of devices. Everything today is wireless, and wireless is everything—you might as well get ready for it.

How This Book Is Organized

I've organized this book into five main parts, as follows:

- **Part I, "Getting to Know Wireless Networking,"** shows you how networks (wired and wireless) work, and discusses the three major types of wireless networks: Wi-Fi, Bluetooth, and mobile wireless. This is the place to start if you don't know a thing about wireless networking.
- **Part II, "Setting Up a Wireless Network,"** is where you start getting your hands dirty. This section describes, in step-by-step detail, how to plan your home network, purchase the right equipment, install and configure a wireless router, connect your network to the Internet, extend your network into larger spaces, and connect selected devices via Ethernet cable. You'll even learn why and how to employ network security. (Hint: It's to protect against unwanted intruders.)
- **Part III, "Connecting Devices to Your Network,"** shows you how to connect all sorts of different devices to your new wireless network. You'll learn how to connect notebook and desktop computers (both Windows and Mac), home servers, videogame consoles and portable game players, network media players, Internet-capable TVs and Blu-ray players, and even audio/video receivers. You'll also learn how to connect your favorite handheld devices to your network. (We're talking smartphones and tablets, folks.)
- **Part IV, "Using Your Wireless Network,"** is all about doing stuff over your network. You'll learn how to share printers and scanners, share and transfer computer files, watch streaming movies and TV shows, and listen to streaming music. You'll also learn how to troubleshoot potential network problems—just in case.
- **Part V, "Connecting Wirelessly Outside the Home,"** is where you learn how to use your wireless devices outside your home or office network. You'll learn how to connect your computer, smartphone, or tablet to public Wi-Fi hotspots, and how to access the Internet from your car. Wireless is everywhere!

Taken together, the 21 chapters in this book help you progress from an absolute beginner to experienced wireless networker. Just read what you need and, before long, you'll be connected wirelessly all over the place!

Conventions Used in This Book

I hope that this book is easy enough to figure out on its own, without requiring its own instruction manual. As you read through the pages, however, it helps to know precisely how I've presented specific types of information.

Windows or Mac?

First, know that this book attempts to be relatively platform agnostic. That is, I cover a lot of different devices on multiple operating systems; it shouldn't matter whether you're using a Mac or Windows PC, or even which version of Windows you're using; there should be ample information between these two covers for whatever device you're using. (That means there's also coverage of wireless for smartphones and tablets—so there.)

Web Page Addresses

This book contains a lot of web page addresses, because that's where you go for additional information. Technically, a web page address is supposed to start with http:// (as in http://www.molehillgroup.com). Because most web browsers automatically insert this piece of the address, you don't have to type it—and I haven't included it in any of the addresses in this book.

By the way, when it comes to web page addresses, know that they change. So if you enter a specific URL I mention in this book and get a "page not found error," don't blame me; it worked when I wrote it! (And that's why we have the Google; just search for anything you need.)

Products and Services

I mention a lot of specific products in this book, and products, like web pages, come and go. It's likely that, by the time you read this book, some of the products I mention may be discontinued or replaced by newer versions. That's life in the big city, folks. Hopefully, any newer products you find will work even better than the ones I mention in this book.

Special Elements

This book also includes a few special elements that provide additional information not included in the basic text. These elements are designed to supplement the text to make your learning faster, easier, and more efficient.

TIP A *tip* is a piece of advice—a little trick, actually—that helps you use your wireless network more effectively or maneuver around problems or limitations.

NOTE A *note* is designed to provide information that is generally useful but not specifically necessary for what you're doing at the moment. Some are like extended tips—interesting, but not essential.

CAUTION A *caution* tells you to beware of a potentially dangerous operation or situation. In some cases, ignoring a caution could cause you significant problems—so pay attention to them!

Let Me Know What You Think

I always love to hear from readers. If you want to contact me, feel free to email me at abgwireless@molehillgroup.com. I can't promise that I'll *answer* every message, but I do promise that I'll *read* each one!

If you want to learn more about me and any new books I have cooking, check out my Molehill Group website at www.molehillgroup.com. Who knows, you might find some other books there that you would like to read.

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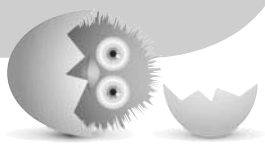


HOW MOBILE NETWORKS WORK

There's one last type of wireless network we need to discuss, and it's one with which you're probably intimately and constantly familiar. I'm talking about the ubiquitous wireless network employed by the humble cell phone—or, more common today, the high-tech cellular-data network used by iPhones and other smartphones to connect not only to each other, but also to the Internet.

