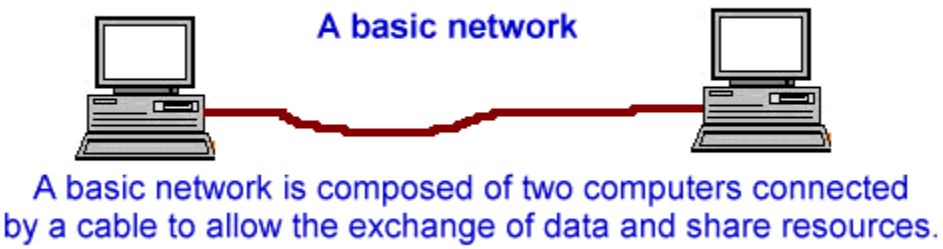
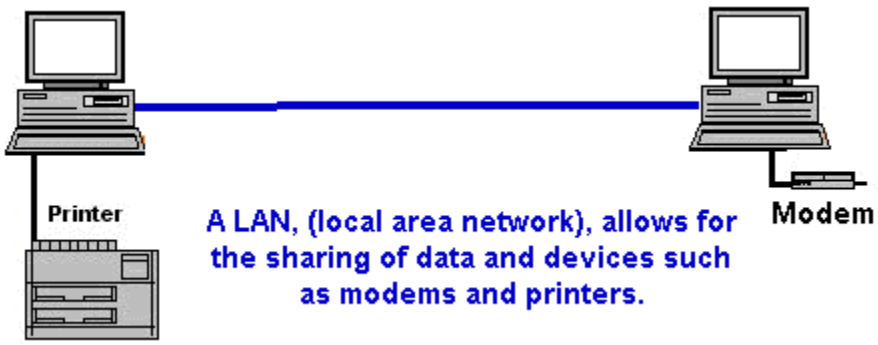
Networking Basics

Networks are merely a means to allow computers to communicate with one and other. That can be two computers in your home or a hundred computers in your office. Since you are reading this, you are using the largest existing network in the world, the Internet.

In our discussions we will be connecting Personal Computers, PCs, into an environment where they utilize common data, common peripheral devices such as printers or modems, common software programs and sharing these resources.



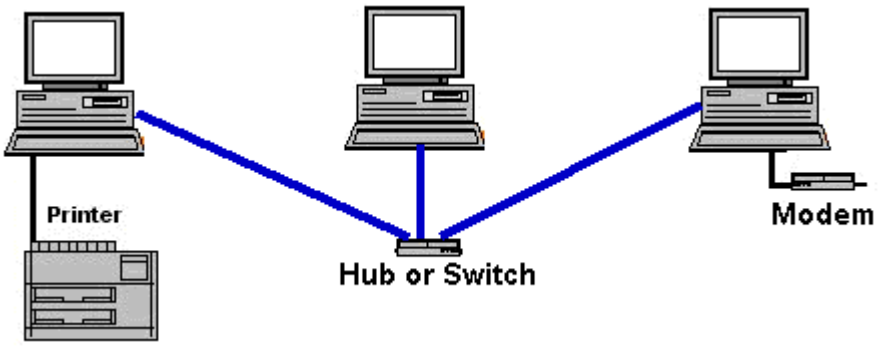
A basic network is composed of two computers connected by a cable to allow the exchange of data and share resources.



These are examples of simple peer-to-peer networks, where only two computers are connected by a single cable. In these types of networks only a network card in each computer and a connecting cable is required. In these examples although you have two computers, they share the resources of data, modem access, printer and other components.

A peer-to-peer network requires a special cable, different from a normal network patch or connecting cable. This cable is called a "cross-over" or "cross-pin" cable.

If your network contains three or more computers, then you are required to add one more component, either a hub or a switch.



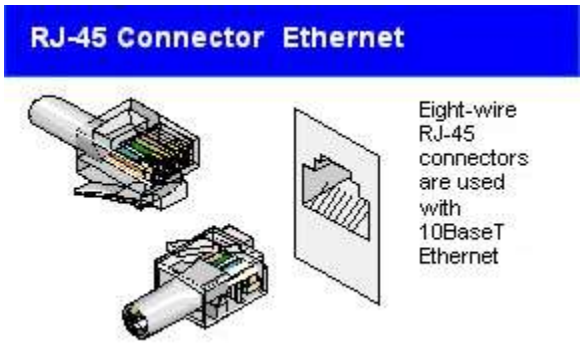
A network connected with either a hub can have two or more computers connected. The hub allows for additional computers to be added to the network at any time. All that is required is an additional cable connected from the hub or switching hub to a network card inside of the new computer. Each computer, printer, or other peripheral device that is connected to the network is called a node. Networks can have tens, thousands, or even millions of nodes.

