



Wireless Home Networking **Simplified**

- The full-color, fully illustrated, **simple** guide to wireless home networking
- **Step-by-step** instructions: Plan, install, secure, optimize, and troubleshoot your wireless network
- Discover all the **fun** things you can do with your wireless network



Wireless Home Networking Simplified



Jim Doherty
Neil Anderson
Illustrations by Nathan Clement

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Wireless Home Networking Simplified

Jim Doherty and Neil Anderson

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Dedications

From Jim Doherty:

I would like to dedicate this to my good friend and coauthor Neil Anderson. Working together across ten years, two companies, and six books has been both fun and rewarding, and I'm better off for having been a part of it.

From Neil Anderson:

I would like to dedicate this book to my great and talented coauthor Jim Doherty. I could not ask for a more creative and humorous friend and coauthor. It's been a kick to work with you Jim on our common passion.

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Introduction

We assume that if you read the front cover you know what this book is about, but there's a bit more to it than that. With the explosion of popularity in wireless networking, there is a proportional number of people who do not understand the technology, and a similar number of people who think they understand it (but don't) and are all too willing to dispense advice. Usually it ends poorly, and you get stuck with a network that does not work.

This book is written for all of you out there who want to get the benefits of wireless networking but don't feel like you have the technical background to set it up yourselves. We are confident that if you read this book and follow the steps we lay out, you will have a much better understanding of the technology and, most importantly, a working wireless network. We will try to do this without you having to get a technical degree just to deploy your home network.

What to Expect

We've divided this book into five parts, each of which describes a major part of the process of building and using a wireless network. These sections describe

- How wireless works
- What you need to know
- How to set it all up
- What to do if it doesn't work
- What other cool things you can do with it

Each section is described in greater detail in the following sections.

Part I, "How Does It Work?"

Part I starts by explaining the basics in Chapter 1, "How Wireless LANs Work." We think it's worth mentioning that a basic working knowledge of wireless networking should be of interest to you if you are about to set up your own wireless network, and at a minimum it will help you make some better-informed decisions. In Chapter 2, "Wireless Standards: What the Letters Mean," we cover the main wireless standards. There are a number of choices with regard to the frequency, speed, range, and costs of each of the main standards, and we cover all of them here. We finish this section with Chapter 3, "Selecting the Right Wireless Standard for Your Network." There are a lot of choices out there. This chapter will help you cut through the confusion.

Part II, “What You Should Know”

In Part II we focus on what you should know before setting up your wireless network. This is where we put all the information in Part I to good use.

Chapter 4, “Planning Your Wireless Network,” covers how to plan your network to meet the needs of today and bridge the gap to tomorrow. Chapter 5, “Wireless Security: What You Need to Know,” covers the very important topic of wireless security. Don’t skip this chapter.

Finally, in Chapter 6, “What to Buy,” we explain how to figure out what equipment you need to buy. It’s important to wait until this point in the book to actually buy gear, especially if you are starting from scratch. Trust us, this will save you money in the long run.

Part III, “How Do I Set It Up?”

In Part III we get to work and build your network. Chapter 7, “Wireless Router Setup,” covers setting up your wireless router. This is the heart and soul of your network. In Chapter 8, “Wireless NIC Setup,” we help you set up your wireless network interface card (called a NIC). This is the piece that allows your computer to be “wireless.” Once everything is up and running, Chapter 9, “Wireless Security Setup,” covers the implementation of wireless security in a step-by-step manner, because we need to keep the bad guys off our network.

Part IV, “Honey, This Stupid Wireless Thing Is Not Working”

Into every life a little rain must fall. Part IV covers how to troubleshoot a network that does not want to work the way it ought to. Chapter 10, “Troubleshooting: I Can’t Connect at All,” focuses on what to do when you can’t get a computer to connect to the wireless network. Sometimes you can connect but the coverage is lousy. Chapter 11, “Troubleshooting: I Can Connect Sometimes,” covers what to do in these cases. Chapter 12, “Troubleshooting: I Can Connect, but It’s Slow,” wraps up the section with steps to take when your connection seems slower than it ought to be.

Part V, “Bells and Whistles”

For those of you who want to take a step beyond a basic wireless network, Part V covers some bells and whistles you can add. Chapter 13, “Wireless Video and Entertainment,” provides information on how to set up wireless-based entertainment options on your network. Chapter 14, “Wireless to Go,” shows you how to take your wireless on the road and connect to hotspots. We close the section and the book with a summary in Chapter 15, “The Future of Wireless Networking,” on what we think the future holds for wireless networking.