How does cellular networking work—and what does it have to do with the other wireless networking you employ on a daily basis? Good questions, and two of many that are answered in this chapter.

Understanding Cellular Phone Technology

Cellular phones work much the same way as do the other wireless devices we've been discussing. Signals carrying voice, text, and digital data are transmitted via radio waves from one device to another. In the case of cellular networks, the data is transmitted not to a central hub in a small network of devices (as it is with Wi-Fi) or even directly from device to device (as it is with Bluetooth), but through a global network of transmitters and receivers.

Cells in a Network

What's interesting about mobile phone networks is their cellular design. (Hence the terms "cellular network" and "cellular phone.") By that, I mean that a mobile phone network is divided into thousands of overlapping geographic areas, or *cells*. A typical cellular network can be envisioned as a mesh of hexagonal cells, as shown in Figure 4.1, each with its own *base station* at the center. The cells slightly overlap at the edges to ensure that users always remain within range of a base station. (You don't want a dropped call when you're driving between base stations.)

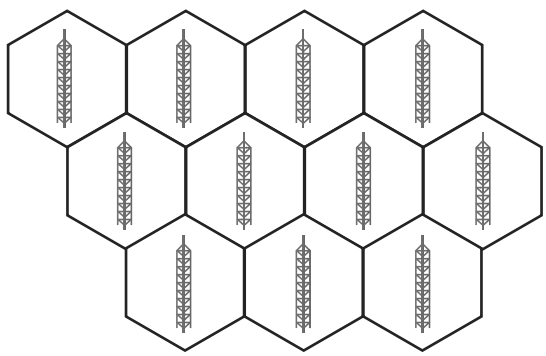


FIGURE 4.1

Cells in a cellular network.

NOTE The cells in a cellular network vary in size, depending on how many calls are conducted within that geographic area. The smallest cells, which might cover only a few city blocks, are those where there's the heaviest population density, and thus the largest demand for service. The largest cells are most often in rural areas with a smaller population per square mile.

The base station at the center of each group of cells functions as the hub for those cells—not of the entire network, but of that individual piece of the network. RF signals are transmitted by an individual phone and received by the base station, where they are then re-transmitted from the base station to another mobile phone. Transmitting and receiving are done over two slightly different frequencies.

Base stations are connected to one another via central switching centers which track calls and transfer them from one base station to another as callers move between cells; the handoff is (ideally) seamless and unnoticeable. Each base station is also connected to the main telephone network, and can thus relay mobile calls to landline phones.

Carrying a Two-Way Radio

All this transmission within a cellular network originates with the handheld cell phone. A mobile phone is actually a two-way radio, containing both a low-power transmitter (to transmit data) and a receiver (to receive data).

When I say low power, I mean low power—really low power. The typical cell phone includes a dual-strength transmitter, capable of transmitting either 0.6-watt or 3-watt signals. In comparison, a larger AM radio station will typically broadcast a 50,000-watt signal; even smaller AM stations broadcast 5,000-watt signals. A cell phone's 3-watt signal is puny in comparison.

The reason mobile phones can get by with such low-power transmitters is that they're transmitting within a relatively limited range—within the current network cell. It's not necessary or desirable for a phone's signal to extend beyond the current cell; this way, the same broadcast frequencies can be used by multiple cells without danger of interference.

Pulling Some Gs

If you're a mobile phone user (and you are, of course), then you've probably heard talk about something called 3G, and maybe even something called 4G. Each "G" is a generation of technology, which means we're currently in the middle of the third generation and moving into the fourth. Let me explain.

1G

Before the age of digital mobile networks, all cell phones broadcast analog signals. In the U.S., this meant using the Advanced Mobile Phone System (AMPS) standard, which operated in a range of frequencies between 824MHz and 894MHz, dubbed the 800MHz band.

This type of analog transmission was the first generation of cellular phone technology, or what some refer to as 1G. Because analog phones could transmit only analog voice data, not digital data, they couldn't be used to access the Internet or transmit text messages. Fortunately, there were more Gs to follow.

2G

Moving past the analog age, the cell-phone carriers needed to cram more calls into each frequency they were assigned. The way to do that was to move beyond inefficient analog signals into more efficient digital ones. That is, the original analog voice signal is digitized into a series of 0s and 1s; the resulting digital signal is then compressed and transmitted across the assigned frequency band.

NOTE Because of the digitization and compression, a digital system can carry about ten times as many calls as an analog one.