Like most things, networks are are assembled according to certain rules. Cabling, for example, has to be a certain length, each cabling strand can only support a certain amount of network traffic, etc. The rules that govern how a network is set up is called its topology. The most popular topology in use today is called Ethernet, which consists of computers and peripherals cabled together in specific ways. Ethernet is relatively inexpensive, easy to set up and use, and very, very fast.

Ethernet networks are categorized by how fast they can move information. Speed is expressed in megabits per second (or Mbps), where one "bit" is equal to 1/8th of a character, letter, or number. There are currently two Ethernet speed categories. Standard Ethernet operates at a fast 10Mbps, which is quick enough for most networking tasks. Fast Ethernet, by contrast, races along at 100Mbps, making it ideal for desktop video, multimedia, and other speed-hungry applications. The new technology behind Fast Ethernet, which was introduced in the beginning of 1995, is not readily compatible with standard Ethernet. Making the two "talk" with each other requires special equipment (see switching hub below) and some knowledge of internetworking. If you're building your first network, decide whether to go with standard or Fast Ethernet before you begin shopping around for network hardware and software. Unless you plan on using video, multimedia, or heavy graphics software, plan on using standard Ethernet. For more information on standard and Fast Ethernet, see the Cabling & Hubs section.

Cabling Basics

The two most popular types of network cabling are twisted-pair (also known as 10BaseT) and thin coax (also known as 10Base2). 10BaseT cabling looks like ordinary telephone wire, except that it has 8 wires inside instead of 4. Thin coax looks like the copper coaxial cabling that's often used to connect a VCR to a TV set.



Which type of cabling is best for you?

Thin coax and 10BaseT can both be used exclusively or together, depending on the type of network that you're putting together. Small networks, for example, may want to use 10BaseT cabling by itself, because it's inexpensive, flexible, and ideal for going short distances. This is recommended for home networks as it is the easiest.

Larger networks (usually with 10 or more computers) may use a thin coax backbone with small clusters of 10BaseT cabling that branch off from it at regular intervals.

I will bet you have lots of questions already, here are a few quick answers:

Network Adapter Card

A network computer is connected to the network cabling with a network interface card, (also called a "NIC", "nick", or network adapter). Some NICs are installed inside of a computer: the PC is opened up and a network card is plugged directly into one of the computer's internal expansion slots. 286, 386, and many 486 computers have 16-bit slots, so a 16-bit NIC is needed. Faster computers, like high-speed 486s, Pentiums, PentiumII and PentiumIII, all have 32-bit, or PCI slots. These PCs require 32-bit NICs to achieve the fastest networking speeds possible for speed-critical applications like desktop video, multimedia, publishing, and databases. And if a computer is going to be used with a Fast Ethernet network, it will need a network adapter that supports 100Mbps data speeds as well. These cards are often referred to as 10/100cards.

If a PC lacks expansion slots (which is true with portable PCs), special network adapters are used. A PCMCIA network adapter connects a PC to a network if the PC has a credit card-sized PCMCIA expansion slot, while a pocket adapter connects a PC to a network through the its printer port.

HUB

The central connecting device is called a hub. A hub is a box that is used to gather groups of PCs together at a central location with 10BaseT cabling. If you're networking a small group of computers together, you may be able to get by with a hub, some 10BaseT cables, and a handful of network adapters. Larger networks often use a thin coax "backbone" that connects a row of 10BaseT hubs together. Each hub, in turn, may connect a handful of computer together using 10BaseT cabling, which allows you to build networks of tens, hundreds, or thousands of computers.

Like network cards, hubs are available in both standard (10Mbps) and Fast Ethernet (100Mbps) versions.

