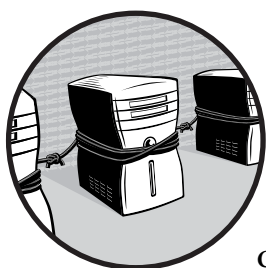


# 5

## DESIGNING YOUR NETWORK



It's quite possible to construct a computer network "on the fly," stringing Ethernet cables from a central hub or switch to individual computers and other devices as you need them. But it's almost always better to spend some time planning your network before you start to install it.

It's a lot easier to make changes to your design on paper rather than making adds, moves, and changes in physical space. This chapter offers advice and instructions for preparing a network plan.

I'm assuming in this chapter that you have chosen not to use either power line or video cable as your primary network distribution medium. Both of those methods can be practical in some situations, but a traditional Ethernet system, possibly with a supplementary Wi-Fi base station, is usually a better choice for a small business or household network, because the equipment is widely available, it's often inexpensive, and it's easy to install and maintain.

To begin your network plan, start with a floor plan of the house, apartment, or workspace where you want to install your network. The plan doesn't have to be exactly to scale, but it should be big enough to add notes

within each room or cubicle, and it should show the relative positions of each room. Figure 5-1 shows a typical floor plan for a small one-story house. If it's convenient, use a copier or scanner to make several copies of the floor plan.

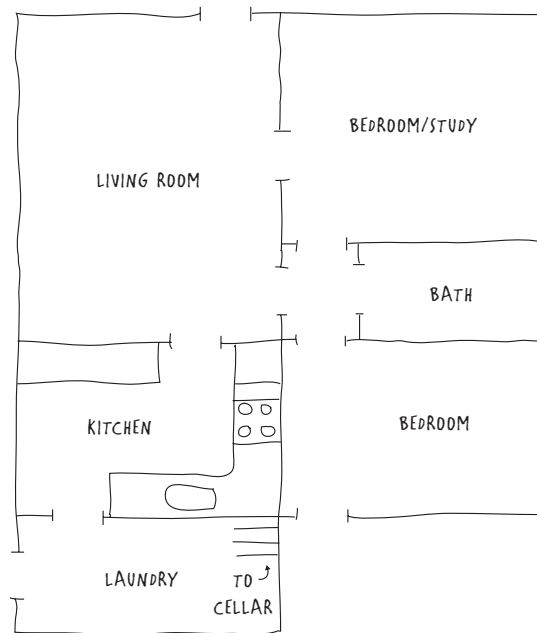


Figure 5-1: Use a floor plan to identify locations for network connection points.

## Identifying Current and Future Nodes

The next step is to decide where you will want network connections. Use different colors to note the locations of each of the following items:

**Electrical outlets** Network wiring and outlets should be at least 12 inches away from AC wiring, so it will be helpful to identify all of the AC outlets in each room. In addition, you will want access to AC power for your computer, router, modem, and other network hardware.

**Your home entertainment systems** Home theater equipment, stereo systems, televisions, and game consoles can all exchange data through your home network, so network outlets should be within close range.

**Telephone wall outlets and connection boxes** If you plan to use a DSL or dial-up connection to the Internet, your network will use telephone outlets to connect.

**Cable TV or other video outlets** If you get your Internet service from your cable TV provider, you will connect a modem to a cable outlet. Even if you don't use cable Internet service, you might want to use combined wall plates for video and data outlets.

**Furniture placed next to a wall** You won't want to plan a network outlet socket in a place that forces you to move a bookcase or a sofa to get to it. On the other hand, if there's a table against the wall, you could probably crawl underneath easily to plug in a cable in a place where it won't call attention to itself.

**Closets, stairways, and other hiding places** If your home or workplace includes spaces on more than one floor of the building, be sure to note the locations of closets, stairways, and other places where it will be relatively easy to run hidden cables through ceilings or floors. As with the other wiring in your home or workplace, your goal will be to hide all your network cables inside walls, under floors, and in other invisible locations.