In this second generation of cellular transmission (dubbed 2G, of course), several competing standards came into play, and different cellular carriers adopted different standards. There are two of these standards used in the United States:

- **Code Division Multiple Access (CDMA).** This standard operates in the same 800MHz band used by the previous analog transmissions and is employed by Sprint and Verizon.
- **Global System for Mobile Communications (GSM).** This standard operates in the 1,900MHz band and is used by AT&T and T-Mobile.

That's just in the United States, of course. Other standards and frequency bands are used in other countries.

NOTE CDMA and GSM are mutually exclusive technologies. A CDMA phone will not work on a GSM network, and vice versa.

2G networks and phones could also be used to transmit non-voice data. This ushered in the era of text messaging, in the form of Short Message Service (SMS) and, later, Multimedia Message Service (MMS). It also enabled access to the Internet, for email, web browsing, and the like.

NOTE SMS transmits text-only messages. MMS transmits text messages with multimedia attachments (photo, video, and so on).

3G

The next generation of cellular transmission was developed with the smartphone in mind. So-called 3G networks feature increased bandwidth and transfer rates that better accommodate the transfer of digital data necessary for Internet access and the use of web-based applications.

How much faster is 3G? A lot. Today's 3G networks boast transfer speeds up to 2Mbps; in contrast, 2G phones can only transfer data at around 144Kbps. That's a 13-fold increase in speed, more or less, if you're doing the math.

Just as with 2G digital networks, there are several different 3G standards in use in the U.S. (and a few more in use overseas):

- **CDMA2000** is an evolution of the previous CDMA standard. It's used by Sprint and Verizon.
- **Universal Mobile Telecommunications System** (**UMTS**) is an evolution of the GSM standard used by AT&T and T-Mobile.

If you use your smartphone for anything other than voice calls and text messages, you need to be on a 3G network. In those areas where you're forced to use a 2G connection, accessing the Internet is painfully slow. In this respect, 3G is the de-facto minimum requirement for using a smartphone today.

4G

Now, we get to the fourth generation of cellular networking. Carriers are just starting to roll out 4G networks, and suppliers are just starting to produce 4G smartphones. 4G promises data transmission rates in excess of 1Gbps, which is more than 30 times the rate of 3G networks. (That should make it a lot easier to watch streaming video on your iPhone!)

Naturally, competing 4G standards are in play. Look for the following protocols used by U.S. carriers:

- **Long Term Evolution (LTE).** This standard promises data download rates to mobile users up to 300Mbps. It's used by AT&T and Verizon.
- **Evolved High Speed Packet Access (HSPA+)**. This standard promises data download rates up to 168Mbps, although current rates top out at 42Mbps. It's used by T-Mobile.
- **Worldwide Operability for Microwave Access (WiMax)**. This standard promises data download rates of 128Mbps. It's used by Sprint.

To put all these Gs into perspective, see Figure 4.2. This chart compares the data-transmission (download) rates of 2G, 3G, and 4G networks. (Remember, 1G was analog, not digital, and thus couldn't transmit non-voice data.) There's been a lot of improvement over the years!

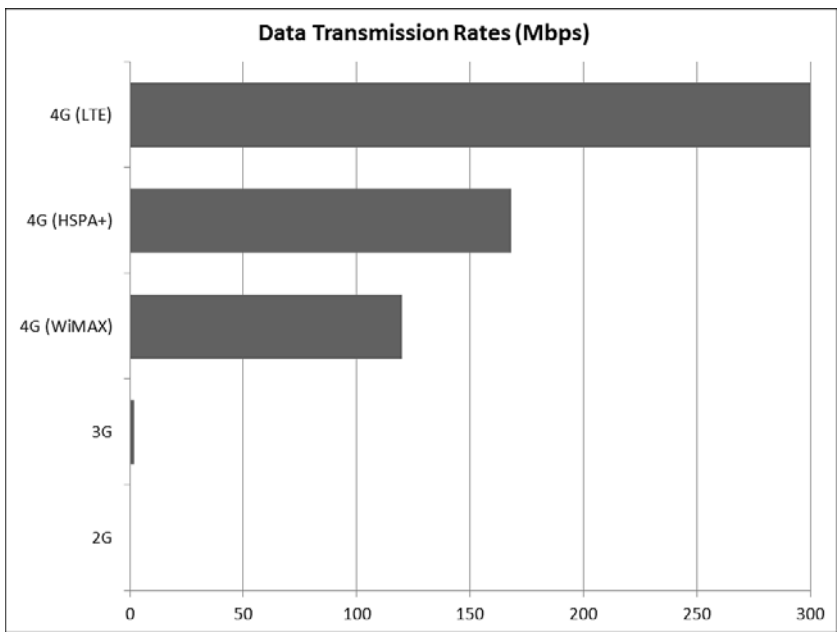


FIGURE 4.2

Comparing 2G, 3G, and 4G data download speeds.