Housekeeping Stuff

This book focuses on the Windows operating systems and all screenshots were taken from computers running Windows XP. If you are not running Windows XP, you can still follow the recommendations and tips for the chapters where changes or setups are made, or where directory paths are followed. The general steps still hold true, but the directory paths and filenames may change. Your user manual or help files should help get you where you need to go for operating systems other than Windows XP.

We also had to make some decisions regarding what type of gear and programs to install as examples. Most of the gear we recommend here is from Linksys. In the spirit of full disclosure, our current (Neil) and former (Jim) employer is the parent company of Linksys. That said, we believe that Linksys has the most complete and easy-to-use wireless portfolio.

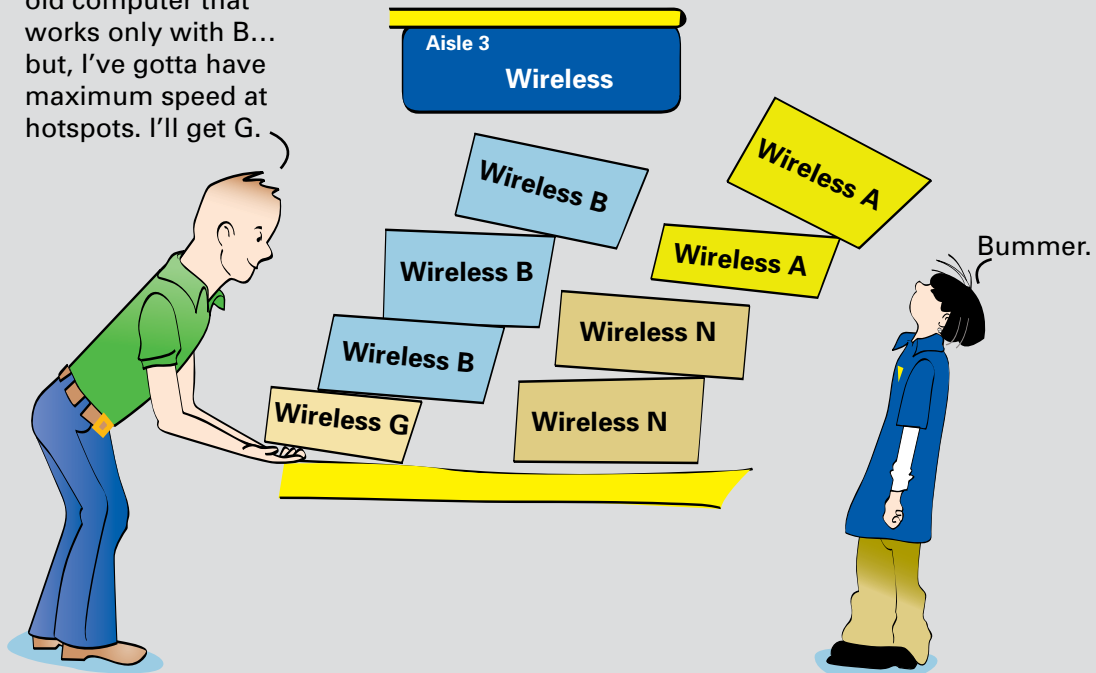
We hope you find this book useful, usable, and entertaining. Good luck, and happy networking.

Selecting the Right Wireless Standard for Your Network

If you have looked around at your local technology store for wireless networking equipment, you probably noticed the array of wireless designations. With several broad-based standards available and even more vendor extensions, it's no wonder people leave the store confused and probably empty handed.

This chapter helps you choose which wireless standard is right for you. The decision does not have to be difficult at all. We try to boil the facts down and make it easy.

...cordless phone,
old computer that
works only with B...
but, I've gotta have
maximum speed at
hotspots. I'll get G.



What to Consider When Choosing Your Wireless Standard

So how do you sort through the many wireless options that are available to you and decide what's best for your home network? First, you must keep in mind that there are two sides to this decision process:

- What to choose for the wireless access point/router that will “host” your wireless network
- What to choose for wireless network interface cards (NICs) that will allow the computers on your home network to “join” the network wirelessly

The previous chapters covered the various wireless standards that exist and the advantages and disadvantages of each. Knowing the frequencies and other facts about the various standards is all well and good, but you still need to make a decision that will work well for you not only now, but also for at least a couple of years so that you can recoup the investment you made. In our opinion, you need to weigh the following six primary factors:

- **Compatibility**—How well will all your wirelessly connected stuff work together?
- **Speed**—How fast is fast enough?
- **Range**—How far from the router can I get a wireless signal?
- **Security**—What level of security is supported?
- **Cost**—How much?
- **Future proofing**—Will the technology be obsolete the day after I buy it?