If you're adding the network in an existing home or office, all of these elements are probably in place already. Before you start to add new network wiring and connection points, you must understand how they will relate to the other things in each room. If you're planning a network as part of a major remodeling or new construction, plan to coordinate your efforts with the contractors or outside installers who will provide electrical wiring, telephones, cable or satellite TV, and wiring for a home theater or home entertainment system.

With all this information in one place, it's easy to decide where you will want to install network connection points. Use yet another color of pencil to mark an unobstructed place for the network outlet on the wall nearest to each computer and every other device you plan to connect to the network.

Each outlet should be at least a foot from the closest electrical outlet, both because AC wiring can generate interference that affects data signals, and because it's often required by the local electric code to prevent shorting between AC and data cables.

If your telephone or cable TV outlets are mounted on wall plates (rather than in small boxes attached to the baseboard), consider replacing the existing wall plate with a new one that combines two or three outlets of different types on a single wall plate, as shown in Figure 5-2.

When you design your network, you should also plan for the future. You probably don't need them today, but within a few years, it's quite possible that you will want to connect your household appliances, a bedside radio, and other devices to your LAN and the Internet. And if you plan to eventually add one or more online cameras or home automation devices (such as lighting or climate controls) to the network, it's a good idea to mark their tentative locations.



*Figure 5-2: This wall plate combines TV and data network outlets.*

Remember, it doesn't cost anything to mark a location for an outlet on your floor plan. You don't have to install every outlet right away, but it's helpful to know where they're likely to be when you plan your cable runs. You can always change the exact locations before you actually pull cable through the walls.

**NOTE** *Planning for a lot of extra network connection points might seem unnecessary right now, but that will almost certainly change. If you plan for more network connection points than you think you need today, you might have enough for the next ten years. Consider this: If you live in an old house with the original electrical wiring, you probably know that one or two AC outlets in each room was considered more than enough back in 1925; more would have been extravagant. Today, you should have several electrical outlet plates on every wall. In the future, household data networks will be as common as electricity and telephones.*

In your home, consider placing at least one network outlet in each major room—don't worry about hallways and other odd spaces. In the kitchen, place one outlet close to a counter, and plan to place another on the wall next to the refrigerator and range. You might also want an outlet in the laundry room, not far from the washer and dryer—you probably won't want to connect your appliances to the network right now, but remote control and monitoring through your home network is a real possibility in the future. In each bedroom, plan for an outlet near a desk or table where the room's occupant uses a computer or video game console, and (if it's not close to the first outlet) another outlet for a bedside Internet radio or a laptop computer.

In an office, plan for at least one network connection point next to every desk and every other location where you expect to place a computer or other network device, such as a printer.

If you expect to use both Ethernet and Wi-Fi connections to your network, note the locations for one or more Wi-Fi access point on your floor plan.

All of your network wiring should use CAT5e or CAT6 data cable; less expensive CAT5 (no "e") cable can't handle the higher-speed network data that you're likely to need in the future.

## The Control Center

The network control center is the location of the switch, router, modem, and other equipment at the core of the network. All of the wiring that connects each outlet to the network converges at the control center. Common locations for a network control center (sometimes known as a *wiring closet*) include closets, utility rooms, and garages or basements. For a very small network (no more than five nodes), you could also consider placing the modem and router on a table next to one of your computers, but that might limit your opportunities for easy expansion of the network in the future.

If you plan to distribute audio, video, telephone, or home automation wiring around the house along with computer network data, your control center should have enough space for all of the necessary equipment required by all those services. It will be easier to pull two or more types of cables at the same time than to install each type separately.

A network control center can have several possible forms: It could be a simple plywood panel attached to the wall, or it might be a pre-wired modular cabinet mounted on a wall or between the wall studs. Or if you have the floor space, it might be in one or more freestanding equipment racks.

The control center's location should have the following characteristics:

- It should be easily accessible. Don't choose a location that forces you to climb over bicycles and storage boxes or push clothes on hangers aside to reach it.
- It should have enough light to allow you to see what you're doing at any time of day or night.
- It should be in a place that remains dry and has a stable temperature.
- It should be close to at least one electrical outlet.
- It should be relatively central, in order to reduce the length of connecting cables.
- It should be at or slightly below eye level, so you can work comfortably.
- It should have enough space to allow for additional wiring and equipment in the future.
- It should *not* be adjacent to the fuse box, circuit breaker box, or other electrical panel. AC power wiring must be kept separate from network, telephone, and video cables to prevent interference and to comply with the National Electric Code.