Sharing a Mobile Data Connection with Your PC

With the advent of 3G cellular technology, it suddenly became feasible to use your cell phone to access the Internet. Before 3G, rates were just too slow; loading a simple web page could take minutes, not seconds.

3G's maximum 2Mbps data download speed is close to that offered by many home Internet service providers (ISPs); DSL, for example, typically delivers speeds in the same 2Mbps range. Naturally, when we're talking 4G networks with speeds approaching 300Mbps, cellular Internet is suddenly faster than what you get at home—or sitting in your local Wi-Fi hotspot.

With that in mind, why not use your smartphone to provide Internet access for your computer? Well, you can—and there are two different ways to do it.

External Data Modems

Most cellular providers offer external data modems that provide access to their 3G or 4G cellular-data network. These modems are small and portable and connect to your computer via USB; they let you access the cellular network with your PC, just as you do with your phone.

What this means is that you can now connect to the Internet anywhere you can receive a cellular connection. This lets you surf the web in places where you can't get Wi-Fi, such as when you're driving your car.

Figure 4.3 shows a typical USB modem from AT&T. You'll want to purchase the right modem for the connection you want; most carriers offer separate 3G and 4G modems. Expect to pay anywhere from $30 to $300, depending on the unit, the carrier, and which service plan you subscribe to. Oh, and you'll have to pay for a data service plan; the more data you use, the more you'll pay each month.

FIGURE 4.3

AT&T's USBConnect Force 4G USB modem.

Tethering Your Smartphone

Some carriers let you connect your computer to their data networks without purchasing a separate modem for your PC. Instead, you connect a cable between your computer and your smartphone; you connect to the data network with your smartphone and then share the Internet connection with your PC.

This process is called *tethering*, and it's a great way to share a connection and an existing data service plan. Not all carriers support this type of tethering, however, and those that do may charge extra for it—in addition to the normal data usage plan. For example, T-Mobile has a $15/month tethering charge, Verizon charges $20/month, and Sprint charges $30/month, all in addition to your normal data plan; AT&T includes tethering in its $45/month 4GB data plan.

NOTE Check with your cellular carrier to see what's available and what you have to do to use it.

Tethering can be done both physically or via Wi-Fi. We'll look at both methods.

A physical tether requires the use of a USB cable or special data connection kit. Essentially, you connect one end of the cable to your smartphone and the other to your PC, as shown in Figure 4.4. Once everything's connected, you run a special tethering app to pipe the Internet signal from your phone to your computer.

FIGURE 4.4

Sharing a cellular data signal via physical tether.

A Wi-Fi tether turns your smartphone into a portable Wi-Fi hotspot. You establish an ad-hoc Wi-Fi network with your phone as the router, and then connect your computer to that network to share the phone's Internet connection. It's easier than it sounds, especially when facilitated by using the appropriate tethering app on your phone.

CAUTION Some technically adept users try to get around carriers' tethering charges by jailbreaking their phones and using third-party tethering apps. This is breaking the rules, however, as most carriers like to charge you extra for the privilege of tethering—not that there are any technical reasons to do so. If your carrier detects the tethering, you'll get charged for that usage—or, perhaps, kicked off the service entirely.

Powering Your Home Network with Your Cellular Signal

Here's something else you may not have considered. Some manufacturers make what they call *mobile broadband routers* that receive a 3G (or, in some instances, 4G) mobile signal and then convert it into Wi-Fi. The Wi-Fi signal is then broadcast throughout your home, same as with a wireless router, and all of your Wi-Fi-enabled devices can connect to it to access the Internet.

Figure 4.5 shows one such device from NETGEAR. The little receiver on the right is what picks up your cellular signal; it's connected to the big unit on the left, which is essentially a wireless router. The router provides the Wi-Fi signal for your network of devices.

FIGURE 4.5

NETGEAR's MBRN3000 Mobile Broadband Router. (Photo courtesy of NETGEAR.)

CAUTION The big problem with using a mobile broadband modem in your home is that, unless you have an unlimited data plan from your cellular provider, you're going to pay through the nose for all the data downloaded by all the devices on your network.

