Introduction to Personal Computers

Q1-Workbook 595-5984

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Introduction

The technical career you have chosen to pursue has, at its core, a personal computer. The vast majority of technical careers have been revolutionized by the power of personal computers, which can handle both mundane and complex tasks without growing tired or making mistakes.

This course provides you with an overview of the operation of a personal computer, its organization, common terminology, and hands-on experience with real PCs. As you work through this course you will be building a base of knowledge that will provide you with a solid foundation for using the personal computer. You aren't likely to become a computer expert as a result of this course, mainly because there isn't time for that, but you will be capable of handling the most common and routine tasks. These include operating systems navigation and organization, and basic hardware troubleshooting, upgrades, and the essential concepts of networking.

Unit 1

General Knowledge, CPUs, and Safety

This lesson sets the foundation for further study of the personal computer. and operating systems. You will gain an understanding of the evolution of computers, which will shed light on how they work today. Many of the principles used in the earliest computers still apply to the contemporary electronic personal computer.

This chapter will also concentrate on many of the general terms that you will encounter throughout this course, then discuss CPUs, static electricity, and computer disassembly. Let's begin with some computing history.

A Short History of the Computer

A basic understanding of how a computer came to its present form is essential to understanding how today's computers work. Many of us think only in terms of "electronic" computers. (If you can't plug it in, is it a computer?) The truth is that to "compute" is to "ascertain (an amount or number) by calculation or reckoning." In fact, the Chinese invented the first computers about 2500 years ago. Their computer is called the abacus, and they are still used throughout Asia today.

Objectives

- Describe some of the earliest forms of computers.
- Develop a familiarity with the history of the PC and operating systems, from 1971 to the present.

The Abacus

The abacus is a calculator; its first recorded use was around 500 B.C. The Chinese use it for addition, subtraction, division, and multiplication. But the abacus was not unique to the continent of Asia; archeological excavations have revealed an Aztec abacus in use around 900 or 1000 A. D.

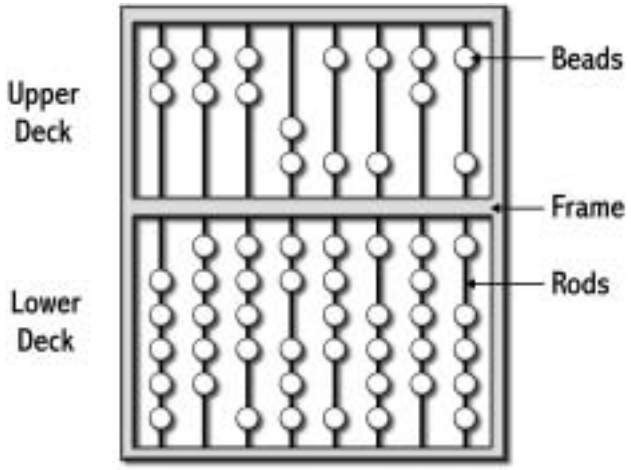


Figure 1
An Abacus, the first computer.

The Analytical Engine

The first *mechanical* computer was the analytical engine, conceived and partially constructed by Charles Babbage in London between 1822 and 1871. It was designed to receive instructions from punched cards, make calculations with the aid of a memory bank, and print out solutions to math problems. Although Babbage lavished the equivalent of $6,000 of his own money – and $17,000 of the British government's money – on this extraordinarily advanced machine, the precise work needed to engineer its thousands of moving parts was beyond the technology of the day. It is doubtful whether Babbage's brilliant concept could have been realized using the available resources of his own century. If it had been, it seems likely that the analytical engine could have performed the same functions as many of the early electronic computers.

The First Electrically-Driven Computer

The first computer designed expressly for data processing was patented on January 8, 1889 by Dr. Herman Hollerith of New York. The prototype model of this electrically operated tabulator was built for the U.S. Census Bureau and was used to compute the results of the 1890 Census.

Using punch cards containing information submitted by respondents to the Census questionnaire, the Hollerith machine was able to make instant tabulations from electrical impulses actuated by each hole. It then printed out the processed data on tape. Dr. Hollerith left the Census Bureau in 1896 to establish the Tabulation Machine Co. to manufacture and sell his equipment. The company eventually became IBM, and the 80-column punch card used by the company is still known as the Hollerith card.

Figure 2
Typical 80-character Hollerith punch card.

The Digital Electronic Computer

The first electronic digital computer was built in the basement of a building on the Iowa State University campus. This project took place between 1939 and 1942 and was led by John Atanasoff and a graduate student. This machine had many firsts, including binary arithmetic, parallel processing, regenerative memory, separate memory and computer functions, just to mention a few. When completed, it weighed in at 750 pounds and could store 3,000 bits (0.4KB) of data. The name given to this computer was ABC (Atanasoff – Berry Computer).

The technology developed for the ABC machine was passed from Atanasoff to John W. Mauchly, who is responsible for the first large-scale digital electronic computer. This project, called ENIAC (Electronic Numerical Integrator and Computer) was built at the University of Pennsylvania – Moore School of Electrical Engineering. ENIAC began as a classified military project and was used to prepare firing and bombing tables for the US Army. When finally assembled in 1945 it consisted of thirty separate units, plus power supply and forced air-cooling. ENIAC weighed in at thirty tons, used 19,000 vacuum tubes, 1,500 relays, and hundreds of thousands of resistors, capacitors and inductors. It required 200 kilowatts of electrical power to operate.

Although programming of ENIAC was a mammoth task requiring manual switches and cable connections, it became the workhorse for the solution of scientific problems from 1949 to 1952. ENIAC is considered the prototype from which most of today's computers evolved.

Another early digital electronic computer that played an important part in history was called Colossus I. It was built at a secret government research establishment at Bletchley Park, Hertz, England, under the direction of Professor Max Newman. Colossus I was built for a single purpose: crypto analysis—the cracking of codes. Working from an input of punched paper tape, it was capable of scanning and analyzing 5,000 characters per second. Colossus became operational in December 1943, and proved to be one of the most important technological aids to victory in World War II. It helped the British to break the otherwise impenetrable German "Enigma" series of enemy codes.

The 60s and 70s were the age of the mainframes. Using the technology of ABC, ENIAC and Colossus, large computers and emerging companies were the norm for the industry.

As these highlights show, the concept of the computer has indeed been with us for quite a while. The following table provides an overview of the evolution of modern computers—it is a timeline of important events. You may not be familiar with some of the terms in this timeline, but all will be explained in the following chapters.

1971 The 4004, the first 4-bit microprocessor, is introduced by Intel. It boasts 2000 transistors with a clock speed of up to 1 MHz.

1972 The first 8-bit microprocessor—the 8008—is released.

1975 Digital Research introduces CP/M — an operating system for the 8080. The combination of software and hardware becomes the basis for the standard computer.

1976 The Apple I is built, although it is not yet very popular.

1977 The Apple II and the Commodore PET are introduced. They use Z80 technology and become the basis for the home computer. Apple's popularity begins to grow.

1978 Intel introduces a 16-bit processor (the 8086 and the math coprocessor 8087). Intel also introduces the 8088.

1981 The IBM personal computer is born; it contains a 4.7 MHz 8088 processor with 64 KB of RAM and MS-DOS 1.0.

1982 Intel completes development of the 80286—a 16-bit processor with 150,000 transistors.

MS-DOS 1.1 supports double-sided disks that hold 360 KB of data.

1983 IBM introduces the XT with a 10 MB hard drive. MS-DOS 2.0 arrives — it features a directory structure.

1984 The first computer with the 80286 chip — the IBM AT — is sold. It is a 6 MHz machine with a 20 MB hard drive and a high-density 1.2 MB floppy disk drive.

1985 MS-DOS 3.2, which supports networks, is released.

1986 The Intel 80386 is introduced; it features a 32-bit processor with expanded multitasking. Compaq releases a 386-based PC, but software is not yet available to take advantage of 32-bit instructions.

1987 MS-DOS 3.3 allows operation of 1.44 MB 3½-inch disk drives and hard drives larger than 32 MB.

1988 IBM introduces the PS/2 series. It does not support the hardware and software available on IBM personal computers or clones.

Microsoft and IBM develop OS/2, which allows genuine multitasking and full MS-DOS compatibility. Microsoft also releases MS-DOS 4.0.

1989 Intel introduces the 80486; it contains a 386, a 387 coprocessor, and an internal cache controller.

1991 MS-DOS 5.0 offers a significantly improved DOS shell.

1992 The Intel i586 (Pentium) processor is introduced, offering 2.5 times the performance of a 486. It contains over 3 million transistors.

IBM expands OS/2. Windows appears and grows in popularity.

1993 MS-DOS 6.0 is released.

1994 Intel delivers the first 100 MHz processor.

1995 Windows 95 is introduced by Microsoft. It features 32-bit architecture, but still uses plenty of 16-bit code.

IBM has shipped over 1 million OS/2 Warp software packages.

The Internet evolves from its predominate use by government and educational institutions to everyday use by anyone who has a modem.

Computer prices continue to drop!

1997 CPU speeds exceed 200 MHz. Hard drive and memory prices fall while sizes continue to increase.

CD-ROM drives and Internet connections now considered standard equipment for computers.

1998 CPU speeds exceed 450 MHz and motherboard clocks reach 100 MHz. CD-ROM writers become inexpensive. USB (Universal Serial Bus) is introduced. Windows 98 becomes the standard operating system for most new personal computers.

1999 Pentium III is released with processor speeds in excess of 500 MHz. Microsoft introduces Windows 2000 operating system. Multimedia and Internet considered standard equipment.

2000 Pentium III speeds reach 1 GHz (1,000 MHz).

The Language of a Computer

Communication is the act of giving, transmitting, or exchanging information. A key element in developing a device such as a computer is establishing a method of communication, both internally (for the transfer of information between hardware components) and externally (with the outside world). An understanding of this process is fundamental to understanding how computers work.

Objectives

- Describe how communication has evolved throughout history.
- Understand the terms *binary*, *hexadecimal*, *bit*, and *byte*.
- Count to ten using binary numbers, and count to 16 using hexadecimal numbers.

The History of Communication

Humans primarily communicate through words, both spoken and written. This system works as long as all participants are within hearing or seeing distance. But what happens when we want to communicate over long distances? In ancient times, and up until about a century ago, we would send a messenger with verbal or written messages. This worked, but it was slow and sometimes the message (or the messenger) got lost in the transmission.

As time progressed, people developed machines to communicate. Prior to the Industrial Age, items like lanterns were used to send messages over long distances (remember "One if by land two if by sea"?). Early Native Americans used smoke signals; armies of yesteryear used flags and mirrors to send signals from one location to another. Over the years, devices were created to signal or send messages over increasingly greater distances.

The ability to harness electricity and the development of the telegraph accompanied the Industrial Revolution. The telegraph allowed people to send instant or real-time messages long distances over a single wire — we no longer had to see the person on the other end, or wait for the mail carrier to communicate. All of these methods had one thing in common. They required some method of converting human language to a form of information that a machine or device could transmit. On the receiving end, this data needed to be converted back to a language that people could understand. These early communication devices formed two concepts that are the basis of today's computers. The first is *digital*, meaning either on or off. The second concept is *machine language*. Machine language is simply a form of language that a machine can use (usually digital code) to process data.

The Telegraph and Morse Code

Telegraphs and early radio communication used a common code for transmissions. Morse code, named after its creator, Samuel F. B. Morse, is based on assigning a series of dots (short pulses) and dashes (long pulses) to represent each letter of the alphabet. These pulses are sent over a wire in a prescribed series. The operator on the receiving end would generally use a "code book" to interpret the code back into letters and words. (Of course, experienced operators became familiar with the code and could interpret each character from memory.)

Today's computers are similar to the early telegraph — they both transmit information over a wire in a digital fashion using a special code. However, the telegraph's primary function was to communicate over long distances while the computer communicates internally. Another big difference is that computers use more than one wire and a different type of code (based on multiple wires).

Parallel and Serial Devices

In modern terms, the telegraph could be described as a digital serial communication device. It is digital because it uses some discrete (on/off) signals and serial because it sends each piece of information one bit at a time. If we create a code in which each letter of the alphabet represents some combination of eight pieces of digital information (on or off), and we send each piece of information one at a time, we are communicating with a digital serial device. This form of communication works well (if we have only one wire), but it's slow because we have to send eight pieces of information one after the other to represent one piece of information (a letter of the alphabet). We could save a lot of time if we could send all eight pieces of information at the same time. The solution is to use eight wires instead of one. By using eight wires, we are sending information in parallel. This is precisely how a computer communicates. Figure 3 illustrates the difference between serial and parallel communication.

The Language of Computers – Counting by 2s

Computers are machines. In order for them to communicate, they need a language of their own. Computer language is called *binary*; it is based on either being on or off.

Bits

A *bit* is the smallest unit of information that is recognized by a computer. A bit is similar to a light bulb since it can exist only in two states—either on or off. A bit is the method used for transmitting information on a single wire telegraph system.

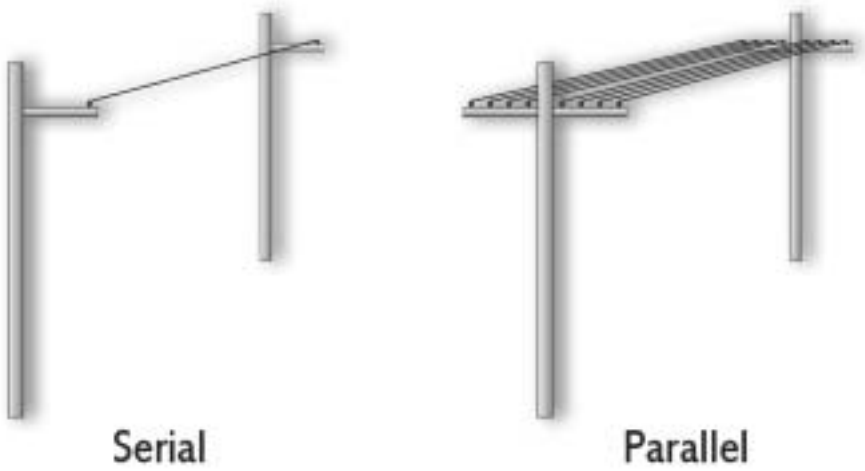


Figure 3
Serial and parallel communication

Bytes

A *byte* is a group of eight bits. A byte is required in order to represent one character of information. Pressing one key on a keyboard is equivalent to sending one byte of information to the CPU (the computer's Central Processing Unit). A byte is the standard unit of measuring memory in a microcomputer—values are expressed in terms of kilobytes (KB) or megabytes (MB). Following is a list of computer memory units and their values:

Bit – Smallest unit of information, shorthand term for binary digit.

Nibble – 4-bits. (Half of a byte.)

Byte – 8-bits. (One character equals 8-bits.)

Word – 16-bits on a computer. (Larger computers can use words that are up to 64-bits long.)

Kilobyte (KB) – 1024 bytes.

Megabyte (MB) – 1,048,576 bytes. (Approximately one million bytes or 1024 kilobytes.)

Gigabyte (GB) – 1,073,741,824 bytes. (Approximately one billion bytes or 1024 megabytes.)

Terabyte (TB) – 1,099,511,627,776 bytes. (1024 gigabytes)

Binary Numbers

As previously mentioned, a bit can exist in only two states, on and off. When bits are represented visually:

- 1 (one) equals on
- 0 (zero) equals off

The following is one byte of information in which all eight bits are set to zero. In the binary system, this represents a single character—the number 0.

0 0 0 0 0 0 0 0

The binary system is similar to the decimal system, which is used for our everyday numbers and values. With the decimal system, the prefix “dec” stands for ten and means that the numbering system has a base of ten. The binary system has a base of two, since “bi” means two.

Starting from the first digit on the right with a value of one (1), the value of each digit is doubled as you proceed from right to left. *Remember two is the factor used in the binary system*. So the bit on the far right has a value of 1, the next bit has a value of 2, the next (third) bit has a value of 4 and so on through the last bit shown, which has a value of 128. When the bit has a “1” or “on,” its associated value is added to the value of any other bits with an “on” value. This gives you the value of the byte.

To illustrate, here are some examples of bytes of information:

Example A—The value of this byte is zero because all bits are off (0 = off).

0	0	0	0	0	0	0	0	8 bits
128	64	32	16	8	4	2	1	# values

Example B—In this example, two of the bits are turned on (1 = on). The total value of this byte is determined by adding the values associated with the bit positions that are on. This byte represents the number 5 (4 + 1).

0	0	0	0	0	1	0	1	8 bits
128	64	32	16	8	4	2	1	# values

Example C—In this example, two different bits are turned on to represent the number 9 (8 + 1).

0	0	0	0	1	0	0	1	8 bits
128	64	32	16	8	4	2	1	# values

For those mathematically inclined, you will quickly realize that 255 is the largest number that can be represented by a byte.

Since computers use binary numbers and humans use decimal numbers, it is necessary to be able to make simple conversions. The following table shows decimal numbers and their binary equivalents (0 to 11).

Decimal	Binary	Decimal	Binary
0	0000	6	0110
1	0001	7	0111
2	0010	8	1000
3	0011	9	1001
4	0100	10	1010
5	0101	11	1011

Numbers are nice, but it is not practical to represent only numbers with bytes. Remember, people think in terms of words. Since computers need to handle many other types of information, a code is needed to translate between machine language and human language.

Counting by 16 – Hexadecimal

Binary works great for machines and computers, but large binary numbers are difficult for people to remember. To simplify the representation of numbers and notations, designers and programmers use a numbering system called *hexadecimal*. Fortunately, as a computer professional, you don't have to be an expert in hexadecimal, but you do need to know how it relates to numbering and computers.

Where binary is a base 2 numbering system and decimal is a base 10 numbering system, hexadecimal (usually just called *hex*) is a base 16 numbering system. Hex uses the numbers 0 through 9 and the letters A through F to represent the 16 numbers. The numbers 0 through 9 represent their respective values, but the letters A through F are used to represent the values of 10 through 15 (A representing 10, B representing 11, C representing 12, etc.).

Since a group of four binary digits can represent a number between 0 and 15, we can replace it with one hexadecimal number. The following table shows the binary, decimal and hex equivalents. We are going to use five binary digits and two hex digits to count from 0 to 21_{10}. Just like in the binary to decimal example, there will be 22 numbers but we will only count to 21_{10}.

Note: When discussing number systems, we need a way to identify what system applies to a number.

Without such a method, you would have no way to determine exactly what quantity the number is referencing. One method, used in the preceding text, is to put the base of the number system in subscript immediately following the number. For instance, when referring to the number 26 in the base ten system, we would present it as 26_{10}.

Binary is usually easy to identify, but the proper way to identify such a number would be 101100010_2. Hex is easy to identify because letters are often mixed in with the numbers, but has two types of identifiers in common use. $BA74_{16}$ is the method used in most texts, but BA74h is the method used in many computer books. Hex can be troublesome simply because often there are no letters within the number to help with an identification.

The first thing to do to convert a binary number into hex is to break it up into groups of four bits (nibbles). If there are not enough numbers to break evenly into four, zeros are added to the left of the binary number to make it evenly divisible. For example, the eight bit binary number of 01100011 (whose decimal equivalent happens to be 99) would be broken into two nibbles: 0110 and 0011. The hexadecimal value of the first nibble would be 6 and the hexadecimal value of the second nibble would be B. So the cumbersome eight bit binary number of 01100011_2 could be represented in hex as 6B.

For the same reason, a 32-bit binary number such as: 01000111001010001110 101110100110_2 could be translated into a much less cumbersome hex number through a couple simple steps.

First, break the long binary number into nibbles:

0100 0111 0010 1000 1110 1011 1010 0110

Then assign the corresponding hex value to each nibble:

0100 = 4 0111 = 7 0010 = 2 1000 = 8

1110 = E 1011 = B 1010 = A 0110 = 6

So, the hex representation of the binary number: 01000111001010001110 01110100110_2 is $4728EBA6_{16}$. And as you can see, the hex number would be much easier for a human to handle than its binary equivalent.

Memory addresses are represented in hex and this is the reason you need to be familiar with hexadecimal numbers. We will discuss memory addressing later in this text.

A useful trick for learning and converting numbers in Windows is to use the built-in calculator. First change it to the scientific view. There are four radio buttons, *Hex*, *Dec*, *Oct* and *Bin*. Each of these represents a different numbering system. If you type the number 62106_{10} into the calculator and then change the numbering system from *Dec* to *Hex*, you will see the equivalent hex number. Also, if you type a binary number (be sure to select *Bin* number system first), then change to *Dec*, you will see the decimal number.

Binary	Decimal	Hex
00000	0	00
00001	1	01
00010	2	02
00011	3	03
00100	4	04
00101	5	05
00110	6	06
00111	7	07
01000	8	08
01001	9	09
01010	10	0A

Binary	Decimal	Hex
01011	11	0B
01100	12	0C
01101	13	0D
01110	14	0E
01111	15	0F
10000	16	10
10001	17	11
10010	18	12
10011	19	13
10100	20	14
10101	21	15

Figure 4
A comparison of the three major number systems.

The Computer Bus

Our earlier discussion pointed out the difference between bits & bytes and the difference between serial & parallel data transfers. Within computers and computer equipment, data is moved around on either a single wire (serial) or several parallel wires. These wires or circuit traces (the copper lines on a circuit board) are called a bus.

Objectives

- Describe the difference between parallel and serial data transfers.
- Describe the purpose of a computer bus.

What is a Bus?

The principle of serial communication — first used by the telegraph — is still employed today for communications. As mentioned earlier in this chapter however, communications within a computer need to occur at a much quicker rate; a number of signals are processed at one time. Therefore, the computer moves information through a *bus* rather than a single wire. There are several types of buses used within a computer and they will be more fully discussed in later chapters. For now, let's simply look at what a bus is and how it works.

A bus is a group of electrical conductors that run parallel to each other. These conductors can be copper traces on a circuit board or wires in a cable. Normally, they are found in multiples of eight (8, 16, 32, 64, and so on). The early computers used eight conductors for a bus, which allowed the transmission of eight bits – or one byte – of information at a time.

The physical configuration of a bus, whether it is a circuit board or a flat cable, is not as important as its function. The purpose of a bus is to provide a common path to transmit information (in the form of code) to all parts of the computer. Therefore, any device that is connected to the bus can receive or send information to any other part of the computer that is also connected to the bus. This is not unlike the aforementioned telegraph. A single wire was strung from one end of the country to the other, and any town that tapped into the wire could exchange information with any other town also connected to the wire.

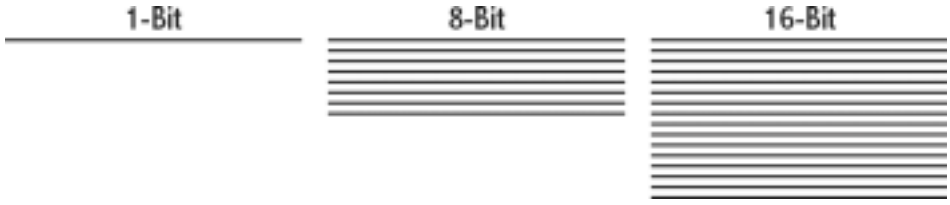


Figure 5
A Computer bus

A familiar example of a bus system is the electrical wiring in a home or office. The AC outlets are wired (with three wires—hot, neutral, and ground) in parallel from one outlet to another. Each time a device is plugged in, it is connected to the bus (in parallel).

Remember: in a computer, a bus is a set of parallel wires or lines to which the CPU, the memory, and all input/output devices are connected. Everything in a computer is connected to a bus. The actual number of wires or lines in a bus varies from one computer to another. The bus contains one line for each bit needed to give the address of a device or a location in memory. It also contains one line for each bit of actual data being transmitted from device to device. A manufacturer may use additional lines for power or other communication within the computer. When we are speaking of buses within a computer (data bus, expansion bus, or address bus) we are speaking of a specific number of wires dedicated to a specific purpose.

It is worth mentioning here that engineers have developed methods to allow data to be transmitted across a serial bus at rates very close to, or even faster than, parallel buses. The catch is that a parallel bus can only keep its speed advantage over a short distance. Serial buses have no such restriction, so engineers have been able to push data transfer rates to extremely high levels for very long distances.

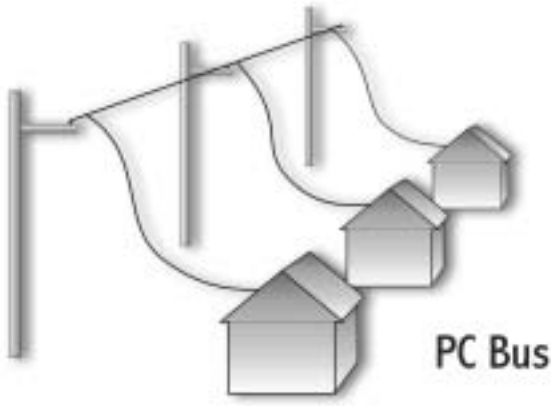


Figure 6
Connecting to a bus is like connecting a house to power lines.

Computer Components

As you might expect, the components of a computer reflect the function of the machine; specifically, the three stages of computing as outlined earlier in this section. Let's take a closer look at some of the components that make up a computer and classify them by their stage.

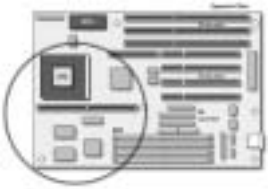
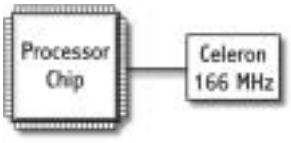
Objective

- Demonstrate which computer components provide processing, input, and output functions for a computer.

Processing

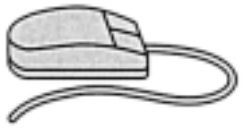
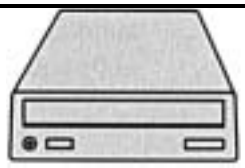
The CPU (Central Processing Unit) is considered the brain of a computer. This component or "chip" does all the number crunching and data management. It is so important that whole generations of computer technology are based and measured on each "new and improved" version of the CPU.

When we refer to the CPU, we are generally speaking of the processor. But the CPU actually encompasses several other components that support it with the management of data. These components, when working in harmony, make up the computer we know today. The following table lists these components:

Device	Description	Image
Chipset	A group of computer chips or ICs (integrated circuits), that when working in harmony, manage and control the computer system. This set includes the CPU and other chips that control the flow of data throughout the system.	
Expansion slots	Sockets that allow additional devices (circuit boards) to be attached to the motherboard. They are used to expand or customize a computer. They are an extension of the computer's bus system.	
Clock	Establishes the speed at which the processor can execute commands. Not to be confused with the clock that keeps time. A CPU and a bus can run at different speeds provided by different clocks.	
Memory	Stores information (in the form of data bits) that the CPU and software need to keep running.	

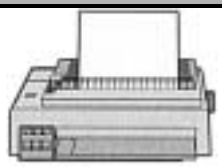
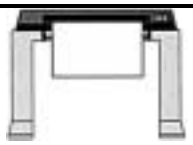
Input

Input is any device that provides a path for information to flow from us into the computer. The following table lists the devices that are used exclusively to get information into the CPU:

Device	Description	Image
Keyboard	The primary input device for a computer.	
Mouse	Used with graphical interface environments to point and select objects on the system's monitor. Can be purchased in a variety of sizes, shapes, and configurations.	
Scanner	Converts printed or photographic information to digital information that can be used by the computer. Works similar to the scanning process of a photocopy machine.	
Microphone	Just like the microphone on a tape recorder. Allows input of voice or music to be converted to digital information and saved to a file.	
CD-ROM	Compact Disc–Read Only Memory: Stores large amounts of data on a compact disc that can be read by a computer.	

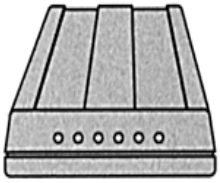
Output

The following table lists the common devices used exclusively for output:

Device	Description	Image
Printer	Generates a "hard copy" of information.	
Display	Generally called a monitor. The primary output device. Visually displays text and graphics.	
Plotter	Similar to a printer, but uses pens to draw an image. Most often used with graphics or drawing programs.	
Speakers	Reproduce sound. Optional high-quality speakers can be added to provide improved output from games and multimedia software.	

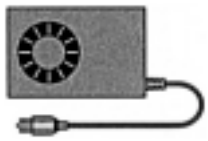
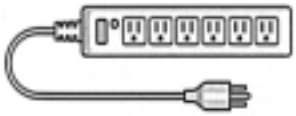
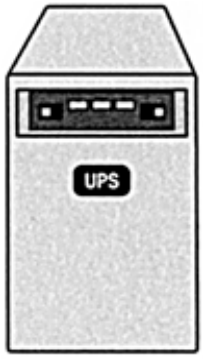
Input/Output (I/O)

Many devices can handle both input and output functions. These devices are called *I/O* devices, a term you will encounter quite often.

Device	Description	Image
Floppy Drive	Mechanism to read and write to low-capacity, removable, magnetic disks. Used to store and easily transport information.	
Hard Drive	High-capacity internal (and sometimes external) magnetic disks for data storage and program files. Also called fixed disks.	
Modem	Converts computer data to information that can be transmitted via telephone wires and cable lines. Allows communication between computers over long and short distances.	
Network Card	An expansion card that allows several computers to connect to each other and share information and programs.	
WORM Drive	Also called optical or CD/R—a version of CD that allows the user to Write Once Read Many. You can create a CD with this device, but you can only write to it once. Currently these devices are slow and expensive. The latest technology is the CD-RW (CD Write/Read). This product will allow you to read, write, and overwrite a special CD-ROM disc.	
Tape Drive	Large capacity magnetic data storage devices. Ideal for backup and retrieval of large amounts of data. Works like a tape recorder and saves information in a linear format.	

Support Hardware

We have been looking at various devices that are part of a computer. There are, however, many additional pieces of hardware that can be used to support safe operation of a computer. Let's look at a few of the devices that protect and enhance the value of a computer. The following table lists some of these:

Device	Description	Image
Power supply	Converts a local power source (typically 120 volts AC) to 5 and 12 volts DC.	
Switch box	Allows the user to manually (or automatically) switch cable connections so that one computer can use several printers or devices with one parallel port.	
Surge suppressor	Used to prevent large power spikes (for instance, lightning) from damaging a computer.	
UPS	Uninterruptible Power Supply – Acts as both a surge suppressor (to prevent high power spikes) and a power leveler to provide the computer with a constant source of power. May even provide power during a power failure or interruption (although the duration depends on the UPS and the computer's power consumption) so the user can safely save data before shutting down.	

CPUs

The *Central Processing Unit*, or *CPU*, and the bus in a computer can be thought of as a central nervous system, with the CPU acting as a brain and the buses acting as nerves. Continuing our "computer-as-body" metaphor, the heart is the clock that keeps everything working in time. At this point the similarities between computers and humans is just about complete, so we will instead describe how these devices actually work in a computer.

This section will focus on those components that allow a computer run our programs and perform much of our work. Because the CPU is such an important part of a computer, we will discuss the many issues surrounding this device.

CPU Support Components

If you review the history of the computer from the ancient Chinese abacus to today's high-speed marvels, you will note that technology progressed in jumps usually centered on some technological breakthrough. With each new breakthrough, the computer is elevated to new heights. Most of these developments are based on the progress of the CPU.

Objectives

- Describe the components that make up a CPU.
- Demonstrate the purpose of a CPU clock.
- Discuss the role of a clock in determining CPU speed.

For most people, to identify the CPU (Central Processing Unit) as the "brain" of their computer is sufficient. However, for some people this definition is just too simple. The CPU is a complicated, highly integrated device that performs many different, simultaneous functions. To understand how the CPU works is to understand the computer.

A microprocessor can be viewed as a little black box. Inside this box is the genius to resolve nearly any problem. Before we dive into details about the CPU itself, we need to look at some additional components that support the CPU.

The Central Processing Unit

The CPU is the part of a computer where arithmetic and logical operations are performed and instructions are decoded and executed. The CPU controls the operation of the computer. A microprocessor is an integrated circuit that contains a complete CPU on a single chip. The following figure shows a close-up of a CPU and other chips on a motherboard.

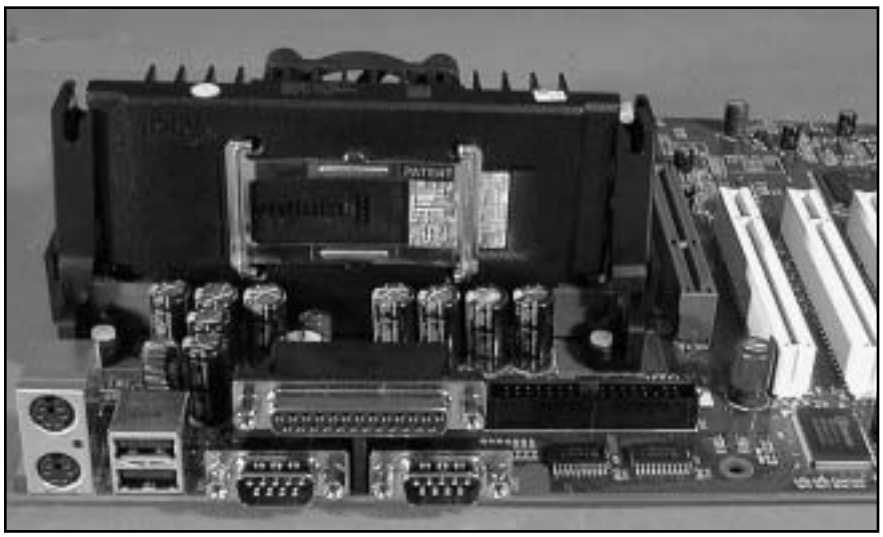


Figure 7
A Pentium II CPU mounted on the motherboard.

Although it is not necessary to know exactly what goes on inside the processor, here are a few terms that you will encounter as your exposure to this technology increases:

Transistors

A transistor is a small electronic device that allows a small electric current to control a larger electric current. They are used as amplifiers and as switches in electronic circuits. Microprocessors are made of thousands of transistors all incorporated into one chip. Today's Pentium CPUs each contain several million transistors. In reality, the CPU is little more than several million digital switches made from transistors.

Integrated Circuit

An integrated circuit (IC) is an electronic device consisting of many miniature transistors and other circuit elements (resistors and capacitors, etc.). The first integrated circuits were developed in the late 1950s. As manufacturing technologies have improved, designers fit more transistors into smaller ICs. The ability to make circuits smaller and smaller allows more devices to be placed on the same IC, and the more devices on an IC, the more powerful the device.

Microprocessors

A microprocessor is an IC containing the entire CPU of a computer, all on one chip. Only memory and input/output devices need to be added. The first microprocessor, (the Intel 8080) sold in 1973 for $400. It now sells for about $1.

Registers

Once data has been placed on the data bus, the CPU needs a method of temporarily storing or manipulating the data. Inside the CPU are temporary memory storage areas called "registers." Each register is a microscopic circuit made of a row of 16 "flip flop" circuits (16 bits long). Each of these circuits can be held in one of two states (on or off). If they are holding a charge, they are "on." If they are not holding a charge, they are "off." The CPU uses these registers like workstations for manipulation of the data.

Clock

Timing is everything. Without some means of timing and synchronization, there would be chaos. Clocks are used to set the pace for all activities inside the computer. Each time the clock "ticks" it sends a pulse. One pulse is considered a clock cycle. All the activity in the computer occurs at the same pace as the clock pulses. The clock pulses synchronize every activity in the CPU, and in the computer. By setting this pace and synchronizing activities, the clock provides a beat for all the individual components to follow.

Usually, a motherboard will have two clocks. One is used to control the speed of the CPU while the other is used to control the speed of the external data bus. This is done so that a single motherboard can accommodate several different CPU speeds while maintaining a constant speed for all the devices on the external data bus. The figure below shows an external data bus with a CPU and two devices. Notice the crystal or clock is attached to the CPU to set the timing.

The main selling point for computers today is the system clock rate – measured in Megahertz (MHz) or millions of cycles per second. If a command requires 2 cycles to complete (*minimum time required to execute a command*), then a 1 MHz computer can execute 500,000 commands in one second. The process of adding two numbers together would take about four commands (8 clock cycles) or 125,000 calculations per second. Today's computers, running at 750 MHz, could then do about 88 million simple calculations per second.

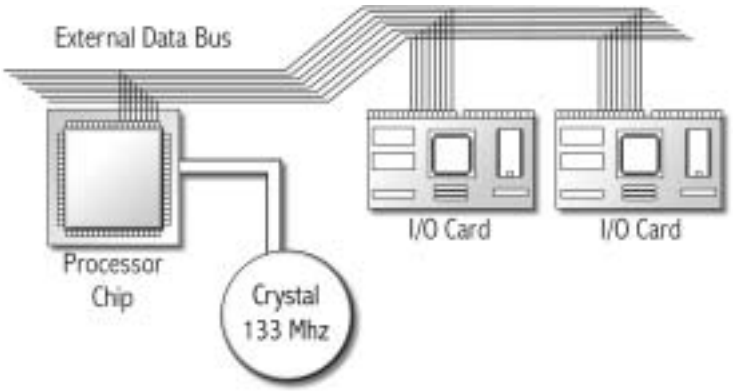


Figure 8
A simplified diagram of a CPU with a clock.

Clock speed is determined by the CPU manufacturer and is the fastest speed at which the CPU can operate. The Intel 8088 processor had a clock speed of 4.77 MHz. Processors today have clock speeds up to, and exceeding, 1,000 MHz, with no limits in sight!

One method of increasing the processor speed is to increase the speed of the clock on the motherboard. This is called clock doubling or tripling. Often a motherboard will be designed for several versions of CPU, thus you can upgrade to a faster chip. When you upgrade, part of the installation will include the changing of a setting that will in turn increase the clock speed. For example, upgrading a 33 MHz chip to a 66MHz chip would require that the clock be doubled.

Remember that this speed is the CPU's *maximum* speed. If you place too many clock cycles on a CPU, it will overheat and stop working. The term used when running a CPU at speeds that are faster than recommended is overclocking. While this can be done, it is not recommended.

A quartz crystal is usually used to provide a clock signal. Look for a silver component, usually with a label indicating the crystal's output frequency. Do not confuse this "timing clock" with the "real-time clock" that keeps the time of day. They are two entirely different devices.

The History of Processors

Microprocessors have evolved from the first 8088 to today's high-speed Pentiums. Each new processor has brought with it new technology. Four basic elements have customarily been used to measure the performance of each new chip design.

Objectives

- Describe Define the main factors used to compare CPU performance.
- Develop an understanding of earlier processors, and how processors have evolved through the years.

Speed – the maximum number of clock cycles measured in MHz (megahertz). Higher speed means more commands executed in less time.

External Data Bus – As data bus size increases, so does the amount and complexity of code (information) that can be transferred between all devices in the computer. The size of this bus determines how much data can go in and out of the CPU. Along with its speed, the size of the external data bus is a primary factor in a CPU's overall performance.

Address Bus – The size of the address bus determines the maximum amount of memory addressable by the CPU.

Internal Cache – Internal cache is high-speed memory built into the processor. This is a place to store frequently used data rather than using slower devices (speed is relative in computers) such as RAM and hard drives. It is built into the processor and has a dramatic effect on speed.

In the Beginning

In 1978, Intel introduced their first 16-bit microprocessor known as the 8086. The processor had 16-bit registers, a 16-bit external data bus and a 20-bit address bus, which allowed it to access 1 MB of memory. When IBM entered the computer business, the 8086 was too advanced (and expensive) to meet their requirements. As a result, Intel introduced the 8088, which was the same as the 8086, but used an 8-bit external data bus. This modification meant that 8-bit components (more common and much cheaper at the time) could be used for the construction of computers.

The first 8088 PCs ran at 4.77 MHz while later models ran at 8 MHz. The original IBM PCs used the Intel 8088 microprocessor. The processors came as a 40-pin DIPP (Dual In-line Pin Package) containing approximately 29,000 transistors.

Processor	*Speed (MHz)*	*Internal Registers*	*External Data Bus*	*Address Bus*	*Cache*
Intel 8088	4.77 to 10	16-bit	8-Bit	20-Bit	None
Intel 8086	4.77 to 10	16-bit	16-Bit	20-Bit	None

The 8088 and 8086 are very similar – they can run exactly the same software. The benefit of using an 8086 is the 16-bit external data bus. This makes an 8086-based computer execute the same software faster than an 8088 computer with the same clock speed.

A few features of the original PCs based on 8088/8086 CPUs were:

- 16 KB of memory.
- Cassette tape recorder interface for program and data storage.
- Non-graphical monochrome monitor

This family of CPUs are considered to be the benchmark microprocessor, and virtually all of today's PCs will still run software written for the 8088/8086.

The Mainstays

The next three processors began a rapid acceleration of CPU development. By overcoming the limits of the 8088 and 8086, they opened the door for color and graphics. Each one is a significant step up from its predecessor.

80286

In 1981, Intel released the first 80286, which is normally called the 286. In 1984, IBM released the AT-Computer, which used the 286. The AT was the first microcomputer to be cloned by large numbers of other manufacturers. The main advantage of the AT was that it could run the same applications as the 8088/8086, but faster. The 286 could also utilize more memory, allowing it to run bigger and more powerful programs than any previous PC. Intel manufactured the 286 microprocessor that operated at 12 MHz, but Intel also licensed the specifications of the 286 to other manufacturers, notably Harris and AMD, who made versions of the 286 that could run at up to 20 MHz.

The use of a 24-bit address path allowed the 286 to access up to 16 MB of memory. This was a huge improvement over the 8088/8086, which could only accept 1 MB of memory.

Processor	*Speed (MHz)*	*Internal Registers*	*External Data Bus*	*Address Bus*	*Cache*
Intel 80286	8 to 20	16-bit	16-Bit	24-Bit	None

A few features of the original PCs based on the 286 were:

- The ability to use Virtual Memory
- Ability to Operate in two Modes (Real and Protected)
- Address 16 MB Memory
- Clock Speeds up to 20 MHz
- Reduced Command Set (fewer commands do more work)
- Multitasking Abilities

Virtual Memory

Virtual Memory can be described as hard disk space, which can be used as additional memory for holding data not immediately required by the processor. This technique allowed the 286 to address up to 1 GB of memory (16 MB of actual memory and 984 MB of virtual memory). This feature was used by the new generation of operating systems such as Windows and OS/2.

Real Mode

The 286 emulates the 8086 processor and consequently can only address the first 1 MB of memory. Without this mode, 286-based PCs could not run programs written for 8088/8086 PCs, which always ran in real mode. This mode ensures the AT machines are backward compatible with software written for the earlier computers.

Protected Mode

This mode, which was created for the 286, allows the 286 to access all available actual and virtual memory. In protected mode, different parts of memory are allocated to different programs. The memory is "protected" in the sense that a program can only write to the memory allocated to it. In addition, this mode allows for multi-tasking programs, or running two programs at the same time.

When the 80286 was first released, it was too powerful for its time. Only special applications were able to take advantage of the performance improvement offered by the protected mode. In order to switch between Protected Mode and Real Mode, the computer had to be re-booted (turned off and then back on).

80386

In 1985, Intel introduced the 80386. This processor, normally called the 386, had two forms:

386DX – this was a real 32-bit processor with a 32-bit external data bus, 32-bit registers and a 32-bit address bus (enabling 4 GB of memory to be accessed). The 386DX was capable of addressing a total of 64 TB (terabytes – a trillion bytes) of total (actual and virtual) memory. The 386DX can easily be identified by its square shape, and distinct inscription.

Processor	*Speed (MHz)*	*Internal Registers*	*External Data Bus*	*Address Bus*	*Cache*
80386DX	16 to 33	32-Bit	32-Bit	32-Bit	None
80386SX	16 to 25	32-bit	16-Bit	32-Bit	None

386SX – the SX processor was similar to the DX except that it had a 16-bit external data bus and 24-bit address bus (it could only address 16 MB of memory). The 16-bit configuration lent itself to easy upgrades for existing 16-bit motherboards, such as the 286, therefore providing an easy introduction to the next generation of computers.

The 386 CPU was originally offered with speeds of 12 or 16 MHz. Intel produced faster 25 and 33 MHz versions, while AMD manufactured clones that ran up to 40 MHz. The 386 provided both the real and protected modes available in the 286. In addition, the 386 had a third mode called "virtual real mode" which allowed DOS programs to be multi-tasked. This processor mode allows independent DOS sessions (called "virtual machines") to coexist on the same system. The 386 had the equivalent of about 250,000 transistors.

80486

In 1989, the 80486 line of processors was released. The 486 processor is the equivalent of an upgraded 386DX. Inside the 486 is a faster and more efficient 386 processor, an 80387 numeric coprocessor, a cache controller and an internal 8K cache. This was the first truly integrated chip.

Processor	Speed (MHz)	Internal Registers	External Data Bus	Address Bus	Cache
80486DX	25, 33, 50	32-Bit	32-Bit	32-Bit	8 KB
80486SX	20, 25, 33	32-bit	32-Bit	32-Bit	8 KB
80486DX2	20, 25, 33 (40, 50, 66)	32-bit	32-Bit	32-Bit	8 KB
80486DX4	25, 33 (75, 100)	32-bit	32-Bit	32-Bit	16 KB
80486SL	25, 33	32-bit	32-bit	32-bit	8 KB

Intel 486 CPUs ran at clock speeds up to 100 MHz. Other CPU manufacturers, notably Cyrix and AMD, built clones that ran up to 133 MHz. Improvements in its architecture allowed the execution of a single instruction in two clock cycles rather than the four cycles of the 386. The 486 was manufactured with new tools that allowed 1.25 million transistors to be built into the chip. These new processes also allowed both a numeric coprocessor and on-board cache to be included in one unit.

Intel 486 processors could be "clock-doubled" or "clock-tripled." These were called the *486DX2* and *486DX4* respectively. These processors were either 25 or 33 MHz versions that had been altered to run internally at double or triple their external speed. (Intel used the "4" to represent clock-tripling.) For example, the DX4 version of the 486 runs at 33 MHz externally, but internally at 100 MHz (3 x 33.3 MHz). This differential in speed means that internal operations, like numeric calculations, or data movement from one register to another, occur at 100 MHz. But the trick is that at the same time external operations, like loading data from memory, take place at 33 MHz. Slower external clock speeds (25 or 33 MHz) allowed existing motherboard and memory designs to be used, which meant that existing 486 systems could be readily upgraded simply by replacing the processor. The DX4 processor contained 16 KB of on-board cache to improve performance.

The *486SX* is a version of the 486 with the math coprocessor disabled – it is cheaper than the full "DX" version of the 486. The coprocessor could be added-on later to increase the power of the computer. While the DX incorporated the math coprocessor, the SX was a fallback to the old ways. Intel claims that only 30% of users need a numeric coprocessor. It is still a full 32-bit CPU.

Originally designed for the laptops, the *486SL* ran at lower voltage (3.3 volts instead of 5 volts). These small yet powerful CPUs also included System Management Mode (SMM), which can dim the LCD screen and power-down the hard drive. These features extended the life of the battery.

Up to this point, laptops, or portables as they were once called, used the same CPUs as the desktops of the day. This was fine until the faster 486 CPUs started to be used in these portables. The higher the clock speed of a CPU, the more power it needs to run. And the more power it needs, the faster the battery's charge runs out. The lower voltage of the 486SL reduced the amount of power the CPU needed, and the new power management modes allowed the CPU to control its own power usage. As a result the portable could run much longer with smaller and lighter batteries.