As it turns out, compatibility and speed are intimately related. The following sections explore all six factors, followed by our bottom-line recommendations.

Compatibility

Whatever wireless standard you choose, it's very important that the wireless router and wireless NICs are compatible. Otherwise, your wireless network will not work at all or, at best, will work rather poorly.

There are three primary factors to consider for compatibility:

- What are the relationships between the standards, and which standards are compatible with each other?
- How does multi-standard, or dual-band, equipment fit into the picture?
- Are the proprietary extensions offered by manufacturers, like SRX, something you should consider?

We examine these questions in the following sections.

Relationships Among Wireless Standards

The first really important point to understand is the relationships among the wireless A, B, G, and N standards, introduced in Chapter 2, “Wireless Standards: What the Letters Mean.” As previously mentioned, NICs need to be compatible with the wireless router you purchase or your router won’t be of much use to anyone. Fortunately, the relationships are pretty straightforward:

- A NICs are compatible *only* with A routers.
- B NICs are compatible with B, G, and N routers.
- G NICs are compatible with B, G, and N routers.
- N NICs are compatible with B, G, and N routers.

Likewise, the relationships work in both directions such that a G router is compatible with B, G, and N NICs.

The key point to remember is that the lowest standard (in terms of speed) shared by the router and the NIC dictates the performance of the interaction between the two devices. This means that N and B devices work together, but only at the B level of performance. Figure 3-1 and Figure 3-2 illustrate this concept.

