

How WiFi Works

by [Marshall Brain](#)

If you have a network in your home or office, there are several different ways to connect the computers on your network together. The article [How Home Networking Works](#) covers all of the basic networking principles.

WiFi is the wireless way to handle networking. It is also known as **802.11 networking** and **wireless networking**. The big advantage of WiFi is its simplicity. You can connect computers anywhere in your home or office without the need for wires. The computers connect to the network using radio signals, and computers can be up to 100 feet or so apart.

In this article, we will discuss two different aspects of WiFi. First we will discuss the basic technology that makes WiFi networking possible. Then we will discuss the hardware you need to create a WiFi network, and help you understand how to set up and access a WiFi hotspot in your home.

The Walkie-Talkie Network

If you want to understand wireless networking at its simplest level, think about a pair of \$5 walkie-talkies that you might purchase at Wal-Mart. These are small radios that can transmit and receive radio signals. When you talk into a Walkie-Talkie, your voice is picked up by a microphone, encoded onto a [radio](#) frequency and transmitted with the antenna. Another walkie-talkie can receive the transmission with its antenna, decode your voice from the radio signal and drive a [speaker](#).

Simple walkie-talkies like this transmit at a signal strength of about 0.25 watts, and they can transmit about 500 to 1,000 feet.

Let's imagine that you want to connect two [computers](#) together in a network using walkie-talkie technology:

- You would equip each computer with a walkie-talkie.
- You would give each computer a way to set whether it wants to transmit or receive.
- You would give the computer a way to turn its binary 1s and 0s into two different beeps that the walkie-talkie could transmit and receive and convert back and forth between beeps and 1s/0s.

This would actually work. The only problem would be that the data rate would be very slow. A \$5 walkie-talkie is designed to handle the human voice (and it's a pretty scratchy rendition at that), so you would not be able to send very much data this way. Maybe 1,000 bits per second.

WiFi's Radio Technology

The [radios](#) used in WiFi are not so different from the radios used in \$5 walkie-talkies. They have the ability to transmit and receive. They have the ability to convert 1s and 0s into radio waves and then back into 1s and 0s. There are three big differences between WiFi radios and Walkie-talkies:

- WiFi radios that work with the 802.11b and 802.11g standards transmit at 2.4 GHz, while those that comply with the 802.11a standard transmit at 5 GHz. Normal walkie-talkies normally operate at 49 MHz. The higher frequency allows higher data rates.
- WiFi radios use much more efficient coding techniques that also contribute to the much higher data rates. For 802.11a and 802.11g, the technique is known as orthogonal frequency-division multiplexing (OFDM). For 802.11b, it is called Complementary Code Keying (CCK). See [this page](#) for details.
- The radios used for WiFi have the ability to change frequencies. 802.11b cards can transmit directly on any of three bands, or they can split the available radio bandwidth into dozens of channels and **frequency hop** rapidly between them. The advantage of frequency hopping is that it is much more immune to interference and can allow dozens of WiFi cards to talk simultaneously without interfering with each other.

Because they are transmitting at much higher frequencies than a Walkie-Talkie, and because of the encoding techniques, WiFi radios can handle a lot more data per second. 802.11b can handle up to 11 megabits per second (although 7 megabits per second is more typical, and 802.11b may fall back as low as 1 or 2 megabits per second if there is a lot of interference). 802.11a and 802.11g can handle up to 54 megabits per second (although 30 megabits per second is more typical).

You might be wondering where the funny 802.11 nomenclature comes from. The Institute of Electrical and Electronics Engineers (IEEE) creates standards, and they number these standards in unique ways. The 802.11 standard covers wireless networks. The a, b and g notations identify different flavors of the 802.11 standard:

- 802.11b was the first version to reach the marketplace. It is the slowest and least expensive of the three. As mentioned above, 802.11b transmits at 2.4 GHz and can handle up to 11 megabits per second.
- 802.11a was next. It operates at 5 GHz and can handle up to 54 megabits per second.
- 802.11g is a mix of both worlds. It operates at 2.4GHz (giving it the cost advantage of 802.11b) but it has the 54 megabits per second

speed of 802.11a.

Fortunately, all of this radio technology is hidden in a WiFi card and is completely invisible. WiFi, in fact, is one of the easiest technologies that you will ever use.

Adding WiFi to a Computer

One of the best things about WiFi is how simple it is. Many new laptops already come with a WiFi card built in -- in many cases you don't have to do anything to start using WiFi. It is also easy to add a WiFi card to an older [laptop](#) or a desktop [PC](#). Here's what you do:

- Buy a 802.11a, 802.11b or 802.11g network card. 802.11g has the advantage of higher speeds and good interoperability on 802.11b equipment.
 - For a laptop, this card will normally be a PCMCIA card that you slide into a PCMCIA slot on your laptop. Or you can buy a small external adapter and plug it into a USB port.
 - For a desktop machine, you can buy a PCI card that you install inside the machine, or a small external adapter that you connect to the computer with a [USB](#) cable.
- Install the card
- Install the drivers for the card
- Find an 802.11 **hotspot**
- Access the hotspot.