SWITCHING HUB

The Switching hub, sometimes called a "Switch" is a more advanced unit over the basic hub. In a basic hub, all the computers connect to it and the speed of the network is defined by the slowest computer network card connected. If you have 10 100Mbps cards on the network and just on 10Mbps card, the system cannot run faster than that one 10Mbps card. There in comes the Switching hub. This hub treats each network card independently and in the matter of the 10 100Mbps network with the one 10Mbps network card, the Switching hub allows all of the faster connections to remain at the higher speed and still interact with the 10Mbps system.

Switches vs. Hubs

There are plenty of choices to be made, and one of the most confusing is whether to use a switch or a hub to connect your computers.

A little background will probably help. In the old days of computer networking, there used to be very few choices for connecting computers. You could use coaxial cable, also called "ThinNet". All of the computers connected in a line, one computer to the next, sort of like a long cable with computers attached to it. Network architects called this sort of thing a bus topology.

Another choice was to connect the computers together using twisted pair cables, almost like telephone wire, with a central hub or concentrator, to connect everything together. This kind of assembly was called a star topology, or sometimes "hub and spoke".

There were also variations on the two themes that combined both bus and star topologies, sometimes with dizzying levels of confusion.

Each method had its strengths and weaknesses, trading price for performance and vice versa. Ultimately, the star topology won out because it became the lowest cost, high performance method on the market. It's what we use today.

The early concentrators were all hubs. A hub is a fairly simple device that effectively connects all of the ports together, adds some logic for detecting errors and moves data in from one system and out to every other system. They're cheap and a virtual no-brainer to configure. But they aren't the best of performers because a hub can't establish a direct connection from one computer to another. When a data packet is transmitted from one computer, it actually goes to all of the computers, although only the destination computer receives the data. When large numbers of data packets are moved, the network slows down because in the process of moving data from one computer to another, every computer sees it, tying up bandwidth. Also, if two packets enter the network at the same time, the packets collide with each other, which means that they must be retransmitted, wasting more time.

As time passed, smarter hubs entered the networking scene. These were called switches because they were capable of actually switching data from one port directly to another. That meant faster network performance and fewer errors. Packets could be sent directly from one computer to another without wasting the bandwidth of the entire network attached to that switch.

The switch accomplishes its task by using a little bit of intelligence. Many switches on the market today actually hold an entire packet in a buffer, then "look" inside the packet for its destination address, then route the packet directly to the destination. That saves precious network bandwidth, since only two computers are involved with the data exchange, instead of all of them. And once the packet is exchanged, the switch "knows" how to route future packets to their destinations, since it has now associated an IP address to a MAC (Media Access Control) address, a unique identifier to each network card.

Switches also tend to reduce network collisions by monitoring the network as specified by IEEE 802.3. Without delving into technological gobbledygook, the switch examines the network lines and holds any packets that would result in a collision until the lines are clear. That specification also allows switches to detect packets with errors and direct the computer to resend them.

Most switches are capable of full duplex. Many times this is advertised as something like "200Mb/s bandwidth", but that's just marketing spin. Full duplex means that data can simultaneously travel to and from a system on the network. No matter what the box says, the fastest you can go on a 100Mb network is 100Mb each way. Of course, your network card must also support full duplex operation.

So, this probably makes switches look like a very tasty option in your network. And you're right. Four or five port switches are in the US$100.00 range, with similar hubs going for less than half of that. But as nice as switches seem, there is still a market for hubs.

If you only have two or three computers on your network, a switch may be overkill, unless you're transferring a lot of data between all three systems. You'll probably find that you just don't move enough data to generate any packet collisions.

On the other hand, if you've got four or more systems, you'll probably want to take a close look at a switch. Data transfers and online games can quickly clog up your network if you're using all of the computers at once. While you won't be able to increase your bandwidth, a switch will more effectively use what you have. Also, if you have just a couple of computers now, but you're going to expand in the future, get a switch so that you'll be ready.

Other situations may call for combinations of switches and hubs. When switches were new and very expensive, they were usually used to connect different hubs together to form larger networks of hubs. Although traffic could potentially become bogged down within a particular hub's network, that slowdown wouldn't affect systems outside of the hub.

In a home network, you probably won't come across that sort of situation, but if you've got more than one hub in your network, you may want to consider connecting the hubs to a switch instead of to each other.

The bottom line comes down to the number of computers in your network and the size of your wallet. Even though hubs are very cheap, switches aren't too much more expensive. If you've got more than a few computers to network and your wallet isn't too thin, it's probably worth your while to consider a switch.