After you choose a place for the control center, note its location on your floor plan.

### **Home Run Wiring**

When you have identified the locations of your network connection points and found a place for the control center, you can plan the routes for your network cables. The preferred method for network wiring is called *home run wiring* because each cable runs "home" to a central hub or switch. The alternative, which is more practical for telephone and video wiring than for data networks, is *point-to-point* wiring that uses long cable runs that connect to each outlet through a splitter, as shown in Figure 5-3.

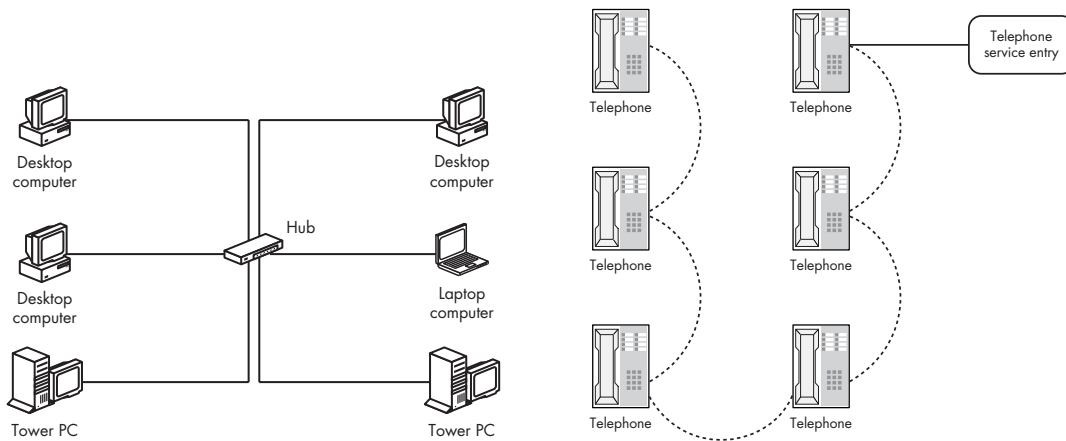


Figure 5-3: Home run wiring (left) is best for data networks; telephones and video can use either home run wiring or point-to-point networks (right).

If you haven't already done so, this is a good time to look around the rooms where you plan to install network outlets, and the spaces directly above and below each room. If you have access to an unfinished basement or attic, you can run cables through the rafters and joists; but if you have to run cables through finished walls and ceilings, you will probably have to hide cables inside walls and behind baseboards and patch some holes after the wires are in place. Either way, look for the best routes for cables from each network outlet to the control center. Use a pencil to mark the routes on your floor plan.

There are two ways to attach a network outlet to a wall. For a finished appearance, use a wall plate similar to the ones used for electrical outlets, like the one shown in Figure 5-2. If the outlet will be hidden behind furniture or in some other place where it won't be visible, you can use a small terminal block mounted on a baseboard like the one in Figure 5-4.