Today's CPU "Standard"

The statement that "there is a standard today" is dangerous. As this is written, Intel has released a 2.2 GHz CPU. By the time you read this book, you may be able to buy a 4 GHz CPU. Your "today" is different from the author's "today," and all books suffer from this problem. If the information presented here seems to be missing the latest and greatest developments, take it as more proof that this industry is moving at the speed of sound and that the published word cannot keep pace. The CPU speed numbers may change continuously, but the fundamentals evolve slowly. With that in mind, let's now look at the development of the Pentium Processors.

Lesson Objectives

- Describe how the Pentium family of CPUs has evolved.
- Describe the major differences between Pentium CPUs, as well as non-Pentium CPUs.

Pentium

The Pentium CPU was introduced by Intel in 1993. What made this chip big news was that it was not just a new and improved processor; it was a true technological advancement. The most important features were the 32-bit address bus and 64-bit data bus.

Processor	*Speed (MHz)*	*Internal Registers*	*External Data Bus*	*Address Bus*	*Cache*
Pentium	60, 66 (90, 100, 133, 150, 166, 200)	32-Bit	64-Bit	32-Bit	8 KB + 8 KB

Figure 9
The original Pentium processor.

In the early days of Pentium, Intel had problems manufacturing reliable 66 MHz processors. However, by reducing the clock speed to 60 MHz the processors became stable. This minor reduction in speed reduced the temperature of the CPU, and reduced the power consumed to 14.5 watts.

Later Pentium CPUs required considerably less power despite an additional 200,000 transistors. Intel was able to reduce the voltage required by the CPU from 5V to 3.3V, which reduced the amount of heat produced by nearly one half. Additional improvements in power usage were gained by making the components inside the CPU smaller.

Another feature that has now been incorporated into all new CPUs is the addition of on-board cache. Cache, as it will be explained in detail later, is special fast (and expensive) memory. Pentiums have two 8 KB caches, compared with the single 8 KB cache on the 486.

Pentium Pro

Intel's successor to the Pentium processor, the Pentium Pro, was a departure from the simple speed boosts of the past. While compatible with all of the previous software written for Intel CPUs, the Pentium Pro is designed to run 32-bit software.

The Pentium Pro was primarily designed for use in servers and workstations. This was the first Intel *x*86 CPU that could be used in pairs. Motherboards were designed to accept two Pentium Pro CPUs, which nearly doubled the power of the system. Of course, a special operating system was needed as well, one that could also take advantage of two CPUs.

Pentium Pro servers are still being used, but they were never widely available to the public. The main issue with the Pentium Pro is that it actually ran Windows 95 slower than an equivalent-speed Pentium CPU. However, Windows NT ran much faster on the Pentium Pro.

Figure 10
The Pentium II processor

Pentium II

With the release of the Pentium II processor, the traditional chip and socket design went by the wayside. These chips are mounted on their own circuit board and housed in a new SEC (single edge contact) cartridge. This cartridge has a special heat sink and fan, sometimes built right into the cartridge. A special power connector located on the system board provides power to the fan, or one of the system's optional power connectors is used.

The Pentium II didn't provide a brand-new technology, as previous processors had done. There were improvements in the efficiency of the CPU, to be sure, but the main improvements were the CPU speeds that were now possible. Starting at 233 MHz, the Pentium II topped out at 450 MHz.

Processor	*Speed (MHz)*	*Internal Registers*	*External Data Bus*	*Address Bus*	*Cache*
Pentium II	233, 266, 300, 333, 350, 400, 450	32-Bit	64-Bit	36-Bit	16 KB + 16 KB

One of the more significant advances in computer performance came about during the Pentium II's run. Early Pentium IIs ran on a 66 MHz motherboard, and multiplied the internal clock by 3.5, 4, 4.5, and 5 times. By increasing the motherboard bus speed to 100 MHz, all the other components in the computer also ran faster. The Pentium II still multiplied the motherboard clock by 3.5, 4, and 4.5, but the resulting CPU clock speeds were now 350, 400, and 450 MHz. As a result, a computer system with the Pentium II 350 is much faster than the same system running a Pentium II 333.

Celeron

When first introduced, the Pentium II was expensive as compared to earlier CPUs. Seeing the Internet craze just beginning, with people flocking to stores to buy PCs, Intel's competitors saw a chance to develop low cost, slightly less powerful CPUs for a fraction of the Pentium II price. Most of these new PC buyers didn't need all the horsepower of the big Pentium IIs and the big price that came with them. Since the CPU is usually the single most expensive component in a PC, (the cheapest Pentium II at the time sold for about $450) some new low-cost CPUs allowed manufacturers to offer PCs under $1,000 for the first time.

Intel didn't want to lose the entire market for lower-cost PCs, so they looked at ways to quickly provide a low-cost, lower-powered CPU. By removing the cache memory from the cartridge, they could reduce the cost of the CPU. They called this CPU the *Celeron*. Unfortunately, the performance of the original Celeron CPUs was abysmal because cache memory is key to the performance of the underlying CPU. The first Celerons earned their reputation as bad investments after competitors showed that their low-cost CPUs were faster at the same price.

Figure 11
The business end of a Celeron processor.

Next, Intel figured that by removing some, but not all, of the cache memory, they could strike a balance between cost and performance. The strategy worked, and the second-generation Celeron became a winner. Interestingly, removing a portion of the cache works so well that the new Celerons are nearly as fast as their Pentium II equivalents, but with a much lower cost. (This may be why you don't see Celeron CPUs available at the same speeds as their Pentium siblings.)

Pentium III

The release of the Pentium III in early 1999 took CPUs to yet another level of new clock speeds and power. The Pentium III has its share of internal performance improvements, but the obvious improvements are the new clock speeds that make your applications run faster than ever before.

The first Pentium III's were built exactly like the last group of Pentium IIs, and for most users there is very little difference between them except for their speed. Later versions of the Pentium III were built in a different package.

Figure 12
A top view and front view of the Pentium III processor.

Processor	*Speed (MHz)*	*RAM*	*Level 1 Cache*
Pentium III	1200, 1130, 933, 866, 850, 800, 750, 733, 700, 667, 650, 600, 550, 533, 500, 450	SDRAM RDRAM	32 KB

As of this writing in mid 2002, Pentium III is standard for most portable computers and laptops. This trend is likely to continue as the Pentium 4 matures. Intel has released a mobile version of the Pentium 4, which will be common by 2003.

Pentium 4

As of this writing, Intel is shipping a Pentium 4 CPU clocked at 2.2 GHz. By the time you read this, it's possible that processor speeds could be well past 4 GHz. This is a good time to point out that the engineers at Intel and AMD (see the following section) are in a battle to offer the most powerful CPU. Battles like these push the development of new technologies at a rapid pace. So rapid in fact, that the software industry just cannot keep pace.

Processor	*Speed (GHz)*	*RAM*
Pentium 4	2.2, 2.0, 1.9, 1.7, 1.6, 1.5, 1.4	Dual channel RDRAM, SDRAM, DDR SDRAM

So we end up with incredibly powerful machines, run by an operating system being developed on a slower schedule.

In any case, the Pentium 4 contains over 4.2 million transistors, and a slew of new instructions designed to make your games, graphics, and calculations faster than ever before.

Non-Intel Processors

A discussion of Pentium chips would not be complete without some mention of Intel's competitors. Prior to the introduction of the Pentium, processor manufacturers were producing "clones" of the Intel processors. In fact, due to some contractual issues with IBM, Intel was required to provide the specifications for all 8088-based processors to competitors. This way, IBM was sure that if Intel went out of business they could still get the CPUs they needed.

Obviously, Intel did not go out of business, but with the advent of Pentium technology, which was not based on the 8088 design, Intel's competitors were on their own. Therefore, they are currently designing their own processors with unique features. These are the most common:

- AMD K6, Duron, Athlon
- Cyrix 6x86, Cyrix III

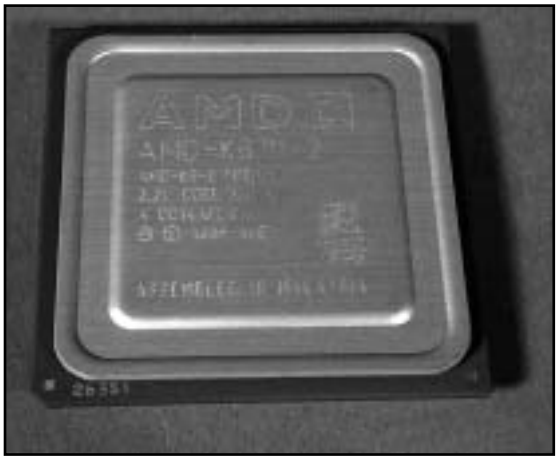


Figure 13
The AMD K6-2 is a popular CPU for lower-cost computers.

At certain times in the past, choosing a processor other than Intel was risky. Today the alternative CPUs are generally as good as Intel, and sometimes even better, especially when you compare the price to the performance. Purchasing a Cyrix or AMD CPU *may* get you a bit less performance, or even the same performance, but this choice will usually save you some money. Today, there are several good and reliable processor alternatives to the higher-priced Intel products.

Choosing a Processor

Which processor is best for you? That's impossible for us to say, except that it depends on what you'll be doing with the PC. Maybe it's best to approach this question with a couple examples.

For our first example, let's say you plan to set your parents up with a PC for sending and receiving email and doing a bit of web browsing. If that was all they need, a Pentium II 233 would do the trick. But you can't buy that one anymore, so you'll have to go with a mid-level Pentium III. You should always consider the applications that the users will be running most of the time, and how much power is necessary for the primary tasks. Email requires no power at all, and most browsing simply requires capable video and a decent data connection. So buying them a high-end name-brand PC doesn't make much sense. A low-end name-brand PC would be a better use of good money.

As a second example, you need to specify a system for budding artist or graphics designer. In this case, the user will be running some high-end graphics programs, maybe even some video editing software. This user needs a high-end CPU, 1.5 GHz or higher, plus a powerful video card. High-end all the way.

Remember, the processor is but one part of a complex computing system. It's an important part, but it's not the only important part. You could have a super-powered processor in a system with a bunch of junk parts, which gets you nowhere. Think of it as the computer-equivalent of a six-lane superhighway with five lanes under perpetual construction. Or, no fun at all.

Power and Connectors

The power supply is the least problematic part of a computer. For all practical purposes, one size fits all; the exceptions being laptops and PCs designed in unique packages. A power supply takes AC power from a local source (the wall outlet) and converts it to +/- 5 volts DC for on-board electronics and +/- 12 volts DC for drive motors. Many newer power supplies have a universal input and will work either with 120 VAC 60 Hz (US standard power) or 220 VAC 50 Hz (European/Asian standard). When replacing a power supply, there are three things to consider: size, wattage rating, and connections. This section covers the basics of power supplies, including troubleshooting.

Any discussion about powering a computer can quickly digress into a discussion about electronics and electricity. While some discussion of peculiar terms is unavoidable, we will try to keep the jargon to an absolute minimum, and we won't try to slip anything past you.

Power supplies are available in "standard" sizes and shapes. Unfortunately, there are several standard types, and a few dozen proprietary designs that are unique to certain manufacturers.

Objectives

- Determine the power rating necessary for a replacement power supply.
- Describe the typical power supply connectors, and how to connect them.

The best thing to do when replacing a power supply is to take the old one and compare it to the new one. As long as it is physically the same and will produce at least as much power, it will work.

How Much Power is Enough?

Power supplies are rated by the maximum power (stated as watts) that they can produce. It is important to keep in mind that the power supply must produce *at least* enough energy to operate *all* the components of the system at one time. During the initial startup of the computer, many components will require additional power to get going. On average, a computer will use 115 to 130 watts while running and up to 200 watts when booting. The following table can be used as a guide for calculating the power requirements of a computer.

These values do not take into consideration many common accessories. For instance, many computers are outfitted with modems, network cards, or additional drives such as a Zip drive or CD-RW drive. Memory uses power, and newer high-end video cards use a lot of power, too.

Your computer will use whatever power it requires, but only as much power as it requires. Don't get confused about power supplies with higher ratings... upgrading to a 450 watt supply will not harm your system at all.

Computer Configuration	Estimated Wattage
1 floppy disk drive 1 hard disk drive	200
2 floppy disk drives 1 or 2 hard disk drives 1 CD-ROM or tape drive 1 Sound Card	250
More than 2 floppy disk drives More than 2 hard disk drives More than 1 CD-ROM drive	300

Getting Connected

A power supply is essentially a small box with wires on both ends. We don't care what is inside, and we are not going to open it to find out. The inside of a power supply is the only truly dangerous part of a PC.

NEVER OPEN A POWER SUPPLY UNLESS YOU KNOW EXACTLY WHAT YOU ARE DOING.

One end of the supply is the input side and a standard power cord. Sometimes you may find a switch so that you can change the input between 120 and 240 VAC. You should never have to adjust this switch.

On the other end of the supply are the output connectors. This will be a bundle of colorful wires with several connectors at the ends. Aside from the physical dimensions of the power supply case itself, the difference between the three major types of power supplies are the number of wires and the type of connectors.

All supplies have the special connectors used to provide power to hard drives and floppy drives. Some supplies have more of these connectors than other supplies, but they are otherwise all the same.

The most widely used supply today has a single rectangular connector containing 20 wires. This connector is in addition to the connectors used to power the drives, and is used for all Pentium II and Pentium III motherboards.

Most Pentium, 486s, and many 386s used two connectors, often called the P8 and P9 connectors, with six wires per connector.

The third type of supply uses special connectors. Some manufacturers built unique supplies and connectors to work with their motherboards. These can be very difficult, if not impossible, to replace. There are dozens of the unique, or proprietary, designs.

Figure 14
The external end of a typical power supply.

P8 & P9

These are perhaps the most important connectors on the power supply used with AT-style computers. Since the two connectors are identical, there are two problems to consider when installing them. First, they could be installed backwards. While this is possible, it is not likely. The P8 and P9 connectors are numbered and keyed. These keys or notches will prevent all but the most stubborn technician from installing them backwards. You would have to force them on the connector, so if it seems difficult to make the connection, it is most likely wrong.

The second problem is installing them into the wrong connector. This is more likely to happen than installing them backwards. If they are installed in the wrong connector, they will damage the motherboard and possibly destroy the supply. The P8 connector provides the 12-volt power and the P9 provides the 5-volt power. If the 12-volt power is connected to devices that only use 5 volts, there will be smoke, and that's bad. To prevent this, you have to do is pay attention to what you are doing and follow these two simple rules:

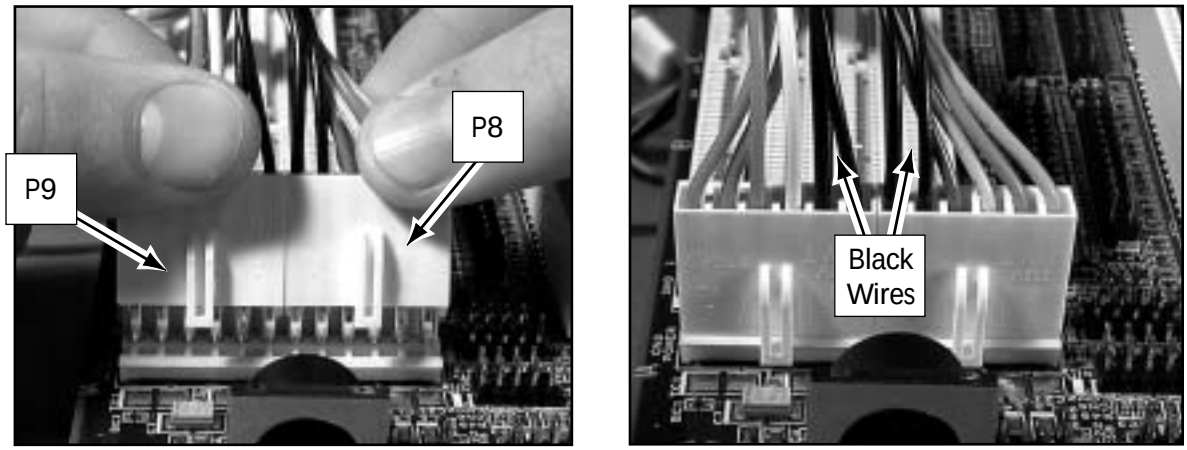


Figure 15
P8 & P9 connectors found on Pentium I and earlier "AT-style" motherboards.

1. The P8 and P9 connectors are numbered and are installed into the P1 and P2 power connectors respectively. Look for the numbers on the connectors and on the motherboard for guidance.

2. Always install P8 and P9 with the black wires together. Both connectors have a pair of black wires. If you hold them so that the four black wires are side-by-side and the keys on the connectors are on the same side, you cannot go wrong.

ATX Power Connectors

With the release of the Pentium II, a new type of motherboard, called the ATX motherboard, was developed. ATX is really a specification that describes where all the board mounting holes will be, and where the connectors will come out of the back of the computer, among many other details. One important detail was a new power supply connector.

All ATX-style motherboards use a single rectangular 20-pin connector to provide power to the board. This connector cannot be installed backwards, no matter how hard you try. The connector also has a strong latch, which keeps the connector from working itself loose.

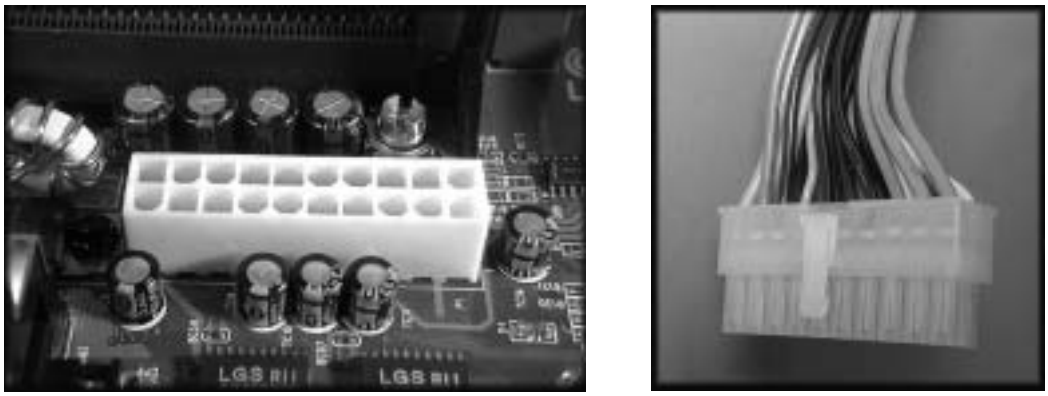


Figure 16
The ATX-style power connectors found on Pentium II/III motherboards.

Molex or mini

In addition to the motherboard connector, a power supply output will have at lease four other connectors. These are used to power the floppy drives, hard drives, or any other internally installed drives. There are two standard types of connectors that can connect to peripheral hardware. They are called the Molex and the mini.

The early power supplies used only the Molex connector. They were used to power up to two 5¼-inch floppy drives and up to two hard drives. These connectors provide both 12V and 5V power to the drives. Like the P8 and P9 connectors, Molex connectors are keyed to prevent misalignment when connecting them.

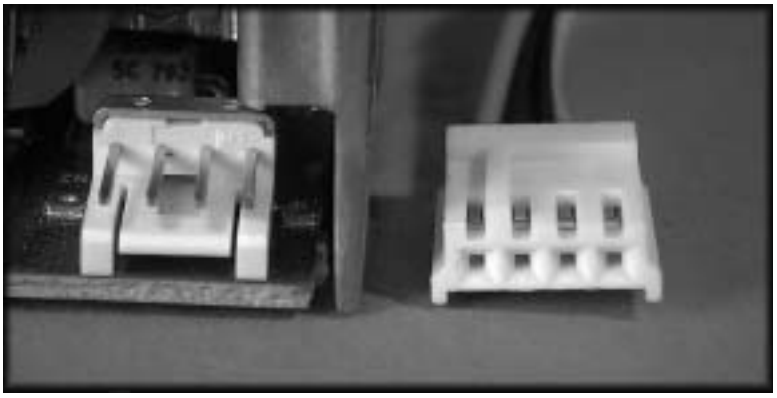


Figure 17
The "mini" or "berg" power connectors used for floppy drives.

With the introduction of the 3½-inch floppy came a smaller connector called the "mini." The mini connectors work just like their predecessor but are smaller. They too are keyed to prevent improper insertion, but BE CAREFUL – with a minimal amount of force you can insert them upside-down. Installing a mini connector incorrectly will destroy the device!

Power Switch Connectors

ATX power supplies have no power switch connector. The switch on the front of the computer is attached to the motherboard, where a signal is sent to the power supply telling it that the power needs to come on.

On older supplies the power switch connectors are highly variable and dependent on the case manufacturer. In general, they will come in two types, either as part of the power supply or remote to the power supply. If they are part of the power supply, they will be located on the back of the computer and you will not have to worry about them. Those that are mounted remotely could be of any size and shape.

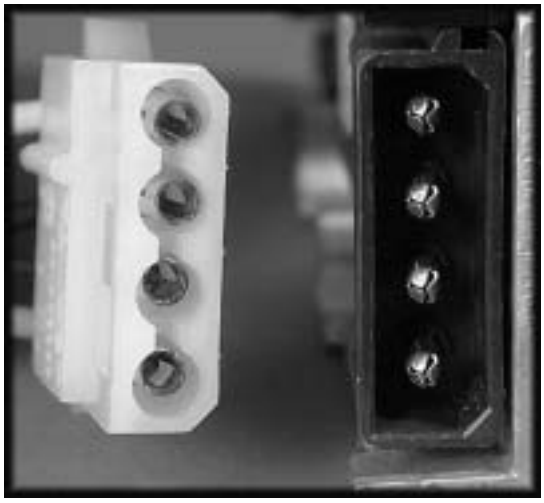


Figure 18
The "Molex" power connector used for hard drives and CD ROM drives.

When the power switch is attached to a long cord, you must be careful not to touch any bare wires. The long cord is usually attached directly to the wall outlet.

When Things Go Wrong

Power problems can come from one of two places, either the power company or the power supply itself. Let's look at ways to deal with these problems.

Objectives

- Describe the differences between spikes and surges, sags and brownouts, and blackouts.
- Describe how power protection devices may help with the various power problems.
- Discuss power supply troubleshooting techniques.

The Power Company

Power company problems come with the names of spikes, surges, sags, brownouts and blackouts. None of these are under your control, but there are a few things that you can do to protect your equipment and data:

Spikes and Surges – A brief, but often catastrophic, increase in the voltage source (very high voltage for a very short time). These can be caused by the power company, but most often are caused by lightning strikes. A spike, or transient, is a very short over-voltage condition measured in nanoseconds, while a surge is measured in milliseconds.

Sags – A brief decrease of voltage at the source.

Brownouts – If a sag lasts more than a second, it is called a brownout. The overloading of the main power source can cause brownouts. Some brownouts are "scheduled" by power companies to prevent overloading of circuits and potential catastrophic failure of the system.

Blackout – A complete power failure that may be caused by equipment failure (local or regional) or accidental cutting of power cables. When the power comes back on after a blackout, there is danger of a power surge.

Surge Suppressors

Surge suppressors are used to filter the effects of voltage spikes and surges. They are good for cleaning fluctuating commercial power sources. Surge suppressors filter incoming power signals to smooth out variations. They are available from local computer dealers and superstores. A good surge suppressor will protect your system from most problems, but remember, you get what you pay for.

If you purchase the "econo-brand" it may not work when you need it the most. Look for performance certification and power ratings when evaluating surge suppressor quality.

Uninterruptible Power Supplies

Surge suppressors protect up to a point, however for complete protection of fluctuations plus complete power outage protection, the Uninterruptible Power Supply (UPS) provides more coverage.

Note: The best defense against voltage spikes caused by lightning is to unplug your equipment during storms or long periods away from your office or home.

When properly installed between your computer and the wall outlet, a UPS will protect from surges and act as a battery when the power dips or fails. It will also provide a warning that the power is out of specification. Many of the more expensive models can also interact with the computer and initiate a safe shutdown in the event of a complete power failure.

When purchasing a UPS, consider:

- How much peace of mind do you require?
- How much protection does your equipment need?

The VA rating (Voltage × Amps = Watts) must be enough to supply all the equipment with power long enough to safely shut down the system. The easiest way to calculate this number is to add up the power rating (Watts) for *all* pieces of equipment that are to be connected to the UPS.

Figure 19
A typical UPS (Uninterruptible Power Supply).

In this case, a minimum 600 VA UPS would be required if all equipment is connected, or a minimum 400 VA UPS if only the computer, monitor and back-up drive are connected.

Troubleshooting the Power Supply

The most recognizable power supply problem is a complete failure of the power supply. This is easily detected—nothing will happen. When there is apparently no power, be sure to check the power source and the plug (in the outlet *and* the computer). The symptoms of this type of failure are:

- No noise, lights, and no fan running.
- Blown fuse or circuit breaker.
- Smoke or acrid odor.

Power supplies can be the source of intermittent failures such as memory loss or memory error. Intermittent errors occur when a power supply begins to fail. When it approaches the point of complete failure any sudden increase in load (hard drive start ups, etc.) will cause the power to drop below the minimum requirements. Therefore, if you are experiencing intermittent failures and you cannot relate them to any particular event, check the power supply.

You should suspect power supply problems when you see the following symptoms:

- Power-on failures or lock-ups.
- Spontaneous rebooting.
- Hard disk and fan stops spinning.
- Overheating caused by no cooling fan.
- Electrical shocks from the system case.

When a power supply fails, replace it!

Static Electricity and the Computer

There is no way around it, if you are going to work around computers, you will eventually have to take one apart and put it back together. *Electro-Static Discharge* (*ESD*) is one of the most damaging events that occur with electronic equipment. ESD destroys thousands of circuit boards a year. Fortunately ESD is one of the easiest things to avoid. Understanding ESD and how to prevent it is an important part of being a computer technician.

Lesson Objectives

- Describe how static electricity charges are generated, and how to reduce their inadvertent generation.
- Describe how ESD can damage computer circuits.
- Describe several techniques to prevent ESD damage when working in a computer.
- Describe several guidelines for working safely around electrical devices.

What is Static?

Static electricity is generated when two dissimilar materials are rubbed together. The rubbing causes positive electrons to migrate to one material and negative electrons to move to the other. When the materials are quickly separated (before the electrons have time to neutralize) one becomes positively charged while the other becomes negatively charged. The two materials are now electrically unstable and will discharge their energy to ground as soon as there is an available path (a conductor) for the flow of electrons. The discharge of this energy is called an electro-static discharge, or simply ESD.

It is important to know that static electricity itself does not cause electrical damage. The damage occurs when these extremely high voltages are discharged in an uncontrolled manner, typically through a semiconductor such as an integrated circuit. Controlling static charges is difficult once they are generated, so the best defense is to reduce the creation of static charges in the first place.

There are two important points that you need to remember about a static discharge. First is that low relative humidity increases the possibility of generating static charges. This is particularly true in the low humidity environments caused by dry heat during the winter. The second is that ESD does not have to be seen to do damage to electronic components. It generally takes a potential of about 20,000 volts before we will actually “see” or “feel” the discharge; voltages of less than 1,000 volts can be fatal to some components. While it is generally accepted that humans can accumulate voltages of 25,000 volts or more, it is the smaller charges that cannot be felt that do most of the damage to semiconductor devices. The simple act of improperly handling memory chips can damage them without us even knowing what happened.

When a device fails, attempting to prove that ESD caused the trouble can be impossible, unless the device fails immediately after you feel a static discharge. In many cases the damage is not complete failure, but a weakening of one or more devices within the IC. The IC may not fail right away, it may not fail in a month, but rather than lasting forever (as it probably should) it fails in six months. The other type of failure is the worst kind, a device that works most of the time, but fails intermittently.

The rules regarding static electricity, ESD, and computers must be followed at all times. ***The best ESD defense is prevention.***

Preventing Static Electricity Around Computers

Improper handling is the number one cause of ESD damage. When you purchase new memory modules or a hard drive, you may notice that they are packaged in a special bag. These are called anti-static bags and are designed to prevent ESD. You should save a few of these bags, just for storing electronic components temporarily while you are working on a computer.

The answer to ESD prevention is to maintain all components and yourself at the same potential—GROUND POTENTIAL. As long as you make sure that you are discharged before you pick up any electronic parts, you will not have any problems with ESD. The electronics industry has designed and approved several devices you can use to prevent ESD when working on electronic equipment. Several techniques can be used to prevent ESD. The following are some guidelines:

- Use an anti-static wrist strap. Be sure that you are using it properly and that the resistor is good. Connect the clip to the computer chassis.
- Make sure that the computer chassis is grounded.

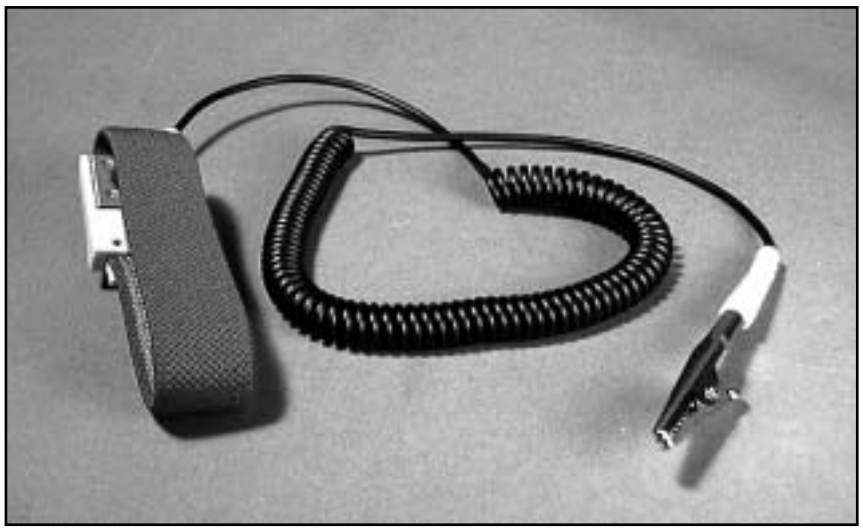


Figure 20
A typical anti-static wrist strap.

- Keep electronic devices in protective bags until needed. You can use the bags to lay the parts on after removing them from the computer.
- Do not place circuit boards on metal or foil.
- Create an ESD workstation; anti-static mat, wrist strap, and ground wire.
- Maintain the relative humidity between 50 and 70 percent.

There may be times when you do not have your tool kit with you and you need to make a repair. The best way to eliminate any static charge is to ground yourself to the chassis of the computer. By simply touching the frame, you will discharge any built-up ESD. As long as you and the computer are at the same potential the possibility for ESD is minimal. Always touch the chassis before picking up any parts or removing parts from the computer.

Electricity and Safety

Computers are electronic equipment and therefore consume electricity. Although most circuits in a computer use 12 volts and 5 volts DC, which are normally safe, the main power source and the monitor use high voltages.

ELECTRICAL SAFETY IS YOUR RESPONSIBILITY!

Standard outlet voltages in the US provide a 120 VAC at 15 to 20 amps. It is possible to receive a lethal shock from much lower voltages than these, if you are not careful. Inside a monitor, voltages as high as 30,000 volts may exist even *after* the power is turned off. A computer power supply can have voltages in the 2,000-3,000 volt range, and unplugging them does not always remove these charges. As we have said before, do not open up a power supply or a monitor unless you have electronics training.

It is vital to follow basic electrical safety guidelines when working on computers. There is no substitute for good old common sense. However, here are a few tips:

- If in doubt, don't! If you are not sure, then you are probably wrong.
- Always use grounded outlets and power cords.
- Switch off all equipment before removing any covers.
- Always replace blown fuses with the correct rating and type.
- Do not work alone, you might need help in an emergency.
- Remove all jewelry, these are conductors and can cause short circuits.
- Power supplies and monitors use and store potentially lethal voltages, often for days or even longer. Only trained personnel should service them.

Disassembling and Reassembling a Computer

Upgrading a computer is one of the most common reasons to open a computer case. With new technology coming out every day, we are in a constant struggle to stay current. Often the first step when repairing a computer is knowing how to take one apart *and put it back together*.

Anyone who knows how to use a screwdriver can take a computer apart. There's usually no special skill involved with that. Putting it back together, and making it work the same as it worked before, or even better, is what this section is all about.

Objectives

- Demonstrate the steps to be taken when disassembling a computer.
- List the various tools necessary for servicing computers, and their common usage.
- Describe the types of software necessary to troubleshoot a malfunctioning PC.

Preparation

Preparation is the main ingredient to a successful, efficient and profitable repair or upgrade. Before attempting any work on a computer, it is wise to know what you are working with and have a good understanding of the problem, or task, at hand. Ten minutes or even an hour in preparation can save hours of endless guessing and frustration. Documentation is the key to preparation. If adequate documentation is not readily available, collect it or create your own.

When you finish a job, don't forget to save the documentation, including what you did and any problems encountered. Then the next time you work on this machine, or one just like it, you won't have to re-learn everything. At the end of this chapter is a sample data sheet that can be used a model for data collection. The following lists some examples of the types of documentation that should be available and some questions that should be considered before the job starts.

Documentation to Collect Before Starting the Job:

- Copies of the computer and/or motherboard documentation.
- List of all installed expansion cards. If possible, include when they were originally installed, the type, model, and who made it.
- Copies of documentation for the operating system (especially if you are not familiar with this system).

- Make or find a list of the current configuration of the computer. This will include make and model of drives and peripherals and a list of their IRQs, I/O addresses and DMA channel assignments. Note the software that is installed.
- A plan of action. Writing down a plan of action *before* starting a project will often keep you focused and on target. Remember, plans can always be changed, but without a plan you may wander aimlessly through the project and even get sidetracked or lost.
- And finally, never begin a job without a comprehensive reference book to turn to in case you get stuck. We suggest Mark Minasi's *PC Upgrade & Maintenance Guide* or Scott Mueller's *Upgrading and Repairing PCs*.

Questions to Ask Yourself Before Starting the Job:

Carefully consider the following questions before you open the case of any computer.

- Why am I taking this apart? Do I really need to take it apart?
- Do I have everything necessary to do the job?
- Do I need more information before starting this job?
- Are there any components of this machine that may be proprietary hardware? If so, do I have the right tools and parts to do the job?

Toolkit

A computer technician does not need a large toolbox, as a computer only requires a few basic hand tools and a handful of diskettes to resolve most matters. Be careful when working on a proprietary machine, as special tools are often required. Often a briefcase will be sufficient to carry everything that you will need. The following list includes a minimum of hand tools and software that will meet most needs.

Screwdrivers – One large and one small flathead (regular) and a set of Philips-head (sometimes called a cross**).** Don't buy cheap screwdrivers – the good ones work better, save you time, and last forever. Cheap screwdrivers don't fit the screws; they strip screw heads, make your work harder, and might last a few weeks. *Be careful with magnetic screwdrivers.* They are convenient for picking up lost screws, but being magnetic, they could cause other problems if laid in the wrong place...like around floppy disks

Tweezers – Convenient for picking up lost small parts (screws). You might consider long plastic tweezers that won't short out anything.

Needle-nose Pliers – They can be used to pick up dropped items and to hold or loosen things. Think of them as an extension of your fingers.

Tube for Small Parts – A short plastic tube (with caps on both ends) will keep those loose screws and small parts from wandering. Old film cans work well, especially the clear ones.

Compressed Air – A can of compressed air is helpful to remove dust.

ESD Tools – An anti-static wristband is a must. Anti-static mats and anti-static bags are helpful.

Multimeter – A small digital type that is capable of measuring volts (AC and DC) and ohms (resistance or continuity) is all that is needed.

Flashlight – A small (bright) light for seeing in dark places.

Nut Driver Set – Sizes 3/16", 7/32", and 1/4".

Curved Hemostats – Good for picking up and holding small parts. Straight hemostats will work most of the time, however, the curved ones will get into small places the straight ones won't. Having a set of both wouldn't hurt.

Many computer stores sell small tool kits for repairing computers. If you are a beginner, one of these kits will suffice but should be considered a minimum requirement. With time you will be able to build your own customized tool kit a piece at a time.

Software

Software is a key component of any tool kit. What you need is highly dependent on the operating system that you will be working with. At the very least, you will need a bootable floppy disk (one for each operating system – DOS, Windows, Linux, etc.).

Operating System Disk – Make sure copies of the original operating system disks are available. If it becomes necessary to install one or more components that were left out during the original installation, the computer may require serial numbers before allowing additional files to be installed.

Some technicians build complete sets of the important operating systems, and put them on CDs. You can fit DOS 6.22, Windows 3.11, and several versions of Windows 9*x* onto a single CD. Since you cannot get to the CD without booting the computer, you'll need bootable floppies for the major OSes.

Note: If you do not own the software, you cannot put it onto a CD. If the user of the computer does not own an original copy of the software, you cannot put it on their computer.

Software Utilities

There are many good quality utility programs available on the market today. These programs will allow an experienced user to find and correct a multitude of problems. You are far better off to master one good software system than to have a box full of ones that you don't know how to run effectively. The best software diagnostics are DOS-based for a good reason: DOS allows direct access to the system and hardware, but Windows sits in between you, your diagnostics, and the hardware system.

Software diagnostics are of no value if the computer cannot run them. That means the computer must be running before the software can attempt to diagnose the problem, and that means there cannot be much wrong with the computer in the first place.

WARNING! Older versions of utility programs, such as Defrag and Scandisk, are designed to work with DOS and Windows 3.x. They can completely destroy a Windows 9*x* system. Win 9x has its own versions of these handy DOS utilities located in a folder called COMMAND.

Unit Summary

This Unit covered a lot of territory, the fundamentals of computer operation, through the various CPUs and basic safety precautions. Most of the information here serves as a foundation for further study, and the last two sections, discussing static electricity and system disassembly, were provided as preparation for the Lab exercise that follows.

Lab 1-1

Inside the Computer

In this lab, you will disconnect the external components from the computer, remove the cover, and examine the hardware inside. While inside the computer, you will disconnect and reconnect a couple of cables, and remove and replace one of the cards. Why do this? Because it is a good way to get a close-up look at the various parts and pieces that make up the PC.

While we will supply descriptions and photographs showing you how to disassemble things, don't rely on these alone. You must develop the habit of taking good notes. In your notes, describe where cards are located, how cables are routed, and what hardware is used to secure each component. Make sketches of everything. If you don't develop this habit now, you will not do it later when it really counts. That could turn out to be a very expensive mistake. So, take good notes as you work through this lab. To this end, you will need pencil and paper for sketching the location and orientation of cables, boards, and connectors. You will also need some tape and a pen for identifying things.

Objectives

When you complete this lab, you will be able to:

- Identify, disconnect, and reconnect the computer's external units.
- Remove and replace the computer's cover, cables, and interface cards.
- Identify the external connectors on the computer.
- Identify the major internal units.

Materials Required

To complete this lab, you will need your computer system, a phillips screwdriver, an antistatic wrist strap, antistatic bag, paper, pencil, and tape.

Procedure

Disconnecting External Components

1. Make certain that the computer and monitor are turned off.

2. When working inside the computer, you must take precautions against causing damage by static electricity. The little crackle you hear when you comb your hair, or when you walk across a rug and touch metal, is enough to destroy circuits inside the computer.

3. To prevent electrostatic charges from building up on your body, clip the antistatic wrist strap to *ground* on the back of the computer. The end of the screw shown in Figure 1 is a handy place to connect the strap. Then slip the other end of the strap on your wrist so that the conductive metal button is against your skin.

4. Examine the back of your computer and identify the cables that are attached to it. There may be several cables attached at this time. A typical example is shown in Figure 2.

5. Using Figure 2 as a guide, list the purpose of each of the cables on your computer:

   _____
   _____
   _____
   _____

6. Disconnect the power cord from the computer. As you disconnect cables, leave your antistatic wrist strap connected to chassis ground on the computer. If it comes loose during the disassembly process, reattach it immediately.

7. Find the cable that connects the keyboard to the computer. Disconnect the keyboard connector from the back of the computer by pulling it straight back from the computer.

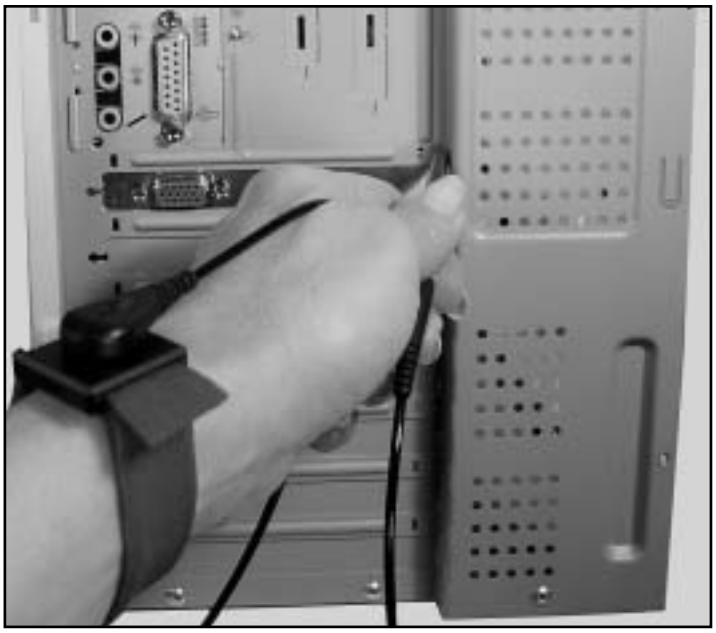


Figure 1
Connecting the antistatic wrist strap.

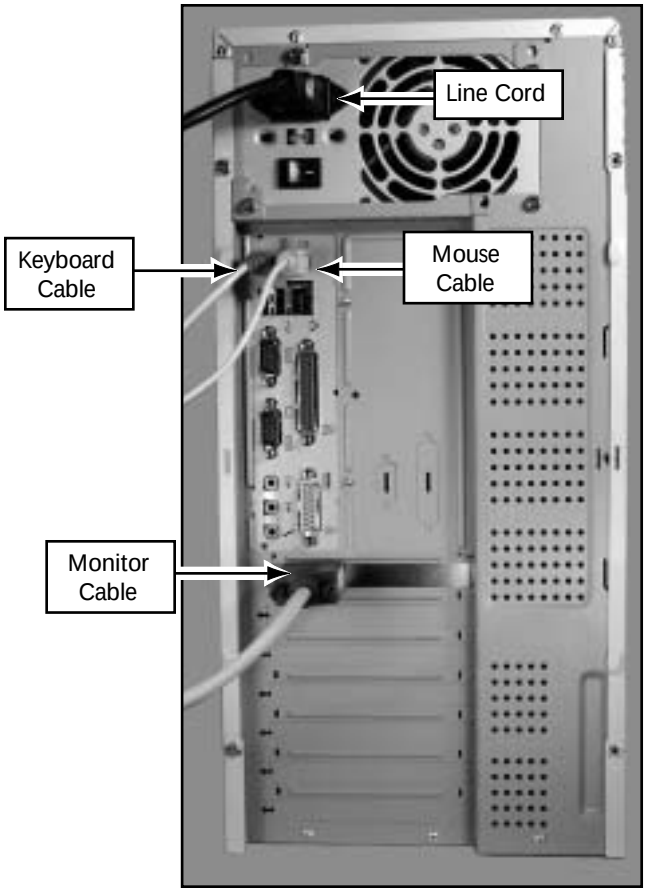


Figure 2
Identifying the cables on the computer.

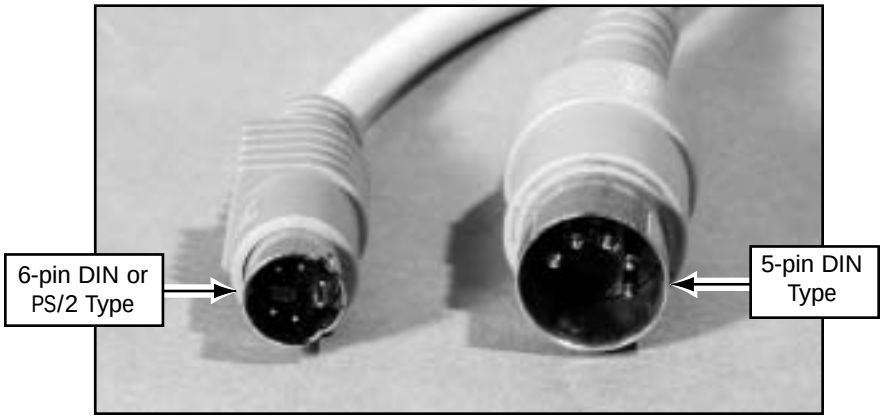


Figure 3
Common keyboard connectors.

8. Compare the connector on the free end of the cable coming from the keyboard to those shown in Figure 3. Most PCs use one of two connectors, both introduced by IBM on early PCs. The connector on the right is the original. It is called a 5-pin DIN connector. This is the one IBM chose for its original PC. The one on the left was introduced by IBM on its PS/2 computer. For this reason it is usually called a PS/2 type connector. It is smaller and has 6 pins. Which type does your computer have? _____

9. Set the keyboard aside until it is called for later.

10. Find the cable that connects the mouse to the computer. Once again two different types of mouse connectors are popular. Compare the connector on your computer to the one shown in Figure 4. The connector on the right is for a serial mouse. It connects to one of the serial ports on the computer. The one on the left is for a PS/2 type mouse. Which type of mouse does your computer have? _____

11. The PS/2 type mouse simply pulls off much like the keyboard did. However, the serial mouse is held on by two screws which must be loosened before it can be pulled off. Disconnect the mouse and set it aside until called for later.

12. Find the cable that connects the monitor to the computer. It is held in place by two screws that must be loosened before you can slide it off. Disconnect the monitor and set the free end of the monitor cable aside until it is called for later.

Figure 4
Common mouse connectors.

13. Disconnect any remaining cables from the rear of the computer, making careful notes of where they are connected. Move the monitor, keyboard, mouse, and anything else you disconnected out of the way so you have room to work.

Removing the Cover

14. Refer to Figure 5, on the next page. It identifies several of the screws on the rear of a typical computer. Notice that only four of the screws hold the cover in place. Use the proper screwdriver to remove only those cover screws necessary to gain access to the inside of the computer (two screws if your computer has a separate left side cover). Set the screws aside where they will not become lost. It is a good idea to label the screws. When disassembling a computer you may have a dozen or more screws of various types. A little organization now can save a lot of confusion later on.

15. If your computer has a one-piece cover, slide it toward the rear of the computer about one inch. Lift the cover straight up about two inches. Grasp the lower edges of the cover and gently spread them apart just enough to clear the sides of the chassis —about one quarter of an inch. Lift the cover straight up and away from the PC. Set the cover aside.

    If your computer has a separate left side panel, slide it toward the rear of the computer about one inch. Then pull the cover away from the side of the PC.