Mobile Data Versus Wi-Fi: Choosing One or the Other

You've just seen one way that cellular networking and Wi-Fi networking can work together—by tethering your smartphone and computer together, via Wi-Fi, to share the cellular data signal. In most other aspects, these two wireless technologies work side-by-side, offering similar Internet-based functionality, but in different ways.

Here's the deal. Your smartphone can connect to the Internet either via Wi-Fi or via your cellular service's network. Most phones are configured to use the nearest Wi-Fi signal by default, as Wi-Fi is both faster than 3G data connections and doesn't rack up charges against your phone's data plan. So, if you're near a Wi-Fi network, your phone tries to connect to that network; if there's not Wi-Fi nearby, then your phone switches to the standard cellular data network.

This default-to-Wi-Fi behavior makes a lot of sense, especially if you consume a lot of media online. Checking your email won't necessarily eat up your available data plan, but viewing a lot of photos on web pages or consuming streaming music or video will. If you use your phone to watch a lot of streaming movies or TV shows, chances are you'll blow through your data plan much sooner than you'd like, and be liable for costly overage charges.

Naturally, you can, at any time, switch off your phone's Wi-Fi, which then forces your phone to connect to the cellular network to access the Internet. In most instances, however, you probably want to use Wi-Fi when it's available and fall back on your 3G network only when you have to.

NOTE Some smartphones won't let you perform certain functions, such as updating your existing iPhone apps, over cellular. To access these functions, your phone needs to be connected to a Wi-Fi network.

Mobile Service and Bluetooth: Learning to Co-Exist

Then, there's the issue of Bluetooth wireless, which is also built into most smartphones. Bluetooth is typically used to connect your phone to cordless headsets and your car's built-in phone/audio system. In this respect, Bluetooth and cellular wireless co-exist quite nicely; in fact, you can easily flow one wireless connection through the other.

You can see this co-existence in action when you connect to your phone's data network while your phone is connected to another Bluetooth-enabled device. The Bluetooth connection then carries your cellular voice call to your headset or car system, in a nice little flow that looks something like the one in Figure 4.6. One wireless stream flows into the other.

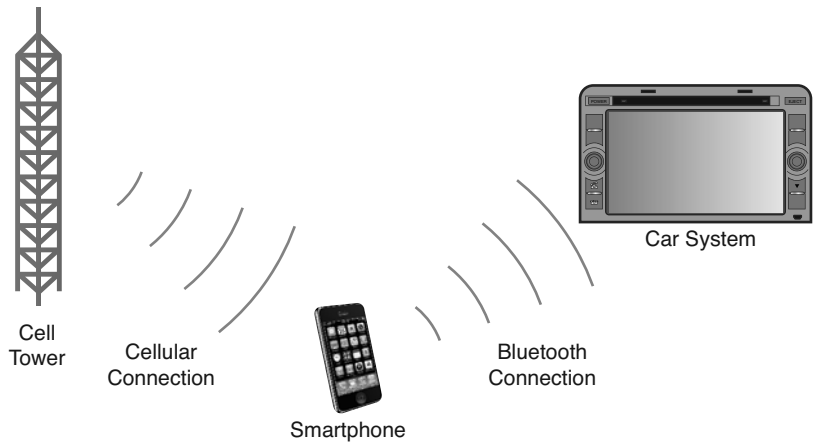


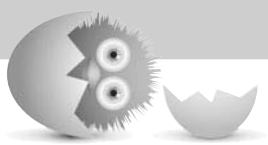
FIGURE 4.6

Flowing a cellular connection through a Bluetooth connection.

THE ABSOLUTE MINIMUM

Here are the key points to remember from this chapter:

- Cellular telephone networks are so-named because they're built from a series of adjoining cells; as a phone travels from one point to another, its signal is handed off from cell to cell.
- There have been four generations of cell phone technology: 1G (analog), 2G (original digital), 3G (faster digital), and 4G (even faster digital, designed specifically for smartphone and streaming video use).
- Using a smartphone to access the Internet is painful on older 2G networks, acceptable on 3G networks, and downright enjoyable on the latest 4G networks.
- Most smartphones can connect to the Internet via either Wi-Fi or cellular data networks; Wi-Fi is faster than 3G cellular (but not as fast as 4G) and doesn't use up your monthly data plan.
- Smartphones can connect to cellular and Bluetooth networks simultaneously, in order to beam cellular voice calls to a Bluetooth-enabled device.



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