Figure 3-1 B NIC on Different Routers

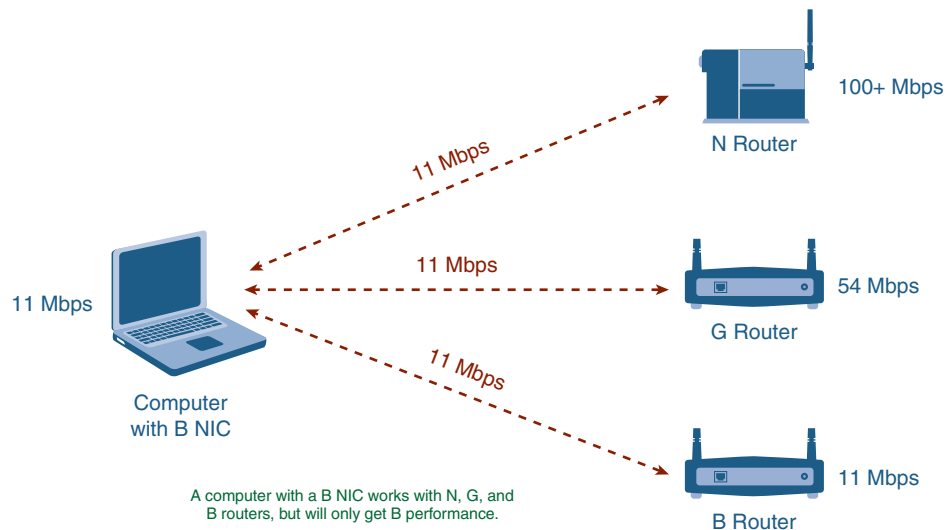


Figure 3-2 G Routers with Different NICs

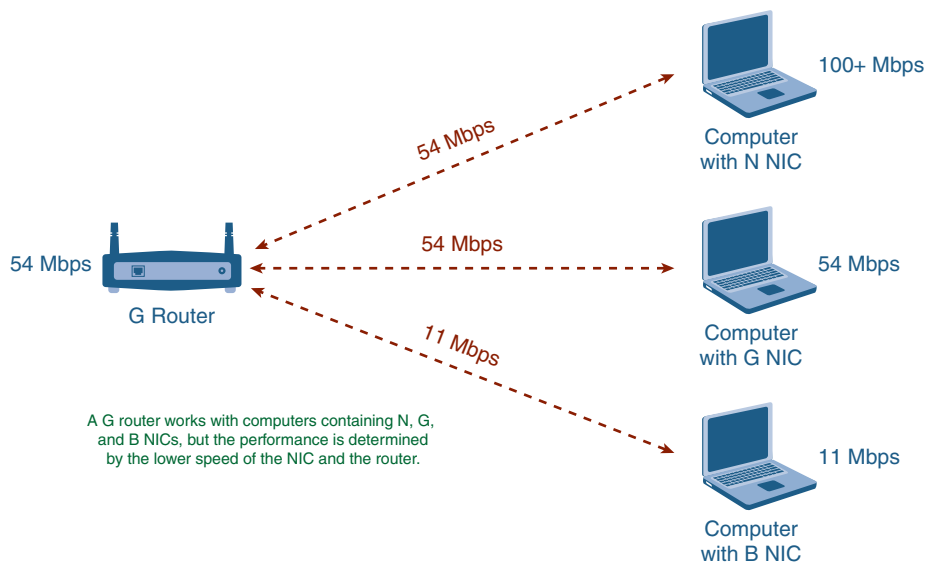


Table 3-1 summarizes the compatibility between standards and the performance you will have when combining NICs and wireless routers.

Table 3-1 Wireless Standards Compatibility Summary

	A Router	B Router	G Router	N Router
A NIC	A performance	Not compatible	Not compatible	Not compatible
B NIC	Not compatible	B performance	B performance	B performance
G NIC	Not compatible	B performance	G performance	G performance
N NIC	Not compatible	B performance	G performance	N performance

Dual-Band Products

Another point to consider is that some manufacturers provide *dual-band* (also known as *dual-standard*) wireless NICs and routers, meaning that the product supports two bands. As discussed in Chapter 2, 802.11a operates in the 5-GHz band, while 802.11b, 802.11g, and 802.11n all operate in the 2.4-GHz band. The designation of a router or NIC as *dual-band* means that it supports at least one wireless standard in each band, meaning 2.4 GHz and 5 GHz.

By definition, G routers and NICs are dual-standard, because they are backward compatible with the B standard. So, *dual-band* almost always refers to the wireless A standard, plus another standard like B, G, or N. Thus, you will see products labeled A+B and A+G. You will likely see some A+N routers as well. The same holds true for wireless NICs. You can have NICs that are single-band only, such as B or G, or dual-band, such as A+G.

Proprietary Extensions

The next complication is that some vendors provide proprietary extensions to their products to make them run even faster. For example, we mentioned in Chapter 2 that Linksys provides a Speed Booster version of its wireless G products that improves the transmission speed beyond the standard 54 Mbps. Linksys also provides an SRX series of wireless G products that doubles the speed to 108 Mbps. Other vendors have similar product extensions. You need to understand three things about such extensions:

- They are (or should be) backward compatible with the base standard.
- The extended speeds typically work only when you are using both that vendor's NICs and its routers with that particular extension. So, to get the benefits of SRX, you need to have both an SRX router and an SRX NIC.
- If you already own or intend to purchase a laptop with a built-in NIC, it most likely is not going to support such proprietary extensions.

Remember this when you are thinking of buying products with such extensions. Make sure they are compatible with the base standard, at a minimum. You should also make sure that you have the correct NIC for any manufacturer-based extensions. It would be a waste to pay the extra money for the Linksys SRX router, for example, if your NIC supports only the base G standard.

Speed

The second consideration when choosing your wireless standard is resulting speed. Later in the chapter, in the section “Comparing the IEEE WLAN Standards,” Table 3-2 gives an indication of the performance you will receive when you use a type of wireless NIC with a type of wireless access point/router. In general, the maximum performance the different wireless standards offer follows:

- **802.11a**—54 Mbps
- **802.11b**—11 Mbps
- **802.11g**—54 Mbps (up to 108 Mbps with extensions)
- **802.11n**—100 Mbps+

However, these speeds are the “stated” numbers, which are often only achieved in a lab setting. Once you have a router in your house, any number of factors can come into play that impact the speed you actually get. These factors include the distance between the router and the computer, the building materials in your home, interference from cordless phones and other devices, and, in some cases, even sunspots. Okay, that last one is pretty rare, but it can happen, and the basic point is that many factors—most of which are out of your control—affect the actual speed of the router.

Also, at the risk of being redundant, remember that the lower of the NIC and router speeds dictates the speed. For example, a NIC for the 802.11b standard will certainly function with a wireless router for the 802.11g standard, but it will only operate at the 11-Mbps rate, not the higher 54-Mbps rate of the G standard. Similarly, a NIC for the 802.11g standard will work just fine with a wireless router for the 802.11b standard. It will just operate at the slower 11-Mbps rate of the B standard.



