Beyond the Basic Star

The basic single hub with star configuration only works acceptably in the simplest networks. In the real world, networks tend to have many hubs, and often span floors, buildings, states, and even countries. Starting with the basic star, and using structured cabling where applicable, you can progress beyond that rudimentary configuration using certain equipment and strategies designed for larger, more advanced, and more efficient networks.

To see the many ways we can progress beyond the basic star, let's look at an example. The Bayland Widget Corporation's network has three 10BaseT hubs. Each hub serves a different department: hub A is for accounting, hub B is for sales, and hub C is for manufacturing. Bayland's clever network tech has connected the three hubs, enabling any system on any of the three hubs to communicate with any other system on any of the three hubs (see Figure 8.42).

Switched Networks

As you add PCs to a 10BaseT network, your network traffic will increase. As network traffic increases, your users will begin to experience a perceptible slowdown in network performance. One of the fastest and cheapest hardware solutions for too much traffic on any star-bus Ethernet network is the addition of a switch. To switch (sorry, the pun was just hanging there!) to a switched 10BaseT network, simply remove a hub and replace it with a switch. You don’t have to do anything to the cards or the cabling.

Like hubs, switches come in a dizzying variety of shapes and sizes. As you might have guessed,
companies that make hubs tend to make switches, too, most of which use the same casing for equivalent hubs and switches. In fact, from 20 feet away, an equivalent hub and switch look identical. Figure 8.43 shows an Intel small office hub next to a small office switch; note that they are virtually identical.

In the past, switches were tremendously more expensive than hubs, but in the last few years, the price of switches has dropped immensely—from thousands of dollars to mere hundreds. Small eight-node switches are available at your local computer store for under $100. With the dramatic price drop, the switch has moved from a luxury technology to a standard part of all networks.

So, now you can buy a switch without selling your house to pay for it, but what do you do with it once you have it? You have many possibilities, depending on the type of network you have, but odds are you’ll want to choose between two common implementation strategies. The first option is to switch everything—forget about plain hubs and connect everything to a switch. The second option is to use the switch as a bridge between hubs. Let’s look at both of these options, using Bayland Widget as the example.

Bayland’s network has three hubs, each of which you can replace with a switch (see Figure 8.44). This eliminates the collision domain problem: with three cascaded hubs, the packets sent from any PC go to all the other PCs on all three hubs, raising the likelihood of collisions. Because switches direct each packet only to the specified recipient PC, no collisions occur (after the switch determines the MAC addresses and creates a direct connection between the two computers). This is wonderful because it means that every connection runs at the full potential speed of the network—in this case, the full 10 Mbps of a 10BaseT network. Remember, the moment you start using switches, you can throw the 5-4-3 rule out the window!

It’s useful to note that replacing hubs with switches reduces but does not eliminate collisions. Even in the most efficient Ethernet network, some collisions will occur when the switch and NIC establish a communication channel. That initial contact goes out over the full collision domain.
If you’re monitoring network collisions in an office environment, for example, you’ll notice a sharp increase when people first get to their desks in the morning and log onto the network. Then collisions virtually disappear for the rest of the day.

Multispeed Networks

In the networking world, the fastest technology isn’t always the best. My office uses a 100BaseT network. Even though Gigabit Ethernet is available with relatively inexpensive switches and NICs, the CAT 5 cable in our network simply was installed too poorly to handle it. The RJ-45 jacks were poorly crimped at the wall outlets and the horizontal cabling was laid too close to my fluorescent lights, so I’d need to replace all my structured cabling. The work we do is such that the vast majority of the users on the network wouldn’t even notice the extra speed of Gigabit Ethernet. Computers that cruise the Web, pull down e-mail, and transfer an occasional Word document barely make use of 100-megabit connections, let alone gigabit! On the other hand, my hard-working servers handle almost 50 times as much traffic as my workstations, so they would benefit dramatically from a speed increase. How can I make my servers run at Gigabit Ethernet speeds, while my regular PCs run on 100BaseT?

The secret lies in a class of switches called multispeed switches. Multispeed switches come in two types. One type is a switch with some number of—for example—100BaseT ports. To the side of those ports lie one or two Gigabit ports. I can snap Gigabit Ethernet cards into my servers, and then plug those servers directly into the Gigabit ports (Figure 8.45).