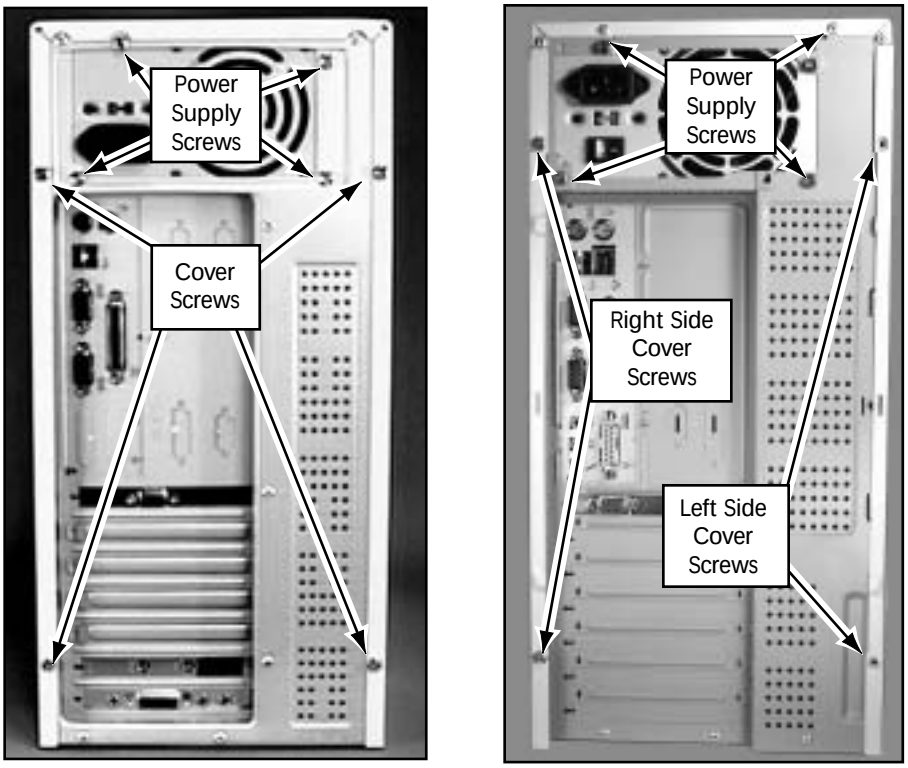


Figure 5
Identifying the important screws on the rear panel.

16. Look at Figure 5 again, and compare it with what you can see inside your computer. Now that you can see where the screws go, it's easier to determine the purpose of each screw. When you open a computer for the first time, don't remove all of the large screws thinking they might hold the cover on—especially if the cover fits tightly. You may wind up damaging something inside. Although the cover screws on your computer are rather obvious, other computers may have cover screws that are less obvious.

Identifying the Major Components in the Computer

17. Look at Figure 6. It points out six major units in the computer numbered 1 through 6. Identify these six units by placing the proper number by the names given below. Your computer may not have all six units installed, or they may be installed in different locations.

___ Power Supply
___ Motherboard
___ Hard Disk Drive
___ CD-ROM Drive
___ Floppy Disk Drive
___ Video Card

The Power Supply

18. Locate the power supply. It is easy to identify because the AC power cord plugs into it through the back of the computer.

19. The purpose of the power supply is to convert the AC voltage supplied by the electric company to the DC voltages required by the computer.

20. Find the bundle of colored wires coming out of the power supply inside the computer. Trace the colored wires from the power supply to their various destinations.

21. The power supply is distributing power to which units in the computer?

    _____
    _____
    _____
    _____

Figure 6
Identifying the major units.

The Motherboard

22. The motherboard is the large circuit board at which all the various cables seem to converge. It contains much of the important circuits of the computer either as part of the board itself or as a module that plugs into the motherboard. In the next unit you will take a closer look at this all important board.

Removing the Video Card

23. The video card serves as an interface between the motherboard and the external video monitor. Refer to Figure 7 and locate the video card.

24. As you repair or upgrade computers, you will be constantly removing old interface cards of one type or another, and putting in new ones. To make sure you are comfortable with doing this, we will have you remove and then replace the video board.

25. Remove the retaining screw at the top of the bracket holding the video card. Grasp the board along its top edge. Gently lift the end of the board nearest the bracket a fraction of an inch or so. Then gently lift the opposite end by the same amount. In this way, gently rock the board lengthwise until it is free of the bus connector.

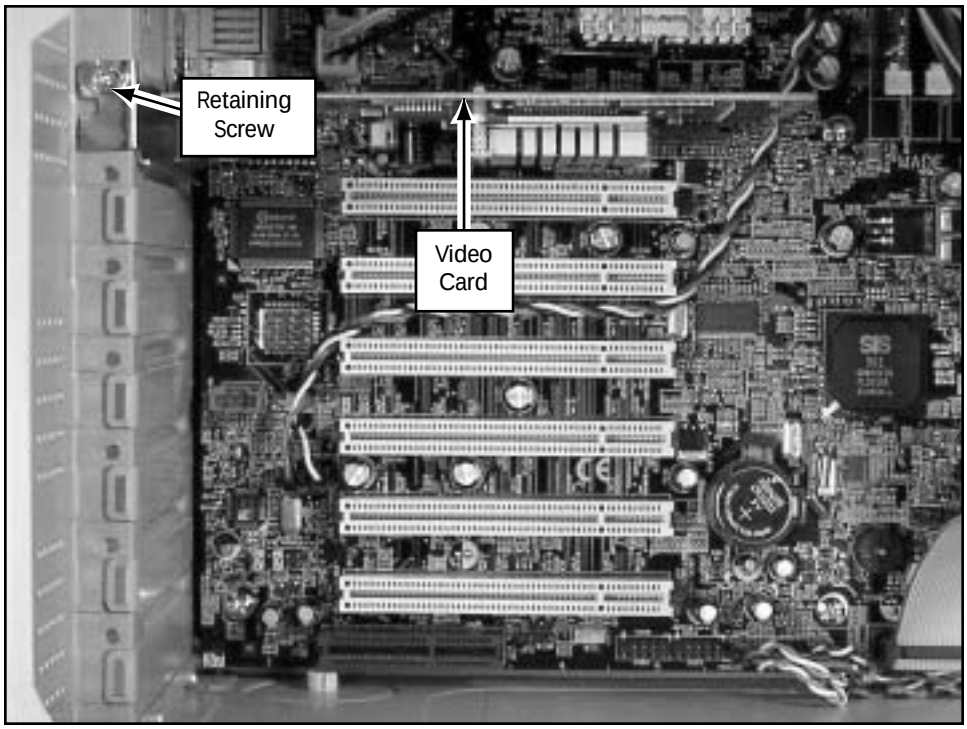


Figure 7
Location of the video card.

26. Place the video board in the antistatic bag. Because these boards are very susceptible to electrostatic discharge, they should be kept in antistatic bags when not installed in the computer.

The Floppy Drive

27. Replacing one of the drives in the computer is a relatively common occurrence. A floppy drive may become balky after a few years. Or, the hard drive may crash or simply have to be replaced because the storage capacity is no longer adequate. Or, a new, faster CD-ROM drive becomes available. So removing a drive is a skill that can be of value to every computer owner. In this lab, you will go through the steps in removing the floppy drive to make sure you are comfortable with the process. For now, because of time constraints, you will simply disconnect the cables and identify the screws that hold the drive in place. In a later lab you will actually remove the floppy drive.

28. Use Figure 8 to find the floppy drive. Two cables are connected to the floppy drive. The one with the four colored wires is the power cable. If you follow it back you will see that it connects to the power supply. Grasp the power cable by the plastic connector, not the wires, and gently rock the connector back and forth as you pull it from the drive.

29. The remaining cable is the data cable. Locate the side of the ribbon cable that is color keyed—one edge of the ribbon cable has a color stripe or stripes. The color key tells you how to align the connector. It identifies the end of the connector that contains pin 1.

30. Before removing this cable, cut a short piece of tape and place it on the cable just behind the connector that plugs into the floppy drive. Using a pen, mark the tape “FD” for floppy drive.

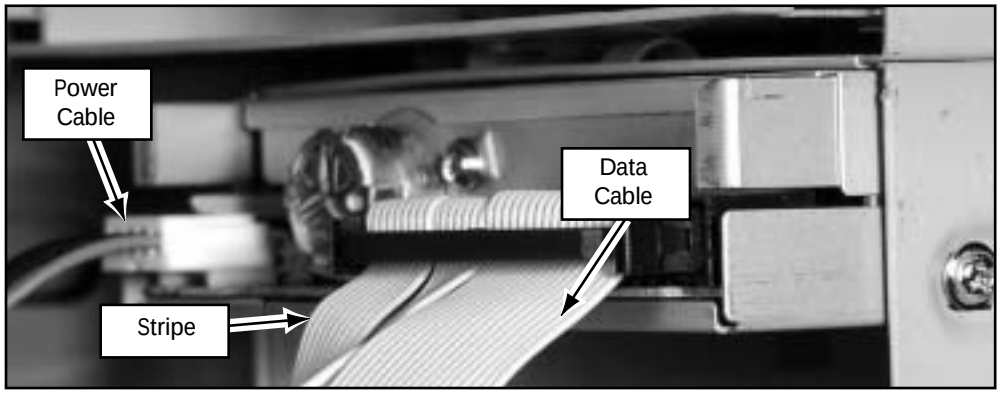


Figure 8
Two cables are connected to the floppy drive.

31. Next, draw an arrow on the tape pointing toward the red stripe on the side of the cable. Under the arrow, write the word "inside." When you reinstall the cable later, this will remind you that this cable connects to the floppy drive and that the stripe goes toward the inside of the drive. Admittedly, this may be overkill for this exercise. However, in real life, where you will be disconnecting several cables, you simply must document where everything goes, if you hope to reassemble everything correctly.

32. Grasp the ends of the ribbon cable connector that plugs into the floppy drive. *Gently* rock it back and forth a few times as you pull it from the drive. Be careful, the connection is usually very tight and it is possible to pull the connector apart if you pull on the cable instead of the connector. Do not disconnect the other end of the cable from the motherboard.

33. Find the screws on the side of the floppy drive that secure it to its support bracket. There should be two screws on each side. The ones on the back are accessible through slots on the other side of the computer. **Don't remove them now.** But if you did, you should first make a sketch of which holes the screws are in so that you could reinstall the drive later in the same location. Then, you would carefully remove all the screws holding the drive in place.

The Hard Disk Drive

34. Refer to Figure 9 and find the hard disk drive in your computer. The hard disk drive is the main data storage unit. It contains copies of all your programs, files, and directories.

35. Two cables are connected to the hard drive. The one with the colored wires is the power cable. The other is the data cable.

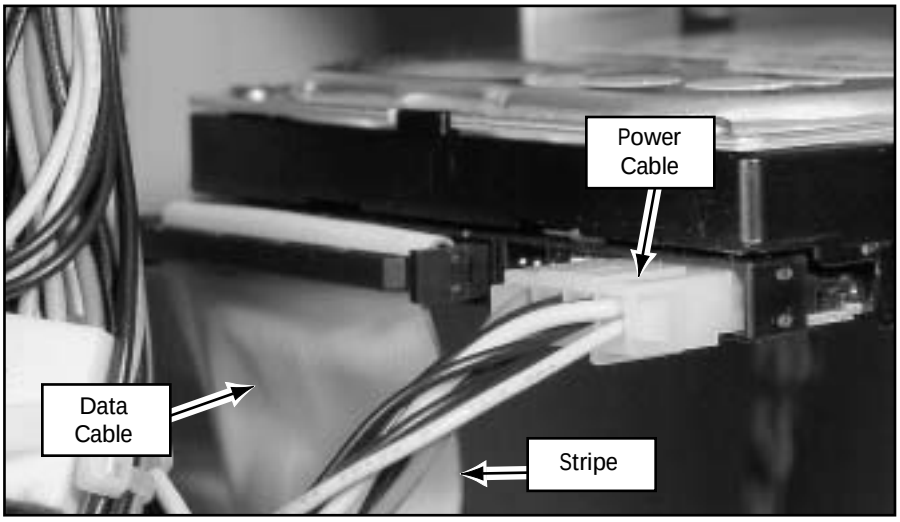


Figure 9
The hard drive cables.

The CD-ROM Drive

36. Use Figure to find the CD-ROM drive. Note that it has a power cable and a flat ribbon data cable much like those on the hard drive. In addition, if you have a sound card, an audio cable connects the CD-ROM drive to the sound board.

37. Find the screws on the side of the CD-ROM drive that secure it to its support bracket. There should be two screws on each side. Here again, don't remove the drive now.

38. The CD-ROM drive slides out the front of the chassis.

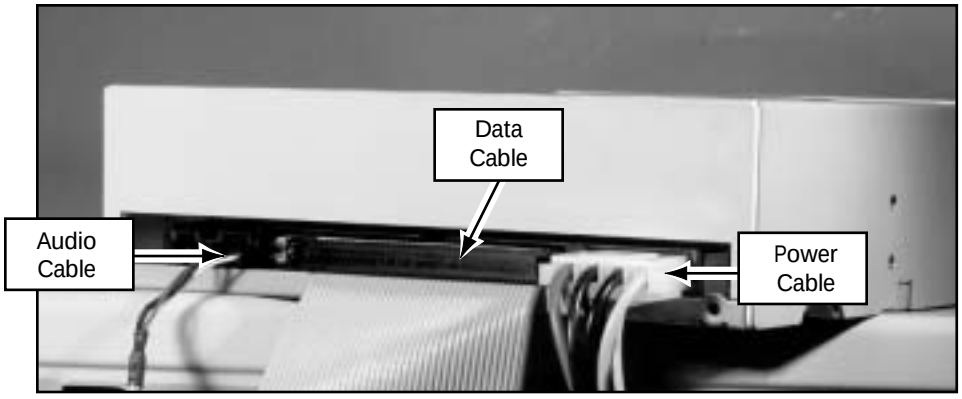


Figure 10
The CD-ROM drive cables.

The Motherboard Port Assembly

39. Figure 11 on the next page shows several different communications ports available on the back of the computer. From inside the computer you can see that all these ports connect directly to the motherboard.

40. You are already familiar with the two PS/2 ports into which the keyboard and mouse were originally attached. While they are shown connected here, you will recall that you disconnected them earlier in this lab. The PS/2 Port has _____ pins arranged in a semicircle. Because the two PS/2 ports appear identical, small icons are provided by each so that you know what goes where.

41. Two serial ports called COM1 and COM2 are also available on the back of the computer.

42. Each serial port connector has _____ pins arranged in ____ rows. Serial ports such as these are sometimes used by a serial mouse, a serial printer, or an external modem.

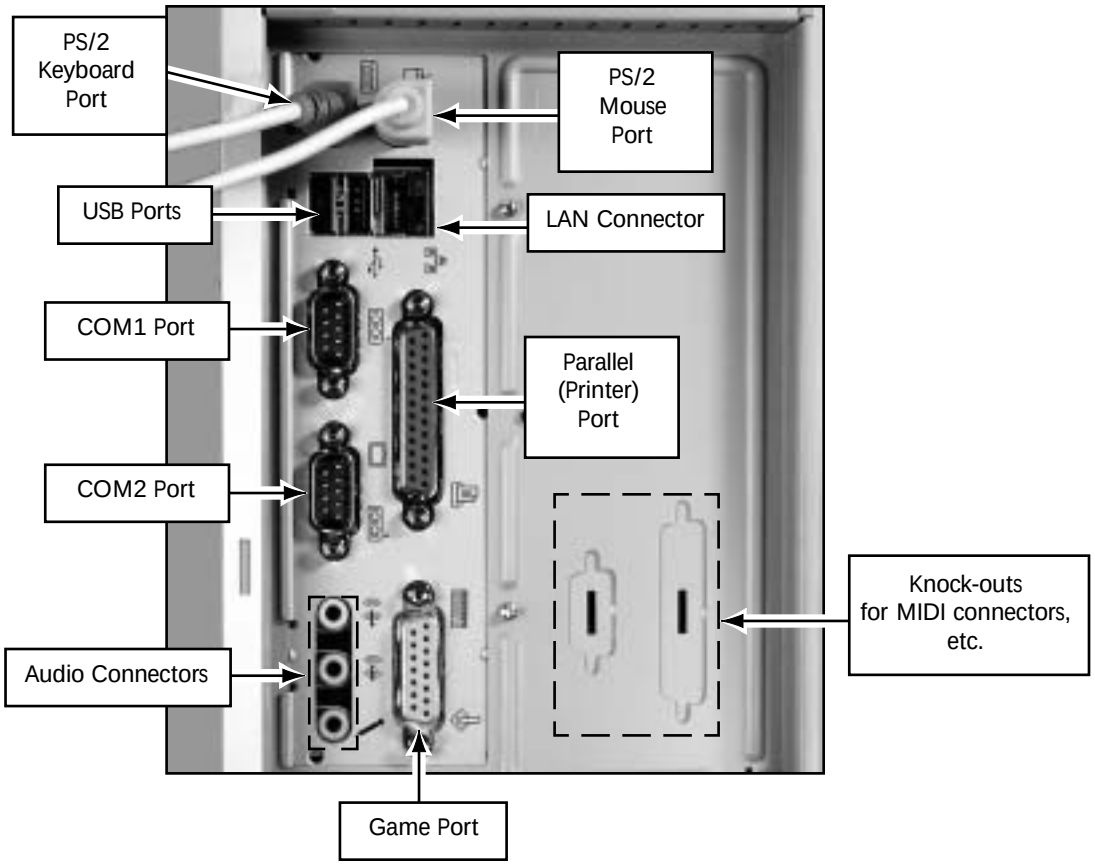


Figure 11
The motherboard ports

43. The parallel port assembly brings the parallel port on the motherboard out to the back of the computer. As the small icon indicates, a printer is normally connected here.

44. The parallel port connector has _____ holes arranged in ____ rows.

45. Finally, provisions have been made to accommodate two Universal Serial Bus (USB) connectors. This is a new high speed serial bus which may someday replace the slower serial and parallel ports in use today.

46. For maximum flexibility, knockout slots are provided for additional future expansion.

Reinstall Floppy Cables

47. Find the floppy drive ribbon cable. You labeled this cable earlier, so it should be easy to find.

48. If the cable were not labeled, you could identify it by matching its connectors to the one on the floppy drive. Compared to a hard drive cable, the floppy drive cable is narrower. However, to avoid confusion, your best bet is to label everything.

49. Now, if you had completely removed the cable, there would also be some confusion about which end of the cable connects to the motherboard. Here again, a sure fire way of knowing this is to label the cables as you remove them.

50. Examine the connector on the back of the floppy drive. It may be keyed so that the connector fits only one way. If not, then pin 1 or 2 may be identified on the floppy drive. It might be necessary to remove the drive just to find the pin 1 number. So, as always, your best bet is to label the cable before you remove it. Because you took the precaution of doing this, you know that the stripe goes on the inside of the drive, toward the power connector.

51. Orient the cable properly and plug the end connector on the ribbon cable into the floppy drive connector. Examine your connection carefully. Make certain that you did not miss the top or bottom row of pins or a pair of pins at either end of the connector.

52. Find the end of the power cable that you labeled FD. Because of its unique shape, this connector cannot be easily attached backwards. You may recall that the wider side of the connector faces down. Reconnect the power cable to the floppy drive.

Reinstall the Video Card

53. Find the video card and remove it from its antistatic bag. From inside the chassis, insert the video card into the opening in the back of the chassis. The straight end of the L-shaped bracket should slide between the motherboard and the chassis. Do not secure the card to the chassis with the screw yet.

54. Align the length of the card with its socket on the motherboard. Gently rock the card down into its socket. This may be a very tight fit, so take your time and try not to flex the motherboard too much.

55. Once the board is properly seated in its socket, align the slot in the L-shaped bracket with the screw hole at the top of the slot in the chassis. Secure the card to the chassis with the proper screw.

Reinstall the cover

56. Find the computer's cover and position it as shown in Figure 12. The cover uses tabs to create a strong mechanical bond to the chassis. These tabs engage with the brackets along the edges of the chassis. Try to visualize how the cover and chassis fit together.

57. If your computer has a one-piece cover, orient it properly and slide it down over the chassis so that the cover is about two inches back from the front panel and about one inch up from the bottom of the chassis. Push in gently on the sides of the cover just enough to line up the internal tabs with the bottom bracket of the chassis. The idea is to insert the bottom bracket of the chassis into the channel formed by the tabs inside the cover. Once you think they are lined up, push the cover down. When the cover is properly mated with the bottom bracket on the chassis, the cover will not flex out at the sides. You may have to try it a few times before the cover fits down properly.

    If your computer has a separate left side panel, orient it properly and start the top and bottom tabs into their corresponding slots along the top and bottom of the chassis. Then slide the cover toward the front of the computer so the tabs along the front edge of the panel engage with the front edge of the chassis.

58. When the cover is mated properly with the bottom bracket of the chassis, slide the cover forward so that the tab that sticks out from the top of the cover slides under the top of the front panel. This will force the front brackets of the chassis into the channels formed by the tabs inside the cover.

59. Once the cover is properly mated with the chassis, secure the cover to the chassis with the mounting screws you removed earlier.

Reconnecting the Cables

60. Find the free end of the cable that connects the keyboard to the computer. Find the matching connector on the computer. Reattach the keyboard to the computer.

61. Find the free end of the cable that connects the mouse to the computer. Find the matching connector on the computer. Reattach the mouse to the computer.

62. Find the free end of the cable that connects the monitor to the computer. Find the matching connector on the computer. Reattach the monitor to the computer.

63. Reconnect any remaining cables to the computer using the notes you created earlier.

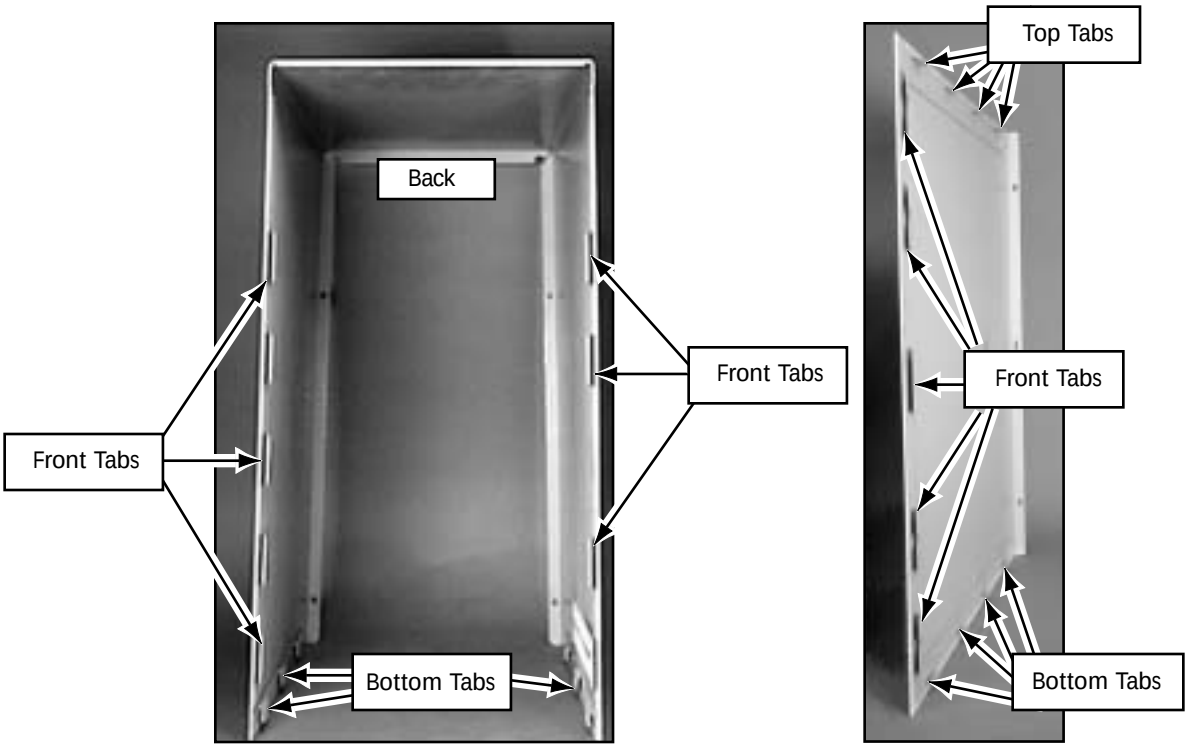


Figure 12
Visualize how the cover fits over the chassis.

64. Reconnect the power cord to the computer. Plug the free end of the power cord into the wall or bench socket.

65. Turn on the computer and monitor and allow the computer to boot. Everything should once again be working properly. If the Norton Anti-virus Information Wizard appears, click on the X near the upper right corner of the window.

66. Shut down Windows by clicking the Start button, selecting *Shut Down*, and clicking *OK*. This completes the lab.

Discussion

You now know how to take a typical computer apart and put it back together—well, not quite everything. But you get the idea. In future labs, you will remove and then reinstall virtually everything that can be removed without a soldering iron.

Incidentally, a component that can be removed from the computer without unsoldering is called a field replaceable unit, or FRU—a popular "buzz word" in the computer industry. As you will see in the next lab, the motherboard also contains several FRUs—things like the CPU, memory modules, and the ROM.

What you should have learned from this lab is that computers aren't that mysterious inside. In the next lab you'll examine in greater detail some of the parts inside the computer.

Lab 1-2

Computer Power

This lab is devoted to the power supply and power distribution in the computer.

The power supply is one of the most failure-prone devices in the PC. For this reason alone, it is imperative that you become familiar with its operation. In this lab, you will become familiar with the installation and connection of the power supply. In the process, you will gain some additional practice using the voltmeter.

The purpose of the power supply is to convert the AC line voltage to the low-level DC voltages required by the motherboard, hard drive, floppy drive, fans, and all of the other devices inside your computer.

Objectives

When you complete this lab, you will be able to:

- Identify the input and output voltages of the power supply.
- Explain how power is distributed throughout the computer.
- Demonstrate the proper way to remove and replace the power supply in the computer.
- Compute the power consumption of the PC.

Materials Required

You will need your computer, paper, tape, and a pencil.

Procedure

Examining the Power Supply Outputs

1. Turn the computer off, but leave the power cord, keyboard, mouse, and monitor connected. Remove the two screws that hold the left side panel in place. Lift the side panel from the computer. Then set the panel and the two screws aside until they called for later.

2. Place the antistatic wrist strap around your wrist. Adjust it so that the conductive contact is against your skin. Connect the ground clip of the antistatic wrist strap to the chassis of the computer.

3. Refer to Figure 1 and find the large power connector on the motherboard. Your board layout may be different from the one shown here, but the power connector should be easy to find.

4. The +5 Volts on the red wires is the supply voltage for much of the circuitry on the motherboard and expansion cards. What is not so obvious is that many of the circuits on modern motherboards now require a variety of supply voltage of +3.6 Volts or less. Consequently, on many computers at least some of the lower voltages are created on the motherboard from the +5 Volts provided by the power supply.

5. Look at the motherboard and find the voltage regulators shown in Figure 2. Although the figure shows only five regulators, you will find others at several locations on the motherboard. These regulators are used to reduce the +5-Volt supply to the lower levels required by the processor and some of its supporting circuits.

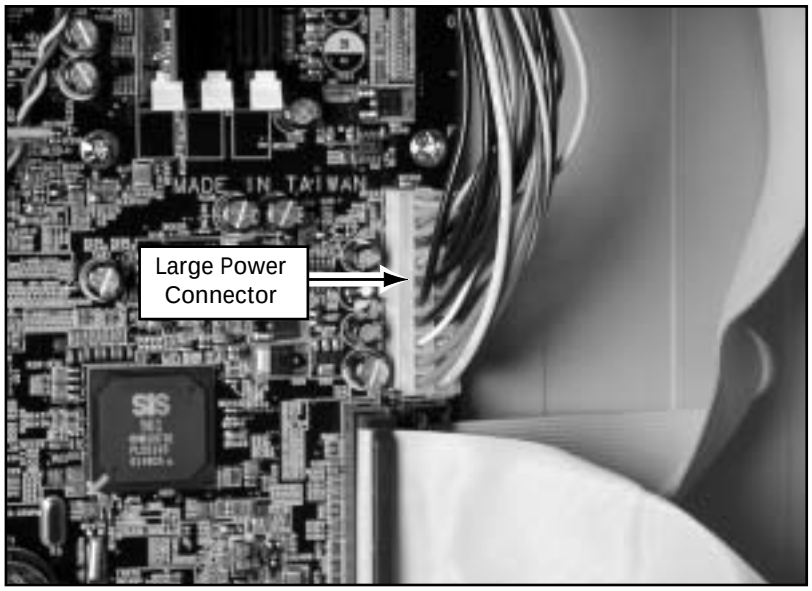


Figure 1
Large power connector on the motherboard.

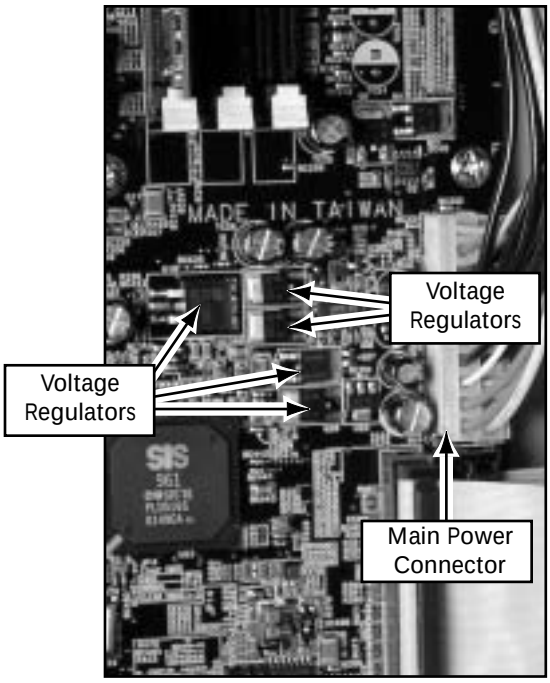


Figure 2
The voltage regulators may be located in different places on your motherboard.

6. The yellow wire provides +12 Volts which is routed to the CNR bus, to the PCI bus, to the FAN connector, and to the various disk drives. Surprisingly, this voltage is hardly used at all on the motherboard. The +12 Volts are supplied to the CNR and PCI buses because that is part of the CNR and PCI standard. (This voltage is also routed to the ISA bus present in older computers.) A card which plugs into one of the expansion slots may require it.

7. The –12 Volts (brown wire) is also routed to the CNR and PCI buses. Again, this is required by the CNR and PCI standards. (This voltage is also routed to the ISA bus present in older computers.) However, the –12 Volts is not used on most modern motherboards. Presumably, an expansion card may have more use for this voltage than does the motherboard.

8. In somewhat the same way, the –5 Volts (blue wire) is a holdover from earlier days. It is no longer required by the motherboard, and is simply routed to the ISA bus in older computers where it is still part of the standard. It is not part of the CNR and PCI standards though.

9. The orange wire provides +3.3 Volts to the motherboard. As mentioned earlier, many of the circuits on the motherboard now use this voltage rather than the +5 volts which was the standard for many years.

10. The white wire is the “power good” signal. This is a signal from to the motherboard that tells the PC that the power supply has stabilized. The PC will not boot until it sees this signal.

11. The black wires are ground wires.

Removing the Power Supply

12. There are several reasons why you might want to remove the power supply. It could be defective, or you might simply be upgrading to a heftier unit. Unplug the computer from the wall or bench , if necessary.

13. Locate the power supply. It is easy to identify because the AC power cord plugs into it through the back of the computer. Find the bundle of colorful wires coming out of the power supply inside the computer. This bundle breaks into several different cables.

14. Find the cable which has a connector shell that is not connected to anything. Notice that the end of the cable simply dangles free. The purpose of these extra connectors is to power an additional disk or tape drive should you later decide to add one. Cut a small piece of tape; stick it to the shell of the open connector; then mark the tape “open” to remind you later that this is the connector that was not attached. Also label any additional unused connectors on this cable “open.” There may be more than one of these cables.

15. Find the large cable that supplies power to the motherboard. The power connector on this cable is labeled P1, although you may not be able to see the label clearly until the cable is disconnected.

16. Using pencil and paper, make a sketch of the connector. On your sketch note the location and orientation of P1. In particular note the location of the yellow lead so that you can reconnect P1 correctly later in this lab.

17. Look at Figure 3. It shows P1 being removed from the motherboard. Notice the rocker latch on the side of P1. This latch hooks under a tiny lip on the socket into which P1 is plugged. To unplug P1, grasp the connector shell with your fingers. Push down on the end of this latch as shown to release it from the lip. At the same time, rock P1 gently back and forth as you pull on the connector shell. **Don’t pull on the wires!** Take your time and *gently* rock the connector slightly as you pull on the shell.

18. On some older computers power is supplied to the motherboard through two connectors labeled P8 and P9. Remember to note the “P number” and location of each connector on the circuit board. This is

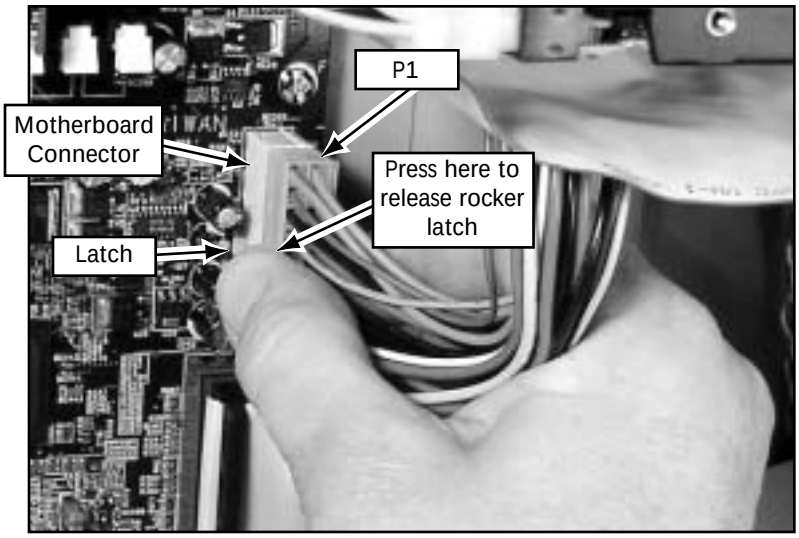


Figure 3
The latch side of P1.

very important because, on some computers, it's easy to interchange these connectors. Unfortunately, interchanging these connectors could severely damage the motherboard.

19. Locate the smaller 4-wire cable which supplies power to the motherboard. Note that this connector also has a rocker latch. Sketch this connector, and note the location and orientation of the yellow wires so that you can reconnect it correctly later in this lab. Then unplug the connector from the motherboard.

20. Locate the power cable going to the hard disk drive. Unplug the cable from the drive. Because the cable connector is tight, you'll have to rock it from side-to-side as you **pull on the connector, not the wires**. Once the cable is unplugged, look at the end of the connector shell. Notice that two of the corners are square and two are beveled. This unique shape insures that the shell cannot be connected backwards. Cut a small piece of tape, stick it to the shell and label it "HD" for hard drive. Label any additional unused connectors on this cable "open."

21. Similarly unplug the power supply cable connector going to the 3½-inch floppy disk drive. Once the cable is unplugged, look at the end of the connector shell. Notice that it also has an irregular shape that prevents it from being plugged in incorrectly. If the shell is not already labeled, cut a small piece of tape, stick it to the shell and label it "FD." Label any additional unused connectors on this cable "open."

22. Find and unplug the power supply cable connector going to the CD-ROM drive. Cut a small piece of tape, stick it to the shell and label it "CD-ROM." Label any additional unused connectors on this cable "open."

23. On some computers one final cable connects to a small fan mounted on the front panel of the computer. If your computer has a front panel fan, disconnect the cable at the point where the two connector shells mate by gently pulling the two shells apart as you rock them back and forth. Once again notice that the ends of the two connector shells are shaped so that they will fit together only one way. Cut a small piece of tape; stick it to the shell of the power supply connector; and label it "FAN." Labeling these connectors may be overkill, but, on the other hand, it will make reassembly faster and less confusing.

24. Before we remove the power supply, turn the computer around so you can see where the power cord plugs in. See Figure 4.

25. In North America, the AC line voltage is usually in the 110 to 120 volt range. In much of Europe, the AC line voltage is 220 to 240 volts. The power supply in the computer can be configured for either of these situations.

26. Notice the small slide switch on the back of the power supply just above or below where the power cord plugs into the computer. See Figure 4. This switch should be set to the power available in your area. Since the computer is working properly, it must be set to the correct position. Therefore, do not change the setting of this switch. The ability of the power supply to be manually switched from one line voltage to another makes the computer usable in many different parts of the world.

27. Before removing the power supply it is a good idea to lay the computer on its side as shown in Figure 5. This will reduce the chance of dropping the heavy power supply on the motherboard.

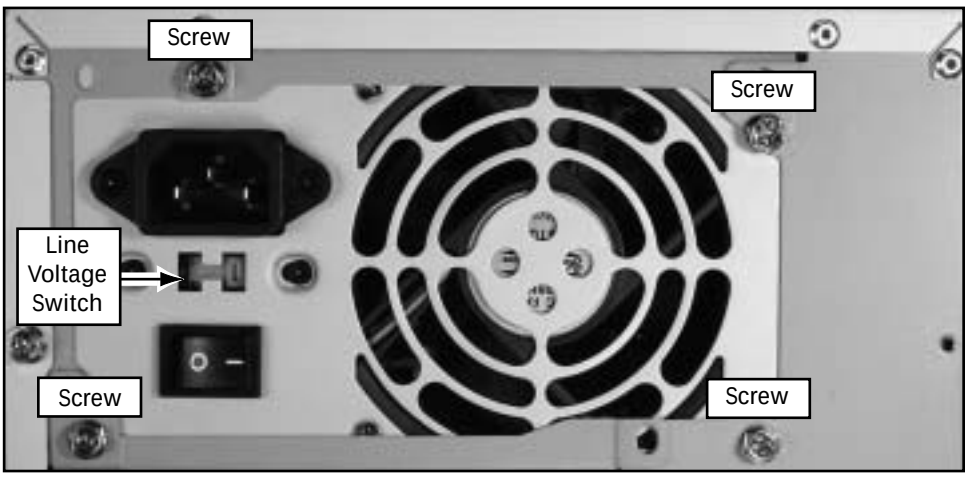


Figure 4
The power supply is secured to the rear of the chassis by four screws.

28. Refer to Figure 5 and locate the screw which secures the power supply to the top of the chassis. Then remove this screw.

29. Refer back to Figure 4 and locate the four screws that secure the power supply to the back of the chassis. Support the power supply so that it does not fall while you remove the four screws. Carefully push the power supply away from the back of the chassis and lift it out of the computer. Be careful to thread the loose ends of the various cables through the maze of the still-attached cables.

Power Consumption

30. Look at the sticker attached to your power supply. All power supplies have these stickers if they meet certain safety standards. The most important number on the sticker is the Total Output Power, sometimes simply called DC Output or just Output. Most power supplies are rated anywhere between 90 watts (90W) and 300 watts (300W). This power rating is the highest amount of power that the supply can provide on a continuous basis.

31. If you are working on an ATX-based computer (any Pentium II, III, or IV, Celeron, or similar) the sticker should also shed some light on the difference between two +5 Volt supplies. Notice that one output is identified as +5 Vsb or +5VSB, for +5 Volts *standby*. This is part of the Advanced Power Management (APM) specification used to help reduce power consumption. In the standby state, most of the system is turned off. However, power is maintained to critical circuits so that nothing is lost until the system powers up fully once again. This is controlled automatically by Windows.

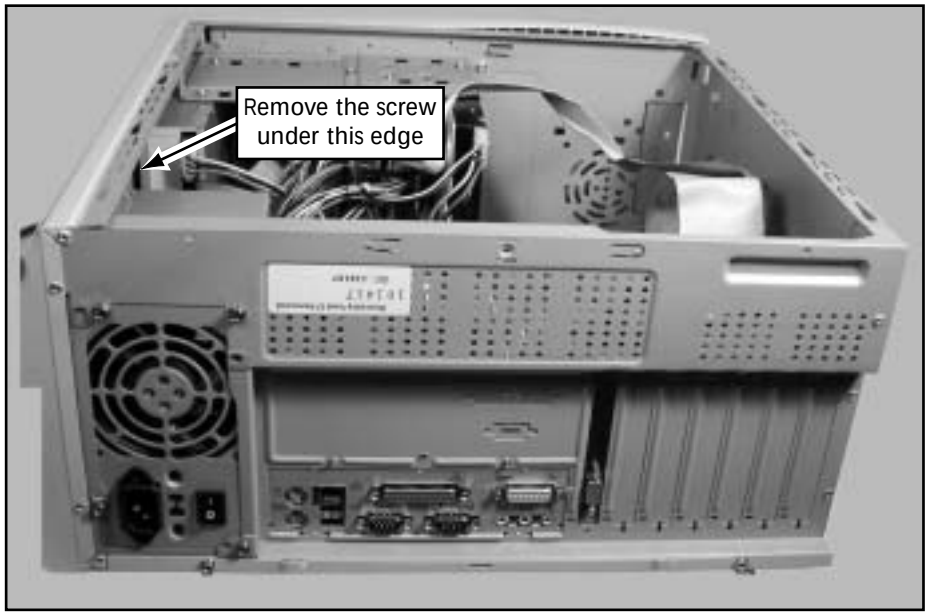


Figure 5
Place the PC on its side as shown.

32. The sticker also identifies the maximum current in amperes (A) available for each of the supply voltages. Refer to this sticker and fill in the currents in the spaces provided below:

Voltage	Current	Power
+3.3 Volts	_____	_____
+5 Volts (sb)	_____	_____
+5 Volts	_____	_____
+12 Volts	_____	_____
–12 Volts	_____	_____
–5 Volts	_____	_____

33. Using the equation: *Power = Voltage × Current*, compute the maximum power that each of the above supplies can provide and record your answer in the space provided. In this equation, the voltage is in Volts, the current is in Amperes, and the power is in Watts.

34. For example, in the case of the 3.3 Volt supply, if the current is 16 Amperes, then the power will be:

    Power = Voltage × Current

    Power = 3.3 Volts × 16 Amperes

    Power = 52.8 Watts

35. When viewed in this way, what is the maximum power that the six supplies can provide? _____ Watts.

Reinstall the Power Supply

36. Find the power supply and its five mounting screws.

37. Set the power supply into the chassis and align its five screw holes with those in the rear and inside of the chassis. Secure the power supply to the chassis with the five mounting screws.

38. Find the 4-wire cable which contains two yellow and two blacks which has a square connector on its free end. Route this cable down toward the rear of the motherboard and reconnect it the proper connector as shown in Figure 6. The cable is connected properly when the latch is toward the power supply.

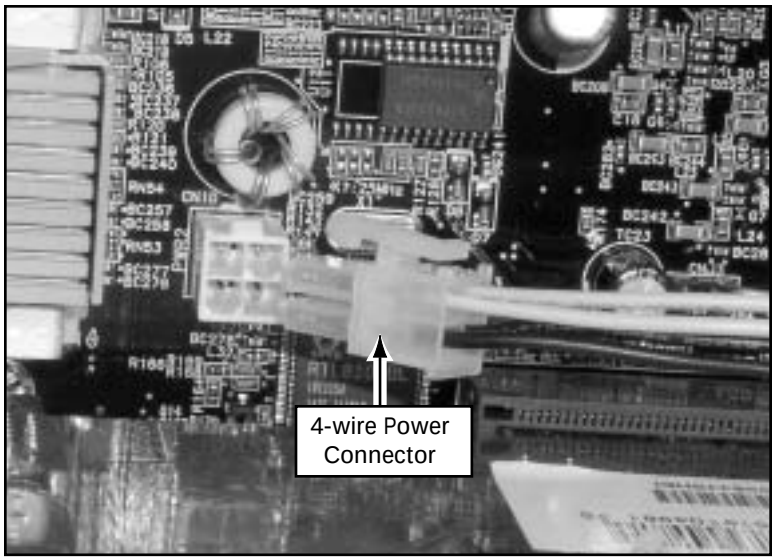


Figure 6
Reconnect the square 4-wire power connector to its corresponding connector on the motherboard.

39. Find the power supply cable with the connector labeled P1. Route this cable down to the motherboard. From your vantage point this cable should be routed in front of the ribbon cables.

40. Refer to Figure 7 and reconnect P1 to the proper connector on the motherboard. The cable is connected properly when the latch is toward the rear of the chassis.

41. Find the cables that you earlier labeled OPEN, HD, CD-ROM, and FAN (optional). Because of their unique shape, these connectors cannot be attached backwards. Also, because most of these cables are identical, they can be interchanged. However, since you already have them labeled, in the next few steps, you will reconnect them just as they were before. Before you reconnect each cable, remove the tape from the connectors.

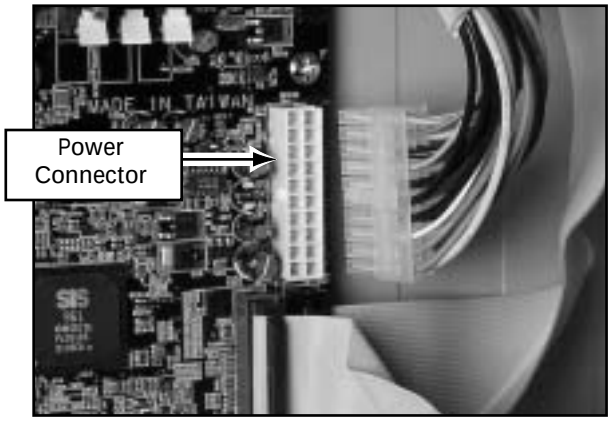


Figure 7
Reconnect P1 to the power connector on the motherboard.

42. Attach the connector labeled CD-ROM to the connector on the back of the CD-ROM drive.

43. Find the power supply cable that you labeled FD. Turn it so that the wide part of the connector is down and attach it to the power connector on the floppy disk drive.

44. Attach the connector labeled HD to the power connector on the back of the hard drive.

45. If your computer has a connector labeled FAN, connect it to the connector on the cable attached to the fan on the front panel.

46. Recall that the cables labeled OPEN were not connected. Leave them disconnected and route them to the empty bay under the CD-ROM drive where they will be out of the way.

47. Recheck all connectors to insure that they are tight and that all tape has been removed.

48. Reinstall the left side panel onto the computer. Plug in any cables that you might have disconnected, including the power cable.

49. Turn on the computer and make sure that everything works properly.

50. Shut down Windows. This completes the lab.

Discussion

In this lab, you examined the electrical characteristics of the power supply. You saw how power is supplied to the various circuits in the computer.

As you have seen, replacing the power supply in a computer is a simple task, once you have seen it done. The trick, if there is one, is to choose the proper replacement supply. The replacement must fit into the case, be able to supply enough power for the entire computer and all of its circuits, and have the proper connectors.

Unit 2

Motherboards and Memory

This chapter begins with the motherboard—the centerpiece of the computer. The motherboard is a large circuitboard. Its purpose is to support the CPU and all of its "helper" circuits (the chipset) and to connect them to the rest of the system. It is also responsible for managing the system buses that, as we mentioned before, move data between the CPU and other components inside the computer. Of all the hardware found in a computer system, it is the motherboard that is the center of activity. All devices in a computer are in some way connected to the motherboard. Next, we will examine the various types of memory used in contemporary computers.

Cases and Motherboards

No discussion of motherboards can be complete without first talking about the computer case. Most components that are assembled within a computer will fit into almost any case (there are some proprietary designs that limit what hardware can be installed), however, the case and the motherboard design are interrelated and must be specified to work together. Although the motherboard is a sub-assembly of the case, they are often considered one and the same.

Lesson Objectives

- Define the term *proprietary*.
- Discuss the purpose of a computer case, and it's major features.
- Describe the major issues to consider when replacing a motherboard.

Case Types

Proprietary is a term you will often see used to describe computer parts, or even entire systems. Other terms used in place of proprietary include *unique*, *peculiar*, or *unusual*. As you begin exploring computers, you will find that many parts are interchangeable between many systems. A regular EIDE hard drive, for instance, can normally be installed in just about every PC you will ever see. If you found a hard drive that wouldn't fit into any case, except for the one it came from, that drive would be considered *proprietary*. You could think of the term as the opposite of both generic and standard.

Being proprietary isn't good or bad, just different. In today's world of standard PC components, a proprietary design is often considered a bad thing. To be fair, keep in mind that sometimes a proprietary design is better than a generic design.