Note: It is important to realize that even the slowest of the wireless standards often provides greater bandwidth than even the fastest residential high-speed Internet connection at the time this book was written. Average broadband provides download speeds (from the Internet) between 1 and 2 Mbps, and upload speeds (to the Internet) between 256 kbps and 1 Mbps). Even very high-speed broadband provides download speeds up to 6 Mbps and maximum upload speeds of around 2 Mbps (and at a price premium).

Even the lowest-speed wireless standard, 802.11b, operates at 11 Mbps and, factoring in the wireless overhead, delivers about 6 Mbps. This can pretty easily keep up with most broadband connections.

The point is, before you go and spend a lot of money on the very fastest wireless router, be sure that you really need the speed you are paying for.

Range

In general, the range of most current wireless routers on the market is adequate for the average house or apartment, so it's not really something to be very concerned about.

If you do have a large house or area you want to cover with your wireless router (maybe you want to lie by the pool or mount your laptop to your John Deere riding mower), then you may want to consider range as a factor.

Wireless B and G offer about the same range. Wireless A operates in the 5-GHz range and therefore signals last a shorter distance. Wireless N is specifically designed to provide up to four times the range of wireless B and G, and therefore offers the longest range on the market today. Keep in mind, though, that the closer you get to the maximum range, the lower the speed will be and, in some cases (such as with B), the speed at the edge of the range will be quite slow.

Security

Most new wireless routers on the market support the full range (or nearly so) of wireless security options available. There are two primary security-related factors to look for:

- What types of encryption are supported?
- Does the wireless router also provide a firewall?

Encryption comes in a number of “flavors” including (from least to most secure) WEP-64, WEP-128, WPA, and WPA2. Similar to wireless standard and speed, encryption that can be used is determined by the lower of the encryption supported between the router and NIC. You want WEP-128 at a minimum, but WPA or WPA2 is preferred. See Chapter 5, “Wireless Security: What You Need to Know,” and Chapter 9, “Wireless Security Setup,” for a more thorough discussion on wireless security types and recommendations.



Note: Unlike the wireless standard performance, with encryption the lowest available standard determines the type of encryption for all devices on the network. In other words, if you have a NIC that is limited to WEP-64 on your network, all the devices on the network must be set to encrypt at the WEP-64 standard regardless of any higher encryption standard that they are capable of.

The other factor to consider is whether the wireless router you buy contains a built-in stateful packet inspection (SPI) firewall. *Stateful* means that the firewall looks inside the packet to make sure it is part of a valid communication session. Basically it keeps hackers from “tricking” your computers into talking with their computer. This provides a good level of security between your home network and the Internet, and we highly recommend it.

By the way, the type of encryption and whether or not a firewall is included are completely independent of the wireless standard supported by the router. In other words, all types of encryption are possible with all the wireless standards. It’s just a matter of determining what types of encryption are supported by the wireless router and NIC you have or are considering buying.

Cost

Costs have come way down for wireless networking, to the point that it is almost the same cost to put up a wireless network as a wired one. Wireless NICs can be more expensive than wired NICs, but costs are falling rapidly. The latest (and fastest) wireless standard (at this time N) tends to be the most expensive option, followed by the next fastest speed (A and G at this time), and finally the slowest wireless standard (at this time B). The gap is rapidly closing as prices come down across the board; however, you pay a price premium for faster speed.

It is getting pretty difficult to find wireless B equipment still for sale because it has been replaced for the most part by wireless G equipment.

Additional Considerations

When making your decision, you need to consider a couple of other points, including

- What types of wireless NICs do you already own versus what you must go out and purchase? Many new laptops (and even some desktops) are sold with built-in wireless NICs.
- Do you want to be able to use wireless network access outside your home in a publicly provided wireless network (hotspot)?

The last thing you want to do is purchase a wireless router only to find out that you need to replace a wireless NIC that came with your laptop because it is not compatible. Similarly, you will be quite frustrated if you buy a wireless NIC for your laptop, intending to use it at hotspots, only to find out you bought the wrong standard.



Note: Wireless NICs come in various form factors, including PCI for installing in desktop computers, PCMCIA and Express Cards (plug-in cards) for installing in laptop computers, and USB for connecting to any computer or device with a USB port. Choose whichever makes sense for your network, computers, and budget.

Comparing the IEEE WLAN Standards

With the preceding considerations in mind, it's time to make a choice between wireless standards. Table 3-2 provides an easy-to-read, side-by-side comparison of the four standards. This table should help you figure out which standard is right for you.