With the second type of multispeed switch, every port is capable of running at more than one speed. Figure 8.46 shows the link lights for the primary switch in my office. Every port on the switch can run at either 10 or 100 Mbps. These ports are autosensing; this means that when you connect a cable into any port, the port will detect the speed of the NIC on the other end of the cable and run at that speed. An autosensing port that runs at either 10 or 100 Mbps is referred to as a 10/100 port. A port that runs at 10, 100, or Gigabit is often referred to as a 10/100/1000 port.

You’ll also find switches that combine both of the types just described. For example, I have a switch with 24 multispeed 10/100 ports and two Gigabit ports.

Multispeed networks are incredibly common, as they provide an easy way to support a few systems that need a high-speed connection, while also supporting lower-speed systems. Another big benefit to multispeed networks is that you can use the high-speed ports on one switch to interconnect other high-speed ports on other multispeed switches. This creates a special, separate, high-speed segment called a backbone that acts as the primary interconnection for the entire network. Backbones are popular in larger networks where systems are separated by floors and buildings. Let’s talk about larger networks and see how backbones fit into this picture.
Multiple Floors, Multiple Buildings

Once you begin to expand a network beyond the basic star configuration by adding more hubs and switches, new demands arise. These can be summarized in a single statement: as networks grow, they take up more space! Adding significantly more PCs to a network usually implies adding more offices, cubicles, and other work areas. Adding work areas means adding more switches and hubs in more equipment rooms.

As a general rule, networks use one equipment room per floor. If the room is centrally located in the building, cabling within the 90-meter limit will completely cover the floor space in most buildings. If your office has work areas on more than one floor, you essentially now have multiple networks on multiple floors. This is a classic example of the need for a backbone network. Backbones tie all the floors together with a robust, high-speed network fast enough to support the demands of combined networks.

Enlarging a network usually also means adding more servers to handle the increased demand. As more servers are added to the network, the administrators who tend to them will find it more efficient to group mission-critical servers together in a single computer room. A computer room not only provides enhanced safety and security for expensive hardware, it also enables administrators to handle daily support chores like backups more efficiently. Bottom line: the larger the network, the larger the space needed to support it, and the more complex your network infrastructure will be.

The concept of structured cabling extends beyond the basic star. EIA/TIA provides a number of standards, centered on EIA/TIA 568 and another important EIA/TIA standard, EIA/TIA 569. These standards address cabling configuration and performance specifications (568), and cable pathways and installation areas (569) involving multiple equipment rooms, floors, and buildings. Slightly simplified, EIA/TIA’s view of structured cabling in larger networks breaks down into six main components: the equipment room, the horizontal cabling, the work areas, the backbone, the building entrance, and the telecommunication closets. The first three were discussed earlier and perform the same roles in a more complex network as in a basic star, so I’ll concentrate on the last three.

Backbones and Building Entrances

When you split a network into multiple floors or buildings, a common practice is to interconnect those floors or buildings with a single high-speed segment—a classic example of a backbone. EIA/TIA specifies using UTP or fiber-optic cable for backbones. While any cable that meets the criteria for a backbone can certainly serve as a backbone cable, EIA/TIA conceives of backbones more as cables that vertically connect equipment rooms (often called risers) or horizontally connect buildings (interbuilding cables).

EIA/TIA provides some guidelines for backbone cable distances, but the ultimate criterion for determining cable length is the networking technology used. Most riser backbones use either copper or fiber-optic cables. Because of its imperviousness to electrical interference, fiber-optic is the only cabling you should use for interbuilding connections (see Figure 8.47).

The building entrance is where all the cables from the outside world (telephone lines, cables from other buildings, and so on) come into a building (see Figure 8.48). EIA/TIA specifies exactly how the building entrance should be configured, but we’re not interested in the building entrance beyond knowing that fiber-optic cable should be used between buildings.
Complexity is Cool!
As networks grow beyond the basic star, they will also grow in complexity. A large network that is switched, multispeed, and multi-floored requires a substantial time investment for proper management and support. Those who take the time to understand their large networks find a beauty—or as Bill Gates would say, an elegance—that stems from a well-running large network. Complexity is definitely cool!