The case is more than just a "box" to house a computer. It is often the identity of a specific brand of computer, and sometimes even the reason why we purchase a particular computer. We do, after all, want something that looks good, especially if we spend a lot of money on it. The early cases were just boxes that sat on the desk and held the computer's monitor. Often they took up the entire desktop, so some users built stands and put their computers on their side under the desk. That idea was so good that manufacturers began to build computers that sat on their side; they called them "towers" and of course, raised the price. Some manufacturers today build "designer" computers in a wide array of colors, which are meant to appeal to a consumers' taste.

From a technical perspective, the case is just a plastic and/or metal box that houses the computer hardware. The main ingredient in the box is the motherboard, which contains the CPU and other primary components that make up a computer. A good case will be designed to act as a shield for *RFI* (*Radio Frequency Interference*). This will shield the computer's electrical "noise" from escaping into the environment. This noise potentially causes interference with other electronic equipment. The shield also prevents external sources of RFI from causing problems *inside* the computer. It is *not* a good idea to run a computer with the case open. Not only can this release RFI, but it can also impede proper airflow and cooling of the components.

Electromagnetic interference (*EMI*) is caused by strong magnetic fields, usually surrounding electric motors. EMI is considered any magnetic field that is harmful to the surrounding equipment, or interferes with the operation of another electrical or electronic device. For example, if you had a fan and computer close together and you notice wavy lines on your monitor when the fan was running, but not when the fan is off. This would be a result of EMI. Other sources of EMI include unshielded speakers, magnets of all kinds, and fluorescent lights.

When it comes to recommending a computer for purchase, the size and configuration of the case should be considered. Depending on the business application, the difference between a tower and a desktop model could be important. There are two general rules to follow when considering the case:

- The bigger the box, the more components it can hold (the greater the expansion potential), and the better the airflow (essential for internal cooling). Large cases are easier to work with.
- The more compact the box, the less expansion potential it has; working on it is much more difficult and airflow is reduced. However, it is easier to find a place for it.

The Motherboard

The motherboard *is* the computer. The type and brand of motherboard determines what type of CPU you can use, what type of memory you need, and how much memory you can install. As mentioned earlier, just about every other PC component is attached to the motherboard.

The motherboard with its components and connectors define the limits for speed, memory, and expandability of the computer. Motherboards come in a variety of shapes and sizes. Before installing a new motherboard in an older computer pay careful attention to size and location of mounting holes, because one size does not fit all. The location of the motherboard inside the

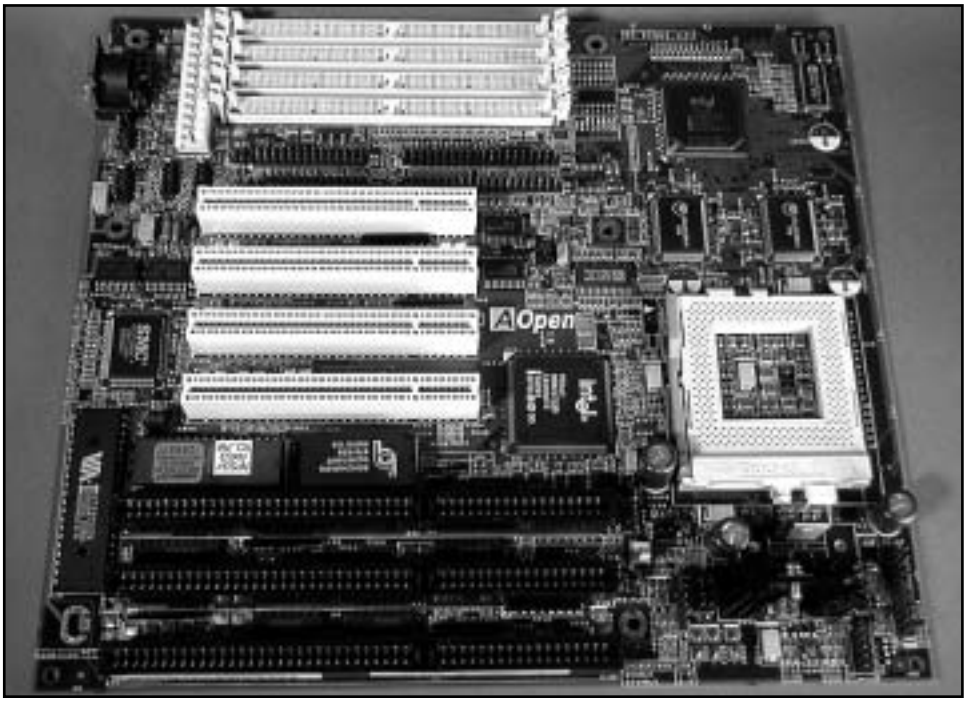


Figure 1
This is a typical AT-style Pentium I motherboard.

case is of no real consequence as long as it fits, receives sufficient ventilation (for cooling of the CPU), and does not conflict with other hardware. The first generation of Pentium chips required a cooling fan to be installed on top of the chip and connected to the power supply. When considering the purchase of a new motherboard, keep these things in mind:

- Most "generic" motherboards will fit into generic computers. One good reason to consider purchasing a computer clone is that it is easier and often less expensive to upgrade.
- Brand-name manufacturers don't want users swapping their motherboard for other manufacturers' motherboards or clones. If you have a brand-name computer, you may be required to purchase a new motherboard from the same manufacturer.
- Before you buy, check technical references to be sure that the new board will fit. Often this information can be found in the owner's manual(s). If not, check the manufacturer's website.
- For all practical purposes, you cannot repair motherboards. They should be replaced if physically or electrically damaged.

- Since it is the most difficult part of a system to replace, check all other internal and external components before removing or replacing the motherboard. In other words, make sure that the problem is the motherboard first.

Motherboard Compatibility

Motherboards are like automobiles; there are many manufacturers that often use the same parts (at least the parts perform the same functions), but they are not interchangeable. You must know the specifics of your car and the parts required before making a purchase. So when you face this issue of upgrading or replacing a motherboard you will have to consider many things. If you are replacing your motherboard with an identical motherboard you will encounter few problems. If not, consider the following:

- The physical size of the board.
- Location of the mounting screws.
- Size and speed of the processor.
- Number and type of expansion slots determine if your other equipment will connect.
- Type and amount of memory.

Chipsets

When you look at a motherboard, one of the first things you notice is all of the connectors. There are plenty of them, but they are not normally what make up the main features of a motherboard. Scattered throughout the board are several ICs. These special ICs constitute the *chipset*. This chipset is a group of highly complex and coordinated ICs that help the CPU manage and control the computer's system. Early motherboards contained many different chips, each designed to control a specific portion of the computer. For example, the 8088 chipset consisted of 6 ICs to support the CPU.

As technology improved, the number of ICs was reduced as more functions were integrated into single devices. Today's motherboards have a few highly-integrated ICs as shown in Figure 4-2. Fortunately we do not have to know all the different ICs and their specific functions. We need to focus only on one, the CPU. When replacing a CPU, you can't go and purchase just any CPU. You must purchase one that is compatible with the motherboard and the other chips on it. If not, the computer won't work. A basic chipset provides many functions:

- Bus Controllers
- DMA and Interrupt Controllers
- Peripheral Controllers (hard drives, floppy drives and keyboards)
- ROM/BIOS
- Bus and cache controllers

The chipset defines the specifications for the motherboard. As we begin to identify and categorize motherboards and computers we will actually be describing the limits of the onboard chipset. Also, when it comes time to upgrade, it will be these chips that determine just how far you can upgrade before being required to replace the motherboard itself.

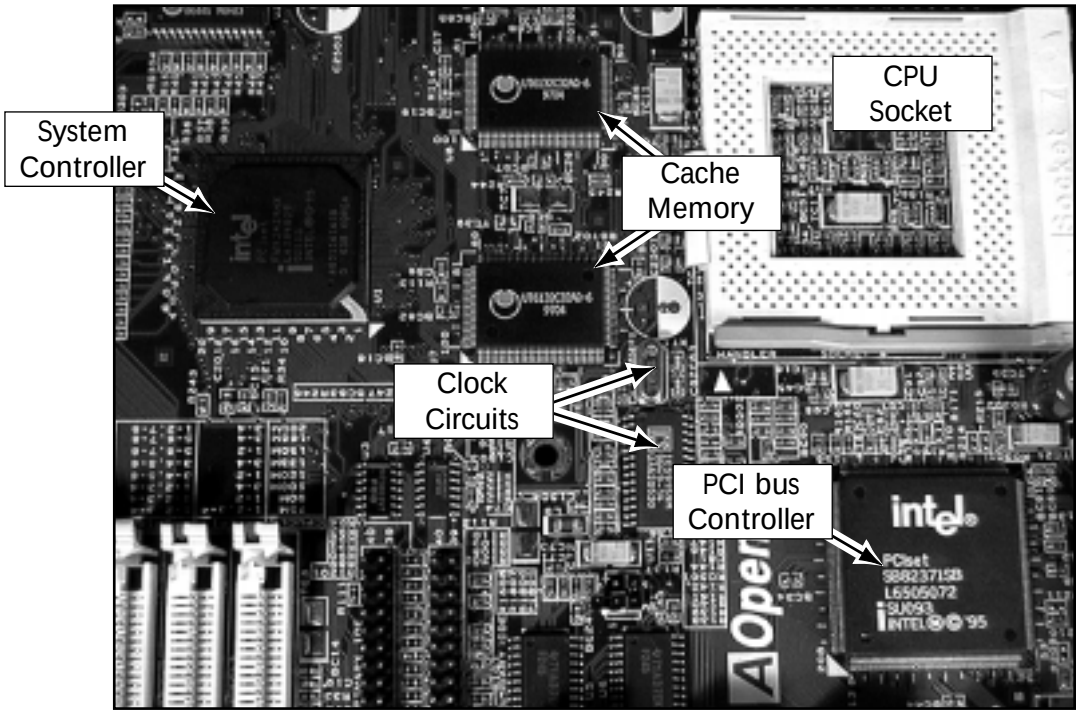


Figure 2
This photo highlights some of the key components that make up a chipset. This is a Pentium I chipset, Pentium II/III chipsets have even fewer ICs.

The ROM/BIOS

On all motherboards and most other computer devices as well, are some special memory devices called *ROM* (*Read Only Memory*). ROM contains special memory that is permanent—it cannot be erased. The function of the data stored on these ICs is to provide special information that is required to start and run the computer or a device. The downside of storing data in ROM is that we have to change an IC to update the data beacuse that cannot be easily changed, and in some cases cannot be changed at all.

Objectives

- Define the terms BIOS, CMOS, and ROM.
- Describe the basic components of a typical BIOS Setup program, and how to access the program.

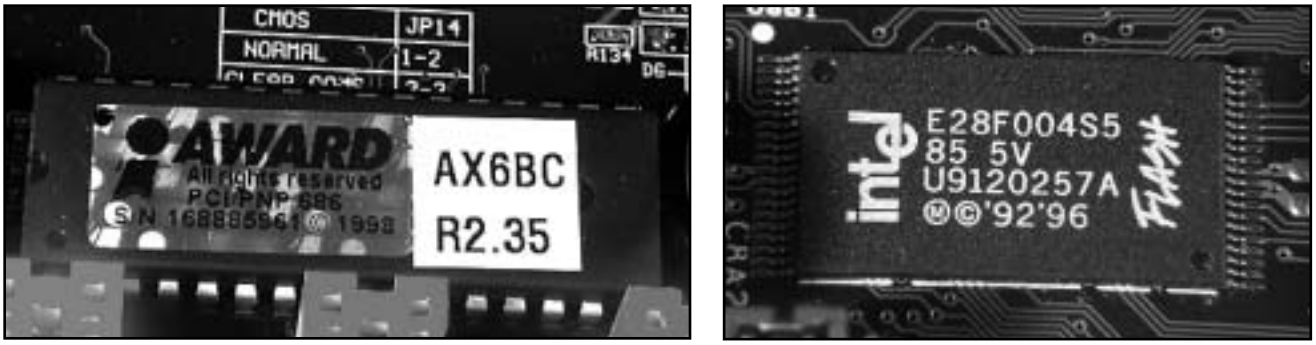


Figure 4
The Award BIOS, on the left, is in a DIP package. The Intel Flash BIOS chip, on the right, may contain any of the major BIOS types.

Most newer systems use a technology called *flash ROM*, which allows ROM data to be updated by software, which is usually available through the motherboard or BIOS supplier. Check the Internet site for the supplier (software and instructions are generally downloadable) if you suspect your ROM chip has flash ROM technology.

BIOS (*Basic Input/Output System*) is a set of procedures stored on a ROM device. The BIOS holds the information a CPU needs to communicate with the most basic of hardware components and is used during the startup of the computer. The CPU needs to know things like what kind of hard drive is attached, how many drives are in the system, and how the ports are supposed to be configured. Without this basic information, the CPU will not be able to boot or start up.

The terms BIOS, ROM, and CMOS are often used interchangeably. Each describes a different device or system, but for practical purposes they all generally refer to the information permanently stored on the motherboard about the devices that are attached.

ROM is generally used to describe any memory that does not lose data when the power is removed. Its opposite is RAM, which *does* lose data when power is removed. ROM is the physical memory package, usually a large IC on the motherboard.

CMOS is an acronym for *complimentary metal-oxide semiconductor*. This refers to a manufacturing technology for ICs, one that was developed to use very little power. In reality nearly all ICs on the motherboard could be classified as CMOS, but in a computer the term is often (incorrectly) used to refer to the BIOS Setup program.

The BIOS is the computer language instructions that tell the CPU how to start up and where to find the other devices on the motherboard. BIOS is a program that normally has a user interface called the BIOS Setup. To use these terms properly, you might say “the setup program for the BIOS is stored on a CMOS ROM device.”

If the setup or hardware information is different from what is on the system, the computer won't work. For example, if the hard drive information is incorrect, the computer can be booted from a floppy disk, but the hard drive may not be accessible. You may have to manually enter the date and time information.

The type of information contained in the BIOS will depend on the manufacturer. Typically, BIOS contains at least the following information:

- CPU and memory size
- Date and time
- Floppy and hard drive disk types
- Optional password for security
- Serial and parallel port information
- Video information

Unless your system utilizes plug-and-play, you will need to make changes to your BIOS setup anytime you upgrade or change any of your system's hardware. This is because the BIOS settings must accurately reflect the hardware types on the system in order to function. If the data in the BIOS does not match the hardware, you will get an error and will not be able to boot the computer.

To make changes to the BIOS, you'll need to run a BIOS setup program. The way to start this program depends on the manufacturer of the BIOS, and not the manufacturer of the computer. Manufacturers of motherboards purchase the BIOS from other companies, most of which specialize in making these chips. Many different computer suppliers use the same BIOS while others customize their BIOS. The BIOS manufacturer and version number is the first thing you see displayed when you boot up your computer.

Many different companies write BIOS code and sell it to motherboard manufacturers. However, the three most common BIOS manufacturers are AMI, Phoenix, and Award. If you would like to know the BIOS manufacturer for a particular machine, start the computer and when the first text appears on the screen, press the "Pause" key. This will pause the program (the BIOS program as it loads and runs) and allow you to read the splash screen for the BIOS.

On many computers you will notice that at the bottom of the screen it says "Press **DEL** to enter SETUP". Or, it might offer the "**Ins**" key, or even "**F2**." This message tells how to access the BIOS setup program. Usually you will have to be quick because the message will flash past. In this case, you would press the DEL. If the keystrokes are not displayed, you will have to rely on the documentation that came with the motherboard, or open the case and look for the BIOS chip on the motherboard (it should have a label) and then contact the BIOS manufacturer.

The name-brand computers, such as Dell, Compaq, Gateway, and the rest, put their logo up on the screen during the system startup. Most of the time pressing the Escape key will remove the logo "splash screen" and from there you might gain access to the BIOS.

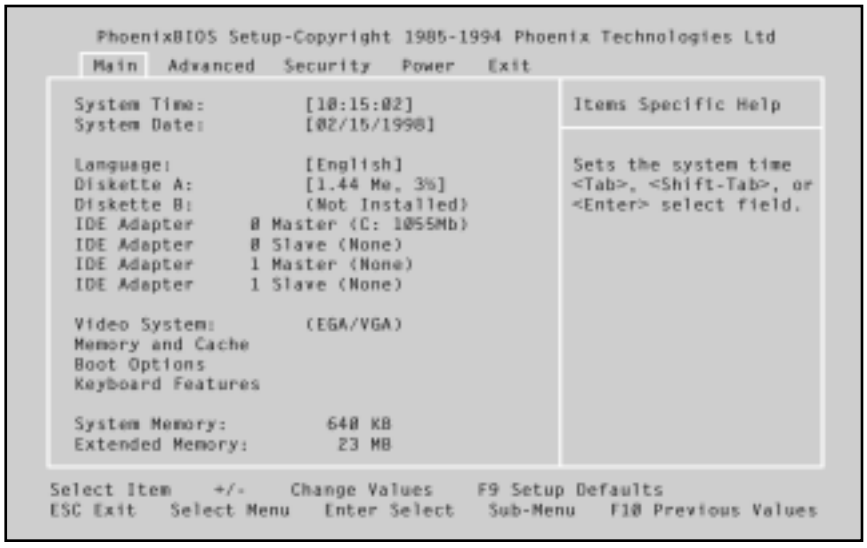


Figure 3
The main screen of the PhoenixBIOS Setup program.

A typical CMOS setup

Phoenix is considered a manufacturer of high-end BIOS and was the company who originally developed BIOS. Their BIOS is found in many computers, including some of the big name brands. To enter a Phoenix BIOS utility program, you use the F2 key. Let's look at some typical screens from a Phoenix BIOS setup program.

Figure 3 shows the Main screen of this CMOS setup. From this point, you can select alternate pages (Advanced, Security, Power) or adjust any of these individual items: floppy drive, hard drive, date/time, and RAM settings.

The Hard Drive setup screen is where individual hard drive settings are selected. This is where you tell the BIOS what type of drive is installed, and what connection method will be used. Most of the settings in this section of the BIOS are handled automatically, but occasionally you will need to adjust something.

The Advanced screen leads to more advanced setup parameters. A lot of customization can be done with these settings. Pay careful attention to any warnings before making any changes to your device settings.

The Security screen allows you to set security parameters. Be careful: once you set a password, you have to remember that password to change it. If you don't remember a password, you can usually remove it by erasing the entire CMOS setup. Check the motherboard owner's manual for the correct procedure. Be aware, you will have to reinstall all the CMOS settings before continuing.

Built-in CMOS anti-virus protectors actually do very little to protect your system. For the best possible protection from viruses, be sure to install a good anti-virus program and keep it current. In most cases, the virus check setting

is disabled. Windows does not like CMOS virus checkers. Turn off the virus check setting if you are trying to install Windows, you are certain no infected code is on the computer, and you keep receiving error warnings you to turn off all anti-virus software.

Maintaining BIOS Configuration Information

If you have ever turned on a computer and for no apparent reason it was unable to detect your hard drive you were most likely experiencing a loss of your BIOS configuration. This situation was very common on older computers, but much less common today.

Objectives

- Describe common BIOS problems and their causes.
- Describe the difference between non-volatile and volatile memory.
- Describe the purpose of a battery on a motherboard.

The Contemporary BIOS

In a computer you purchase today most of the major components send information to the BIOS telling it what they are. For instance, the hard drive will send a packet of information to the BIOS providing all the necessary data to let the system communicate with the drive. All that's necessary is to set the HDD configuration field to AUTO. Another example is the CPU; nearly all current BIOS' detect the CPU and adjust themselves as necessary.

So while losing BIOS data can be upsetting, it is usually easy to correct and is often an indication of other problems. In most cases, you will be given a message and asked to Press F1 or some other key to continue. This will then take you directly into the BIOS setup. In other cases nothing will happen. Some BIOS' will automatically run the setup utility any time there is a problem. The message that you see usually uses the word "mismatch" and will be similar to one of the following:

- BIOS configuration mismatch
- BIOS display mismatch
- Memory Size mismatch

The most common cause of this failure is the motherboard battery. If you notice that every time you start your computer the date and time is wrong, or you are asked to enter a new date and time before the computer will boot, then the battery is most likely weak and failing.

Note: If a setting changes, it is most likely the symptom of a failure rather than the cause of a failure. If you correct the setting and the failure comes back another day, the problem is most likely not the BIOS setup but something else that is causing it to change.

There are many reasons that a BIOS setting can change. Most usually occur right after hardware has been replaced or serviced. Here are but a few:

- A new device was installed that conflicts with an existing device. For example, installing a modem that uses COM2.
- An expansion card has been removed or inserted. This could cause an electrical surge, or it may not be properly inserted, and the BIOS can't find it.
- Improper handling of the motherboard can cause electrical short circuits or failure due to ESD. It can also cause disconnected or loose cables. Handling motherboards can cause the BIOS settings to become reset.
- Installing software such as a new operating system can cause BIOS problems .

In older computers it is wise to back up the BIOS setup just as you do with other important data. For example, print out the screens or *write it down* (especially before making hardware changes).

The Motherboard Battery

In years past the ROM IC would lose its data if the power was removed. This is called *volatile* memory. Since a computer is usually turned off each day, a battery was used to make sure that power was applied and data remained intact. Replacing batteries was a common task for technicians.

Newer ROM ICs do not require any batteries, the data is safely stored whether the power is there or not. This is called *non-volatile* memory. However, virtually all motherboards still have a battery. So just what is this battery used for these days?

As you are aware, there is a clock inside your computer that runs all the time. This clock, like all clocks, requires a source of power. In today's computers the sole purpose of a battery is to keep the clock running.

Just like a battery-operated alarm clock, as the battery reaches the end of its life the clock slows down. If you notice that the time needs to constantly be updated, it is more than likely time to change the battery. A few seconds each day, or several minutes per month is not a battery problem, it's normal. Ten minutes each day, on the other hand, is a sign of a failing battery.

The actual battery and procedure for replacement is dependent on the design of the motherboard. Since each supplier uses its own preferred design you should always check the specifications before replacement. There are, however, a few things to consider:

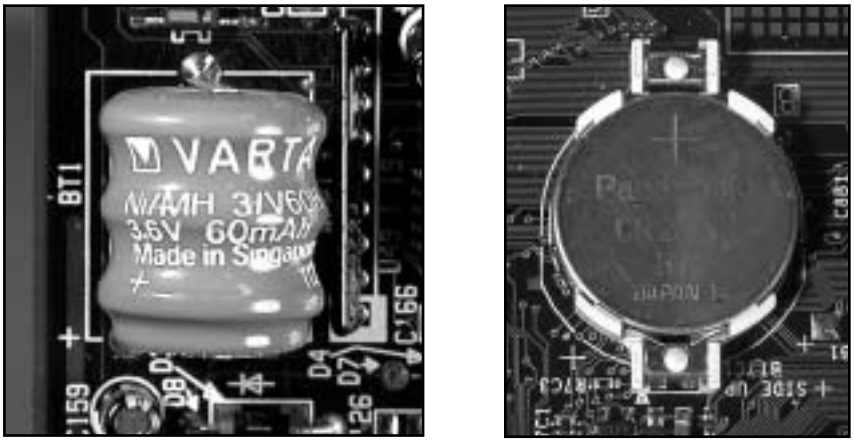


Figure 5
Two different types of motherboard batteries.

- Batteries can be either internal (mounted to the motherboard) or external (in a battery pack attached to the chassis).
- Internal batteries are often mounted in a compartment so that they can be replaced, similar to a watch battery.
- Some, but not all, motherboards have an installed capacitor that will maintain power while you replace the battery, thus preventing the BIOS information from being lost.
- Some batteries are soldered in place and require extra work for replacement. Don't replace these unless you are experienced with a soldering iron.
- Some motherboards have terminals so that an external battery can be installed to replace the internal one.

Not all motherboard batteries are equal. Their voltages range from 3 to 6 volts. You will need to check the motherboard or the motherboard documentation to determine the actual battery requirements. The 3-volt lithium button cell, as shown in Figure 5 on the right, is popular with motherboard suppliers. These are usually mounted in a holder so the battery can be changed; however, some manufactures solder them in place.

Power-On Self Test

Every time a computer is turned on or reset it goes through a self-diagnosis. This test is commonly known as POST or Power On Self Test. The POST will test the power supply to ensure that sufficient power is available; it may test to make sure that a monitor is connected. It will test for drives, it will test for a keyboard and it will test for memory errors. If errors are encountered, it will issue an error warning to the operator.

Objectives

- Describe the purpose of the POST.
- Describe what you should do when a POST error occurs.

If the POST encounters a problem, it will identify the error either by an audible alert (beep) or visually with a text error on the screen. Most POST tests take for granted that the computer's speaker is functioning properly, and give a single beep at startup to alert the user that the test has passed without errors. If you don't hear that first beep, the speaker may not be functioning or connected. The POST doesn't use text error messages until after it determines the video portion of the machine is functioning.

If you get a beep code, you should refer to the motherboard manufacturer's documentation for proper identification and troubleshooting steps. If you don't have access to these documents, troubleshooting after a beep code error can be challenging. First, the fact that you must respond to a beep code means that the boot cycle has not progressed far enough for the monitor to work, therefore, you will not receive any visual codes to help identify the problem. The good news is that since you have not progressed far enough for the monitor to work it limits the problems to a select few.

Instead of beeps, the POST may display either text or numeric error messages on the screen once it has performed the video test. BIOS programmers in the early days were restricted by the amount of memory space available, so in order to simplify error generation a common set of numeric codes were used to identify various problems within the boot process. Service technicians needed to have a list of these codes and their interpretations. Often, this required obtaining a list from each BIOS manufacturer used, in addition to the standard ones.

As the memory limits for BIOS data increased, these codes have been replaced with error messages such as: `Primary hard disk failure` which could mean that the hard drive is fried, a cable is loose, or simply that the BIOS settings are incorrect. In any case, this type of error message is much more user friendly than a "602" at the top of a blank screen, which would mean the same thing.

When you encounter any of these messages, remember two things:

- Read the entire message – don't assume that you know what it is.
- Document the message – write it down.
- Don't let the content of the message intimidate you. Programmers tend to write a limited number of messages and often use the same message for many different events. The message should lead you in the direction of the solution, not necessarily give you the answer.

The key to the POST and all these beeps and screens full of data is to become familiar with what your computer does when it works properly. That way, when something acts up, you'll notice the error sooner and you might be able to resolve the problem quickly.

Beep codes often occur after you have installed a new device, such as memory or a video card. Often these beeps are telling you that the device isn't installed correctly. For example a memory module or video card it may not be inserted into the socket properly and the POST "hollers" to let you know. Sometimes the POST beeps if the hard drive cable is not attached properly. Occasionally, the POST beeps just to let you know that there is a new device attached.

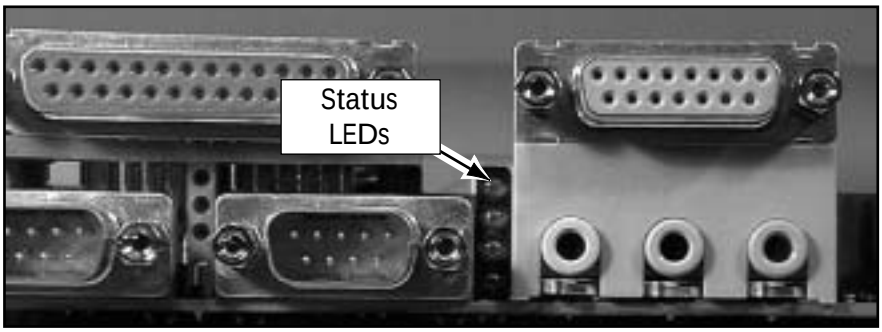


Figure 6
Some newer motherboards have a set of LEDs that tell you the status of the POST, and provide codes if the test encounters an error.

Computer Memory Types and History

The operation of a computer is based on its ability to manipulate and manage data. As time has progressed both with the development of computers and evolution of information technology (IT), the need to store vast amounts of data has increased dramatically. The computer's ability to store and retrieve data is second only to the motherboard and CPU in importance to the user. This chapter is going to explore the many ways that computers can store data. We will begin with the high-speed temporary storage called memory and continue through today's optical storage devices.

Memory can mean different things within a computer. In the previous chapter we briefly discussed ROM or Read Only Memory. ROM holds the data that the computer uses every time it starts or boots. Since this information rarely changes, we don't put much emphasis on it. The kind of memory that we are going to look at now is temporary memory. There are many names for this memory including working memory, system memory and volatile memory.

Objective

- Describe the different types of computer memory.

Early Memory

Programs are little more than a long list of binary code that is sent to the CPU for processing. Since each line of code is nothing more than a pattern of ones and zeros, any device that can store ones and zeroes in some detectable form will work as memory.

The very first computers, such as the one used in the 1890 census, used paper cards with holes punched in them. One card was used for each line of code. A stack of cards, when loaded in the right order and then run through a card reader, would load information into the computer.

This worked great for storing programs or to input data into the computer, but what about the information generated by the CPU? To compute complicated equations, the CPU may have to generate hundreds or thousands of pieces of temporary information that are held and then returned to the CPU at the appropriate time. We needed some type of storage to which the CPU can write and read data. Modern computers use a combination of three kinds of memory; ROM, RAM, and Cache. Each is located on special chips and has its own advantages and disadvantages.

ROM – Ready Only Memory

ROM, or *Read Only Memory*, is a special kind of memory, which contains code (data or a program) permanently installed by the manufacturer. By using ROM, information that is required to start and run the computer cannot be lost or changed. ROM is used extensively on computers that are designed for one purpose only. ROM in a computer is used for the BIOS circuits. The key concept with ROM is that the system can *read* this memory, but cannot *write* to this memory.

ROM is usually in an IC called a *PROM*, or *Programmable ROM*. All that means is that the data can be permanently programmed into the IC. A variation of the PROM is the EPROM, or Erasable PROM. With the EPROM you can erase the original data and program new data into the IC. A small clear window on the top of the IC identifies the device as an EPROM. A label to keep out light, which is used to do the erasing, normally covers these small windows. (Don't worry if the label is missing, intense UV light is required to erase an EPROM.)

Most computers today use a device called *EEPROM*, which means *Electrically Erasable PROM*. EEPROM allows you to run a program on the computer to erase the PROM and program new data. This process is called *flashing* the ROM, and is the method you use to update the BIOS. *Flash ROM* is also widely used on video adapters, modems, SCSI adapters, and sometimes network adapters.

RAM - Random Access Memory

A CPU needs temporary storage space for programs and data. A hard drive or floppy drive will hold the information, but the time required to read/write the information is too slow for today's programs and CPUs. The device used to do this is *RAM* (Random Access Memory). The key concept with RAM is that the system can read *and* write to RAM as needed.

RAM can be looked at in terms of an array of rows and columns. Each cell in this array can store only a "1" or a "0" (in this case, voltage or no voltage). Each cell can hold one "bit." Each row in the array is eight bits across (to match the external data bus of the 8088) and holds one byte of information. When talking of computer memory, we are generally speaking of *DRAM* (Dynamic Random Access memory). There are many different varieties of RAM, each with its own advantages and disadvantages.

Computer Memory Devices

The RAM most of us care about is on the modules that plug into the motherboard. These modules, called SIMMs or DIMMs, will be discussed shortly. In the meantime, we need to discuss some of the details about memory. Nearly all Pentium-based computers use memory modules comprised of Dynamic RAM, or *DRAM* (pronounced *dee*-ram). There are many different versions of the basic DRAM memory module, but they are all similar in many respects.

DRAM has been a stable part of computer systems for a long time, but as with all things in a computer there are improvements. We will also look at some other forms of DRAM and how they have improved memory.

Objectives

- Describe some newer DRAM technologies.
- Describe the purpose of cache memory.
- Describe the differences between DRAM and SRAM.
- Define the term access speed, and describe why a memory device's access speed rating is important.
- Describe memory reliability, and how a computer ensures that data is reliably stored and retrieved.

DRAM

One of the important attributes of DRAM, and the reason it is called dynamic, is that it requires constant *refreshing*. These circuits require a regular voltage refresh, or recharge, in order to maintain stored data. In fact, this information must be refreshed about 128 times per second. The actual rate at which memory requires a recharge is called its *refresh rate*.

DRAM chip circuits are made up of one transistor and one capacitor for each bit of memory. When a bit is assigned the value of one, the capacitor is charged. Capacitors don't stay charged and they immediately begin to discharge, thus slowly losing their stored value of one. For this reason they must be constantly recharged or refreshed. The refresh activity takes a lot of time from the CPU, when it could be doing other things. In most cases other circuits handle refresh, but this is still "wasted" energy.

Another downside to this constant refreshing is that the CPU cannot access memory during a refresh and must wait. This waiting can create an overhead loss of processing time up to as much as 10%.

In summary, DRAM is the accepted standard for memory because it is an excellent balance between fast and cheap, when compared to other methods of storage, but it is still much slower than the CPU.

SDRAM

EDO RAM, while an improvement, was short-lived and has been replaced with *SDRAM* (*Synchronous DRAM*). With SDRAM, the speed of the memory is synchronized with the speed of the bus, which speeds up data-reads and data-writes as compared to older technologies like EDO. Like EDO, the motherboard chipset must support SDRAM and you cannot mix it with other types of RAM. SDRAM was first designed for 100 MHz system buses. The good news is that SDRAM is still DRAM and it is not much more expensive.

SDRAM will operate in the 6ns to 12ns range, (we'll discuss what this means in a moment.) but as mentioned earlier you choose the proper SDRAM module based on the speed of the motherboard. For a motherboard running at 100 MHz, you need PC100 memory.

DDR SDRAM

Double data rate SDRAM, or *DDR SDRAM*, is a newer type of SDRAM. As its name implies, it transfers data at twice the speed of regular SDRAM. Normal SDRAM sends out a single byte of data with each clock pulse, but DDR SDRAM can send out two bytes of data during the same clock pulse. This is an evolutionary step for SDRAM, and is being implemented in most Pentium 4 computers today.

RDRAM

RDRAM (*Rambus DRAM*) is an extremely high-speed memory designed to run on 128-bit buses and with 800 MHz (and faster) processors. Rambus has had a shaky start, just a few manufacturers are shipping systems with this technology. Intel initially supported RDRAM, but dropped that support when it became apparent that DDR SDRAM was viable and much less expensive. The future of RDRAM is questionable at this point, although a small generation of computers use this technology.

SRAM and Cache Memory

One of the inherent problems with DRAM has always been its speed – it's too slow. There is another type of RAM available that does not have a speed problem; its problem is size and cost. An *SRAM* (Static RAM) IC is 30 times larger (in size) and 30 times more expensive than DRAM. The key difference is that DRAM needs to be refreshed and SRAM does not need to be refreshed. Refresh is a simple concept, think of it as "reminding." DRAM forgets and needs reminded, and SRAM does not need reminders.

In part because it does not require refreshing, the main advantage of SRAM is that it is significantly faster than DRAM or SDRAM.

Because of its cost, SRAM is used for special memory called *cache*. (Pronounced: *cash*, not *cashay*.) Cache is defined as a place to hide or store things. In a computer, cache memory is a place for the CPU to store important data yet still have quick access. Since this memory is so much faster, the overall performance of a machine is dramatically improved by using a memory cache.

By placing a relatively small amount of cache memory between the ultra-fast CPU and the slower SDRAM, the CPU rarely has to wait for the slow memory. The cache acts as a middleman, providing data to the CPU at full speed while it is obtaining data from SDRAM.

Cache memory is found in two types, designated as L1 and L2. L1 cache is called internal or integral cache. It gets its name from the fact that it is integrated into the processor chip. This is the fastest memory in the computer because it will run at the speed of the processor, in fact is *in* the processor.

L2 cache is the second fastest memory in the computer. It is called external cache because it is external to the processor. In 486 and Pentium systems the L2 cache was mounted onto the motherboard. Inside the Pentium II and Pentium III modules you will see the L2 cache ICs mounted to the board alongside the CPU.

Before Pentium II, cache memory ran at the speed of the motherboard, which limited its effectiveness. Make no mistake; a motherboard *without* cache was much slower than a motherboard *with* cache, despite this speed issue. By placing the L2 cache directly alongside the CPU, Intel was able to increase the speed of the cache to half the processor speed, which can be as high as twice the motherboard bus speed.

The key points with cache memory are:

- SRAM memory is extremely expensive compared to DRAM.
- SRAM is much faster than DRAM.
- SRAM is much bigger than DRAM.
- Cache memory has a huge impact on the performance of the CPU-memory interface.

Memory Speed

An important attribute of memory is its maximum speed, referred to as *access speed*. Access speed can be described as how fast incoming data can be reliably handled. In our discussion of processors, we rated them by their speed in megahertz, which is a measure of the clock frequency. With memory (and most other ICs) designers are concerned with the inverse of the frequency, which is measured in seconds. Access speed is concerned with how fast a binary zero can be changed to a binary one and back again.

All memory ICs have an access speed rating. It is normally marked on the IC, sometimes as part of the manufacturer number and often difficult to find. It is not important for you to be able to decode these numbers, but it is important to check the specifications before purchasing.

Memory access speed is rated as billionths of a second, or nanoseconds (ns). Keep in mind, the higher the number, the slower the memory. The relationship between processor clock speed and memory access time is shown here:

Clock Speed (MHz)	Memory Speed (ns)
10	100
50	20
66	15
100	10
133	7.5
200	5
300	3.3

Matching Memory Modules to Motherboards

When you buy memory the product literature will list the size and speed of the memory modules, and the motherboard documentation will list the speed and/or type needed. We will discuss the physical characteristics of memory in a moment.

The critical factor when choosing DRAM for your computer is the speed of the motherboard. You will need to know whether your motherboard runs at 66 MHz (Pentium, early Pentium II, and Celeron), 100 MHz (later Pentium II and early Pentium III), or 133 MHz (later Pentium III). 66 MHz motherboards normally use 60ns memory. Earlier 486 motherboards ran at either 25 MHz or 33 MHz, depending upon the speed of the processor.

If you're watching closely, you'll see that something doesn't add up here. The chart shows that a 66 MHz clock needs 15ns memory. But we stated that a 66 MHz motherboard can use memory with a 60ns rating. What's going on? The answer is that 15ns memory is much too expensive, and as a result the computer is being held back just a bit. The CPU, in effect, sits and waits for memory to get ready.

Recently the manufacturers have made memory purchasing much easier. If you have a 100 MHz motherboard, you buy PC100 memory. If you have a 133 MHz motherboard, you simply buy PC133 memory. In any event, check the documentation that comes with the computer.

You can't go wrong buying memory that is faster than your machine needs, except that you are wasting money. But should you try to use 12ns memory in a 100 MHz motherboard, the results may be surprising. On occasion slower memory will function, sometimes the system will just lock up. But once in a while you will be fooled into thinking everything is OK. The memory may work properly for a while, usually just long enough to start trusting the computer with something important. Then the memory fails one day without warning, wiping out an important paper or your entire list of email addresses. Don't say we didn't warn you! By the way, that failure is likely from the circuits being fried after running too fast and getting much too hot.

Memory Reliability

While today's memory chips are considered extremely reliable, this was not always so. Earlier designs were prone to failure. To deal with the issues of chip reliability manufacturers implemented two approaches. The first was to ignore the problem, and just hope that the chips would be reliable enough to do the job. They also hoped that not too many would come back. This was no problem on the low-end of the computer market, but with high-end computers this could present a problem. Imagine if your bank's computer occasionally failed to calculate your bank balance properly. In low-risk situations, no protection was cost effective.

The second method was to add an additional chip called a parity chip. This extra chip is called the parity bit. Parity works via additional programming that will examine each byte of memory and add up the number of 1s in the byte. Then by adding an additional bit (chip) they could change the value of the ninth bit such that the total number of 1s for all nine bits is either odd or even. If parity is odd, the ninth bit will be one if the total of 1s in the other eight bits is even. If parity is even, the ninth bit will be one if the total of 1s in the other eight bits is odd. If any of the bits are corrupted, the count will not be correct and an error will be detected. The downside of parity is that the additional chip will increase the cost of memory by about 12.5 percent.

The third method of provided memory reliability is ECC or Error Correction Code. This is the successor of parity. ECC goes one step beyond parity and will actually correct a single bit error. Since about 98% of all errors are single bit, this method provides for reliable memory. This is a very complex process and well beyond the scope of this course. However, you should be aware of what it is and how it relates to parity.

Working with Memory

The third element in working with memory is the physical package. As memory technology responded to the needs of computers, memory chips were bundled into modules. A module is defined as a small circuit board with memory chips. Let's now look at the various memory modules, as they developed to respond to address buses and data buses.

Objectives

- Identify the various packages used for memory ICs.
- Identify the different types of modules used for PC memory.
- Describe how to choose the proper type of memory for a computer.
- Describe how to install a SIMM or DIMM.

Dual Inline Pin, DIPs

The earliest computers used DIP ICs for each memory bank. Usually you would see row after row of identical ICs, which was obviously the memory circuits. The extreme example is the original 8088 systems that used an entire ISA expansion card to hold 256 KB of RAM, by using hundreds of DIPs. An example of a memory board from an 80386 computer is shown in Figure 8.

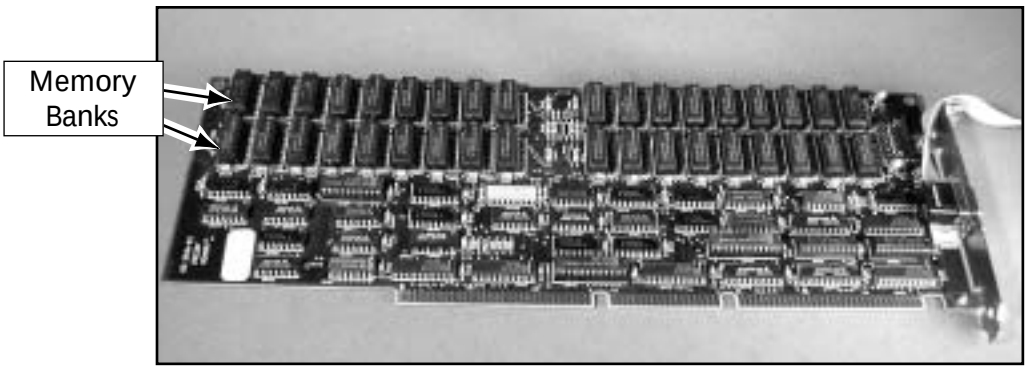


Figure 8
An early memory board that uses DIP memory chips.

SIPPs

A *SIPP* (Single In-line Pin Package) was the first attempt at making the installation of memory simple. Designers simply took a row of 8 memory chips (9 with parity) and soldered them onto a circuit board. On one edge was a row of pins that could be inserted into a connector. Now instead of installing 8 chips, you needed to install only one module with 30 pins.

SIPPs have a row of pins along one side that are easily broken and care should be taken when installing them. However, you are unlikely to encounter SIPPs these days. A later form of the SIPP, the Zigzag Inline Package, was also used in some computers.

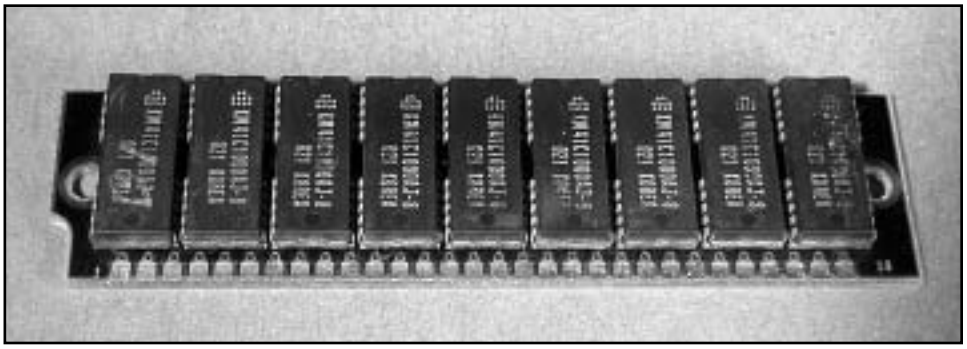


Figure 10
A 30-Pin SIMM package.

SIMMs

SIMMs (Single In-Line Memory Modules) are an improved version of the SIPP. These modules were much more popular since they did not have any pins. Instead, the edge of the module had fingers or contacts, making installation a snap. They fit into a slot at an angle and then snapped into position. Another improvement was a reduction in the number of chips required. Remember, original memory chips were only one bit wide, but improvements in manufacturing technology allow for integration of several into one package. SIMMs come in two varieties, 30-pin and 72-pin.

The 72-pin SIMM rapidly replaced its predecessor. The main difference is that the 72-pin SIMM is designed for a 32-bit data bus. A 64-bit Pentium bus will need only two of these for one bank.

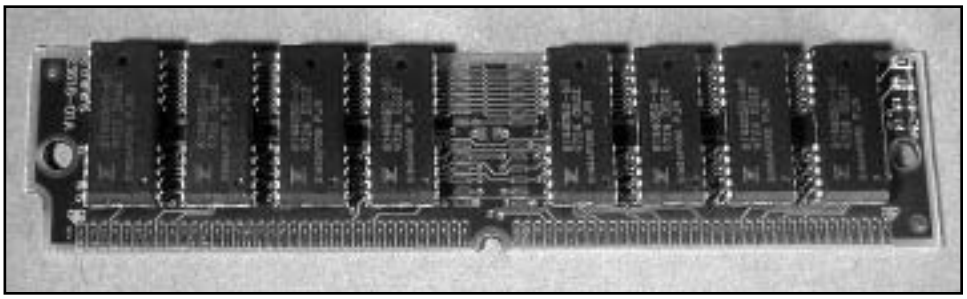


Figure 11
A 72-Pin SIMM package, used with most Pentium I systems.

DIMMs

The latest introduction to the packaging market is the DIMM or Dual In-line Memory Module. Just like its predecessor, the 72-pin SIMM reduced the number of slots you need to fill on a 32-bit data bus. The DIMM reduces the number of rows on a 64-bit data bus to one. These packages have 84 pins but each side is a separate pin, giving a total of 168 pins.

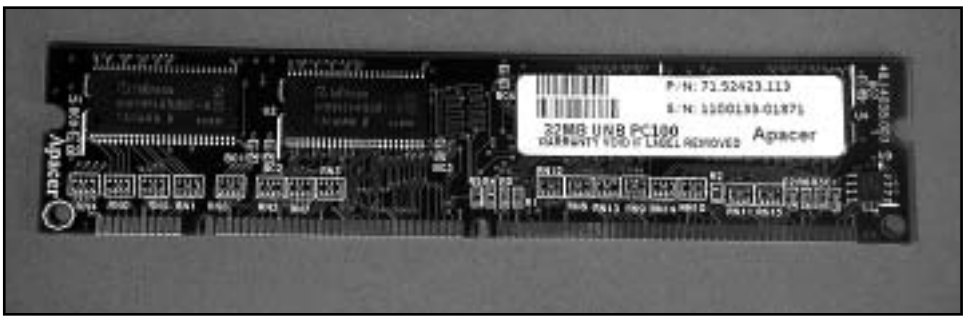


Figure 12
A 168-pin DIMM, used with Pentium II, III and 4 systems.

Installing Memory

One of the most common jobs of a computer technician is to install more RAM. It seems that computers never have enough RAM and increasing RAM is often the best and cheapest way to improve the performance of a slow computer. Doubling the amount of RAM can sometimes double the performance of a computer. A slow processor with lots of memory will usually outperform a fast processor with a minimum amount of memory.