Table 3-2 IEEE WLAN Standards Comparison

	A	B	G	N
Speed	Up to 54 Mbps	Up to 11 Mbps	Up to 54 Mbps (faster with proprietary extensions)	100 Mbps or faster
Cost	\$\$\$	\$ (Finding new equipment for sale is difficult. You may have to purchase via alternative channels such as eBay.)	\$\$	\$\$\$\$
Frequency	Uncrowded 5-GHz band. Can coexist with 2.4-GHz networks without interference.	More crowded 2.4-GHz band. Some conflict may occur with other 2.4-GHz devices, such as cordless phones, microwaves, and so on.	More crowded 2.4-GHz band. Some conflict may occur with other 2.4-GHz devices, such as cordless phones, microwaves, and so on.	More crowded 2.4-GHz band. Some conflict may occur with other 2.4-GHz devices, such as cordless phones, microwaves, and so on.
Range	Shorter range than 802.11b and 802.11g. Typically, 25 to 75 feet indoors.	Typically, up to 100–150 feet indoors, depending on construction, building material, and room layout.	Typically up to 100–150 feet indoors, depending on construction, building material, and room layout. Much farther with extensions such as Linksys SRX.	150–400 feet is claimed although this has not been widely verified on the high end.
Hotspots	Very few hotspots support the A standard.	Most hotspots support the B standard.	The number of public hotspots supporting the G standard is growing rapidly, allowing wireless connectivity in many airports, hotels, public areas, and restaurants.	Very few hotspots support the N standard, but your N NIC will work with G or B hotspots.

Table 3-2 IEEE WLAN Standards Comparison

	A	B	G	N
Key Benefits	Good alternative if the 2.4-GHz band has too much interference.	Widely supported.	Good mix of speed and broad support.	Blazing-fast speed for high-end networking applications.
Shared Internet Connection	✓	✓	✓	✓
Multiplayer Gaming over Internet	✓	✓	✓	✓
Multiplayer Wireless LAN Games			✓ (with speed extensions)	✓
VoIP	✓	✓ (Performance can be an issue in some cases.)	✓	✓ (over Wireless)
Streaming Audio			✓	✓
Streaming Video			✓ (with speed extensions)	✓
Large Homes		✓ (Keep in mind that speed greatly suffers at the edge of the usable range.)	✓ (with speed extensions)	✓

Recommendations

Based on the information in Table 3-2, here are our bottom-line recommendations:

- If you just want Internet access, are on a tight budget, or do not anticipate a large amount of internal traffic (from a wireless juke box, for example), either the B or G standard is a good choice. Choose B only if you already have B-only NICs for most of your computers.
- B equipment may be hard to find for sale in retail locations because it has been mainly replaced by G equipment in the market, so if you can't find B, go with G.
- If you plan on using hotspots or getting on other people's networks, G offers the best bet for compatibility and speed.
- If you anticipate a large amount of internal traffic, plan on setting up a wireless gaming system, or want a little bit of future-proofing, N is the best choice. Purchasing G with an extension such as SRX will give you similar performance, but as N begins to gain popularity (and it will), a proprietary G extension will limit your flexibility.

We do *not* recommend the A standard unless you happen to have a specific reason to avoid using B, G, or N. For example, if you are getting known interference from 2.4-GHz cordless phones, or if you live in an apartment and you are surrounded by G routers, A might be an option. Keep in mind, though, that cordless phones are now also being offered in the 5-GHz range, which can potentially interfere with wireless A networks.

For the purposes of helping the broadest group of readers, we will hedge our bet just a bit and show the setup and configurations for both an N and a G router throughout the remainder of this book.

Summary

There are several important factors to consider when choosing your wireless standard, including compatibility, security levels supported, and the performance you expect.

B, G, and N devices are compatible with each other and offer the most opportunity for compatibility outside your network as well, at wireless hotspots.

Standard A equipment works only with other A equipment. Unless you have an explicit need for wireless A, avoid building out an A network.

If you have typical requirements for speed and range, a G network usually is sufficient. If you need extra speed inside your home for streaming video, heavy gaming, or other wireless applications, or you need significant extra range, then an N network is probably a better bet.

Where to Go for More Information

To learn more about wireless A, B, and G standards, check out Bradley Mitchell's article on About.com titled "802.11 Standards—802.11b 802.11a 802.11g":

<http://compnetworking.about.com/cs/wireless80211/a/aa80211standard.htm>.

Space.com has an interesting article about interference from sun spots: www.space.com/scienceastronomy/solarsystem/sunspot_detail_021113.html.

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