A hotspot is a connection point for a WiFi network. It is a small box that is hardwired into the [Internet](#). The box contains an 802.11 radio that can simultaneously talk to up to 100 or so 802.11 cards. There are many WiFi hotspots now available in public places like restaurants, hotels, libraries and [airports](#). You can also create your own hotspot in your home, as we will see in a later section.

Configuring WiFi

On the newest machines, an 802.11 card will automatically connect with an 802.11 hotspot and a network connection will be established. As soon as you turn on your machine, it will connect and you will be able to browse the Web, send email, etc. using WiFi. On older machines you often have to go through this simple 3-step process to connect to a hotspot:

- Access the software for the 802.11 card -- normally there is an icon for the card down in the system tray at the bottom right of the screen.
- Click the "Search button" in the software. The card will search for all of the available hotspots in the area and show you a list.

- Double-click on one of the hotspots to connect to it.

On ancient 802.11 equipment, there is no automatic search feature. You have to find what is known as the **SSID** of the hotspot (usually a short word of 10 characters or less) as well as the channel number (an integer between 1 and 11) and type these two pieces of information in manually. All the search feature is doing is grabbing these two pieces of information from the [radio](#) signals generated by the hotspot and displaying them for you.

WiFi Security

WiFi hotspots can be open or secure. If a hotspot is open, then anyone with a WiFi card can access the hotspot. If it is secure, then the user needs to know a **WEP key** to connect.

WEP stands for Wired Equivalent Privacy, and it is an encryption system for the data that 802.11 sends through the air. WEP has two variations: 64-bit encryption (really 40-bit) and 128-bit encryption (really 104-bit). 40-bit encryption was the original standard but was found to be easily broken (see [this page](#) for an explanation). 128-bit encryption is more secure and is what most people use if they enable WEP.

For a casual user, any hotspot that is using WEP is inaccessible unless you know the WEP key.

If you are setting up a hotspot in your home, you may want to create and use a 128-bit WEP key to prevent the neighbors from casually eavesdropping on your network.

Whether at home or on the road, you need to know the WEP key, and then enter it into the WiFi card's software, to gain access to the network.

Setting Up a Hotspot in Your Home

It is very easy to set up a WiFi hotspot in your own home. You can do it in one of two ways:

- If you already have several computers hooked together on an Ethernet network and want to add a wireless hotspot to the mix, you can purchase a **Wireless Access Point** and plug it into the Ethernet network.
- If you are setting up a network in your home for the first time, or if you are upgrading, you can buy a Wireless Access Point Router. This is a single box that contains: 1) a port to connect to your [cable modem](#) or [DSL](#) modem, 2) a [router](#), 3) an [Ethernet](#) hub, 4) a [firewall](#) and 5) a wireless access point. You can connect the computers in your home to this box either with traditional Ethernet cables or with

wireless cards.

Either way, once you turn your Wireless Access Point on, you will have a WiFi hotspot in your house. In a typical home, your new hotspot will provide coverage for about 100 feet (30.5 meters) in all directions, although walls and floors do cut down on the range. Even so, you should get good coverage throughout a typical home. For a large home, you can buy inexpensive signal boosters to increase the range of the Hotspot.

If you are setting up your 802.11 network from scratch, you will have to choose between 802.11a, 802.11b and 802.11g. 802.11b is slightly less expensive, but it is the slowest of the three options. For home use, 802.11g costs just a little more, but is up to 5 times faster. If you will be doing a lot of file transfers between computers in your home, 802.11g is definitely the way to go.

Configuring a New Hotspot in your Home

Most wireless access points come with default values built-in. Once you plug them in, they start working with these default values in 90 percent of the cases. However, you may want to change things. You normally get to set three things on your access point:

- The SSID -- it will normally default to the manufacturer's name (e.g. "Linksys" or "Netgear"). You can set it to any word or phrase you like.
- The channel -- normally it will default to channel 6. However, if a nearby neighbor is also using an access point and it is set to channel 6, there can be interference. Choose any other channel between 1 and 11. An easy way to see if your neighbors have access points is to use the search feature that comes with your wireless card.
- The WEP key -- The default is to disable WEP. If you want to turn it on, you have to enter a WEP key and turn on 128-bit encryption.

Access points come with simple instructions for changing these three values. Normally you do it with a Web browser. Once it is configured properly, you can use your new hotspot to access the Internet from anywhere in your home.