Before replacing or adding memory you will need to prepare a strategy. You should never go out and purchase memory without first knowing exactly what you need. There are so many combinations for each computer that it would be almost impossible to predict the correct solution. The best strategy is to look first, then check the motherboard manual, and finally, purchase the required memory. Looking means to remove the cover from the case and look inside. There is no substitute for this.

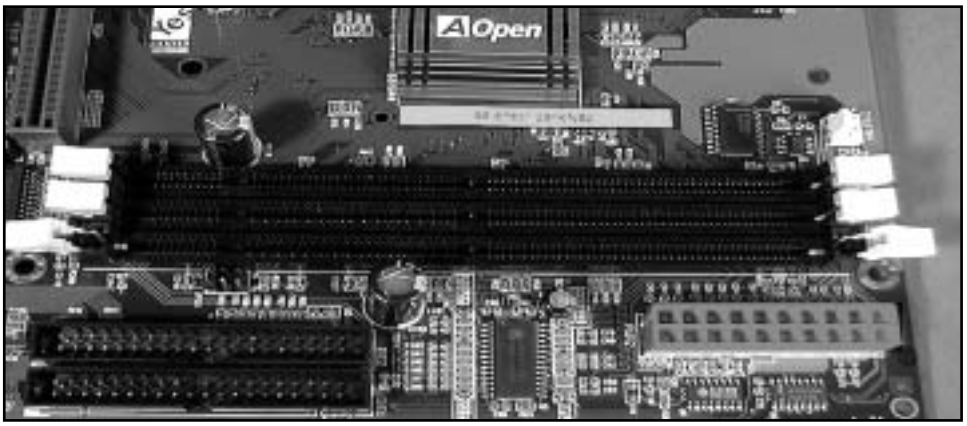


Figure 13
This motherboard has three DIMM slots, others have two or four.

The following are several things to consider before starting the upgrade:

- Are there any free memory slots on the motherboard?
- What types of slots are used?
- How many modules will you need to fill a bank?

The best resource for confirming memory is the documentation that comes with the motherboard. In most cases you can be assured that a 386 or 486 usually requires a single SIMM, but a Pentium requires that you install SIMMs in pairs of identical modules. Pentium II and Pentium III systems again require only one module, but this time it is a DIMM. Once you have determined the correct module(s) to install, the process of physically installing it is simple.

When installing SIMMs or DIMMs remember:

- Always use the appropriate protection from ESD.
- Always handle SIMMs carefully – you should never touch the chips by the edge contacts or the circuitry. Always handle them by the edges.
- All SIMMs have a key on one side that prevents them from being installed improperly. This key will fit a post in the memory slot. Since it is off-center, you cannot install a SIMM backwards.
- You may have to remove or move some power supply wires or drive cables to gain access to the memory slots. Be sure to record the locations if you have to move them. You want to be sure to return them to the correct location.

To install a SIMM, hold it at a 45-degree angle and insert it into the slot, being sure that the key is properly located. When you are sure that the SIMM is correctly inserted into the slot, rotate it upright until it snaps into place. To install a DIMM, you hold the module straight up and push it firmly into the socket.

After the memory modules are installed, replace any cables or other parts that you may have had to move.

Turn on the computer. Watch the RAM counter during the POST test. It should count up to the new value. (This may happen too fast to see if you have enabled the fast boot and/or disabled the POST memory test.) If the RAM value did not change, check the following:

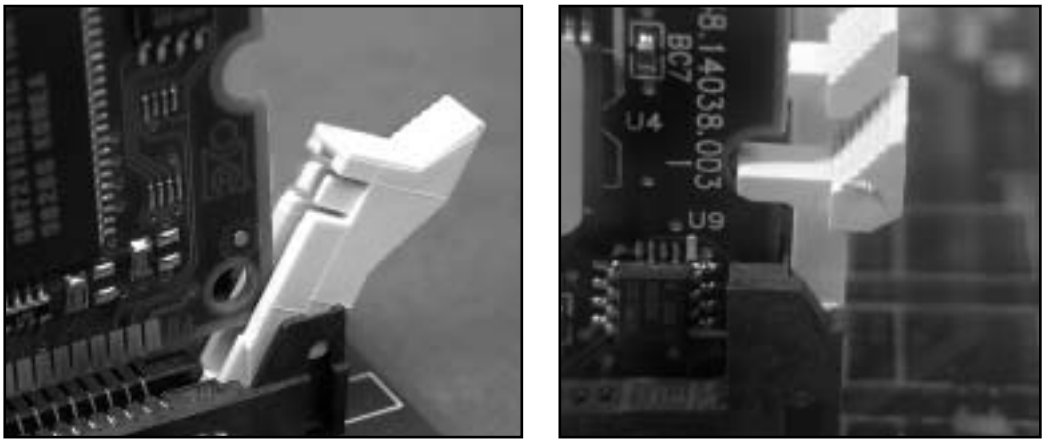


Figure 14
The DIMM latch holds the module securely.

- Make sure all the modules are property seated in their slot.
- Check to make sure that you purchased the correct memory modules.
- On some older systems you may have to rearrange the modules so that the larger one is in Slot 0 and the smaller one is in Slot 1.

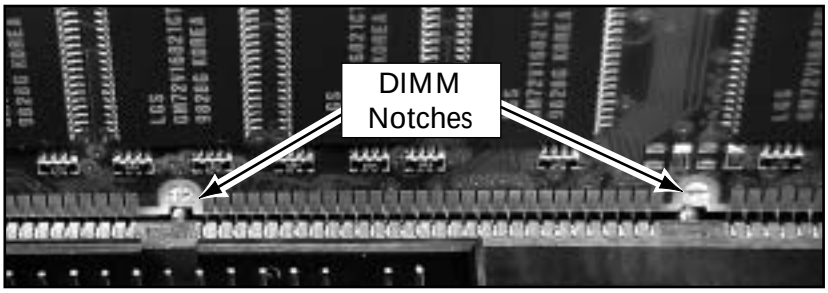


Figure 15
DIMM Matching Notches

Unit Summary

In this Unit you examined two major computer components, the motherboard and memory. These two devices could possibly have the largest impact on the versatility of your computer. A versatile motherboard allows you to connect many different peripheral devices in many different ways, and determines the type and amount of memory the system can utilize. Memory has become such a common upgrade that you can even purchase DIMMs at Walmart!

Lab 2-1

The Motherboard

In this lab, you will examine the motherboard in greater detail. By the end of this lab, you should be able to identify most of the components on the motherboard. The photos in this lab show the AOpen AX45-V model motherboard. Your actual motherboard may have a different layout, but this won't be a problem. Where applicable, the differences are noted in the steps that follow.

Try to locate the manual or installation guide for the motherboard in your computer. This is an essential document if you are doing serious work on a computer. In any event, it is always handy when trying to identify the various modules and connectors on your motherboard.

Objectives

When you complete this lab, you will be able to:

- Explain how power is distributed throughout the motherboard.
- Identify and explain the purpose of the main circuits on the motherboard.
- Identify and explain the purpose of the CNR expansion bus, the PCI expansion bus, and the accelerated graphics port (AGP).
- Identify and explain the purpose of the DIMMs.

Materials Required

To complete this lab, you will need your computer, an antistatic wrist strap, and a flashlight.

Procedure

1. Clip the antistatic wrist strap to ground on the computer trainer and slip the other end over your wrist.

2. If necessary, turn off the computer and monitor and unplug them. Remove the left side panel from the computer but leave the cables connected.

3. Look at your computer's motherboard, and compare it to the one shown in Figure 1. The layout of your motherboard may be different. But it should be similar enough to identify major components. Here we show the motherboard with its cables disconnected and interface boards removed so that you can see it more clearly. However, do **not** disconnect anything from your motherboard. As you examine your motherboard in the following steps, it may be necessary to move some cables out of your way. Also, a flashlight will help you to make out the details on the board.

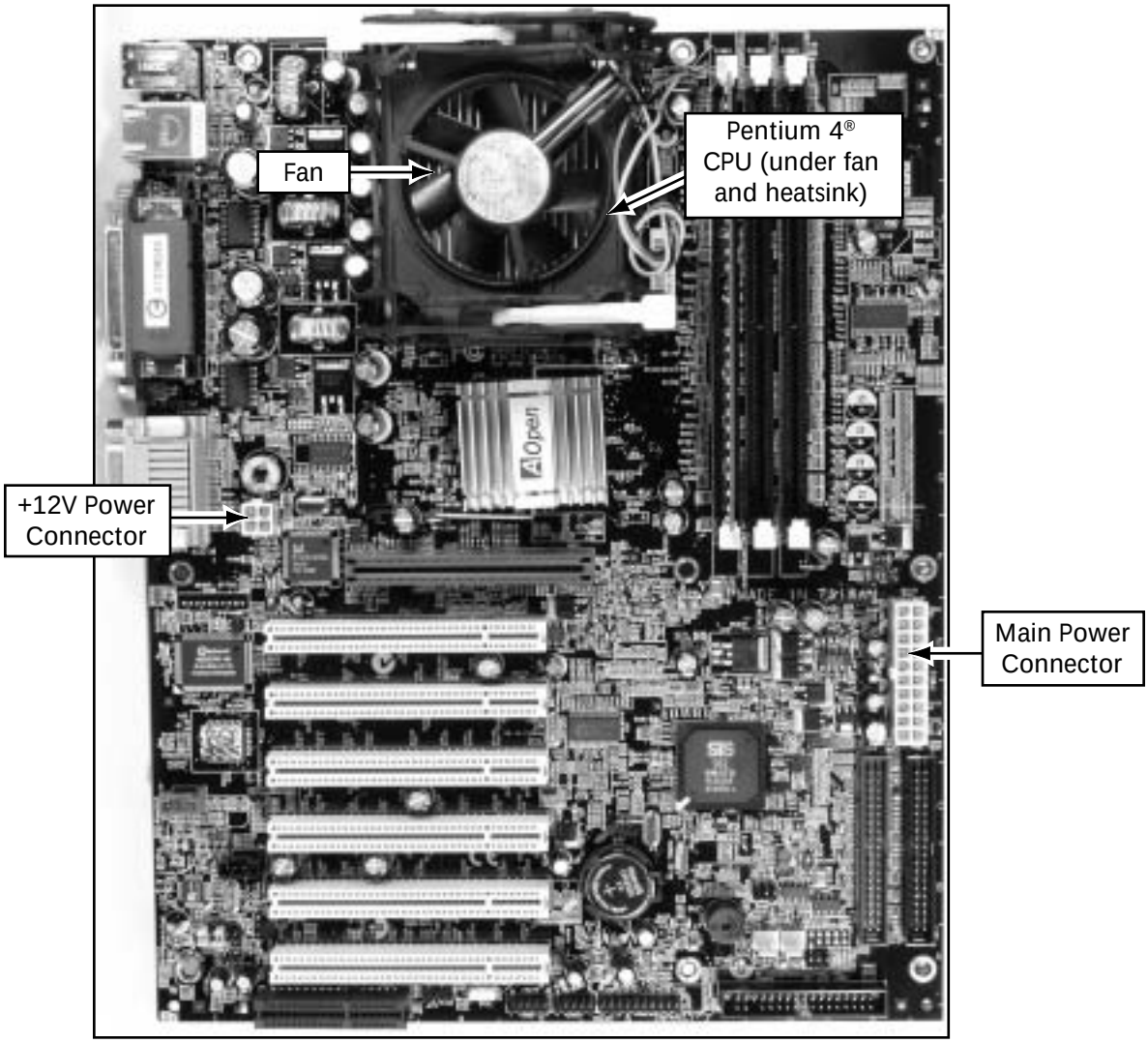


Figure 1
The motherboard.

Examining Power Distribution

4. Find the heavy multicolored cable that runs from the power supply in your computer to the motherboard. It plugs into the large 20-pin connector labeled *Main Power Connector* in Figure 1. On your board the power connector may be in a different location. Nevertheless, you should be able to recognize it by the heavy cable leading to the power supply. The power supply provides voltages of +3.3 volts, +5 volts, –5 volts, +12 volts and –12 volts to this connector. A second power cable plugs into a 4-pin connector labeled *+12V Power Connector* in Figure 1. This serves as another source of +12 volts power. The extra conductors distribute +12 volts across the motherboard to reduce the amount of current carried by each individual +12 volts wire. This connector is used only by Pentium 4 motherboards. Several of the voltages connected to the motherboard are not used by the motherboard itself but are simply routed to the expansion buses or to a fan. The trend is toward ever lower voltages in order to keep power consumption and, therefore, heat to a minimum. Most of the components on the motherboard require a supply voltage of 3.3 volts or less.

5. As you learned in the previous lab, several components in the general vicinity of the power connectors make up *voltage regulators*. Their purpose is to develop the lower voltages required by today's newer integrated circuits. They also hold the voltages constant over a wide range of current. You will learn more about this in a later lab.

6. Power dissipation is a major concern in the PC, especially in the CPU. Notice the heavy heatsink on the processor. Also notice that the processor has its own fan to help dissipate the heat. Heat buildup is a function of processor speed and the size (surface area) of the chip. In this particular computer, the fan is connected to the motherboard. However, this is not always the case. In some computers this fan is connected directly to the power supply.

7. Look at the power supply. Notice the heavy wires used in the cables leading from the power supply. Obviously these cables are designed to handle relatively heavy currents. Now look at the printed circuit board pattern of conductors on the motherboard. Do these look like they were designed to handle heavy currents? Wouldn't you expect to see heavy printed circuit board foil patterns between the power connector and the voltage regulators. How do you account for the fact that these heavy conductors are not there?

8. If you could turn the motherboard on its side, you would see that it is a relatively thick board. If you looked at the edge of the board with a magnifying glass you would see that the board has several layers. It is a *multilayer* board. The DC power is distributed via its own layer inside the PC board. In the same way another layer inside the board makes ground available wherever it is needed on the motherboard.

Examining the Expansion Slots

9. Refer to Figure 2 and compare it to your own motherboard. Find the CNR (Communication and Networking Riser) bus expansion slot on your motherboard. This is a special bus that allows the motherboard manufacturer to support commonly used communication and networking functions, such as audio, modem, and LAN using inexpensive, proprietary circuit boards. Because the CNR interface need only support a few specific functions, the cards designed to work with the interface are cheaper to produce than those for a PCI interface. As an added benefit, the CNR bus may transfer data at up to 266 MB per second. On the other hand, most of the data processing for any card attached to the CNR bus is passed on to the motherboard CPU. This can be an important consideration on a system using a 166 MHz CPU, but on today's systems using 1 GHz and faster CPUs, the processor support for the CNR bus is insignificant. Many of the Intel motherboards provide a CNR bus interface. The motherboard in your computer may not. The CNR bus socket normally shares a card slot with the adjacent PCI bus socket at the edge of the motherboard. That means you can't use both sockets at the same time. What card, if any, is presently in the CNR slot? _____

10. Older computers contained ISA bus expansion slots which date back to the earliest PCs. However, it allows transmission of data at a maximum rate of only 8 megabytes per second. While this is fast enough for slower devices such as modems and sound cards, it is not fast enough for today's video and network cards.

11. Find the PCI bus expansion slots on your motherboard. How many PCI slots are available? _____ Like the CNR slot, the PCI slots align with knockouts on the back panel.

12. The PCI bus is newer and much faster than the older ISA bus. It allows transmission rates as high as 528 megabytes per second. It also reduces the number of interrupt request lines needed to support the expansion bus slots on your computer.

13. On your computer the video card may be plugged into a special connector called the Accelerated Graphics Port (AGP). This special port was designed for high-speed video cards. Prior video cards plugged into the PCI bus, or even earlier, into the much slower ISA bus. The AGP bus allows transmission rates as high as 1,056 MB per second.

14. In today's computers, memory comes in modules called single in-line memory modules (SIMMs), dual in-line memory modules (DIMMs), and Rambus in-line memory modules (RIMMs). Your computer uses the SiS 645/961 system controller chipset to support the Pentium 4 CPU. Therefore, it uses DIMMs for real-time data storage, either DDR or SDR. There is a second Intel chipset, the 850, that is also used to support the Pentium 4 CPU. The 850 chipset uses RIMMs for real-

time data storage. Refer to Figure 3 and find the DIMM sockets on your motherboard. What is the total number of DIMM slots? _____ How many SIMM/DIMM modules are installed in the slots? _____ How many slots are available for extra memory? _____

15. Your computer should have at least 128 MB of *synchronous dynamic RAM* (SDRAM) installed in the form of a single 128-MB DIMM—there may be more than one DIMM installed. Notice also that DIMMs, like PCI adapter cards, are easily removable. Thus, they are field replaceable units or FRUs. We'll show you how to remove, install, and evaluate DIMMs in a later exercise.

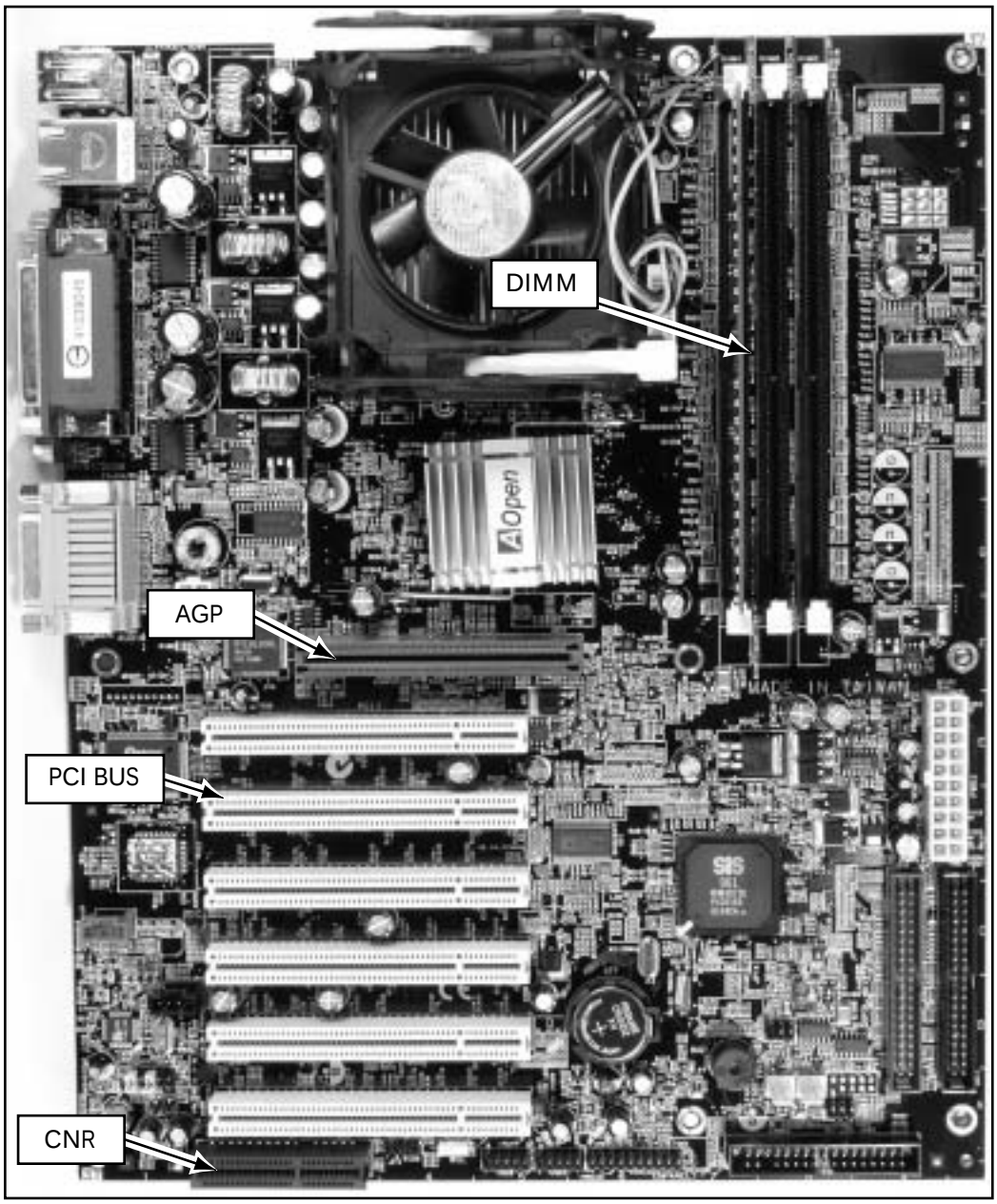


Figure 2
Identifying the expansion slots.

Examining the Integrated Circuits

16. Look at Figure 3 and compare it to your own motherboard. This figure calls out several of the more important ICs. In the following steps you will examine each of these in more detail.

17. The **CPU** is the largest IC on the motherboard. Your computer has a Pentium 4 CPU which plugs into a 478-pin socket. You can't actually see the IC because it is hidden under a large heatsink and fan, but Figure 4 shows you what it looks like. Also known as the main processor, the microprocessor, CPU, or simply the processor, this is the brain, the heart, and the soul of the PC. It contains millions of transistors squeezed into a small space. It runs so hot that it requires a heatsink and its own fan as well.

Figure 4
Pentium 4 processor used in your computer.

18. The Pentium 4 chip contains the main microprocessor itself plus a **cache memory**. This high speed 512 KB memory is used to hold data or instructions that are waiting in line to be processed. Cache memory will be discussed in more detail later in the course.

19. Find the two ICs identified as ***645/961 Chipset***. The memory controller (645) IC may be barely visible underneath its own heatsink, as shown in Figure 3. It controls how data is moved between the CPU, the DIMMs, the AGP interface, and the I/O controller. The other IC is the I/O controller (961) which controls data movement between the slower systems interfaces and the memory controller. These two ICs control a multitude of functions, replacing dozens of ICs in earlier designs as well as performing several totally new functions. They combine all peripheral, bus and memory control logic, as well as, data and address buffer logic. They also contain programmable interrupt controllers, DMA controllers, programmable interval timers, and a cache controller.

20. Another function that has been folded into many chipsets is the **real time clock**. As the name implies, this is a clock that keeps track of the time of day. It also contains a calendar that keeps track of the day, the month, and the year; and often a tiny memory that keeps track of information about the configuration of your PC.

21. On many computers, the real time clock is a separate IC. The IC has a variety of names including *CMOS*. Whether on a separate IC or embedded in the Chipset, *the CMOS* refers to a small memory where the computer's configuration information is stored. If it loses power, the data stored in its memory disappears. When that happens, you have to run the Setup program and reenter the data. Because of this, it is a good idea to keep a record of your computer's CMOS configuration handy. We'll expand on this subject later in the course.

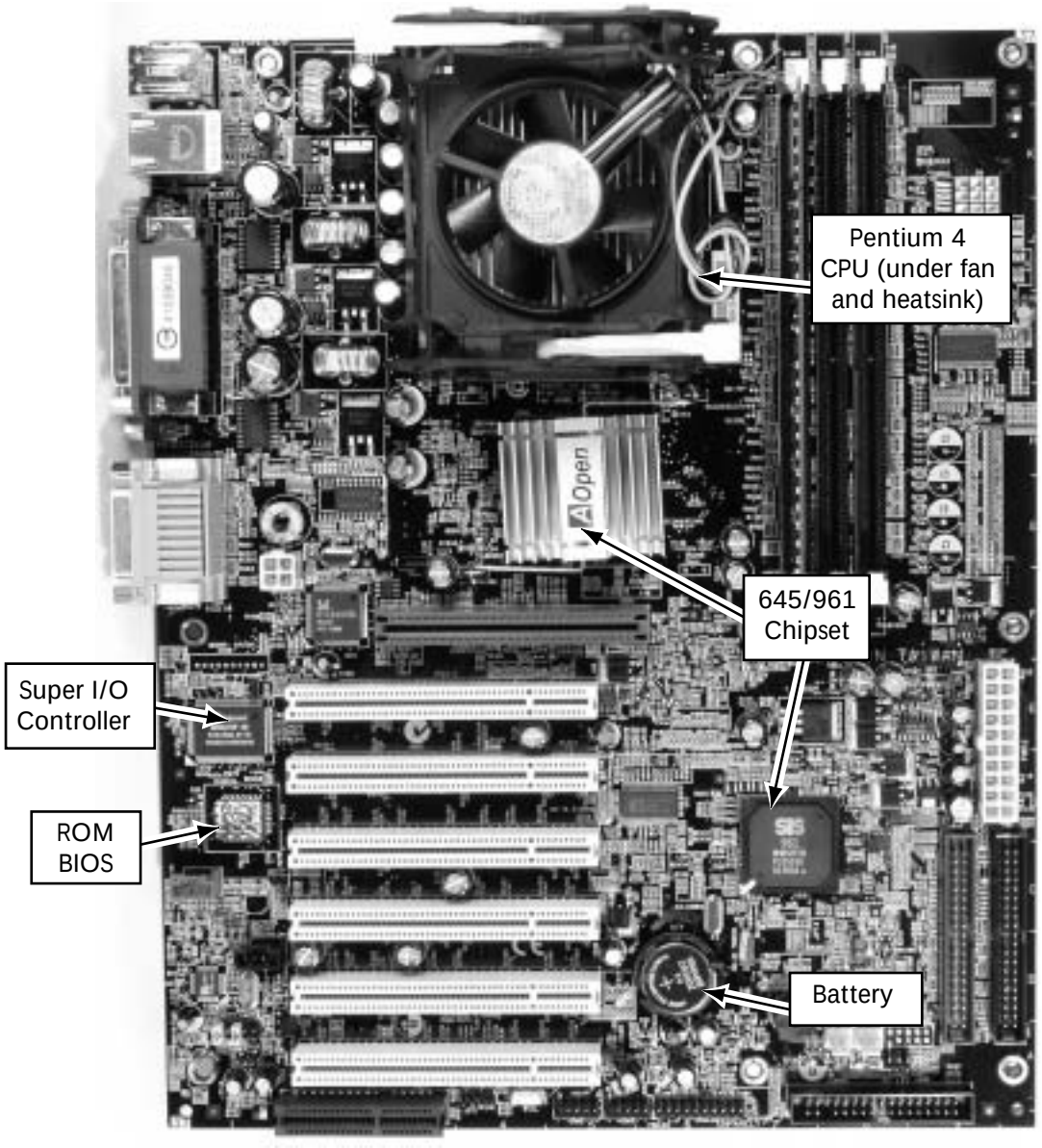


Figure 3
The ICs on the motherboard.

22. The *real time clock* and *the CMOS* must run constantly, even when the system is turned off and unplugged. To this end, a small, long-life battery is usually dedicated to this task. See Figure 3. However, on some computers, the battery is built into the real time clock. Fortunately, the battery is good for several years. But when it finally does die, your system is crippled until the battery is replaced and the configuration information is restored. On your computer this is very easy because the battery is readily accessible. On some computers, it is inside an IC that is soldered to the motherboard. This makes battery replacement more difficult.

23. Find the **ROM BIOS**. On some motherboards, it is located as shown in Figure 3. On others, it is to the right of the bus connectors. Although not the case with this computer, it is sometimes plugged into a socket.

    The ROM BIOS contains the Basic Input/Output System (BIOS) code used by the CPU to handle I/O control and data transfers. It also contains the power-on self test (POST) which is run each time the system is booted up. The ROM BIOS IC was originally socketed so that it could be easily replaced as new versions became available. However, newer PCs, like this one, use a *flash BIOS* IC that can be reprogrammed without removing the IC from the motherboard.

24. Find the super I/O controller IC on your motherboard. It should be in the general vicinity shown in Figure 3. This device controls the operation of the I/O circuits not directly supported by the 645/961 chipset. These interface circuits include the PS/2 keyboard port, the PS/2 mouse port, the serial ports, the bidirectional parallel port, the infrared port, the six USB ports, the CNR slot, and the floppy drive ports.

25. Check all connections to be certain that you have not pulled something loose during your investigation.

26. Reinstall the left side panel onto the computer.

27. Plug the computer and monitor in and turn them on, and make sure everything still works properly.

28. This completes the lab.

Discussion

In this exercise you identified and learned the basic purpose of the major components on the motherboard. We did not examine the minor circuits that form the glue that holds everything together. Even so, you now have a general idea of where things are located on the motherboard. Future labs will give you an opportunity to reexamine several computer functions in more detail, modify some of those functions, and generally tune the computer to your needs and tastes.

Lab 2-2

Award Setup

Setup is a program that allows you to customize the configuration of your computer. The computer is an extremely flexible device which can be configured in endless ways, some of which make sense, some of which do not. The manufacturer of your computer has a wide range of hard drives, video cards, memory modules, floppy drives, Modems, audio cards, etc. from which to choose. The Setup program allows the manufacturer to inform the computer of the characteristics of the devices chosen. This information is stored in a small bank of memory called the CMOS. The computer refers to this information every time it boots. Therefore the information must always be there when needed. To this end, CMOS is protected by its own battery so that the information is maintained even when the computer is turned off or unplugged. Even so, this information is sometimes lost or changed. When this happens, you must be able to restore it.

When you change the hardware, you will use Setup to tell the computer about these changes. With advances such as Plug and Play, some of this is done for you. Even so, conflicts still occur. Often, a working knowledge of Setup is required to resolve these conflicts.

Finally, Setup allows a wide range of personal preferences. Setup gives you several choices so that you can configure the computer to your own personal needs.

In this lab, you will investigate how Setup determines the configuration of your system. As you work through this lab you will find many new terms. Some will be explained or defined here. For others, the explanation must wait until later. Don't be overly concerned about unfamiliar terms. They will all be defined in time.

Objectives

When you complete this lab, you will be able to:

- Start the Setup Program.
- Use Setup to change the configuration of your computer.
- Restore the default configuration if the Setup information is lost or changed.
- Customize your configuration by making changes in Setup.

Material Required

To complete this lab, you will need a computer with an Award BIOS Setup Program.

Procedure

One of the first things you should do when you get a new computer is record the Setup information. This information will come in handy if you ever want to change back to the original configuration. In this lab you will begin to record the Setup configuration. At the same time, you will learn some new terms and concepts.

1. Turn the computer and monitor on. Enter the Setup program by pressing the *Del* key during the boot process. The opening window should look similar to Figure 1, although the options may not be identical.

2. Notice that the opening window is a menu of various Setup options. You navigate through this menu using the arrow keys as indicated by the note near the lower right side of the screen. Practice changing the menu selection by pressing the arrow keys. Notice that each menu item is highlighted when it is selected. Notice also that a brief description of the highlighted item appears at the bottom of the screen.

3. Because changes in Setup may have been made, let's begin by restoring the *default* Setup values. The default values are the settings selected by the manufacturer to provide stable operation under the widest range of conditions. The idea is to get the machine running. Once running you can change to optimal values for your particular case.

   There are different ways to load the default Setup values:

   A. You could select *Load Setup Defaults* from the opening menu.

   B. Or, you could press the *Insert* key during boot up. This method is particularly important and sometimes it is the only way to get into Setup. For example, if the CPU frequency is set too high for the components installed, the motherboard may not start up at all until the default Setup values are loaded.

4. Highlight *Load Setup Defaults* and press the *Enter* key. The message `Load Setup Defaults (Y/N)?` appears. Type Y for *Yes* and press the *Enter* key. The dialog box disappears leaving the opening window.

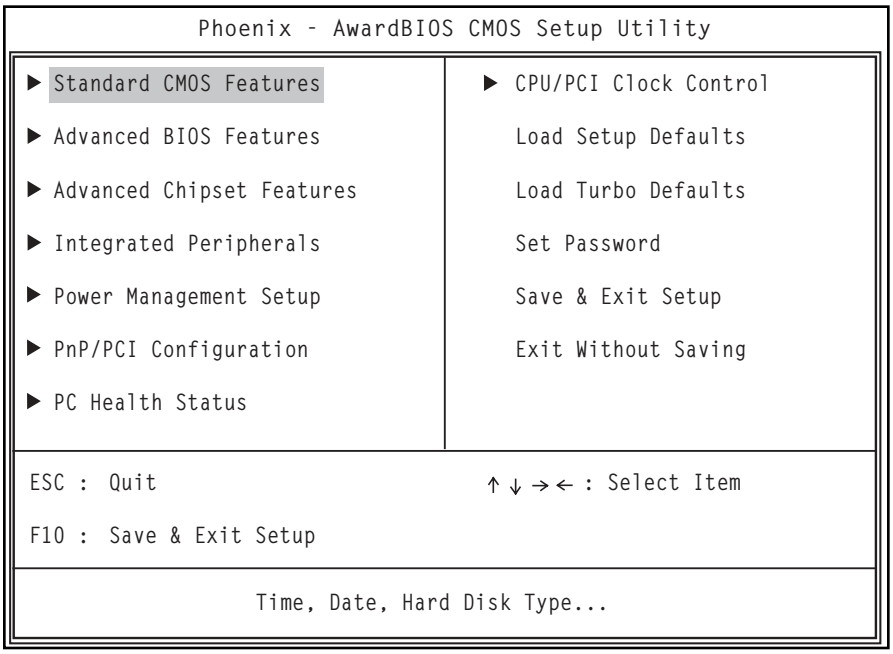


Figure 1
Opening Window of the Setup Program.

5. To save the changes, highlight *Save & Exit Setup* and press the *Enter* key. When the SAVE to CMOS and EXIT (Y/N)? message appears, type Y for Yes and press the *Enter* key. The computer returns to the boot process using the Default Setup values. To see what these values are, we must return to the Setup program.

6. After the computer finishes booting, restart the computer (press *Start*, *Shut Down*, choose *Restart*, and click *OK*). As before, press the *Del* key during the boot process to enter the Setup program.

7. This computer does not respond to the mouse during Setup. Other computers may. Even so, it is a good idea to know how to navigate through Setup using only the keyboard. The mouse may not be working just when you need Setup most.

8. Highlight the menu option *Standard CMOS Features*, if this option is not already highlighted.

Standard CMOS Features

9. Once an item is highlighted, pressing the *Enter* key will take you to a screen that gives more detail on the item. Press the *Enter* key to reveal the *Standard CMOS Features* window as shown in Figure 2.

10. Look at the lower two lines of your screen. A note tells you that General Help is available by pressing *F1*. Unfortunately, Help does little more than list the various options open to you. It does nothing to explain what the various parameters mean.

This screen also allows you to set the date and time and enter configuration information on up to four hard drives and two floppy drives. It allows you to tell the computer what type of drives are available.

11. Look at the line labeled *Date (mm-dd-yy)*. The parameter to the right of *Date (mm-dd-yy)* indicates the day of the week, the month, date, and year. Notice that the letters in the words Date (mm-dd-yy) are one color, the letters in the day are a second color, and the month, date and year are a third color. The second color indicates a value that is set automatically when you change other values. The third color indicates values that you can change.

12. As you can see, there are a number of items that can be changed. You can select an item by moving around with the arrow keys until the item is highlighted. Try pressing each of the four arrow keys to get a feel for how this works.

13. Highlight the month parameter and set it to the present month. Similarly set the date and year to the present date and year. Did you notice how the day changed by itself?

14. Move down to Time (hh-mm-ss) and set it to the present hours in 24-hour format. You can do this in either of two ways. You can either type the number directly (be sure to preface the hours with a zero if the time is between 1 AM and 9 AM), or you can use the *Page Up* and *Page Down* keys on the keyboard to increase or decrease the hours.

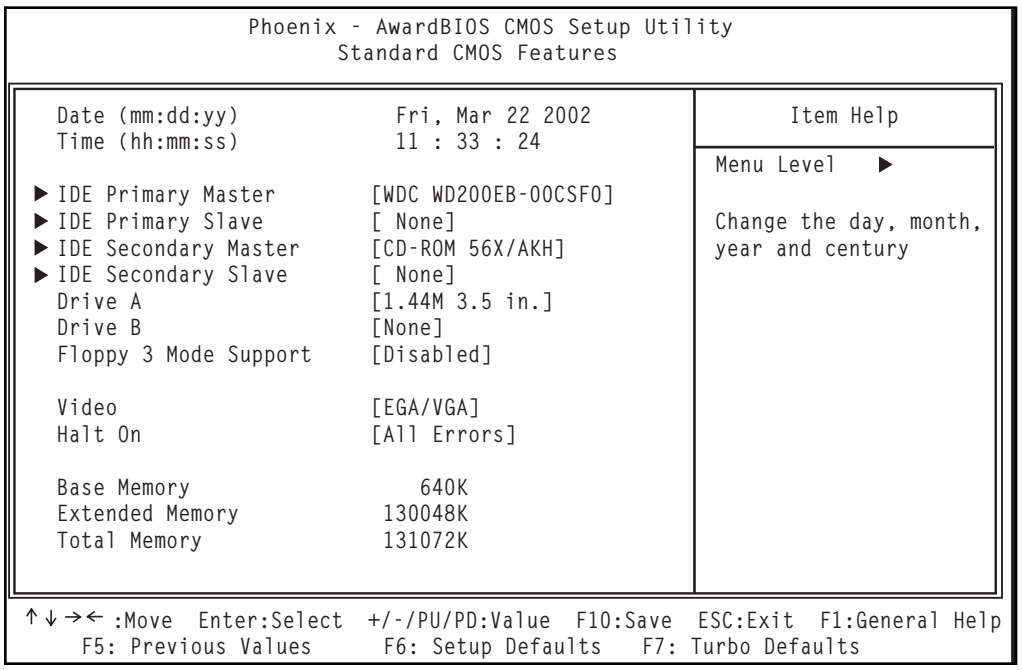


Figure 2
The Standard CMOS Setup Window.

Because there is no provision in Setup to select AM or PM, the hours field is specified in 24-hour format. To specify 9 AM, you need to set the hours to 09. To specify 9 PM, you need to set the hours to 21, etc.

15. Similarly set the minutes and seconds to the present time.

16. Look at the line labeled *IDE Primary Master*. In Figure 2, the parameter to the right of *IDE Primary Master* indicates the model of hard drive in your computer. Yours may be a different model. The triangle to the left of IDE Primary Master indicates that submenus are available for this item.

17. Highlight the parameter to the right of *IDE Primary Master* and press the *Enter* key. This takes you to the IDE Primary Master screen.

18. Highlight the word Auto to the right of IDE Primary Master. Then use the *Page Up* and *Page Down* keys to scroll though the list of options. They are Auto, Manual, and None. Leave this parameter set to *Auto*.

19. Highlight the word Auto to the right of Access Mode. Then scroll through the options Auto, Large, LBA, and CHS. Leave this parameter set to Auto. You will learn more about these parameters later.

20. Highlight the parameter to the right of IDE HDD Auto-Detection and press the *Enter* key. Notice the description of this parameter on the right side of the screen under Item Help. This indicates that the BIOS will automatically determine the type of hard drive in your computer and set its parameters accordingly.

21. Before we leave this screen, use Table 1 on the next page to record the hard drive information given for your IDE Primary Master hard drive. For now, don't worry about what the terms mean, they will be defined later.

22. Press the *Esc* key to backup to the Standard CMOS Features screen.

23. Use the arrow keys to select the parameter to the right of IDE Primary Slave. You do not have an IDE Master Slave connected at this time, so leave this parameter set to *None*.

24. The IDE Secondary Master indicates the model of CD-ROM drive installed in your computer.

25. You do not have a, IDE Secondary Slave drive connect at this time, so leave this parameter set to *None*.

Characteristic	Setting
Capacity	_____
Cylinder	_____
Head	_____
Precomp	_____
Landing Zone	_____
Sectors	_____

Table 1
The Detected Hard Drive Characteristics.

26. The next three lines deal with the floppy drives. Highlight the entry for *Drive A*. Use the *Page Down* key to step through the available options. Notice that the choices are *None* and five possible types of floppy drives. Set *Drive A* to *1.44M, 3.5 in.* to match the floppy drive actually installed as drive A.

27. In the same way, set *Drive B* to *None*, since you do not have a second floppy drive installed.

28. *Floppy 3 Mode Support* refers to a special type of disk drive that is common in Japan but is not widely used in the West. Set *Floppy 3 Mode Support* to *Disabled*.

29. The *Video* option allows you to set the type of video monitor you are using. The choices are EGA/VGA, Mono, CGA 40, and *CGA 80*. The last three choices are incredibly old by computer standards. So set this option to *EGA/VGA*.

30. The BIOS is capable of detecting certain types of system errors. The *Halt On* option allows you to set the type of error that will stop the system. Step through the choices. What are the choices? _____
_____
_____

31. Set *Halt On* to *All Errors*.

32. Finally, this screen lists important information about memory. It informs you of the amount of Base Memory, Extended Memory, and Total Memory installed.

33. Press the *Esc* key to return to the *AwardBIOS CMOS Setup Utility* window.

Advanced BIOS Features

34. Highlight *Advanced BIOS Features* and press the *Enter* key. The Advanced BIOS Features screen appears. Record the settings in Table 2. **Note:** Your screen may not show all the items listed. If the item is

not listed, simply ignore that item for now. As you will see later, if the listed item does not show up on the Advanced BIOS Features screen on your computer, it will show up on another screen in this lab.

35. Set *Virus Warning* to *Enabled*. This option protects the boot sectors and partition tables of your hard disk from the most common type of virus. Any attempt to write to the boot sector or partition table will cause the system to halt and a warning to be issued.

36. Set *Quick Power On Self Test* to *Disabled*. Enabling *Quick POST* speeds the boot process by skipping some of the POST routines. Disabling *Quick POST* takes longer but all POST tests are run.

37. Hard Disk Boot Priority allows you to set the hard disk boot priority when you have more than one hard drive installed in the computer.

Characteristic	Setting
Virus Warning	_____
Quick Power On Self Test	_____
Hard Disk Boot Priority	_____
First Boot Device	_____
Second Boot Device	_____
Third Boot Device	_____
Boot Other Drive	_____
Security Option	_____
HDD S.M.A.R.T. capability	_____
Show Logo On Screen	_____
Intrusion Alarm	_____
AC Power Auto Recovery	_____
FDD and Keyboard Setting	_____

Table 2
Advanced BIOS Features Settings.

38. The First, Second, and Third Boot Device parameters allow you to set the boot sequence. Set the Boot Device sequence as follows:

    First Boot Device — CDROM

    Second Boot Device — A:

    Third Boot Device — C:

39. Set the *Boot Other Device* to *Enabled*.

40. *Security Option* allows you to set when the computer asks for the password. The choices are: *System*, which means the computer will ask for the password every time it is turned on *and* every time you attempt to enter Setup; and *Setup*, which means only when you attempt to enter Setup. Set *Security Option* to *Setup*.

41. Set *HDD S.M.A.R.T. Capability* to *Disabled*. HDD stands for hard disk drive. SMART stands for *Self Monitoring, Analysis and Reporting Technology*. This is a technology that can actually predict the imminent failure of the hard disk drive and provide an advanced warning. It does this by monitoring certain hard drive attributes and watching for subtle changes. Not all failures can be predicted, but many can, giving the user time to back up critical data before the failure. You may have noticed a message during the POST that indicates whether or not your drive has SMART capability.

42. Set *Show Logo On Screen* to *Disabled*. You may have noticed that during bootup, the computer manufacturer's logo appeared briefly near the upper right corner of the screen. Setting this parameter to Disabled will eliminate this log.

43 Set *Intrusion Alarm* to *Disabled*. As part of its security features, this computer has a provision to sound an alarm when the cabinet has been removed by unauthorized persons. Your particular computer does not have this option connected, so this parameter should be set to Disabled.

44. Set *AC Power Auto Recovery* to *Off*. This parameter allows you to choose what action the computer performs after a power interruption that occurs while the computer is turned on.

45. The *FDD and Keyboard Setting* parameter allows you to make some personal choices regarding the floppy disk drive and the keyboard.

46. We're done examining the Advanced BIOS Features, so press the *Esc* key again to return to the main AwardBIOS Setup Utility screen.

Advanced Chipset Features

47. Highlight *Advanced Chip Features* and press the *Enter* key. The Advanced Chip Features screen appears. Record the settings in Table 3 below.

48. The first item listed is *Advanced DRAM Control*. It has to do with how the CPU addresses memory. It has a submenu, but we will not explore it today.

49. Leave *DDR Control* set to *Auto*. DDR (Double Data Rate) matches the RAM to the bus speed (times 2). By setting this to Auto, the system selects the proper speed for the RAM installed.

50. Leave *Prefetch Caching* set to *Disabled*.

51. Leave *Memory Hole at 15M-16M* set to *Disabled*. This parameter lets you set aside an area of system memory so that certain interface cards can map their ROM addresses to this area.

52. *AGP Aperture Size* refers to a special characteristic of the Accelerated Graphics Port that allows you to use system RAM for video RAM. This is an important advantage of AGP since system RAM is usually cheaper than video RAM. This option allows you to set the amount of system RAM allocated for this purpose.

53. Leave *Graphic Window WR Combin* set to *Enabled*.

54. We've finished examining the Advanced Chipset Features screen, so press the *Esc* key to return to the main AwardBIOS Setup Utility screen.

Integrated Peripherals

55. Highlight *Integrated Peripherals* and press the *Enter* key. The Integrated Peripherals screen appears.

    With today's plug and play machines, the computer automatically takes over the configuration of many peripherals. In any event, these are not parameters you should be experimenting with at the beginning of your education. Therefore, we will not have you do anything with this part of Setup at this time.

56. Press the *Esc* key to return to the *BIOS Setup Utility* window.

Characteristic	Setting
Advanced DRAM Control	_____
DDR Control	_____
Prefetch Caching	_____
Memory Hole at 15M-16M	_____
AGP Aperture Size	_____
Graphic Window WR Combin	_____

Table 3
Advanced Chipset Features Settings.

Power Management

57. Highlight *Power Management* and press the *Enter* key. The Power Management screen appears.

58. *ACPI Suspend State* is provided to help reduce power consumption during when the computer is turned on, but not being used. This parameter allows you to choose how much of the computer is shut down during periods of inactivity.

59. *Video Off Option* is also provided to help reduce power consumption by turning off the video monitor during periods of inactivity.

60. *Video Off Method* works with the Video Off Option and allows you to control the screen blanking.

61. *Switch Function* allows you to control the action of the computer's front panel Power button.

62. *Modem Use IRQ* allows you to set the interrupt request line that is assigned to your modem. Any activity on the IRQ you choose will awaken the system.

63. *Hot Key Function As* allows you determine the action of the computer when you press a certain hot key function combination (Ctrl+Alt+Backspace)

64. *HDD Off After* is yet another power reduction feature which allows you to choose how soon the hard disk drive motor shuts down after a period of inactivity.

65. *Power Button Override* allows you to choose whether the computer shuts off instantly when you press the Power button, or if you have to hold it down for a few seconds.

66. *PM Wake Up Events* has a submenu that allows you to choose which events will cause the computer to wake up. One option allows you wake the computer on a specific day of the month and time.

67. We're finished examining the Power Management screen, so press the *Esc* key to return to the main AwardBIOS Setup Utility screen.

PnP/PCI Configurations

68. Highlight *PnP/PCI Configurations* and press the *Enter* key. The PnP/PCI Configurations screen will appear.

69. For the first two parameters in this screen, *Reset Configuration Data* and *Resources Controlled By*, simply read the brief descriptions in the Item Help column.

70. PCI/VGA Palette Snoop should normally be set to Disabled. Multimedia devices, (such as a video capture card) uses VGA snooping to look ahead at the video controller to determine which color palette is currently in use.

71. We're finished examining the PnP/PCI Configurations screen, so press the *Esc* key to return to the main AwardBIOS Setup Utility screen.

PC Health Status

72. Highlight *PC Health Status* and press the *Enter* key. The PC Health Status screen will appear.

73. Observe the list of items shown on the screen. Most of these items display various temperatures, power supply voltages, and fan speed(s) inside the computer. The first parameter allows you choose a temperature which will shut down the computer should the temperature be exceeded.