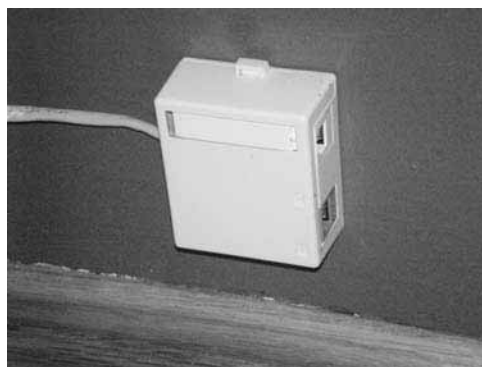
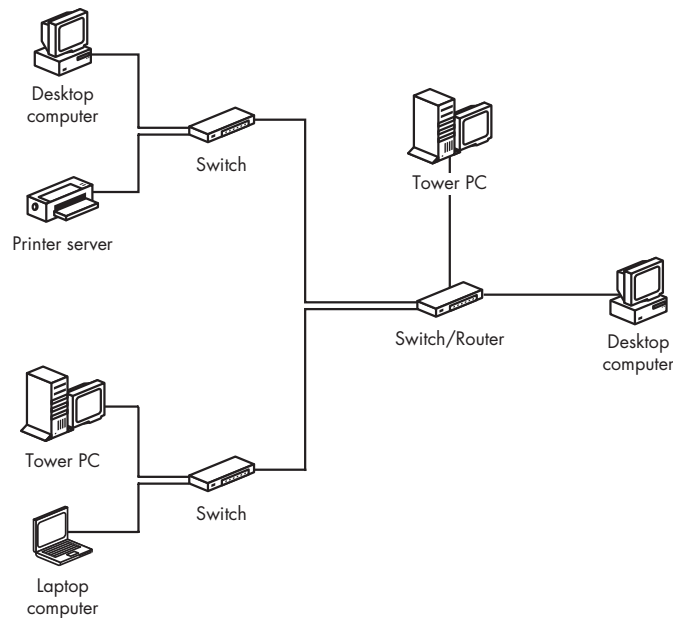


Figure 5-4: A data terminal block can mount directly to a baseboard.

### ***Trunks and Branches: Using Secondary Switches***

There's an alternative to a pure home run wiring design for small networks that can make it possible to expand the network without having to run new cables all the way back to the control center. This approach, which vaguely resembles the trunks and branches of a tree or the tributaries of a river, uses data switches to connect additional computers and other devices to the network through a single outlet, as shown in Figure 5-5. Connecting through a switch can be particularly handy when you want to use two or more devices (such as a computer and a game console or a printer server, or two or more computers) in the same room.



*Figure 5-5: An Ethernet switch can extend a network to connect two or more devices to the network hub through a single cable.*

A secondary switch can also be useful when you want to place network connection points in adjacent rooms that are difficult to reach from the control center. For example, if you have two second-floor bedrooms that share a wall, you could run a single cable to a switch and connect the switch to computers in both rooms.

Many Wi-Fi access points are combined with switches that allow you to connect one or more devices to the network through wired Ethernet outlets. If you locate your access point in a room where you also use a desktop computer or other network device, a combination unit is often an excellent choice: Place the access point next to the computer and use an Ethernet cable to connect it to the switch.

## What About Wi-Fi?

Connecting computers and other network devices through a Wi-Fi network is often an easy alternative to a wired Ethernet system. A single access point is often enough for sending and receiving data to and from computers in many rooms.

A Wi-Fi network can provide Internet access and LAN services, but it has several disadvantages when compared with a wired network:

- Wi-Fi networks are usually slower than wired Ethernet unless all the nodes in the network are compatible with the latest 802.11n standards.
- Wi-Fi networks are less secure than wired networks. Unless you protect your network with a secure encryption method such as WPA, a dedicated intruder can connect to the Internet through your network without your permission and can also steal information from the other computers on the same network.
- Interference between your Wi-Fi network and your neighbors' networks and other wireless devices can reduce your network's data transfer speed.

In spite of those limitations, a Wi-Fi network is often an acceptable choice if you don't want to cut holes through your walls or spend time crawling through your attic or basement. And even if you install a wired network through part of your building, Wi-Fi could be the best way to reach one or two isolated locations such as a top-floor bedroom or a detached garage.

For many families and small businesses, the best approach is to install both wired and wireless in the same network. This will allow you and your users to connect your desktop computers, printer, music server, and other devices that never physically move through wired Ethernet, and use Wi-Fi for laptop computers, Voice over Internet Protocol (VoIP) telephones, smart-phones, and other portable devices.

If you decide to include one or more Wi-Fi access points in your network, mark their tentative locations on your floor plan. In most cases, a single access point can exchange data with computers and other devices within about 300 feet (100 meters), so the exact location is not critical. The best location is often either in the network control center, or on the floor or a table next to a computer in a fixed location. For detailed information about installing Wi-Fi access points and connecting Wi-Fi devices to your home or office network, see Chapter 8.

With your network floor plan more or less complete, you're ready to install the control center and string Ethernet cables to each room. The next chapter will tell you how to do that job.