74. We're finished examining the PC Health Status screen, so press the *Esc* key to return to the main AwardBIOS Setup Utility screen.

CPU/PCI Clock Control

75. Highlight *CPU/PCI Clock Control* and press the *Enter* key. The CPU/PCI Clock Control screen will appear. These parameters are set properly by the computer manufacturer. Changing these parameters can cause adverse operation, or damage to the CPU.

76. *CPU Clock Ratio* indicates the factor by which the system clock is multiplied to obtain the desired CPU speed. For example, if this parameter is set to 16X, and the system (host) clock is 100 MHz, the CPU speed is 1.6 GHz (16 × 100 MHz).

77. *Spread Spectrum* is concerned with the way the clock pulses are modulated. When this parameter is enabled, it could reduce EMI (Electro-Magnetic Interference), but this cab cause other problems.

78. *Set DIMM Clock By* can help improve the efficiency of the computer. When SPD (Serial Presence Detect) is enabled, a small amount of memory is set aside which contains information about the speed, size, addressing mode, and several timing parameters. This helps the motherboard access the memory device better. For this to work, all installed DIMMs must be SPD capable.

79. *CPU Host Clock* allows you to set the speed of the host clock.

80. *CPU Host/SDRAM/PCI Clock* allows you to select the correct time combination for the CPU, SDRAM, and PCI bus. This parameter become active only when the Set DIMM Clock By parameter is set to Manual.

81. We're finished examining the CPU/PCI Clock Control screen, so press the *Esc* key to return to the main AwardBIOS Setup Utility screen.

Miscellaneous

82. *Load Setup Defaults* loads the original, most stable values for BIOS Setup. The idea is to get the system to run without regard to performance.

83. *Load Turbo Defaults* is similar to Load Setup Defaults, except it can increase system efficiency by optimizing the BIOS settings.

84. *Set Password* allows you to set, change, or disable the password at system startup. Be sure to leave the Password set to Disabled for this classroom computer.

85. *Save & Exit Setup* allows you to save any setup changes you have made, leave setup, and return to normal operation. You have already used this function.

86. *Exit Without Saving* provides you with an easy way out, if you have made changes in the Setup Utility parameters, but decide you don't want to keep them. To make sure you didn't inadvertently change something when you performed this lab, highlight *Exit Without Saving* and press the *Enter* key. When the Quit Without Saving notice appears, type *Y* for Yes and press the *Enter* key. The computer will restart.

87. Shut down Windows. This completes the lab.

Discussion

As you have seen, Setup gives you tremendous flexibility in configuring your computer. It allows you to emphasize speed, stability, or power saving. It also allows you to use the existing hardware of to add a wide range of hardware of your own. Finally, it allows you to make several personal preferences of your own.

Unit 3

Starting with Windows

The legend goes that in 1980 IBM approached Bill Gates to develop a program that would make non-programmers productive with a new type of computer. Whether the resultant *PC-DOS* made anyone more productive than before is a matter of debate, but compared to earlier systems, Microsoft and IBM succeeded in changing the way businesses were run and work was done.

In any case, that first IBM computer would have been useless without an operating system. The operating system serves as the interface between the user, you, and the circuits within the computer. The best operating systems work like you think, except that none of us think alike. Thankfully Windows can be customized many different ways, and most of what you'll do in the operating system can be accomplished different ways, too.

This unit will focus on making the Windows *Graphical User Interface* (GUI) work like you want it to work. It will also show you the basics of the GUI, some of which may be a review if you're an experienced Windows user. Stick with it anyway, because you might find a new trick or tip.

The Evolution of Microsoft Operating Systems

Many of the commands and conventions you'll find in today's operating systems seem bizarre, almost as if they were created by programmers from a different world. To some extent that might be true, but more correctly today's operating systems are evolutionary versions of what was popular yesterday. In order to make some sense of all this, and to give you just a bit of perspective as to how we got to this point in the first place, let's take a quick look at where we were before.

Objectives

- Define the term *command-line*, and explain its role in managing operating systems.
- Explain the benefits and drawbacks Graphical User Interfaces.
- Explain the "8.3" and "LFN" file naming conventions and when each should be used.
- Describe the purpose of the Registry.

MS-DOS and the Command Line Prompt

That original IBM PC mentioned earlier ran at about 5 MHz. That's pretty slow, by just about any standard. There wasn't any such thing as a CD-ROM, scanner, mouse, or even a modem. Those slow machines weren't capable of handling any kind of graphics, just letters and numbers on the screen, and if you were lucky, 16 different colors, too. If you needed to do something with these PCs, you needed to type every bit of it, and you had to type in all the commands to make the programs work.

This sounds rough, but remember that prior to this very few people had ever used a computer. And if you were fortunate enough to get your hands on one of these early PCs it *was* rough. Learning all those commands took a lot of time and a lot of work. Once you learned the commands and learned the programs, however you could do some amazing work.

The interface of the day was the *command prompt*. The command prompt was a simple blinking spot on the screen, also called a cursor. And as you may know the operating system that provided this interface was PC-DOS or MS-DOS, depending upon whether you were using a real IBM PC or one of the "clones." See Figure 1 for an example of a command prompt.

As an example of how to use the command prompt, let's say you want to create a directory. (By the way, a directory is the same thing as a folder, but along the way the term changed "folder.") To create that directory, you had to type:

```
mkdir mystuff [enter]
```

or, `md mystuff [enter]`

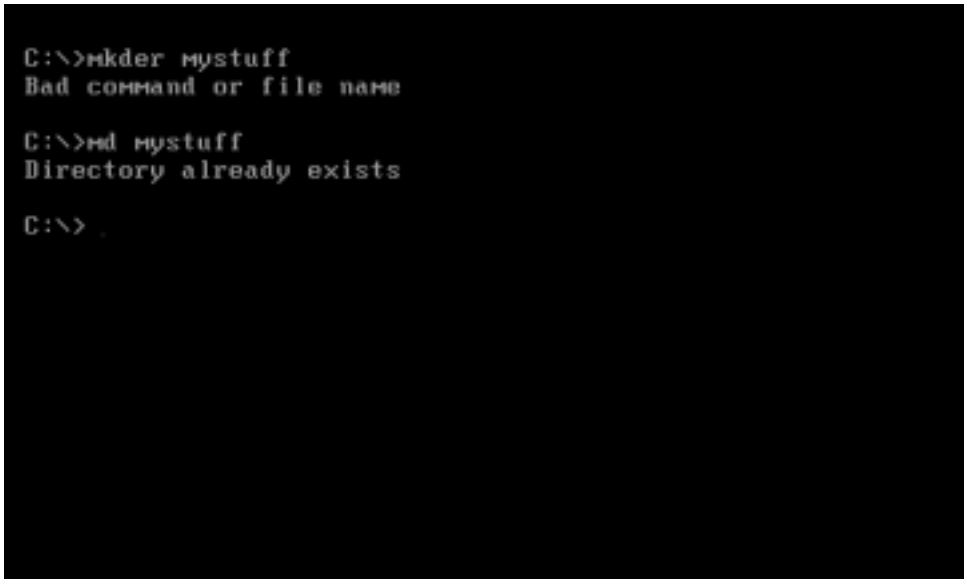


Figure 1
An example of a command prompt on MS-DOS.

That's not too bad, except that there were lots of rules when you used the command prompt and lots of commands, too. For instance, you had to type the commands exactly right, no mistakes. You were also limited to eight characters in the directory or file name, plus an optional three character extension to follow a period. This is where the term "eight-dot-three" originated. There's lots of material available to teach the various commands, so we're not going to spend much time on them here.

These operating systems were fine for their time, but they had several drawbacks. Chief among them was the text-based interface. If you didn't have the user manual or a list of commands handy, you could waste a lot of time trying to accomplish simple tasks. The other major drawback is that every company that made software, and there were a lot of them back then, used a different set of commands for similar functions. In your word processor you might hit "Ctrl-K" to save a document. In your spreadsheet, it might be "/s" because there was no uniformity or standardization. The other major problem was that you could only run one application at a time. So, forget about copying information from one application and pasting directly into another.

An OS running on one of these low-powered systems couldn't display complicated graphics, making the GUI a dream. Slowly and steadily PCs became faster, the operating systems grew bigger and more powerful, and lots of new hardware became available. As the CPUs became more powerful and memory became cheaper and hard disks got bigger, providing a GUI on a PC became feasible. (Not to shortchange the role Apple played in all this progress, but this book is about PCs.)

This particular piece of history is important because you are going to encounter the command prompt again, eventually. This is especially true if you plan to administer or configure networking systems, where much work is accomplished at the command prompt. But it's also true when something in your computer fails, and it can't get up and running so you can click on buttons. In these cases Windows reverts to the command prompt, and having some idea what to do at this prompt can make you the hero of the day. It's also worth noting that using a mouse generally makes you slower with most tasks. Command prompts and keyboard shortcuts are usually faster, but harder to learn. On the other hand, while the mouse is slower, it is easier to learn.

Windows

In between today's Windows interface and the command prompt was Windows 3.*x*. This version of Windows provided a GUI so a user didn't need to know many DOS commands, if any at all. Windows 3.*x* allowed something called *multitasking*, where several applications could run at the same time. In addition, many software developers settled on similar user interfaces and command structures, making the computer easier to use than ever. However, Windows 3.*x* was prone to system crashes, which made it just as frustrating as it was useful.

You're not likely to see Windows 3 these days, mainly because it can't handle dates beyond December 31, 1999. But it was an evolutionary step towards what we use today.

Moving forward a few years, Microsoft released Windows 95 in 1995. This was the initial release of the GUI we use today. Where Windows 3.*x* just sat on top of MS-DOS and provided a nice-looking interface, Windows 95 was an entirely new OS, and a big step forward.

Windows 95 relied much less on a DOS foundation than Windows 3, and it finally provided the ability to run 32-bit applications on the 32-bit processors that had been available for a few years. The new GUI was better, and if you had ever used a Macintosh, "Win 95" was easy to learn. It still suffered from crashes, but fixes were released to help solve that problem. In addition, the applications got better and they crashed less, too. Three years later Microsoft released Windows 98, which added more features and fixed a lot of the fundamental problems that plagued Win 95. Windows 98 was a tremendous improvement, and its second edition, Windows 98SE, is still widely used.

Just after releasing Windows 2000, which we'll cover shortly, Microsoft released an update to Windows 98 called Windows Me. This new OS was a cross between Windows 98 and Windows 2000, but it has not won a lot of fans nor much support from the technical community. Windows 95, Windows 98, Windows 98SE, and Windows Me are often collectively called Windows 9*x*.

DOS is still alive and available in Windows 9*x* (except for Windows Me.). The familiar DOS commands are in the `\windows\command\` directory of the bootable drive. Its popular name is DOS 7, but if you use the VER command at a DOS prompt you will see "Windows 95" or "Windows 98." The last official release of MS-DOS, version 6.22, was released in 1994.

Windows 9*x* and Files

The entire architecture of the operating system changed as Microsoft evolved MS-DOS into Windows 9*x*. We don't care about most of the details in this course, but two of the changes are important to anyone who makes a living using PCs. The first change involves the way files are stored on hard drives, and the second involves the storage of system and user information. Let's look at each of these briefly.

No More 8.3 File Names!

Windows 95 first allowed *long file names*, or *LFNs*. Today, Windows can use file names up to 255 characters long, including spaces and the file path. We no longer have to create an 8-character code to identify files. The "dot-three" part of the file name—the extension—is still extremely important to a Windows system. While LFNs are great, there are many applications, networks, and Web tools that cannot handle them. You are *always* safe using 8.3 file

names when you will be exchanging files or saving them on older network systems or CD-ROMs. In these cases, 8.3 files names are preferred to ensure compatibility with the widest variety of systems.

Although you *can* use really long file names, in most cases it's not a good idea to use more than 20 or 25 characters. First, it's hard to display sentence-length file names, and you can adequately describe your files and documents without all those characters anyway.

Actually, Windows still uses the old 8-character file names to retain backward compatibility. Windows takes the first 6 characters, adds a tilde (~), a number, and then the extension. This process is called *truncation*, and a LFN that has been shortened is called a truncated file name. Of course, all this is transparent to us users, so we don't have to worry about it very much, unless something goes wrong.

Here's an example. If you have two or more files with the same first six characters, the number is incremented for each file. For example, two files called `hello there.txt` and `hello there bye.txt` would be truncated to `hellot~1.txt` and `hellot~2.txt`. Note that the number in the truncated file name has no relation to the name of the file. The directory listing order determines the number. To keep things straight, Windows maintains a table with the short official name and the long name that we see.

The Registry

The biggest technical difference between Windows 9x/2000 and MS-DOS is the *Registry*. The Registry is a database that keeps track of hardware and software configuration and setup information. In Windows 9*x*, it consists of two files called SYSTEM.DAT and USER.DAT. The Windows 2000/XP Registry is made up of several additional files. The SYSTEM.DAT file keeps track of all the system information and USER.DAT keeps track of user information, such as passwords and login information.

The Registry presents new challenges for recovering from system failures, so it's a good idea to make backups. In fact, with Windows 95 it is *essential* that you manually create a backup of the Registry for emergencies, because Windows 95 has a nasty habit of destroying its own backup.

Windows 98 resolved this problem with a strong backup and recovery scheme, where there are five Registry backups stashed away. One backup is created for each of the last five days you booted your computer.

But who cares about Windows 95? Well, you might be surprised to learn that many corporations and other organizations are still running systems with Windows 95. These businesses may have thousands of computers, so an upgrade could cost millions of dollars and require tremendous amounts of training and support resources—for what *appears* to be a "no-brainer" upgrade. Someday you might find yourself working for one of these businesses, so certain issues relating to Windows 95 are worth discussion.

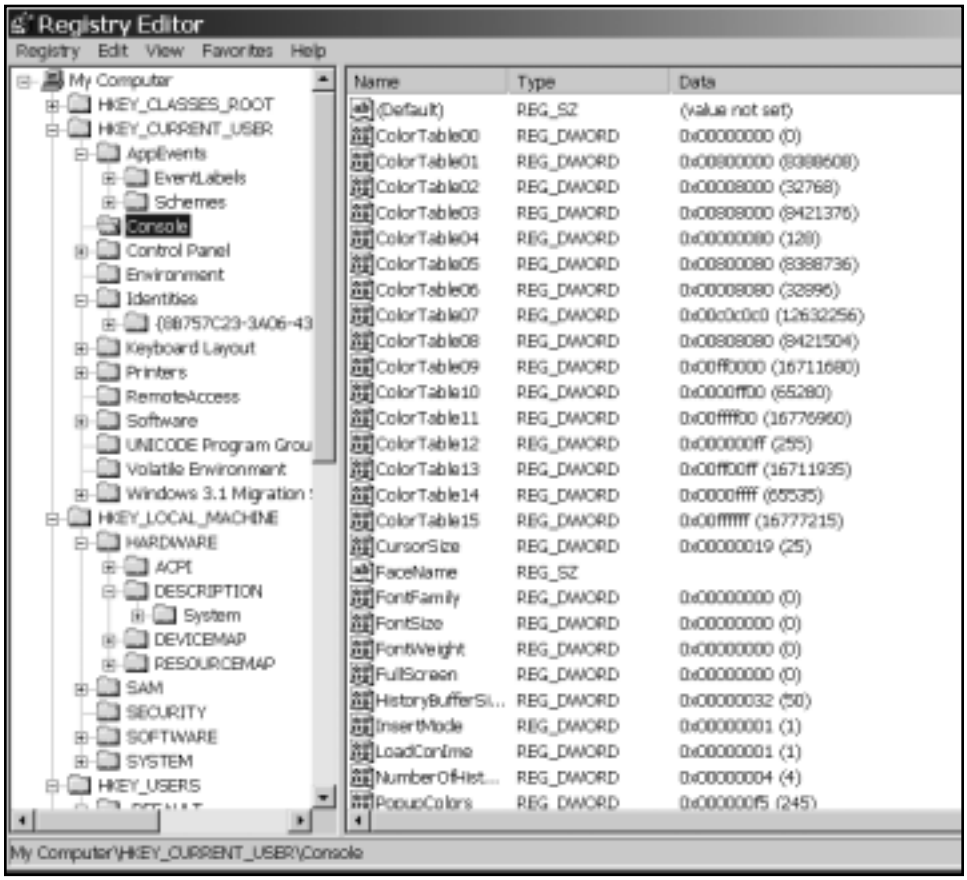


Figure 2
The registry, shown in the Windows Registry Editor.

The Registry is a complex database, and it is fairly complicated even in the hands of advanced users. You edit the Registry all the time, but you do it with check boxes, buttons, selections and information you enter in the dialog boxes you use every day. Generally you'll never need to open the Registry editor and change the data directly. In fact, you would be wise to avoid that unless absolutely necessary, and even then you'll need to exhibit extreme care.

You'll hear about Registry "hacks," which are adjustments and changes that can be made directly to the Registry to fix things or make your system better. Some of these work, but most of them are more trouble than they are worth. However, the Registry is a different kind of animal, in that there is no Undo, and in most cases there is no going back to an earlier version. A simple editing mistake can take down your entire computer. Until you are a Windows expert, you should never edit the Registry directly, use the dialog boxes instead.

The Windows NT Family

About the time the last versions of Windows 3.*x* were being released, Microsoft produced a new OS called Windows NT. This new version of Windows was built as a Network OS, intended to compete with Novell's Netware. Microsoft released two versions of NT, NT Server and NT Workstation. NT Workstation was built from the ground-up as a secure and stable OS for the professional

market. That is, it wasn't intended for home or consumer use. As such, it didn't support most of the new hardware tools and toys, nor did it run all the software available for Windows 3.*x*. And, it was harder to use and harder to manage.

This was a key move; trading versatility and usability for stability and security. Without a secure operating system, Microsoft had no chance at acquiring customers in banks, law offices, and government agencies, among others. And without a stable (crash-proof) system, the large corporations weren't interested, either.

So Microsoft developed Windows NT 3.5, then Windows NT 4. NT 4 is still widely used in many places, but it's slowly and surely being upgraded. Windows 2000 was the next generation of Windows NT-based operating systems, with several server versions available and a workstation version called Windows 2000 Professional. Windows 2000 combines the best of Windows 9*x* along with all the stability and security of Windows NT. If you use well-behaved applications, Windows 2000 is almost impossible to crash, intentionally or otherwise.

Then in 2001, Microsoft released Windows XP. XP is the true combination of the consumer and professional operating systems. Aside from some cosmetic GUI changes and several deeply-technical details, Windows XP is essentially just an upgrade to Windows 2000 plus some new utilities and features.

One of these features is Microsoft's requirement that each copy of Windows XP is registered with Microsoft, a process called *Microsoft Product Activation*, or *MPA*. With MPA, the operating system will run for just 30 days before it will shut down—unless the activation code is obtained from Microsoft and properly entered into the system. When all goes well, this process works transparently. Sometimes it doesn't go well, and you'll have to call Microsoft and talk to an MPA expert.

Where MPA becomes a hassle is in training courses such as this one. You will be restoring hard drives from CDs, and possibly even reinstalling the OS from scratch. As you know, you're not the only person who will use the computer and operating system software in the lab, so this constant re-installation makes Windows XP and the MPA difficult to use in the classroom. However, nearly everything you'll learn about "Win 2k" in this course applies to "Win XP."

The Windows Desktop

Windows uses a system of virtual windows to display the contents of each application and folder on a disk drive. If you've never used a computer before you should have little trouble learning how to operate Windows. It's all a matter of becoming familiar with the way the Windows functions are organized, and where to look for things.

All current versions of Windows share the same GUI elements. That is, the Start button, taskbar, and menu systems are the same. Many of the system tools are

in the same place, too. Granted, there are minor differences here and there, as well as some major differences when you look closely, but if you learn to use an application in Windows 95 you'll barely notice the difference when running the same application in Windows 2000.

Objectives

- Describe the process for satisfying the Windows 2000 security system in order to gain entry to the system.
- Describe the main Windows components found on the desktop.
- Explain how the taskbar works, and describe the main elements found there.

Starting a Windows 2000 Session

If you are familiar with Windows 98 or Windows Me and you have never worked with Windows 2000 or Windows NT before, you're going to find a few differences—even before you can get started. When you begin working with Windows 2000, the first thing you'll encounter is its security system.

When you use Windows 9*x* systems, you might see login screens where you can optionally enter a username and a password—if you want to. With Windows 9*x* the Esc key makes the login screen go away, and the system launches anyway. With Windows 2000, the username and password are *required*. If you sit down at a Windows 2000 system and you don't know the proper username and password, you might as well forget about using that computer because you're not going to get in. You'll be staring at the login screen, as shown in Figure 3, until you can enter data it likes, but calling for help is a better approach.

Windows 2000 can be configured to start just like Windows 9x, that is without any login information required. If you are the only user of a machine in your

Figure 3
The Windows 2000 login screen.

Figure 4
This is your first exposure to some Windows 2000 system and all Windows NT systems.

home or in an office, this might be an appropriate option for you. Most security consultants strongly recommend you implement most of the Windows 2000 security system. This system is continuously using your username and password, which are a part of the user accounts system. The username and password are generally called the *login*.

The entire Windows NT, 2000, and XP security system is based on user accounts. The *Administrator account* is the king of all accounts, and a user who has been given administrator's rights can do just about anything within the system, including the creation and control of other user accounts. If you installed Windows 2000 yourself, by default *you* are the administrator of that system. If somebody else installed the OS, then you'll have to work with that person to obtain a login that will allow you access to that system.

The administrator may give you administrator's rights, by creating an account and assigning those rights to the new account. That gives you full access to the system, including other user accounts. Or, the administrator may create an account with a lesser set of rights, say enough to get your job done but no more. Some users have accounts that prevent them from adding new software, or accessing certain parts of the file system, and so on. Most companies have policies to help them make these daily decisions.

What all of this means to you is that before you can use a Windows 2000 system, you must be able to provide a valid login, one that has been created beforehand. In this course you'll get that information from your instructor, or you may even create your own accounts.

In addition, some Windows 2000 systems (and all Windows NT systems) require that you type Ctrl-Alt-Del before you can access the login screen, as shown in Figure 4. This is yet another security measure that prevents viruses from attacking the system, and also prevents rogue software from stealing your login. The administrator can disable this configuration option, and it's not the default setup for Windows 2000.

If the system is connected to a Windows 2000 server, then all manner of additional issues come into play. It's possible that you can't access the information on the PC under your desk if you cannot provide a proper login. Many of these systems send the login back to the server, and if the server cannot authenticate that login then you cannot use the PC sitting in front of you. It sounds brutal, but some companies need that type of security. Managing and using systems connected to servers is beyond the scope of this course, so we won't be discussing those issues here.

Navigating the Desktop

For those of you without previous Windows experience, this is a brief tutorial on how to navigate the desktop. As noted previously, Windows XP is much like Windows 2000, which is just like Windows 98, which is just like Windows 95. This section is going to explain the Windows 2000 desktop, but rest assured that it will prepare you for any of the current Windows GUIs.

When you install Windows 2000 or purchase a new PC with Windows 2000 preinstalled, and once you get past the security system, it starts with the Welcome Screen similar to Figure 5. Many system manufacturers add items to the desktop, such as icons for special utilities or support options. Sometimes they even provide a custom wallpaper, the background of the desktop. You'll see the Welcome screen until somebody grows tired of it and turns it off by checking the box in the lower-left corner of the window.

At the bottom of the desktop is the *Taskbar*. The Taskbar can be completely customized, but by default, it appears at the bottom of the screen. On a fresh install the Taskbar contains four important elements, the *Start* button, a but-

Figure 5
A freshly installed Windows 2000 desktop.

ton for each program that is open, the quick Launch bar, and the System Tray. Most everything in Windows will begin from the Taskbar or one of the icons on the desktop.

You create icons for the most common tasks you perform and place them in a handy location, such as directly on the desktop or on the Quick Launch bar. Some icons must remain on the desktop, but others can be moved or removed to suit your needs.

Each version of Windows has a different set of icons placed on the desktop, and in addition you may not be the first person to use a given computer. With that in mind, the desktop you see may be well-used and well-customized—different from what is shown in this Unit.

Each icon on the left side of the desktop represents an application, folder, or an operating system function. At the top is *My Documents*. This special folder is a default location for all your original work. Whenever you create documents, presentations, spreadsheets or whatever, you can save them in this folder or sub-folders under this one. The object is to provide a single location from which you can make easy regular backups, and also so you can find your files without searching the entire hard drive.

The second icon is *My Computer*, which allows you to access all of the files and folders on any of your computer's disk drives.

My Network Places is the same as *Network Neighborhood* in Windows 9*x*. This icon opens a folder with special properties, providing links to other computers in a workgroup or domain, and links to shared resources such as printers. (These will be discussed later.)

The next icon is the *Recycle Bin*. It looks like a trash can because that's its function. When you delete a file, it goes into the Recycle Bin. If you decide you really didn't want to delete that file you can retrieve it from the Bin. Every once in awhile, you need to empty the Recycle Bin to recover disk space. Be sure you don't need those files, because once the Bin is emptied there is no way to get your files back.

Another icon is called *Connect to the Internet*. Clicking on this icon starts the wizard that configures your computer to make an internet connection. *Wizard* is an interesting term referring to a tool that guides you through a configuration process. Windows is full of wizards that handle all kinds of configuration issues, and many applications use them, too. Typically you use this particular wizard just once, then you can delete it.

The last icon on the default Windows desktop is for *Internet Explorer*. If you click this icon before you have used the *Connect to the Internet* wizard, it launches the wizard first. Once you have established a connection, then Internet Explorer, commonly referred to as simply "IE," will run normally.

Clicks and Double-Clicks

When you want to open the Start Menu, you move the mouse pointer over the Start button and click the button under your index finger—just one click. But if you want to open My Computer from its desktop icon, you have to double-click on the icon—two clicks in quick succession.

Admittedly, this is a very basic computer-GUI function. But support technicians see this all the time, where users don't fully grasp the distinction between single clicks and double-clicks. It can be confusing, and users often use the wrong type of click, which sends them into menus and dialog boxes they hadn't anticipated visiting.

Generally you have to know whether you intend to *select* an item on your screen or whether you wish to *open* the item. Selecting is one click, opening is two. These are the rules for clicking your mouse:

- When the object you want to activate is a button, you click *once* to push the button.
- When you wish to select an item from a list or menu, you click *once*.
- If you wish to open a file or run a program from its icon, you *double-click*.
- If your mouse pointer turns into a little hand with a pointy finger, like you commonly see on web page links, you click *once* to follow the link.

Eventually all this "click-business" is something that you won't even think about, it will happen naturally. If you want some experience distinguishing between the types of clicks, open the Minesweeper game and see how quickly you can solve the beginner puzzle. There is no better way to become a mouse expert than six or seven hours of minesweeper...just don't do it during class.

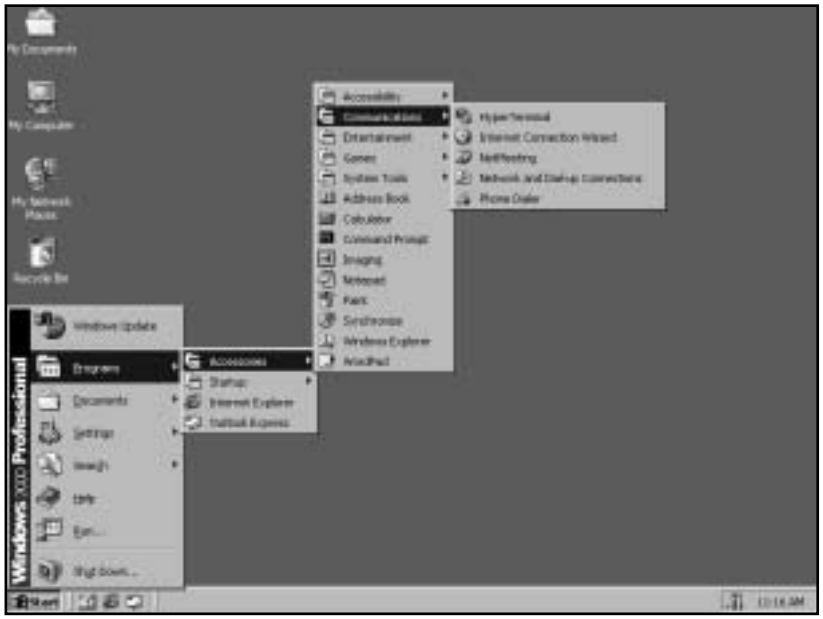


Figure 6
Opening the Start Menu

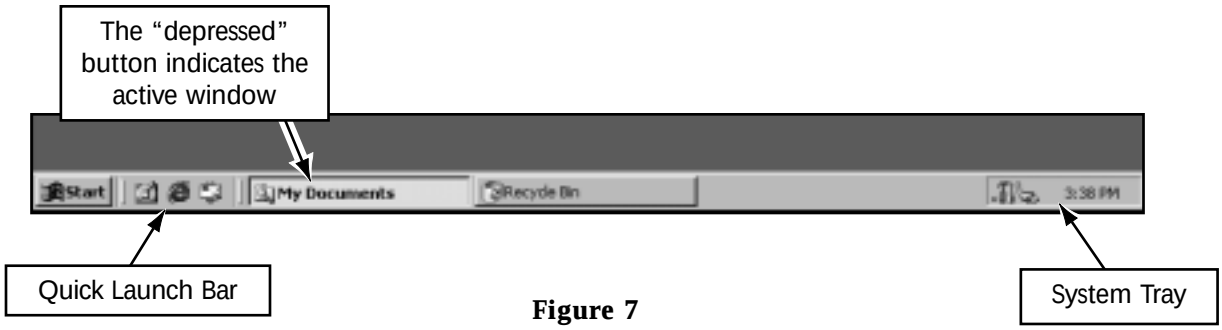


Figure 7
The Taskbar.

The Taskbar

The Start button is your gateway to applications and utilities. When you click the Start button the *Start Menu* will open. When you slide your mouse pointer up the menu, its position is tracked by a blue bar. The menu options with triangles on the right have more options that appear when highlighted by the blue bar.

In this book, and in nearly every other book about software and Windows, you’ll see a method used to locate programs on various menus. As an example, let’s say you deleted the icon from the Desktop, but now you need to locate the Internet Connection Wizard. Figure 6 shows you where that wizard is located on the Start menu. However, we can’t always use pictures to describe the menu. In this case, you might be told to locate the wizard at Start > Programs > Accessories > Communications > Internet Connection Wizard. Compare this with Figure 6. Some books may use a character other than “>” but they all indicate the same action.

The Taskbar in Figure 7 shows what look like two large buttons—labeled *My Documents* and *Recycle Bin*. A button is created in the Taskbar every time you open a window. If the button appears to be depressed, *that* window is the active window on the desktop—the window on top. Right now, the button labeled *My Documents* appears depressed because that is the active window.

Figure 8 shows what happens when you run a lot of applications at the same time. Truly, this is way too much. You can hardly expect a system to run well if you treat it like this, even if you have more than 1 GB of memory installed.

There are several ways to switch between open applications in Windows. The first two are Alt-Tab and Alt-Esc. (Press and hold the Alt key, and at the same time press the Tab or Esc key.) The Taskbar provides direct access to each and

Figure 8
It *is* possible to open too many programs at the same time.

every open application with one click. Simply click the button and the application moves to the foreground.

The *Quick Launch bar* contains icons to launch your most frequently used programs. You can delete icons from the bar, as well as drag-and-drop other icons from the desktop onto the bar. The button on the left of the bar shown in Figure 7 is used to minimize all open windows, leaving you with a clean desktop.

The *System Tray* is located on the right end of the taskbar. This tray contains a clock, and normally several icons representing system tools. Typically these icons are for quick access to tools you use periodically. To use a tool you either double click it or right click and select an option from its menu. As you add tools and utilities to your system this tray soon fills with all kinds of icons, some of which are useful and others you may never use.

We could go on forever about the basic operation of the GUI and desktop, but you'll have a better time if you gain that experience in front of a real computer. Also note that many books are available that cover *all* the minute details and nuances of the desktop, taskbar, and their options and settings. If you're serious about Windows 2000 you would be wise to get one and start reading.

Opening Programs and Files

When you load applications, whether they are utilities that solve or prevent problems, or creation tools for words, numbers, or drawings, the installation program almost always puts its own icons on the Start menu, or sometimes directly on the desktop. Some installation programs get carried away with this idea, and you end up with icons all over the place, and some utilities run whether you want them to or not. The programmers who write these programs want you to use them as often as possible, so locating a program's icon when you want to run it is rarely a problem, unless someone has deleted the icons.

So once you get that application open, now you have to do some work. You'll have to open existing files, or at least save a document you've spent time creating. You do this with File > Save, or by clicking the little disk icon in the menu bar. Depending upon which application you are using, you are presented with the File Dialog box, as shown in Figure 9.

This is an overlooked aspect of working with Windows, and you don't think about this dialog much, but it can be configured and used many different ways depending upon your needs. Some applications have their own file boxes, and some use the boxes provided by Windows. You might be familiar with the Windows 9*x* file box, as shown in Figure 10. Not content to let us get used to anything that could be improved, Microsoft released Office 2000 with an enhanced File box. This one is so good that it has been added to Windows 2000.

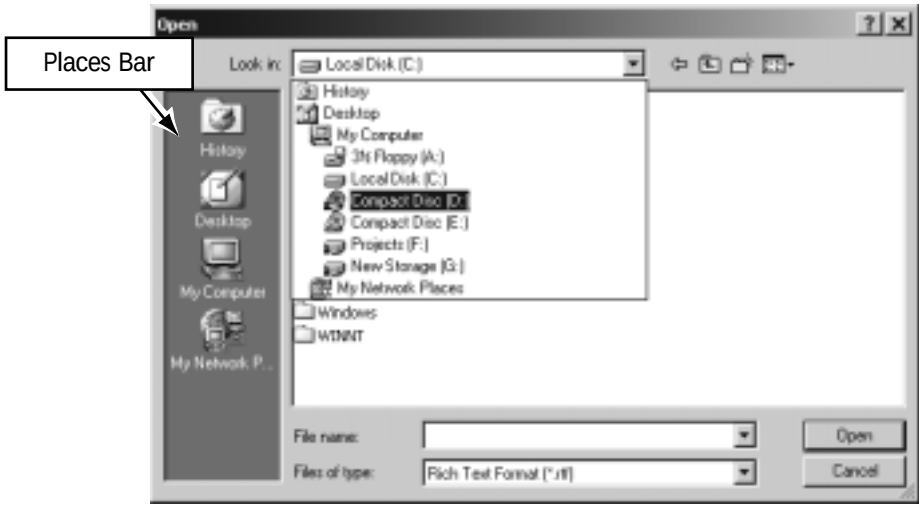


Figure 9
The default File Box for Windows 2000.

The most notable addition to the new File box is on the left side, the *Places bar*. When you want to open or save a file, most applications will point you to some specific place. In some cases, the application remembers the last place you opened or saved files. Sometimes this is a good thing, other times it can be annoying. But the Places bar offers you a one-click method to get at several common file locations. For instance if you click the icon for My Documents, you are instantly taken to that folder.

In the older File box you had two views to choose from, List and Details. The new File box offers new view options, such as an icon view and thumbnails. You should also know that from here you can create new folders, and do just about anything to a file you might do when using Windows Explorer. Just right-click a file or folder, and check out your options.

Figure 10
The default File Box for Windows 98.

Unit Summary

This Unit provided a starting point for those of you who don't have a lot of experience working with Windows systems. Just as Unit 1 provided a foundation for further hardware study, this Unit provides a foundation for further operating system study. This study will continue in Unit 4, after you have had a chance to explore Windows in the lab. If you have ever visited the computer section of a large bookstore, you know that most books about Windows are very large, some several inches thick. Then, there are entire libraries devoted to Windows network administration. Obviously, what you have seen here is just a taste of a much larger world.

Lab 3-1

The Windows 2000 Desktop, Part 1

Windows 2000 Professional is an excellent representative of the Microsoft family of operating systems. It is enough like the other members of the family (Windows 9x, Windows Me, and Windows XP) so that the information you learn here is readily transferable. But unlike the consumer-oriented operating systems, Windows 2000 Professional is a true 32-bit operating system designed from the ground up to withstand the rigors and the security concerns of the business world. Also, at the time of this writing, it is said to be the most stable of all the Microsoft operating systems.

If you are already familiar with one or more of the Microsoft operating systems, Windows 2000 Pro will look somewhat familiar. But even if you are not yet familiar with it, Windows 2000 Pro is easy to learn and fun to use. It's mostly a matter of becoming familiar with the way the functions are organized, and where to look for things. This lab reviews the general characteristics of the Desktop.

Objectives

At the end of this lab, you will be able to:

- Identify the elements on the Windows 2000 Desktop.
- Resize and move a window.
- Open and close a program.
- Use the Start button features: Programs, Settings, and Shut Down.
- Use several different methods to switch between open applications.
- Customize the Taskbar.

Materials Required

To complete this lab, you will need a computer with Windows 2000 Professional installed. A system that still retains most of its default installation settings will work best.

Procedure

1. Turn your computer on. It should boot to the desktop as shown in Figure 1.

2. When Windows 2000 starts up for the first time, the system may start with a screen like that shown in Figure 2. If so, close it by clicking the small "x" in the upper right corner of the window. The Desktop should then resemble Figure 1.

3. Figure 1 shows the Windows 2000 desktop. This desktop arrangement has been around for a few years, so you may be familiar with it already. If not, don't worry, because we will cover the fundamentals in this and in later labs.

4. At the bottom of the desktop is the Taskbar. The Taskbar can be completely customized, but by default it appears as shown. The Taskbar contains two very important elements; the *Start* button and a button for each program that is open. In Figure 3, there are no open programs, and there are other elements on the Taskbar that we have not yet described.

   Until you customize the system, most everything you do in Windows 2000 will begin from either the Start button or one of the icons on the desktop.

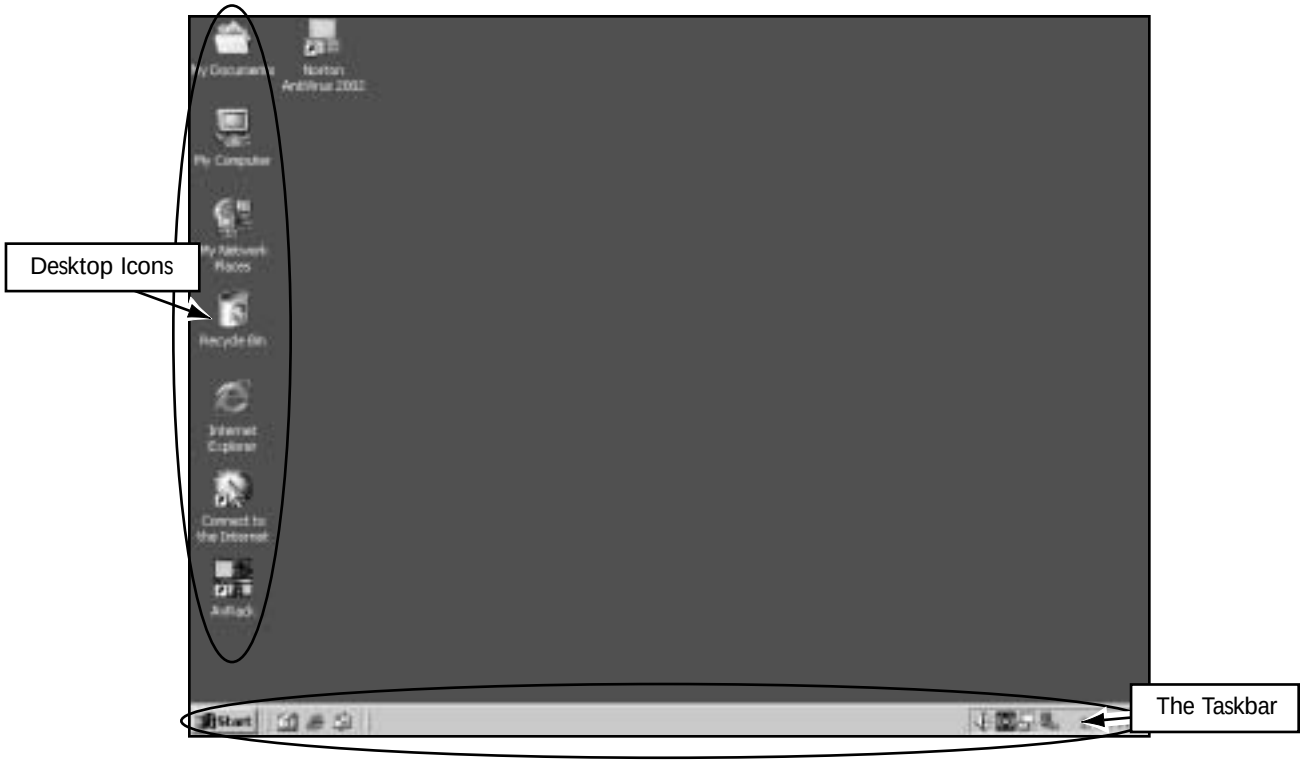


Figure 1
The Windows 2000 Desktop.

Figure 2
Close any start-up windows.

5. Some of the icons on your desktop may be different from those shown in Figure 1. Newer versions of Windows 2000 may have different icons placed on the desktop. In addition, you are likely not the first person to use this computer, so the icons may be arranged differently.

6. You open a Windows 2000 icon by double-clicking on it. Double-click on the icon *My Computer*. You will see a window similar to the one shown in Figure 3. Inside the window, you will see several devices that are installed on your computer.

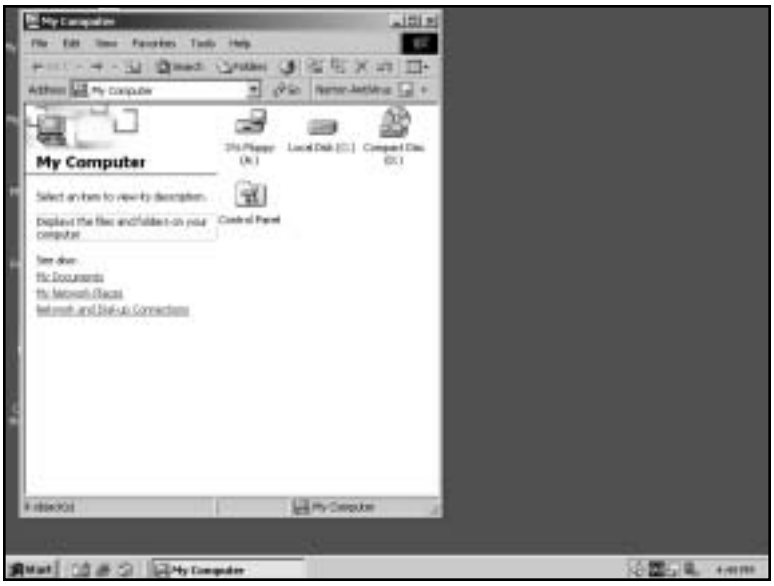


Figure 3
The My Computer window.

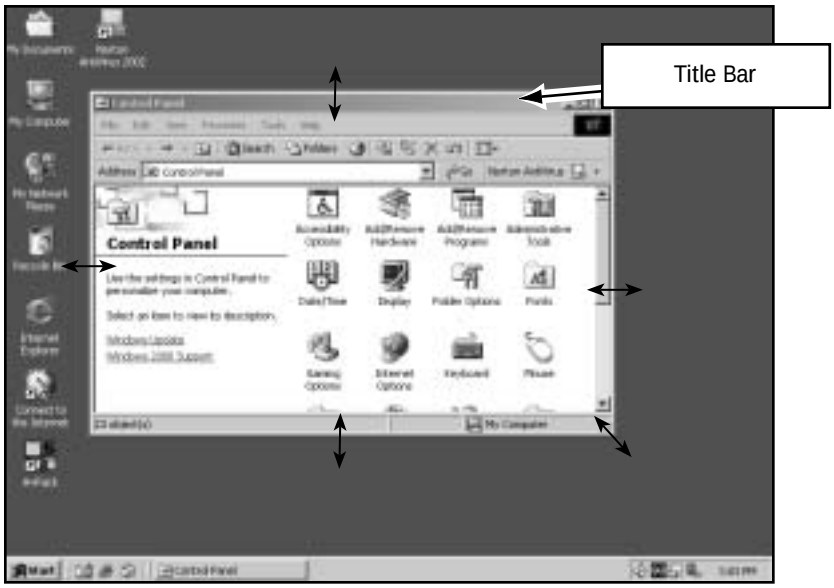


Figure 4
Control Panel window showing cursor locations for resizing.

7. There are several ways to close a window. The most direct is to click on the close button ☒ in the upper right corner of the window. Click on that button now, to close the *My Computer* window.

8. The *Start* button on the Taskbar is the gateway to most of the applications and utilities in Windows 2000. Click on the *Start* button. The Start menu will open. Slide your mouse pointer up the menu to the line, *Settings*. Notice that as you move the pointer up and down the menu, its position is tracked by a blue bar. The menu options with triangles on the right have additional options that automatically appear when the option is highlighted by the blue bar. The *Settings* option has several additional, or sub options. Use your mouse pointer to highlight the *Control Panel* option, then click. You should see a Control Panel window similar to the one shown in Figure 4.

9. Most windows can be resized using the mouse pointer. Figure 4 shows several places where you can position the pointer to resize the window. Try moving your pointer to the locations shown. Notice that only a small area of the window border will respond to the pointer, except for the lower right corner. There you will find a larger area to make window resizing fast and easy.

10. Place the pointer in the lower right corner of the Control Panel window. When the pointer changes to a double-headed diagonal arrow, depress the left mouse button and hold it down as you move the mouse. Notice that the size of the window changes with the movement of the mouse. When it is the size you want, release the mouse button. Practice resizing the Control Panel using each of the locations shown in Figure 4. Finally, resize the Control Panel window until it is approximately the size shown in Figure 4.

11. If a window is not where you want it, you can move it. Here's how. Move the pointer to the title bar (the blue bar) at the top of the Control Panel. Hold down the left mouse button and move the mouse around. Notice that the Control Panel window follows the movement of the mouse. Move the Control Panel window so that its right side just touches the right side of the Desktop.

12. Once again, click on the *Start* button. Slide the pointer up to the option *Programs*. Immediately, a menu of program options will appear. Slide the pointer to the program option *Accessories*. This will open a submenu with several more program options. Slide the mouse pointer to the program option *Calculator*, and click. This will create a display similar to the one shown in Figure 5.

    The Windows 2000 Calculator is a simple 4-function calculator. There is an option within the calculator program to display scientific functions. If your calculator looks more complicated than Figure 5, this option is probably turned on.

13. In the upper left corner of the window is an icon. Most windows have a unique icon that represents their function. It is the same icon that appears in the Taskbar when a window is opened or minimized. The icon in the upper left corner of the window is also the *Control Menu* button. Click once, and the Control menu opens. Click again, and the window closes. Let's take a look at the Control menu—click on the Calculator window *Control Menu* button. You should see a menu like the one shown in Figure 6.

Figure 5
Opening the Calculator

14. Notice that the *Restore*, *Size*, and *Maximize* options are grayed-out. When not grayed-out, these three options are used for resizing purposes. Earlier, we said that not all windows can be resized. The Calculator window is a good example. There are two other ways to determine if a window may be resized. What are they? _____
_____
_____

15. Click on the *Calculator* icon to close the Control menu. If necessary move the Calculator window so that it partially overlaps the Control Panel as shown in Figure 5.

16. Look at the Taskbar at the bottom of the desktop. You should see what looks like two large buttons—one labeled Control Panel and the other, Calculator. A button is created in the Taskbar every time you open a window. If the button appears to be depressed, that tells you that window is the active window on the desktop—the window on top. Right now, the button labeled Calculator appears depressed because the Calculator window is the active window.

17. Click on the Taskbar button labeled Control Panel. What happened?
_____
_____

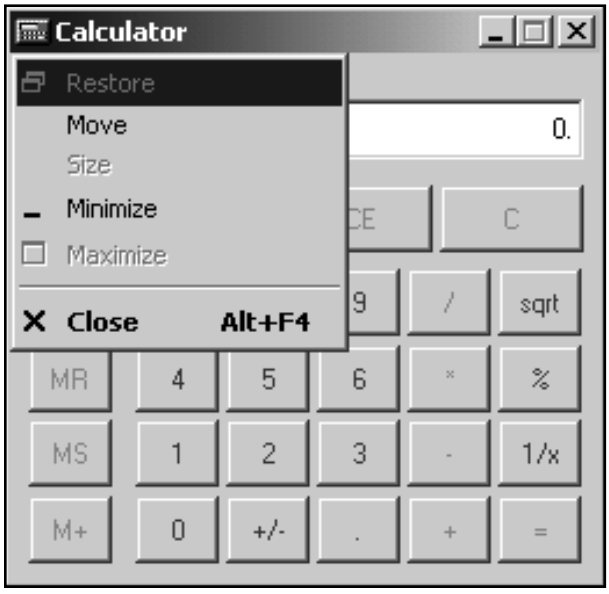


Figure 6
Opening the Calculator Control menu.

18. Open the Control menu in the Control Panel window. What are the differences between this menu and the Calculator Control menu (Figure 6 shows the open Calculator Control menu)? _____
_____
_____
What do these differences tell you? _____
_____

19. Minimize the two open windows—select the *Minimize* menu option to minimize the Control Panel window, and the *Minimize* button to minimize the Calculator window. You can't see any windows in your display now, but the Taskbar shows that the two windows are still open.

20. Click on the *Calculator* button on the Taskbar. Next, click on the *Control Panel* button on the Taskbar.

21. There are several ways to switch between the open applications. The Alt-Tab function is one. It works best when only two applications are open. To switch between the two open applications, depress and hold the Alt key. While holding the Alt key down, press and release the Tab key. Finally, release the Alt key. Repeat the process several times. Notice that the active (on top) window alternates between the Calculator and the Control Panel.

22. Another method is simply to click on the window you want on top. Click anywhere in the Control Panel window. The Control Panel is now on top (active). Click directly on the Calculator window. It will come to the top. To use this method you must be able to see the window you want to bring to the top.

23. Yet another method is to use Alt-Esc, which will "rotate" you through the open applications. Try it. While holding the Alt key depressed, press and release the Esc key. Repeat the process several times. Once again notice that the active (on top) window alternates between the Calculator and the Control Panel. The beauty of this approach is that it will rotate you through multiple open windows. To see it in action, let's open a third window.

24. Click the *Start* button and select *Programs* from the Start Menu. From the *Programs* sub-menu select *Accessories*. From the *Accessories* sub-menu open WordPad by clicking on *WordPad* or its icon. Your display should now appear like that shown in Figure 7. The Title Bar tells you that this is *WordPad* and windows has assigned the default name *Document* to the document it thinks you are about to produce. WordPad is a small word processing programs that you will use in a later lab.

25. Now let's "rotate" through the three open applications using the Alt-Esc keys. While holding the Alt key depressed, press and release the Esc key. Repeat the process several times. Notice that the active (on top) window now alternates between the Control Panel, the Calculator and WordPad.

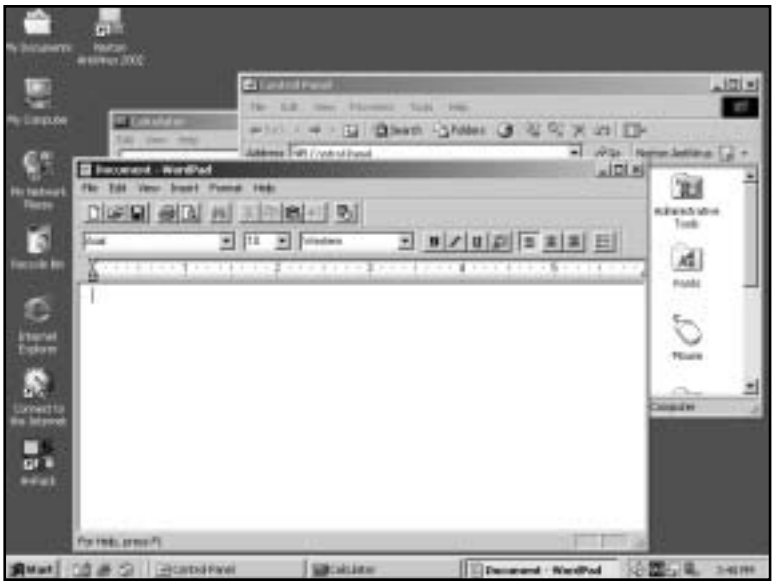


Figure 7
Desktop with three windows.

26. The Taskbar also provides direct access to each and every open application with one click. Simply click the button and the application moves to the foreground. Try it a few times and then leave WordPad as the active (on top) window.

27. Click on the Maximize ☐ button in the upper right corner of the WordPad window. That will produce a display like the one shown in Figure 8. Look at what happened to the button that you just clicked on. Hover over it with the mouse. What is the button called now? _____. It's purpose has also changed. Click on it again and WordPad is *restored down* to its own window once more. Furthermore the button is once more a Maximize button. Click on the Maximize button again. Wordpad once again fills the entire screen—almost.

28. Notice that even when you maximize the window, the Taskbar is still visible, so you can easily access any of the other open documents. In addition, because the *Start* button is on the Taskbar, you can easily access any other program in Windows 2000. You can even modify the properties of the Taskbar. Let's try it.

29. Press the *Start* button and slide the pointer up to the option *Settings*. In the menu that appears, click on *Taskbar & Start Menu…*. This will open the *Taskbar and Start Menu Properties* window. You should see a display similar to the one shown in Figure 9. Notice that the name of this window does not appear in the Taskbar. That's because this is a temporary Windows utility. It is either active, or it is gone. You can't minimize it. Notice too, that this window uses tabs to access different pages of options.

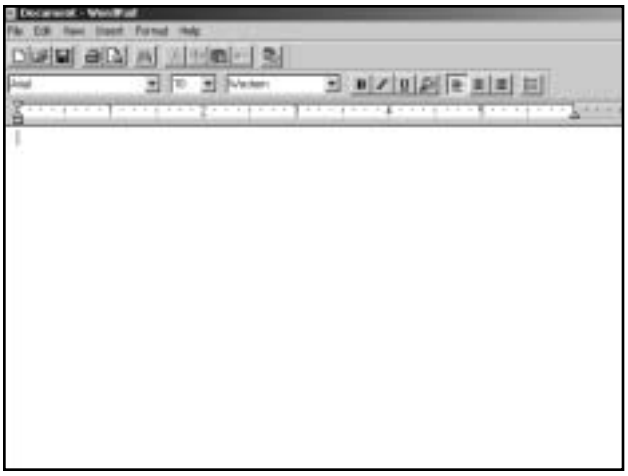


Figure 8
When maximized WordPad fills the entire screen.

30. There are five Taskbar options you can enable or disable. In the next few steps you will click on each of the option buttons and observe the results in the demonstration window. You select a feature by placing a check mark in the option box. You deselect by removing the check mark.

31. Deselect the *Always on top* option while watching the Demonstration Window. Notice that you get more window space for whatever program is open. The downside is you can't get to the Taskbar as long as the window is maximized.

32. That's why you might prefer to use the *Auto hide* option. Select and then deselect *Auto hide* a few times while watching the Demonstration window. Notice that you gain additional space, and yet, as you will see later, the Taskbar is always available because moving the pointer to the bottom of the screen will make it reappear.

Figure 9
The Taskbar and Start Menu Properties window.

33. Select and deselect *Show small icons in Start menu*. Notice the effect on the display. Select and deselect the *Show clock* option. Once again notice the effect on the display.

34. The purpose of the *Use Personalized Menus* option is not obvious from the Demonstration window. When this feature is selected, Windows 2000 simplifies many menus by displaying only the most recently used options. So a menu that once showed 10 items may now show only the last few that you used. You can get the whole list back again by double clicking.

35. Select the options *Always on top*, *Auto hide*, and *Show clock*. Deselect the remaining two. Then, click on the *Advanced* tab to change pages in the window. This page allows you to add programs to the Start menu for easier access, and clear documents from certain menus. We will leave these alone for now.

36. Press *Apply* then *OK* to accept the changes you made and close the *Taskbar and Start Menu Properties* window. As you do so, watch the Taskbar. What happened? _____
_____

    Click on the WordPad window. What happened? _____
_____

37. Move the mouse pointer to the very bottom of the display. What happened?
_____
_____

38. Click on the *Restore Down* button in the upper right corner of WordPad to return WordPad to a smaller window.

39. So far, you have used several different ways to close a window. There is a yet another way. Right-click (press the right mouse button) on the *Document - WordPad* button in the Taskbar. That action will open the Control menu for that window like the one shown in Figure 10.

40. Click on the *Close* option to close the WordPad window. If you make any changes to the document, WordPad will ask you if you want to save the changes or not. Because you didn't make any changes, WordPad simply closed the document file, and the window went away.

41. In the right end of the Taskbar is a recessed area, called the System Tray, that is used to display active applets running in the background called Terminate and Stay Resident (TSRs). At a minimum, you should see the icon for a digital clock, like the one shown in Figure 11, and if your sound system is working, an icon that looks like a speaker. The icons that appear in the System Tray on your computer may be different, and you may have several icons present.

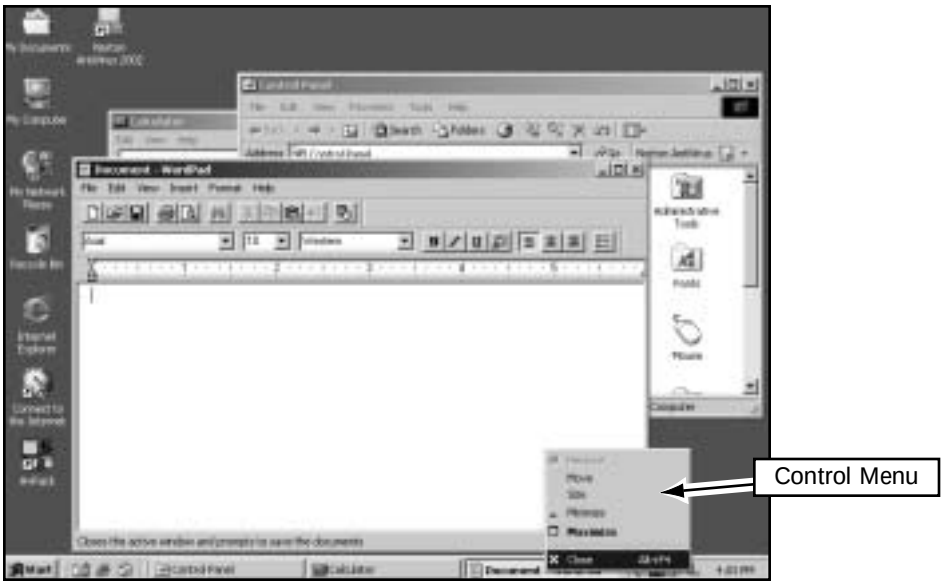


Figure 10
The Control Menu.

42. The clock maintains a continuous display of time. Move the mouse pointer over the clock icon. Notice that the computer now displays the day and date. Double-click the icon, and the *Date/Time Properties* window will open. Try it. This is the screen you will use if you ever have to reset the time, date, or time zone. Close the *Date/Time Properties* window by clicking on its *Cancel* button.

43. Because the Taskbar is so important, let's "unhide" it for the next few labs. Click on the *Start* button, select *Settings,* and then click on *Taskbar and Start Menu*…. In the *Taskbar and Start Menu Properties* window deselect *Auto Hide,* click on *Apply* and click on *OK*. The Taskbar should once again be visible at the bottom of the screen.

44. Close the Calculator and Control Panel windows. This concludes the Lab except for shutting down the computer. Note that it is always important to shut down the system ***properly***. Turning off the power, or pressing the reset button before Windows has closed itself can cause problems.

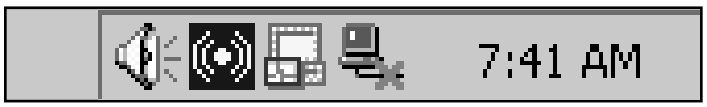


Figure 12
The System Tray.

45. To exit Windows gracefully, press the *Start* button. In the Start menu, select the option *Shut Down*…. In the *Shut Down Windows* window, find the blue bar just below the words: *What do you want the computer to do?* Notice that there is a down arrow button at the end of the blue bar. Click on the down arrow button. A drop down menu opens showing at least three options. For now, select the *Shut down* option by clicking on it. With Shut down selected, click the *OK* button. After a few seconds, the computer should turn itself off.

Discussion

In the first part of this lab we described the different icons found on the desktop. We began with the *Start* button, the focal point of most operations. We had you open the Control Panel to demonstrate common window operations, such as resizing, moving and minimizing a window. Then, we had you open the Calculator to look at a window that can't be resized. To emphasize the point, we pointed out the parts of the Control menu that are disabled when a window can't perform those functions.

Because you will frequently have several windows open at the same time, we had you practice different methods of switching between open applications. You also explored several different ways to customize the TaskBar. Finally, you looked at the proper method of shutting down the computer.

You may have noticed that we use the word *should* quite a bit. You see Windows 2000 can be completely customized. There are very few options and features that *cannot* be adjusted or changed in some way. This is a nice feature when you sit down to do real work with Windows. However, it becomes a problem as we write a specific set of instructions because someone may have changed a setting or location of some Windows element.

Lab 3-2

The Windows 2000 Desktop, Part 2

In this lab you will continue your exploration of the Windows 2000 Desktop. You will also learn some basic computer operations such as creating and saving files, creating and using folder, and using WordPad. Even if you have already mastered these skills, we want you to go through the steps anyway because we use the process to point out many additional aspects of the Windows 2000 Desktop.

Objectives

At the end of this lab, you will be able to:

- Use the functions built into the Windows 2000 *Save As* and *Open* dialog windows.
- Create, name and save files.
- Create and name folders.
- Move files to a folder.
- Use the right mouse button to access common Windows functions.

Materials Required

To complete this lab, you will need a computer with Windows 2000 Professional installed. A system that still retains most of the default installation settings will work best.

Procedure

1. Turn on the computer. You should now be looking at the Desktop.

2. Let's begin by creating a file, naming it, and saving it. You will create a text file using the Windows Accessory called WordPad. Click the *Start* button and select *Programs* from the Start Menu. From the *Programs* sub-menu select *Accessories*. From the *Accessories* sub-menu open WordPad by clicking on *WordPad* or its icon. Your display should now appear like that shown in Figure 1. The Title Bar tells you that this is *WordPad* and windows has assigned the default name, *Document*.

3. WordPad is a small word processing program that can be used for writing messages, notes, letters, etc. Let's assume that you wish to make some notes to yourself about your friends' birthdays. To demonstrate how to create a simple file or document, type in the sentence:

   Linda's birthday is June 5th.

4. Now let's save the file. Click on the pull-down menu *File*. Notice that there are two commands for saving a file: *Save* and *Save As*.... What is the difference between the two? Well first, notice that the *Save As* option has an ellipsis (...) after it. The ellipsis means that more information is required before you can complete the command.

5. Click on the *Save As* option. This opens the *Save As* dialog window, like the one shown in Figure 2. To see what the *Save* option does, close the *Save As* window by clicking the *Cancel* button.

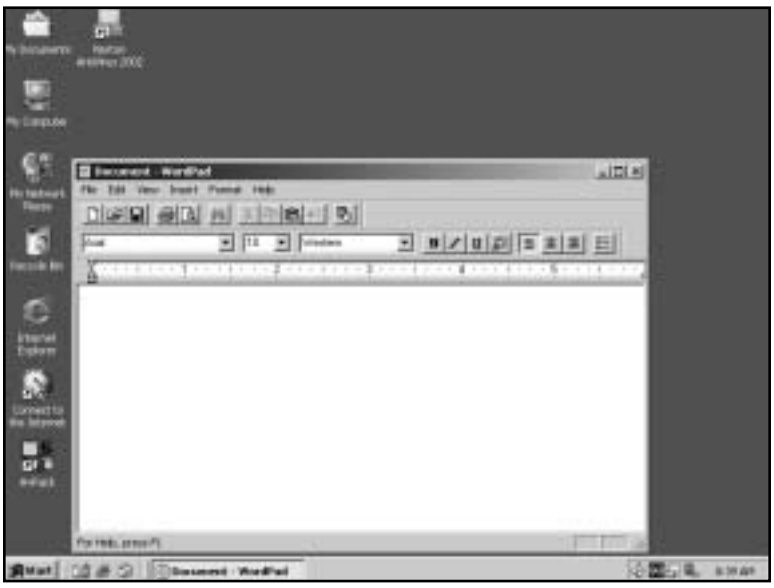


Figure 1
The WordPad window.

6. Once again, click on the pull-down menu *File*. This time click on the *Save* option. Once again the *Save As* dialog window opens. The reason that the two commands appear to do the same thing is that you have not yet named the file. We will revisit this point later.

7. A *Save As* dialog window similar to this one is used in virtually every application. So you need to spend some time becoming familiar with its features.

8. The current directory is always shown in the list box labeled *Save in*. If you wish to back up to a previous directory, you press the *Up One Level* button. The button isn't labeled as such, but Figure 2 shows its location. Also, if you touch the button with the mouse pointer, the name of the button will appear as a Help description tag. Click on the *Up One Level* button until the *Save in* list box shows the *Desktop*.

9. Notice the list of large icons down the left side of the *Save As* dialog window. This is called the *Places Bar* and it contains the icons for several places that you will use frequently.

10. Let's assume that you decide to save the file in *My Documents*. Click on the *My Documents* icon in the Places Bar. Notice that *My Documents* appears in the *Save in* list box and that the contents of *My Documents* are displayed in the Directory Contents box.

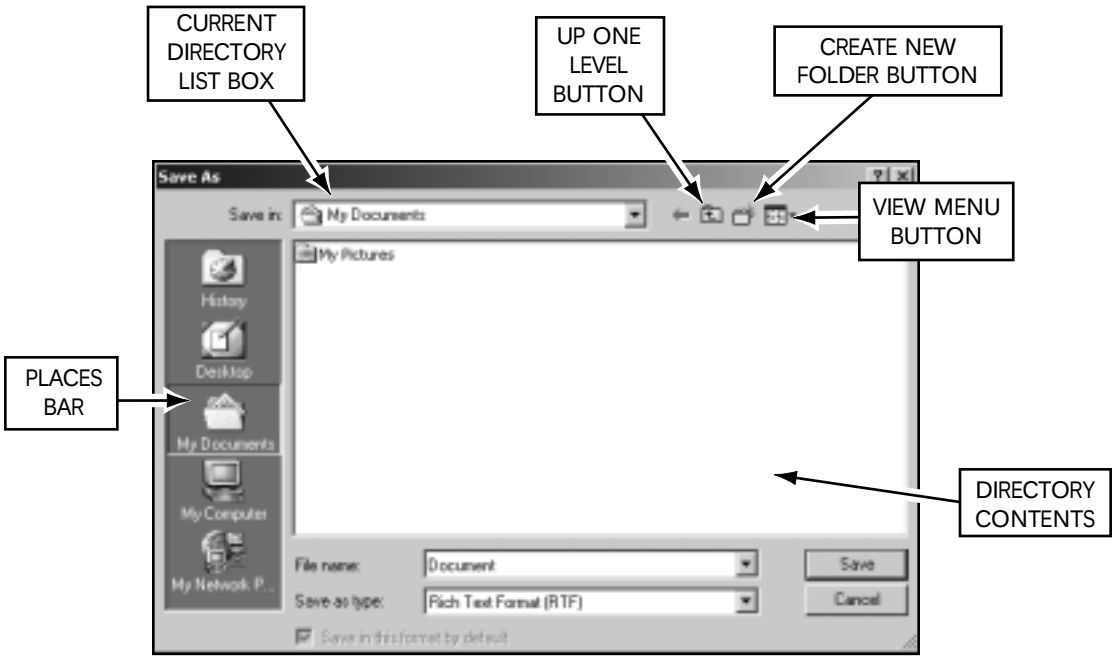


Figure 2
The *Save As* dialog window.

11. Look at the *File name* box. It contains the default name *Document*. Let's change it to something a little more descriptive. Place the I-beam pointer immediately after the *t* in *Document* in the *File name* box and click. At the keyboard, find the *Backspace* key. It is located just above the *Enter* key. It may be labeled *Backspace* or it may be labeled with a left facing arrow. Depress the *Backspace* key until the name *Document* is completely eliminated from the *File name* box. Now type the file name:

    Linda's Birthday

12. Many applications give you a choice as to the type of file you wish to save. WordPad is one of those applications. To see what your options are, look at the *Save as type* box. Click on the down arrow at the right side of the box to see your options. Several popular text formats are listed. Select *Word for Windows 6.0* by clicking on it.

13. Finally to save the file, click on the *Save* button. The *Save As* dialog box disappears leaving the original WordPad message showing. Look at the title bar. What is the name of the file? _____

14. Now, let's suppose you realize that you have made a mistake. Linda's birthday is really on the sixth of June. To correct the mistake, place the pointer immediately after the *5* in the word *5th* and click. At the keyboard, depress the *Backspace* key and the 5 is deleted. Next depress the *6* key to complete the correction.

15. Since you want to save the modified file using the same name as before, you can use the *Save* command rather than the *Save As* command. To save the modified file, open the *File* menu and click on *Save*. Notice that this time, the *Save As* dialog box is not displayed because the file already had a name. The new information is saved in the file that you named *Linda's Birthday*.

16. Let's assume there are other dates you wish to remember. Megan's birthday is July 29. Change the word *Linda's* to *Megan's* by using the following steps:

    A. Place the I-beam pointer immediately in front of the *L* in *Linda's*.

    B. Click and hold the left mouse button down. Move the mouse to the right until the word *Linda's* is highlighted. Release the mouse button. Now type the word *Megan's*.

17. Using the same procedure, replace the phrase *June 6th* with the phrase *July 29*. As you will see later this method of highlighting and replacing works for file and folder names as well as text.

18. Now we want to save the new file but do we use the *Save* or the *Save As* command? If you use the *Save* command, the new information will be saved in the file called *Linda's Birthday*. Clearly, this is not what we want. So you must use the *Save As* command. Once again, click on the pull-down menu *File*. This time click on the *Save As* option. Save your work as a *Word for Windows 6.0* file named *Megan's Birthday*.

19. Close WordPad by opening the *File* menu and clicking on *Exit*.

20. Now let's assume that at a later date you wish to check on Linda's or Megan's birthday. Open the Accessory Program *WordPad*.

21. Open the *File* menu. Notice that just below the center of the *File* menu there is a short list of the last several files you worked with using this application. If the file you wish to open is in the list, you could click on the file name and go directly to it. Because the list is constantly updated as you work on new files, often the file you want will not appear in the list. Let's look at a way to find and open the file if it is not in the list.

22. Click on the *Open* option in the File Menu. The *Open* dialog window will appear as shown in Figure 3.

23. Notice that the *Open* dialog window has many of the same features as the *Save As* dialog window that you explored earlier. Click on the *My Computer* icon in the Places Bar. Notice that *My Computer* appears in the *Look in* list box and that the contents of My Computer (several of the storage devices) are displayed in the Directory Contents box.

24. Click on the *Desktop* icon in the Place Bar. Once again, the *Look in* list box displays the name of the new location. The desktop is the very top of the Windows environment.

25. Recall that you placed the two files you are looking for in *My Documents*. Click on the *My Documents* icon in the *Places Bar*. Do your two files show up in the Directory Content box? _____ The reason for this is that the list is limited to the subdirectory folders and the specific file type specified in the *Files of type* list box at the bottom of the window.

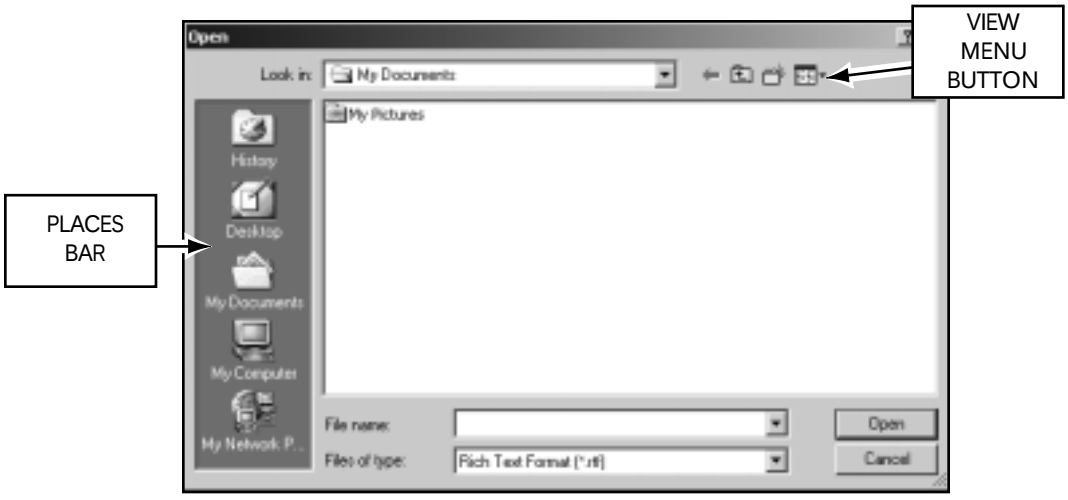


Figure 3
The *Open* dialog window.

26. Open the *Files of type* list box. Now you can see all of the file types that WordPad can open. These options are provided to keep the directory listing to a reasonable length. To see all the files, you must select the *All Documents (*.*)* option.

27. Click on the *All Documents (*.*)* option. Are the two files that you created earlier shown now? _____

28. Open the *Files of type* list box again. Click on the *Word for Windows (*.doc)* option. Are the two files that you created earlier shown now? _____

29. With the help of Figure 3, find the *View Menu* button at the top of the Open dialog window. The *View Menu* button allows you to determine how the files and folders are displayed in the Directory Contents box.

30. Click on the *View Menu* button and notice the options. Select *List* from the menu. This option limits the display to file and folder names, and small icons to help you identify the function of each item.

31. Select *Large Icons* from the *View Menu* and note the change in the display. Open the View Menu again, select *Small Icons*, and note the change in the display. Once again, select *List* from the *View Menu*.

32. Select the *Details* option from the *View Menu*. Notice that you are now able to see more information about each item in the list. Which of the two files did you create first? _____ How can you tell? _____

33. Click on the *Linda's Birthday* file. Notice that its name now appears in the *File name* box. Click on the *Open* button and the file should open. You could also have double-clicked on the file name to open it.

34. Change the message to read:

    Linda's Birthday is Saturday, June 6th.

35. Now open the *File* menu and click on *Exit*. Notice that Windows reminds you that you have not saved your latest work by asking:

    Save changes to Linda's Birthday?

    Click on *Yes*. The changes are saved and WordPad closes.

36. Recall that we saved the two "Birthday" files in a location called *My Documents*. But where and what exactly is this location? To find out, double-click on the *My Computer* icon. The *My Computer* window will open as shown in Figure 4.

37. Among other things, the *My Computer* window shows the various locations at which files can be stored. These include the floppy disk drive (A:), the Local Disk (C:), and the Compact Disk (D:) drive.

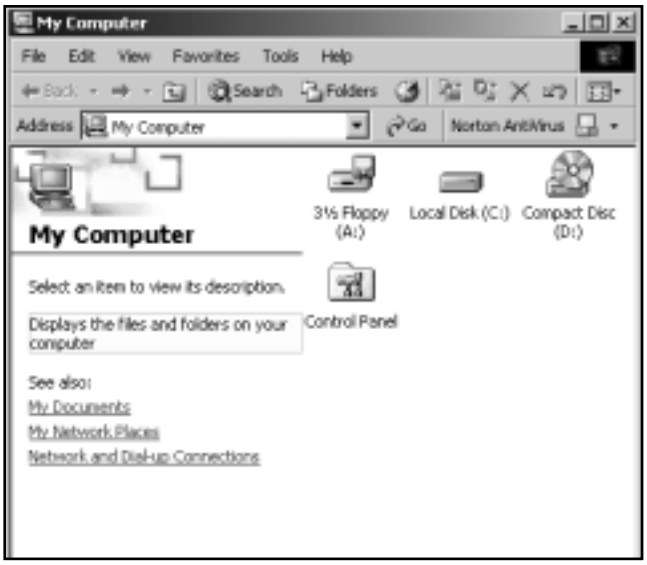


Figure 4
The My Computer window.

38. Double-click on the Local Disk (C:) icon. The contents of your hard drive should be similar to that shown in Figure 5. Notice that the hard drive contains several folders. Open the *Documents and Settings* folder by double-clicking on it. Next open the folder called *Customer*. Find the folder called *My Documents*. Thus, *My Documents* is simply a folder that is hidden inside other folders on the hard drive.

39. Double-click on *My Documents* to open the folder and you should see the two files that you placed there earlier.

Figure 5
The contents of Local Disk (C:).

40. Over time, dozens or even hundreds of different files may find their way to the location called *My Documents*. To keep things organized you will want to create folders so that you can keep common items together. For example, you might want to keep your "Birthday" reminders in a folder called *Birthdays*. In the next few steps you will create a new folder, name it, and place the two birthday reminder files inside it.

41. To create a new folder, open the *File* menu and select the *New* option. From the *New* submenu click on *Folder*. Notice that a new folder appears next to the two files. Currently, it is called *New Folder* and its name is highlighted in anticipation of you changing the name to something more meaningful.

42. Because the name is highlighted, you can change it simple by typing in a new name. Type the name:

    Birthdays

    and then click the mouse somewhere in the desktop. Your display should now look like that shown in Figure 6.

43. Double-click on the *Birthdays* folder to open it. Notice that there is nothing inside. It is simple an empty folder. Click on the *Up One Level* button to return to the *My Document* folder. Once again you should see the display shown in Figure 6.

44. An easy way to place a file in a folder is to "drag and drop" the file on the folder. Click on the *Linda's Birthday* file and hold the left mouse button down. While holding the mouse button down, move the mouse and notice that a ghostly image of the file moves with the mouse. Move the mouse until the file is directly over the folder as shown in Figure 7. You know you have the file placed properly when the name of the folder becomes highlighted. Release the mouse button and the file disappears into the folder.

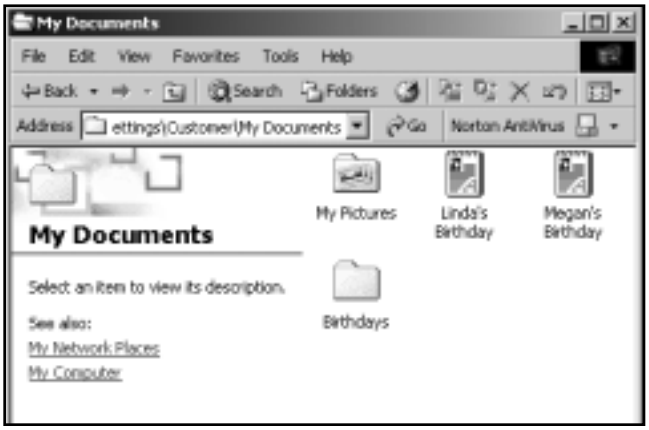


Figure 6
The newly created folder with the two files.

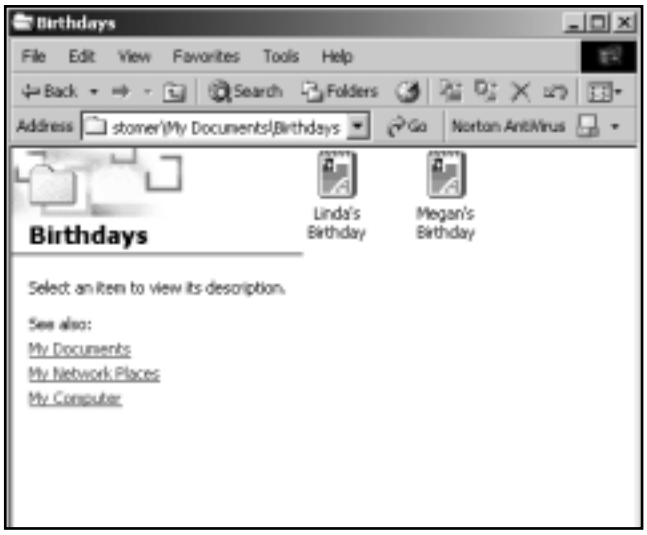


Figure 7
The two *Birthday* files inside the *Birthday* folder.

45. Using the same procedure, drag and drop the *Megan's Birthday* file onto the *Birthdays* folder.

46. Double-click on the *Birthdays* folder to open it. You should find the two files inside as shown in Figure 7.

47. Because you are finished using these demonstration files and folder, you can now get rid of them. Click on the *Up One Level* button to return to the *My Document* folder. Once again you should see the display shown earlier in Figure 6.

48. If necessary, move the *My Document* window so that you can see the *Recycle Bin* icon on the Desktop. Remember, you can move a window by dragging on its title bar.

49. Drag the folder labeled *Birthdays* and drop it on top of the *Recycle Bin* icon. The Birthdays folder should disappear into the *Recycle Bin*.

50. Right-click on the *Recycle Bin* icon. In the menu that pops up, click on the option *Empty Recycle Bin*. At the *Confirm File Delete* message, click on *Yes*. This deletes whatever is in the Recycle Bin. We will discuss the Recycle Bin in more detail in a future lab.

51. Close the *My Document* window.

Figure 8
The *Display Properties* window in Windows 2000.

Desktop Properties

52. As you learn more about Windows 2000, you will discover many uses for the right mouse button. For example, if you "right-click" on the empty desktop, you will open a Control menu that lets you perform several useful tasks. Try it, right-click on an empty area of the desktop. A menu will appear with several options. Click on the option *Properties*. The *Display Properties* window will open. Figure 8 is an example of what you should see.

53. Notice that this window contains six tab pages. Each page is dedicated to a particular display function or property. The *Background* page allows you to control the desktop appearance. You can select a pattern, a wallpaper, or leave the background blank. For now, we'll leave it blank by selecting *(None)* from the list at the bottom of the window.

54. Click on the Screen Saver tab to see that page. Most items will be dimmed except for the Screen Saver list box, unless a screen saver has been activated. There are several screen savers that came with Windows 2000. You can explore them later, if you have time.

55. Click on the Appearance tab to see that page. This is where you adjust your desktop color scheme. The large box in the middle of the window (See Figure 9) shows a sample of the selected color scheme. Open the *Scheme* list box and scroll through the list of color schemes. Some of the color schemes have the letters *VGA* after them. That means they use the colors found in the standard VGA 16-color palette. Some color schemes have the words *large*, or *extra large*, after them. That tells you the text characters in that scheme are oversized. The color schemes that indicate *high color* take advantage of 16-bit, or 15,000 color settings.

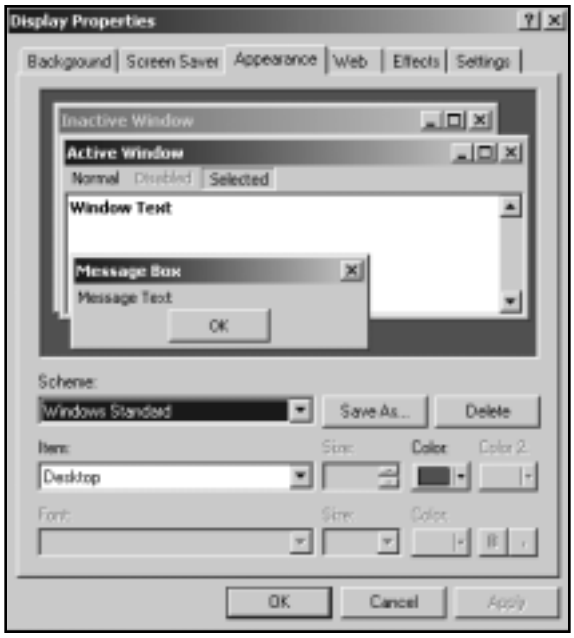


Figure 9
The Appearance Tab in the Display Properties.

56. Click on the Settings tab to see that page. You should see a display similar to Figure 10. Notice that the Color palette is set for High Color (16-bit). The Desktop area should be configured for 800 by 600 pixels, unless this setting was changed by an earlier class.

57. Open the Colors list box by clicking on the small arrow shown in Figure 10. A list opens that shows the available colors for the selected color palette option. There should be three choices available; *256 Colors, High Color (16-bit),* and *True Color (24-bit).* Windows 2000 won't look much

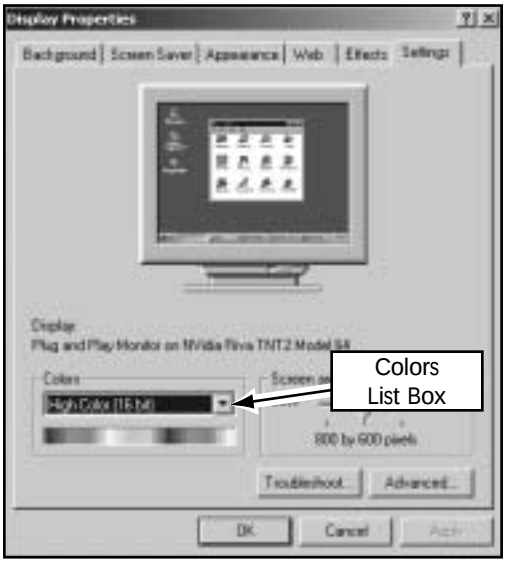


Figure 10
The Settings Tab in the Display Properties.

different on any of these settings, except when you select a High Color scheme and high color icons. For now, you should be aware that these settings will affect the performance of the video subsystem, and as a result can affect the speed of all Windows operations. In most cases, running at true color is slower than running at 16-bit color, which means that Windows puts the elements of your display on the screen at a slower pace. Just because you *can* display 16 million colors doesn't mean it's always a good idea. Close the list box by clicking on an empty part of the display.

58. Close the *Display Properties* dialog window by clicking the *Cancel* button. That concludes this lab. Using the proper procedure shut down the computer.

Discussion

In the first part of this lab we showed you how to use the functions built into the Windows 2000 *Save As* and *Open* dialog windows. These dialog windows serve as mini-file manager, allowing you to perform many useful functions without needing to use another Windows tool. Then you explored creating, naming and saving files and folders, and moving files to folders.

Finally, you learned how the right mouse button is used to access special dialog boxes, such as the Desktop Properties settings.

Unit 4

Working with the Windows Desktop and File System

Once you begin doing serious work with applications, managing your data and files becomes a critical function. Otherwise you may end up with files all over your hard drive, or a gigantic list of files in My Documents. Neither of these situations is ideal, but you can always organize your system to match your own needs and your own organization method. In this Unit, we'll focus on using the basic file tools and making Windows behave the way you want it to behave.

Objectives

- Describe the process for opening and configuring Windows Explorer.
- Explain the importance of file extensions, and how to display them.
- Describe how to move, copy, and find files and folders.
- Explain the purpose and operation of the Recycle Bin.
- Explain how to display disk properties.

Managing Files with Windows Explorer

My Computer is a simple file manager, capable of most tasks. *Windows Explorer*, which should not be confused with the *Internet Explorer* browser, is the powerful file management tool you will use most often. An example of Windows Explorer is shown in Figure 1. There are four simple ways to open Windows Explorer:

- From the Start Menu, select Programs, then Windows Explorer.
- Right-click the Start button and select Explore.
- Right-click My Computer and select Explorer.
- From a Windows Logo keyboard Press ⊞ + E.

Sorting Files and Folders

The objects in the Contents window are viewed in one of several formats. You can use the View menu in the menu bar or the View icon on the tool bar to change the view (*Large Icon*, *Small Icon*, *List*, *Details*, and Thumbnail on some systems.). When using the List view or either of the Icon views, all files

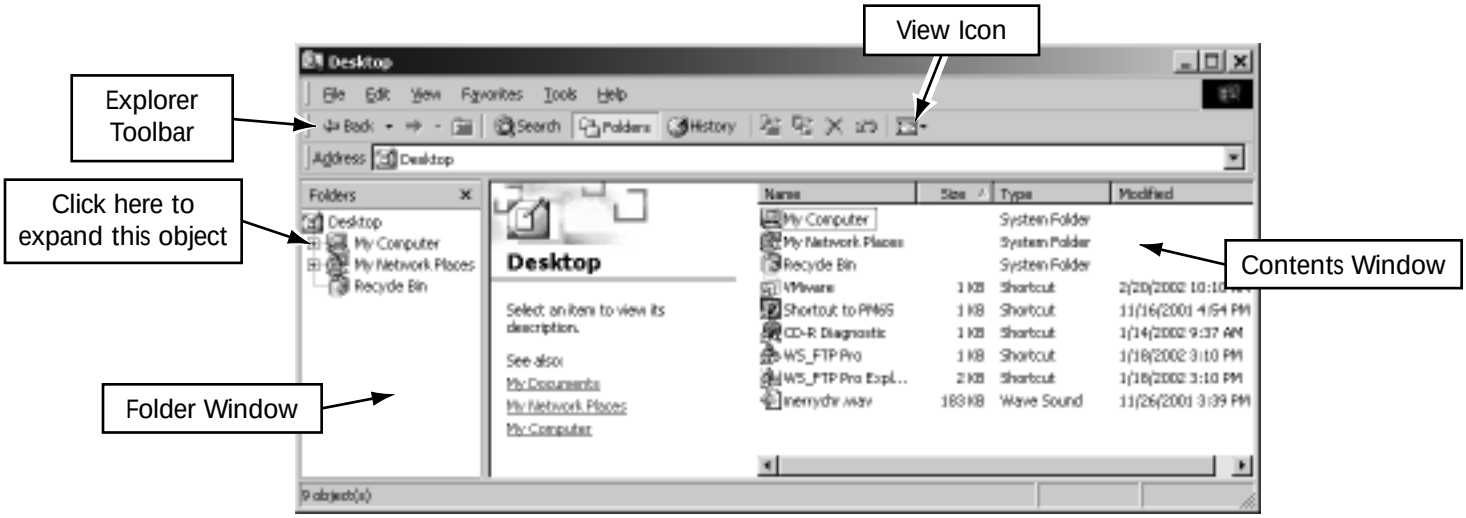


Figure 1
Windows Explorer, showing the desktop.

are displayed alphabetically. However, when using the Details view you have several options for sorting the information. By selecting Arrange Icons from the View menu, you can arrange the information in the Contents window in various orders, as described in the following table:

Sort Order	*Results*
By Name	Alphabetical listing, the default.
By Type	Alphabetical order by file type with folders first.
By Size	Numerical order by file size.
By Date	Ordered by last-modified date/time.
Auto Arrange	Only works in Icon View.

You can also just click on the top of the column by which you wish to sort. For instance, sorting by file size is as simple as clicking in the box containing the word *Size*. The first click sorts the files in descending order (largest files at the bottom) and a second click sorts in ascending order. You will see a small triangle next to the column, as shown in Figure 1. You're never stuck with a sort order, and it's not buried under three levels of menus somewhere, so you can constantly re-sort by whatever criteria you need at the moment.

Selecting Objects, Files, and Folders

Once you have things sorted just right, you might want to do something with the files or folders in that list. This is where an accidental double-click can run a program or open a document, when you would rather move or copy the item instead. Don't double-click unless you intend to open the item.

There are many ways to select items in the Contents Window, starting with Ctrl-A (Press the Ctrl key and hold it down, press A and release both keys.), which will select all the items in the window. You can also click then drag a square around a group of items, as long as they are adjacent. One more common method is to click an item near the top of the list, then hold down the

shift key as you click another item. This selects all the items in-between and including the two clicked items.

And finally, you can hold the Ctrl key and click items individually. This allows you to select any items on the list, regardless their position. While you are Ctrl-clicking, if you click an item that is already selected it becomes *un*selected.

Moving Objects within Explorer

One of Explorer's most useful functions is the ability to move and copy files from one location to another. The difference between Move and Copy is important; when you move a file it's gone from its original location. But when you copy a file, there are now two identical copies located in each location. Explorer uses two methods to accomplish these tasks.

Drag-and-Drop

Drag-and-drop means using the mouse to move an object from one location to another. Most users know how to do this instinctively; select an object by left-clicking, and while holding the mouse button down, move the object to a new location (the drag) and release the button (the drop).

Drag-and-drop is great, but Explorer has some definite rules about what happens to the objects depending upon where you're dragging from and dropping to. Sometimes drag-and-drop is a copy, and sometimes it is a move. Trying to remember whether a file is going to be copied, moved, or only a shortcut created, is difficult. In case you need to know, here are the rules for drag-and-drop:

- When the source and destination folder are on the same disk, drag-and-drop moves an object. To copy the object instead, hold down the Ctrl key.
- When the source and destination folders are on different disks, the object is copied. To move the object, hold down the Shift key.
- When the object is an executable file (.exe) or a shortcut, a shortcut will be created in the destination folder.

One important feature we've not covered so far may be useful here. Explorer allows for an Undo. If you make a mistake or change your mind you can use Edit > Undo, or simply press Ctrl-Z. It's a good idea to do this *immediately*, before you take any other action. Some applications allow for 20 undos, and in Explorer you get an unspecified number of them, too.

Cut, Copy, and Paste

Trying to remember the drag-and-drop rules is too much work. The cut, copy, and paste method doesn't care if you are copying/moving to a different drive, the same drive, or anywhere else, because what you ask for is what you get. Any file or folder (including its contents) can be cut or copied from any folder

or drive and pasted to any other folder or drive. These three commands can be used with virtually every application you'll ever use, in addition to Windows Explorer. Try them out, often there's no better way to obtain or copy information, and it always beats retyping.

The copy command is what you might expect; Explorer makes a note of what you have selected, and prepares for a paste command to come later. When you finally do the paste, the system creates a duplicate in the destination you have chosen. Cut is a bit different, in that when you do the paste the original objects are deleted. If you change you mind or forget to do a follow-up paste, then Explorer simply forgets that you ever used the cut command and the objects remain where they were originally. Note that this action is different than most other applications, where *cut* is more akin to *delete*, and the data to be cut is removed immediately. (You can use Undo to change your mind.)

An object, or group of objects (files and/or folders) to be cut or copied must be selected first. Highlight the objects in the usual manner, then use one of these methods to make it happen:

- Use the Cut, Copy, or Paste icons on the Explorer toolbar.
- Select the object to be cut or copied and right-click. Choose *Cut* or *Copy* from the context menu, go to the destination for the objects and click, then right-click and select *Paste* from the menu.
- Using the key commands: Ctrl+X (Cut); Ctrl+C (Copy); or Ctrl+V (Paste). This is the fastest method, by far.
- Using Cut, Copy and Paste from the Edit menu.

These are powerful commands, and worth mastering. You'll find yourself much more efficient with Windows if you have a mastery of these basic commands, along with Undo.

Properties

The *Properties* command is your next secret weapon, and it can be used throughout the Windows environment. Any time you need to know more about an object, right-click the object and choose Properties. By selecting this option, you will be directed to a dialog box that provides the details of the object and often will allow you to make changes.

The "right-click" is another powerful tool. Nearly all PC mouse devices have at least two primary buttons; the main (left) button under your index finger, and the "right" mouse button under your middle finger. Clicking an object with one button or the other provides completely different results.

One application where adjusting file properties is common is when you need to work on files copied from a CD. All files contain a set of attributes, and one of the most important ones is the read-only attribute. This one can be set when you don't want a file to be modified. As shown in Figure 2, you can easily change the attributes of most files. You might think of this as a form of file protection, but it only works if the other users don't know how to uncheck the Read-only box.

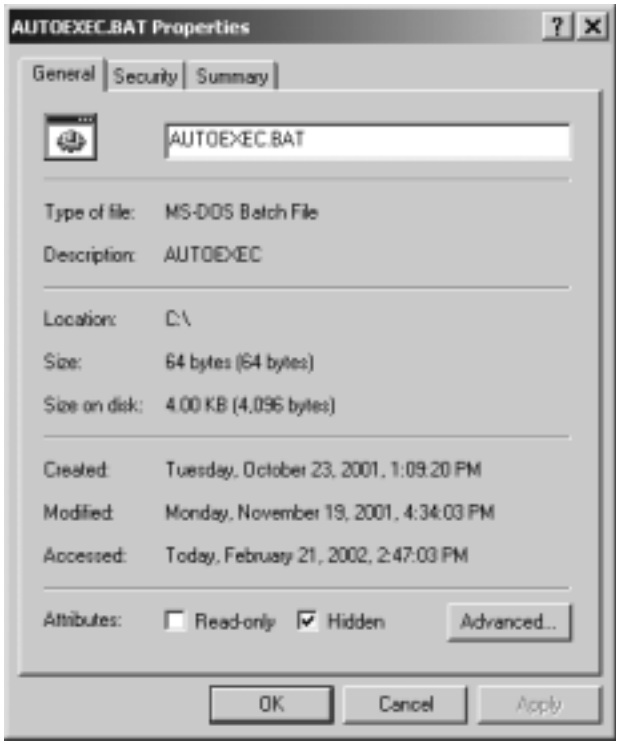


Figure 2
Examining the properties of a file in Windows 2000.

All files that are copied from a CD have their read-only attribute set. So if you're copying a file from a CD, you should have no trouble opening the file and editing it if you have the proper program. But if you attempt to save the file you're going to have a problem, because the file is marked read-only. (You can save it as a different name.) To fix this, and to re-save your file, you have to uncheck the read-only attribute, as described here.

Searching

In today's multi-terabyte world, finding a file is sometimes like looking for a needle in a haystack. To overcome this problem, Windows has an intuitive Search feature, located right on the Start menu. Once you open the Search dialog:

- To search a particular folder, highlight the folder and press F3.
- To search the entire desktop (all drives in the computer), click on any part of the Explorer window (except for a folder or file) and press F3.

The Windows 9*x Search* tool, shown in Figure 3, allows many types of searches, against all kinds of conditions you can specify. The Windows 2000 search dialog, as shown in Figure 4, is arranged differently but works about the same way, except that it can search in more places. If you are familiar with the use of DOS wildcards your searches take on even more power. (We told you that skill might be useful!) There are four methods of searching: Name and Location, Date, Size, and Advanced.

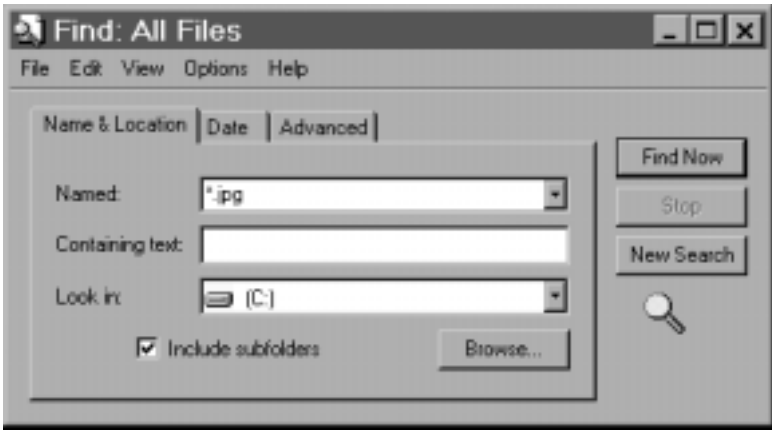


Figure 3
The File Find dialog box in Windows 9*x*.

Search by Name

This function will let you search for files or folders by name. It will also let you specify the drive or folder in which to search. Here are a few helpful hints to limit your search:

- If the filename contains a space (more than one word), enclose it in quotation marks or replace the space with an asterisk (*).
- When searching for multiple files, separate each name with a space, comma, or semicolon.
- File searches are not case-sensitive and all DOS-command wildcards work with Find.

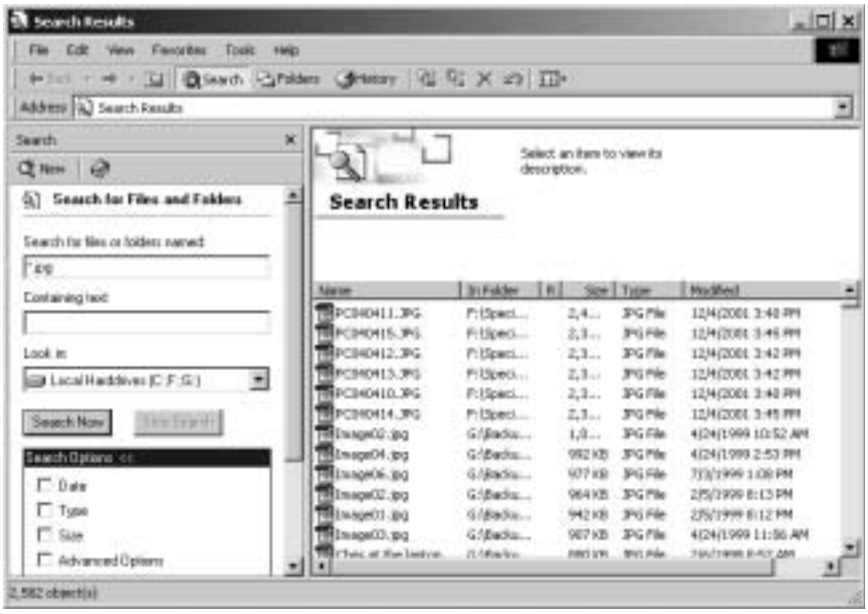


Figure 9
The File Find dialog box in Windows 2000..

Search by Date

If you don't know the name of the file, but know about when it was created or last modified, use this tab. This one can be useful if you create and save a file, but then you can't find it. Just create a search for all files created since today. There are three methods of searching with this tab:

- Between any two dates.
- During the previous *x* months.
- During the previous *x* days.

Search by Size

This one is self-explanatory, you can specify any maximum or minimum file size, such as all files at least 2048 MB.

Advanced Search

The advanced search tab provides some additional search techniques:

- By type of file (requires a registered file extension).
- By size of file.
- For any file containing a specific word or phrase.

Displaying File Extensions

By default, Windows does not display *registered* file extensions. You might recall from our earlier discussion that a file extension is usually a three-character suffix on a filename. As an example, a file might be called `letter.doc`. The "doc" part of the filename is the extension. Nearly all files have an extension.

A registered extension is one that Explorer can understand; in other words an extension that Explorer can associate with an executable program (the source of the file). For instance, you normally don't see extensions such as .exe, .doc., .jpg, and so forth, because Windows knows what to do with these if you double-click them. With file associations, Windows allows users to open nearly any file by simply double-clicking its icon in Windows Explorer.

If you don't care about file extensions, then this setting should work fine. But you *should* care about file extensions, and we'll tell you why in a moment. To display all file extensions in Windows 2000 Explorer, select Folder Options from the Tools menu, select the View tab, and remove the check from the *Hide File Extensions* box, as shown in Figure 10.

From here you can also choose to show all files—including hidden files—select which files to hide, display the full MS-DOS path for each folder, and enable or disable the description bar (which displays the full path and file name of the selected file or folder).

A hidden file extension was one reason the "ILOVEYOU" virus was so damaging to millions of Windows users. The author of the virus named it `ILOVEYOU.TXT.VBS`,

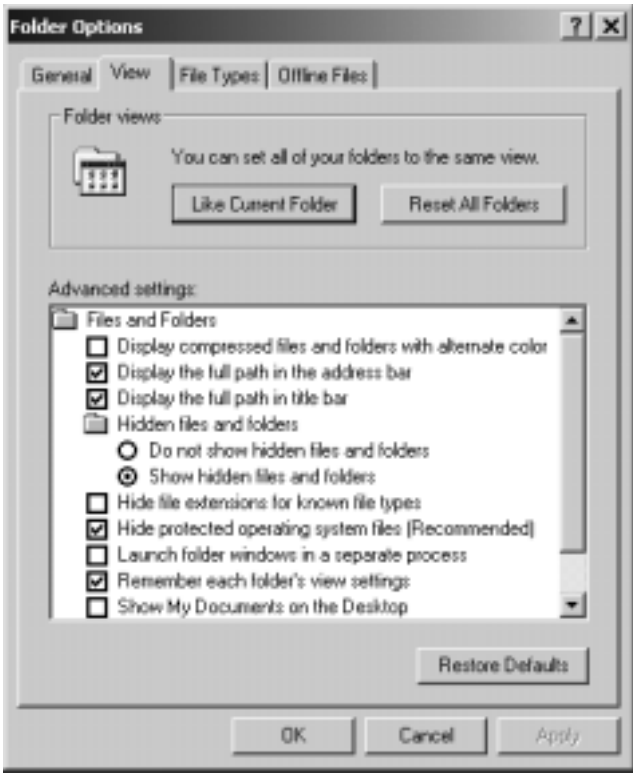


Figure 10
Adjusting the folder view options.

anticipating that you would think the file is harmless. Why would you think it was harmless? Aside from the inviting theme implied by the name, systems using the default setting displayed this "double-extension" as `ILOVEYOU.TXT`, which appears to be a harmless text file. The actual extension remained hidden, which also hid the fact that it was a Visual Basic script (.vbs) file, loaded with instructions that turn off your security safeguards, wreck your data files, then send itself to all your friends to repeat the process. You open this file and expect to read a text file; instead, the Windows Scripting Host runs the script in the background and your system becomes infected.

On balance, file extensions are troublesome. The Macintosh has no need for file extensions; they can figure out file types and associations by looking within the file itself. But Windows is stuck with extensions, so we have to live with them. If that's the case, then you should never be fooled by miscreants and psychopaths and their attempts to sneak past you and ruin your day. Turn on your file extensions, learn to use them, and be safer.

Customizing the Taskbar

The taskbar was discussed in the last Unit, but while we're on the topic of customizing the way files are displayed we should discuss other customization options that are available. The first option is moving and resizing the taskbar. If you click on an open area of the taskbar, you can drag it to any edge of the desktop. As shown in Figure 11, the taskbar is being dragged to the right side of the desktop, and Figure 12 shows the result.

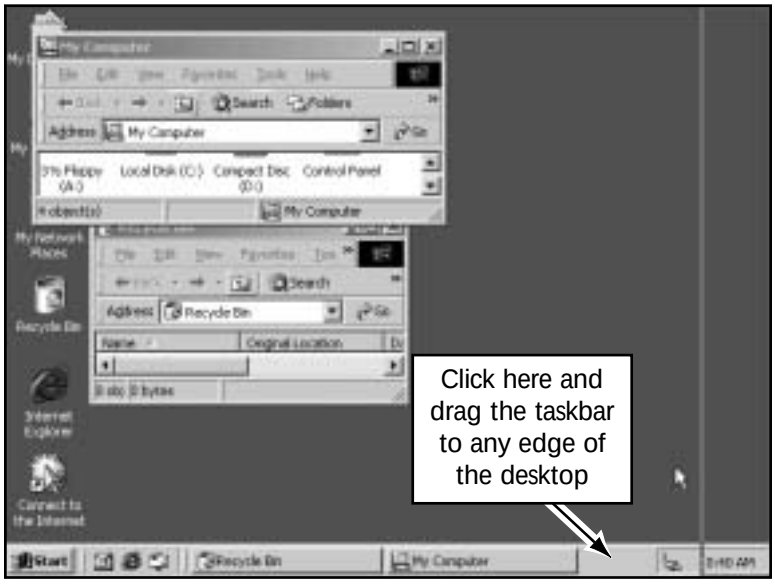


Figure 11
As you drag the taskbar the new location is outlined.

Actually, moving the taskbar to the right edge isn't all that useful, but some users prefer the left edge or the top. Notice that the buttons on the taskbar are too small to read their contents. This is one drawback to this arrangement. To solve this, you could make the taskbar wider. You do this by hovering your mouse pointer over the inside edge of the taskbar until it turns into a double-headed pointer. Then click and drag to make the taskbar any size you like. An example of this is shown in Figure 13, where the taskbar is taller then normal.

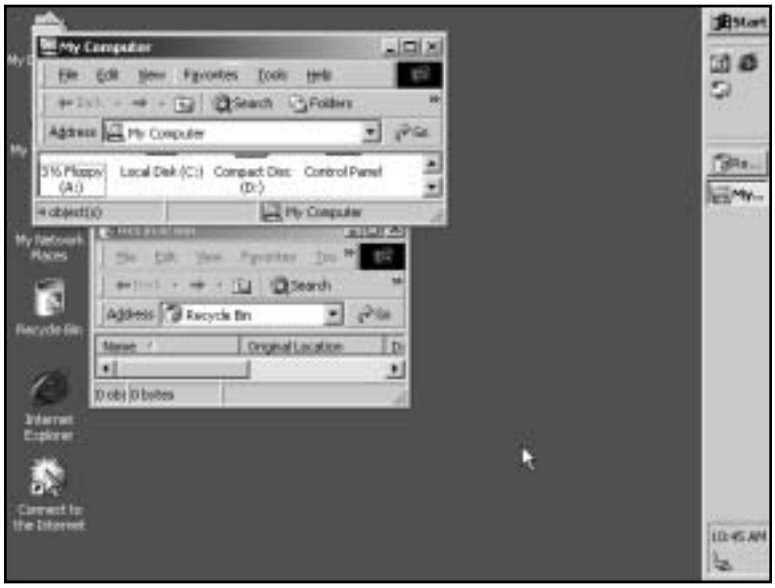


Figure 12
The taskbar is now along the right edge of the desktop.

Figure 13
The taskbar can be larger, too.

Again, there are some drawbacks to making the taskbar larger. First, you are using up precious desktop space, which then cannot be used by applications. If you believe you need that extra space for all your open applications, you might reconsider the number of apps you feel you need open all at once.

If you are an experienced Windows user, you're probably saying to yourself "Auto hide takes care of that, right?" Yes, auto hide is a useful feature, but it can be a problem, too. Auto hide is one of the properties of the taskbar, one that's easier to see than describe. When you turn on auto hide the taskbar slides down below the bottom of the desktop when it isn't being used. When you move your mouse pointer near the bottom of the screen, almost as if by magic the taskbar slides up from the bottom of the desktop. If you are using a very small display auto hide is a great tool. But in many cases, auto hide becomes difficult if you need to click something at the bottom of the desktop and the taskbar keeps popping up when you are trying to click. You'll have to play with this setting to see if you like it.

We've talked about this feature, but where is the setting? Simply right-click on any empty space on the taskbar, and select properties from the pop-up menu, which is shown in Figure 14. This opens the Taskbar and Start Menu Properties dialog box, as shown in Figure 15.

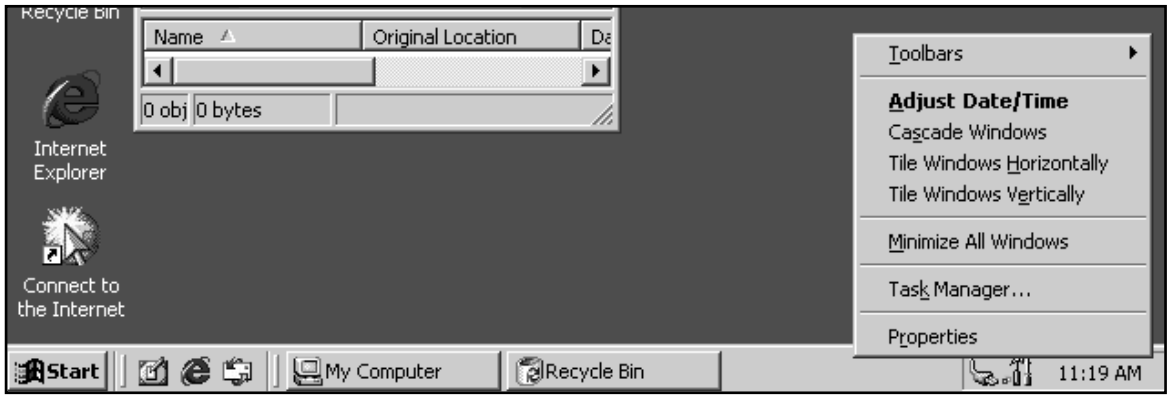


Figure 14
Right-click any empty space to view the menu.

This dialog box controls quite a bit of what happens on your desktop. Most of these options are self-descriptive, but one may be new to you, *Personalized Menus*. Again, this is a feature some users love and others hate. Microsoft decided it was useful, so in all the versions of Office and all the operating systems since Office 2000, customized menus is active. What typically happens is a newer user cannot find the items on the menus they need because they are being hidden.

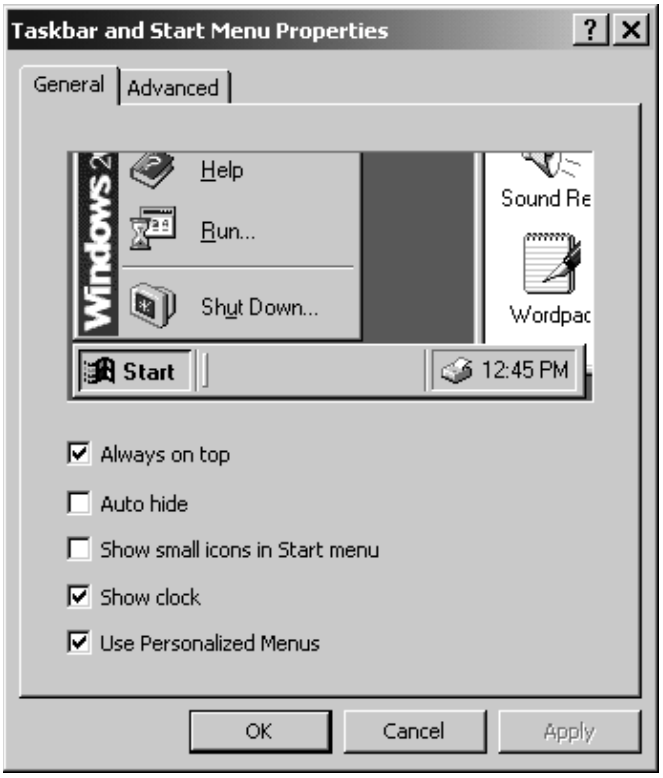


Figure 15
The taskbar and Start Menu properties sheet.

As you load your system with applications and the menus start scrolling off the screen, customized menus can get you to your most commonly used programs fast. This is because the programs you rarely use will remain hidden from view.

There are several more Start menu options under the Advanced tab. This tab is where you can add and delete items from the Start Menu, as well as expand several of the existing menus. For instance, you can remove Favorites from the menu, and change the way the Printers and Control panel items are displayed. Of course, you can always just drag-and-drop items to and from different parts of the menu to make it work your way.

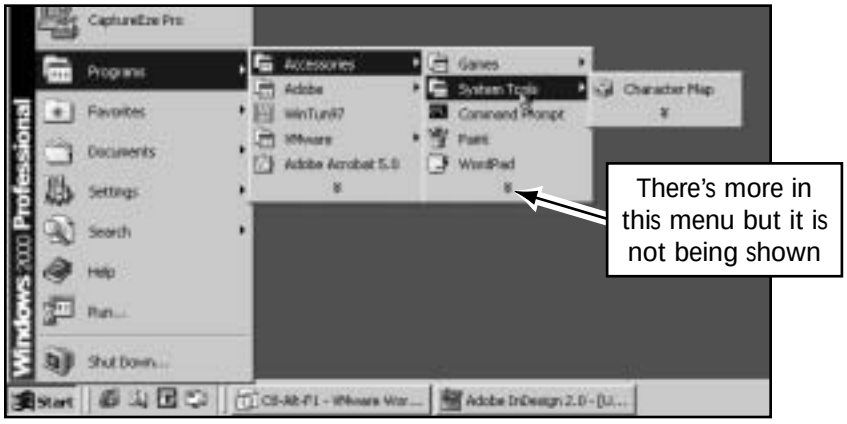


Figure 16
This is an example of customized menus.

Basic System Management

As you begin working with a new Windows system you'll be focused on making it work like you think. You might never actually achieve this goal, but at least you can eliminate many parts that annoy you. Once you've done that, it's time to get some work done. As you complete several projects, or as you grow increasingly more comfortable with the system the time comes to start performing basic system maintenance and management. Most of these tasks are simple, and they don't require much time to complete. Let's spend the balance of this Unit looking at a few of the maintenance tasks that will keep your system running smoothly. Windows provides several tools to make this job easier.

Disk Maintenance

In addition to managing files, Explorer is also helpful for managing disks. By right-clicking a disk's icon in Windows 2000 and selecting Properties, you can access several tabs, each loaded with disk management options, as shown in Figure 17. On the General tab you will see general information about the drive. Right away, you can see how much free space remains on the drive. If the free space is running low, you can click on the *Disk Cleanup* button.

Disk Cleanup does a thorough search of your hard drive for items that you may no longer need. As shown in Figure 18, the system performs a search, then allows you to choose which items should go and which to keep. In a

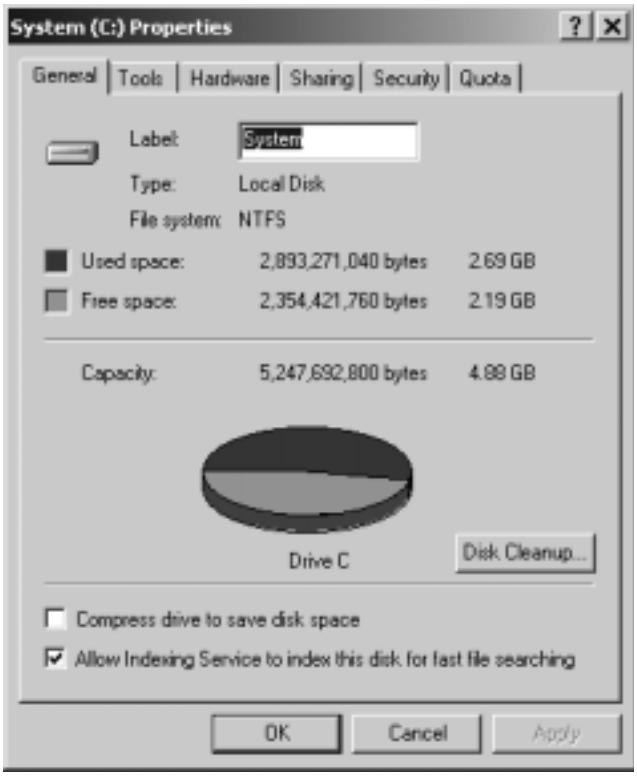


Figure 17
This is an example of customized menus.

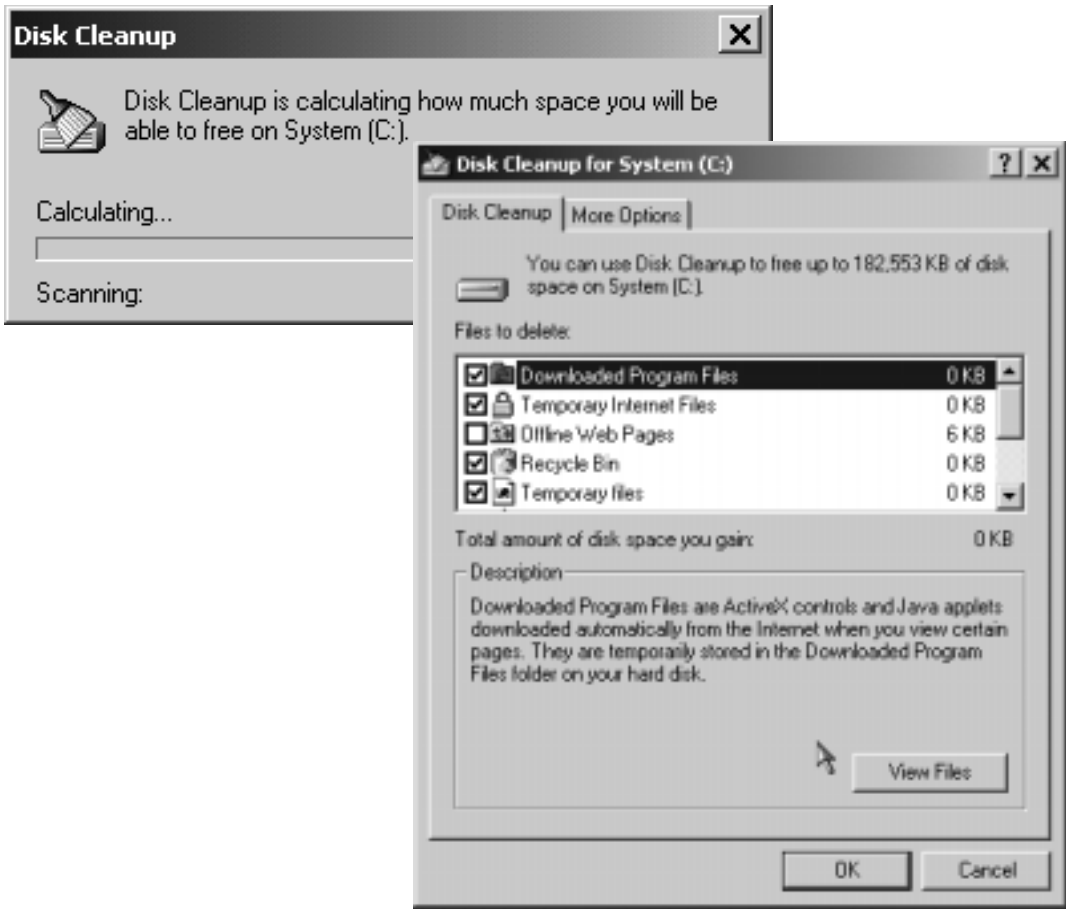


Figure 18
Disk Cleanup eliminates unneeded files.

system that has been neglected for a while, you may find a hundred megabytes of temporary Internet files, any amount of Temporary files (the regular kind) and of course the Recycle Bin. One way to reduce your maintenance load is to configure Internet Explorer to keep fewer temporary files, because the default is a rather large fraction of your hard drive. You can also limit the size of the Recycle Bin in the same manner.

The Temporary Files noted here are those created by many different applications. These files are typically created for use by a program while it is being used, and well-behaved programs will clean up after themselves. Despite your best efforts, this folder can get huge, so a periodic cleanup is recommended. By the way, it's best to do this cleanup while nothing else is running on the computer, and after you're sure you won't need any recently lost files or documents. There are even more tools under the More Options tab, but you'll need to explore those on your own.

Back to the System Properties, if you click on the Tools tab you'll have three additional maintenance tools. The first is Error-Checking, which runs a test on your hard drive that searches for data storage problems. Your hard drive maintains a massive indexing system to keep track of all the files and folders,

and occasionally something is misplaced. This tool, which won't run if other applications are active, fixes any problems it encounters. If you're familiar with earlier versions of Windows, this tool is similar to Scandisk.

The second item on the Tools tab is *Backup*. As you might expect, this runs the Windows Backup tool, which is a fairly powerful utility. The last item is the Defragmentation tool. Fragmentation is a natural consequence of using your hard drive, so it's not a big deal to "defrag" all the time. Still, it's a good idea to perform a full defragmentation once a month or so.

The remaining tools, *Hardware*, *Sharing*, *Security*, and *Quota*, aren't used much, except by system administrators and troubleshooters, if at all. These tools mainly deal with systems on LANs and connected to Windows 2000 servers, and you best advised to leave them alone for now.

Plug and Play

The goal of any computer user is to be able to plug any device into a computer, turn it on, and have it work. This is the concept upon which Plug and Play (PnP) is founded. A well-designed PnP system will eliminate the need for jumpers, switches, and installation software. Does PnP work? It works very well, in fact, as long as you are using newer hardware, such as a Pentium II or better, and a newer operating system, such as Windows 98 SE or later, and newer peripherals, such as those attached to the PCI bus, or the USB and IEEE-1394 ports. If your hardware or OS doesn't meet that criteria, PnP might work anyway, but sometimes not. In order for PnP to work, the system must have three things:

- A PnP BIOS
- A true PnP device
- A PnP operating system

During each Windows startup, the system check to see if any new hardware has been connected. It then searches for information about the new hardware, checks for conflicts, and reconfigures the hardware and OS as necessary. Any time a new device (without a driver) is detected the system will launch the necessary Wizard to configure the device. When all is well, it will simply ask for confirmation of the device and how it should be configured.

Adding New Hardware

Adding new hardware is simple; you follow one of two processes depending on whether or not the device is PnP. Both processes use the Hardware Wizard. With PnP, this wizard launches automatically when Windows detects the device during startup. With a non-PnP device, you will have to start the wizard manually by using the Add New Hardware tool in the Control Panel. When installing manually, Windows will ask if you want to specify the device or let Windows find it. In most cases, Windows does a good job of finding

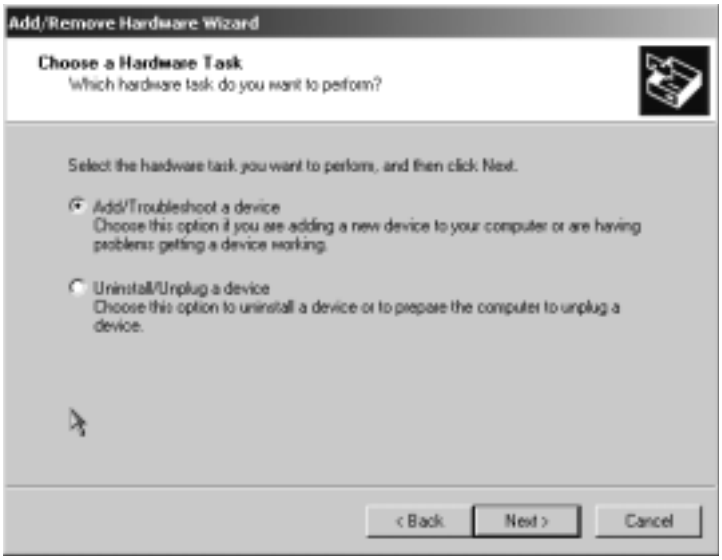


Figure 19
The Add/Remove Hardware Wizard starts with this screen.

it, however, if you know the device and have the manufacturer's software for installation, it is sometimes better to tell Windows what to do. Your experience will be your guide.

Windows uses a special wizard for printers. A new PnP printer is perhaps as close to true PnP as possible; you simply plug the printer into a port, turn on the printer, and boot the computer. Windows will recognize the printer (by polling the ports during startup) and launch the Install Wizard. In many cases, you merely confirm that Windows has recognized the correct printer and it will do the rest.

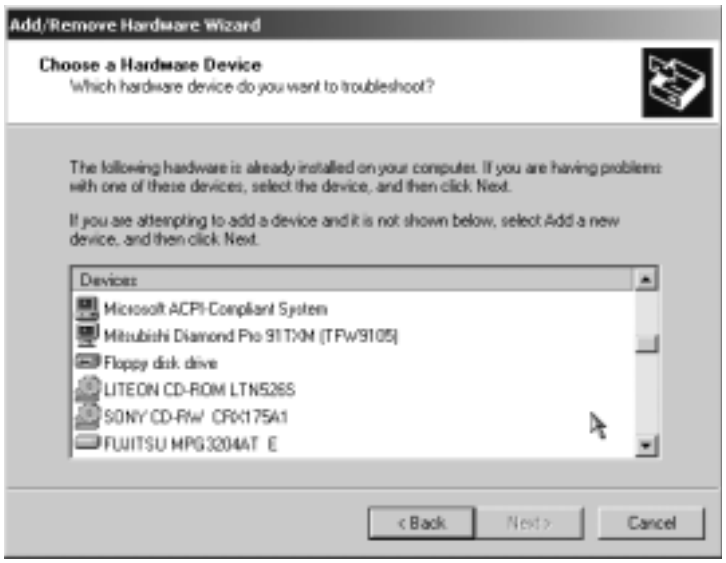


Figure 20
The Add/Remove Hardware Wizard Also allows you to troubleshoot devices. Selecting a device here takes you to a troubleshooting wizard.

Viruses

Viruses are programs that are designed to intentionally destroy your computer data. The sole purpose of a virus is to replicate itself and make life miserable for computer users and administrators. Many viruses are simple annoyances, but some can permanently corrupt your files and cost you time and money. Today, viruses are primarily obtained from Internet downloads and from e-mail attachments.

Objectives

- Describe the main types of viruses.
- Explain the best ways to prevent becoming the victim of a virus.

There are five basic types of viruses:

File Infectors: These attach themselves to executable files and spread to other files when the program runs. With some, they sit in memory and infect every executable file that runs. Most current anti-virus tools handle these well, and new file infectors aren't common.

Boot Sector: These replace the master boot record (or boot sector on a floppy). They will write themselves into memory anytime the computer is booted, and from there they will infect any disk in the system, except CDs and write-protected floppies.

Master Boot Record: These are similar to boot sector viruses, but they infect the MBR instead.

Multi-partite: These are challenging viruses to remove, and infect both programs and master boot records. In order to remove them, all the files and the MBR must be cleaned at the same time, or the system will be quickly re-infected.

Macro Virus: These special viruses take advantage of the scripting and programming tools found in the most common software applications. Visual Basic, or VB, is a powerful programming tool that can make documents and programs interactive and automated. At the same time, these tools can be turned against the user and files can be deleted or destroyed. Macro viruses are simple to create and spread quickly.

Within these five types of viruses, different methods of delivery are possible. The most prevalent method is the *Trojan Horse*. The Trojan Horse is something other than what it claims to be. For instance, you may receive a file that is supposed to be a screen saver. You can usually double-click a screen saver file and see what it's like before you install it permanently. But if you have received a Trojan Horse, rather than seeing a new screen saver the program infects your computer instead. Most Trojan Horses arrive as e-mail attachments, and are presented something like "Check this out...it's cool!" As you soon find out, it wasn't.

Worms

You may have heard of *worms*, which are a different type of virus. By definition, a virus is spread by humans; you send a disk or a file to someone and they run or open the file and the computer becomes infected. That person can do the same, then passes along the infected disk, and so on. The virus is finally halted when people stop giving the infection to other people.

But the worm uses an entirely different mechanism. Worms spread by themselves, requiring little or no human intervention. Worms rely on the automation tools within a computer, such as Microsoft's Visual Basic Scripting tools, or even the scripting system built into Windows itself. The worm enters your system via e-mail in most cases, or if it is active on your local area network it comes in directly. Once it's in, it spreads itself as far as it can, and you don't have to do a thing.

For instance, a worm can begin to spread through Microsoft's Outlook or Outlook Express e-mail clients when you select the e-mail message within the program; you don't even have to open the message or the attachment. In other cases you open the message and the script runs automatically, doing whatever damage the writer intends then sending itself to all your friends. Naturally Microsoft works constantly to close security gaps, but the foundation upon which these worms are built, the scripting tools that automate various tasks, are still in your system. In the end, it's your job to tighten the security of your e-mail programs, and to be vigilant and educated about the risks.

When the ILOVEYOU worm was released from a single computer in the Philippines on May 4, 2000, it spread around the globe in a single day. Millions of users were infected, e-mail systems were overloaded and crashed, and hundreds of thousands of users lost data.

How can this happen? Why didn't our anti-virus programs catch this? The way anti-virus scanners operate is to identify viruses as they enter your system. But in order to do that, they need to know what to look for. If the virus that enters your system today was written yesterday, your scanner doesn't know to call this one a virus and it's free to infect the system. *Your scanner has to know about the virus or worm before it can do anything about it*. This is an important concept because we tend to rely on the virus scanner to protect us, and if the scanner says it's OK, then we think we are safe. Never forget that *you* are the final level of security in your system. If you receive a message or file that seems to be a virus, rely on yout intuition and instincts...not your anti-virus program.

Unfortunately computer viruses have become a way of life. With this in mind, here are several measures you can take to prevent or minimize your risk:

- Purchase a good anti-virus program—there are several on the market. Keep in mind that they only work on previously-known viruses.
- Some viruses are transmitted by floppy disks. Be careful when reading floppies of unknown origin or using your floppy disk on unfamiliar machines.

- Many viruses and macro viruses are transmitted over the Internet. Use *extreme* caution when you download files, especially if they come from sources other than a manufacturer's web site. The most secure protection against Internet-distributed viruses is to make sure you have an anti-virus program running at all times, or at least when you're downloading and running new files.
- Trust no one when it comes to loading programs on your machine or opening e-mail attachments. With the new worms most people who become infected receive an e-mail from someone they know.
- Keep your anti-virus program updated. Check for updates every week, or configure the program to do the checking automatically.
- Install the security patches for your e-mail software. If you don't know how to do this, have a friend or colleague help you.

Viruses are serious business, and the people who create them are sociopaths. Keep in mind that these people intend to destroy your work, and possibly destroy your business. If you are smart, if you act deliberately and you are always diligent, you are less likely to be hurt by a virus. Educate yourself by exploring the anti-virus software developers' websites. They will keep you aware of new viruses, and aware of the virus hoaxes that just won't die.

Virus Hoaxes

The unfortunate side-effect of all this virus and worm activity is that people have written long and involved stories about viruses that are just stories. These are commonly called *hoaxes*, and they are useless messages that warn of some impending danger if you don't pass the message to everyone you know. Realistically, they clog e-mail systems and waste your time.

The vast majority of messages you receive that claim to be virus warnings are hoaxes. This is especially true if the message has been forwarded a couple times, and the message contains little in the way of specific information. The only virus messages you should take seriously are those that come directly from your anti-virus company, and those from trusted friends who's job it is to stay abreast of potential risks.

All of the major anti-virus vendors have websites devoted to the latest virus news and a list of hoax messages. Pick one, and visit it before you forward a message about a new virus that will "melt your monitor." Keep your anti-virus tools updated, and learn how these nasty programs work and how to stop them.

Unit Summary

If you are an experienced Windows user, this Unit may have provided you with a tip or two that you didn't know about before. On the other hand if you're new to the Windows world, or you've never had any formal instruction, this Unit may have shown you how to tame that computer and make it behave your way.

Lab 4-1

Organizing The Desktop

You have already been introduced to the desktop and the Start menu. In this lab you will learn how to move objects like applications, documents, and folders into the Start menu. This includes creating shortcut icons that point to applications, documents, and folders stored in other folders.

You will also discover what's hiding inside the icon, My Computer. There, you will learn how to display the contents of disks. Finally, you will use the right mouse button to perform several different tasks.

Objectives

At the end of this lab, you will be able to:

- Modify the contents of the Start menu.
- Choose between several viewing options.
- View Hidden files and display file extensions.
- Display a file's properties, including version and attributes.
- Locate files using the Search utility.

Materials Required

To complete this lab, you will need a computer with Windows 2000 Professional installed. A system that still retains most of the default installation settings will work best.

Procedure

Customizing the Start Menu

1. Turn on the computer. You should now be looking at the Windows 2000 Desktop.

2. There are two ways to access the *Taskbar and Start Menu Properties* window. You've already accessed it through the Start menu. The other method uses the right mouse button as a shortcut. Right-click on an empty area of the Taskbar. Then, in the menu that opens, click on the option, *Properties*.

3. In the Taskbar and Start Menu Properties window, click on the *Advanced* tab. You will see a display like the one shown in Figure 1. This is where you customize the Start menu and clear the records of recent activity in certain other menus. Let's work on the customizing part.

4. Click on the *Add...* button. The *Create Shortcut* window will open. There, you are asked for the name and path to the object you wish to add to the Start menu. You need to be precise in this description. For that reason, it's generally a good idea to use the *Browse* function to locate the object.

Figure 1
Advanced Page of the Taskbar and Start Menu Properties window.

5. Because you've been using WordPad more than any other application in your computer, why not save yourself some time and add it to the Start menu? Click on the *Browse…* button. The *Browse for Folder* window opens, showing the folder structure starting at the Desktop and working down. The question now is, "where do you find the WordPad application?" If you don't know where to go, you could wind up browsing for a long time. Why not have the computer find the file for you?

6. Right-click on the *Start* button in the Taskbar. A menu with several options will appear. Click on the option, *Search…*. This will open a *Search Results* window like the one shown in Figure 2. Another way to open the Search Results window is to press the -f key combination.

7. Enter the name of the file you wish to find in the *Search for files or folders named* text box. Type:

   `WordPad`

   Then, open the list box, *Look in*, and select the hard disk drive *Local Disk (C:)*. That way the whole drive is searched for the file.

8. You are ready to start the search. Click on the *Search Now* button. After a short pause, a list of files that match the search name will appear in the Search Results box on the right side of the window. If necessary, scroll the list until you can see the column labeled *Type*. Find the WordPad file with the file "Type" *Application*.

   You can see that the file is located in a subfolder in the C:\Program Files folder. But, what is that subfolder? You may need to widen the "In Folder" column of the file listing. Let's see how.

Figure 2
The Search Results window.

9. Move the mouse pointer over the line that separates the column headings "In Folder" and "Relevance." The pointer will turn into a double-headed arrow like the one shown in Figure 3. You may need to make the window larger by dragging the bottom-right corner down and out.

   Click and drag the pointer until you can see the entire path. The *In Folder* column will widen, and the other columns will slide over to make room. Now, you can see the complete file path. Where is the file located?

   _____

   This is Windows' concise way of saying:

   "Start at the *C:* hard drive. Inside of it, find the folder, *Program Files*. Inside of it, find the folder, *Windows NT*. Inside of it, find the folder, *Accessories*. The file you are looking for is inside of it."

10. Close the *Search Results* window. This will take you back to the *Browse for Folder* window. Now that you know where to look, let's follow the path and locate the WordPad application file.

    A. First, find Local Disk (C:) and click on the small plus (+) sign just to the left of its icon. Three new folders will appear as shown in Figure 4A.

    B. Click on the (+) sign just to the left of the *Program Files* folder. A long list of additional folders appear under the *Programs Files* folder as shown in Figure 4B. Scroll down the list and find the folder labeled *Windows NT*.

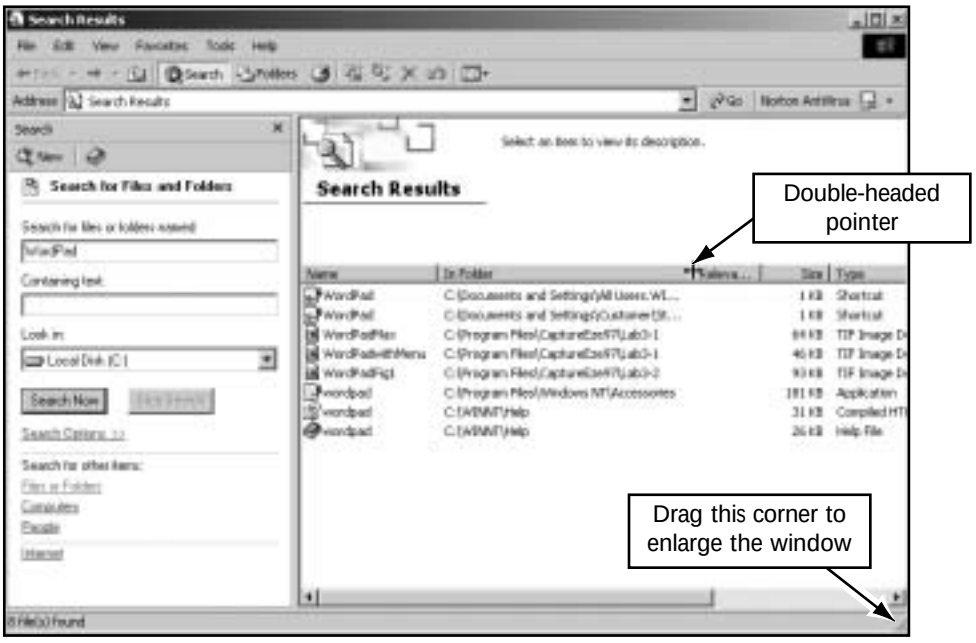
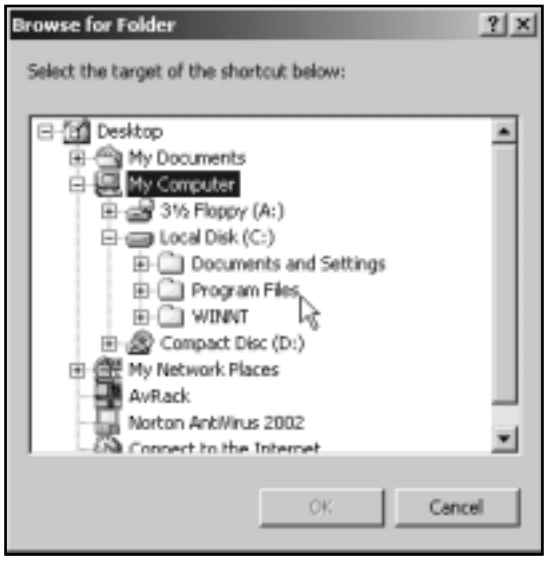
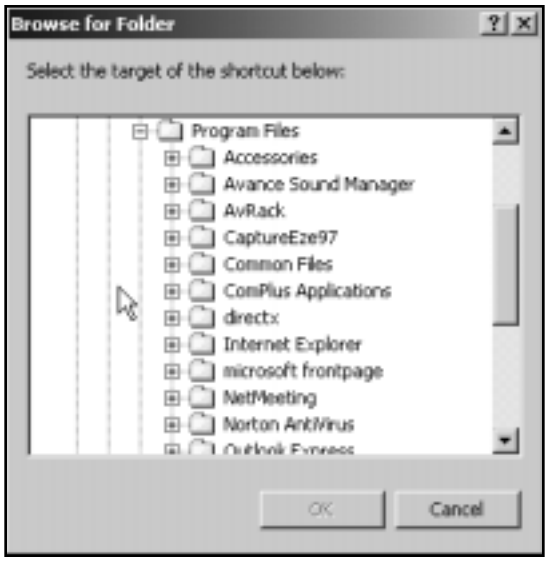


Figure 3
Widening the "In Folder" column to see the complete path.

(A)



(B)



(C)

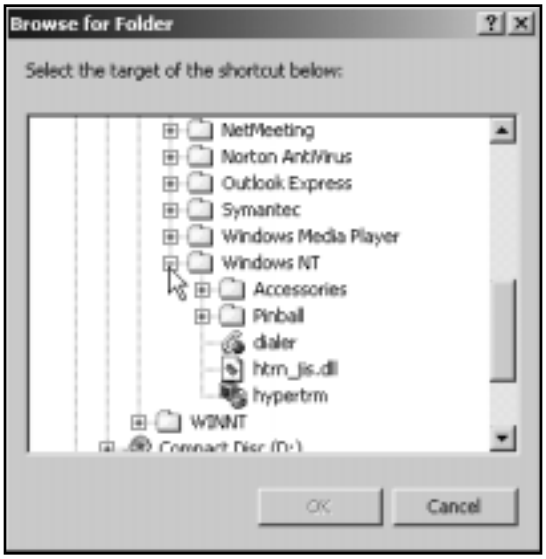


Figure 4
Finding WordPad.

C. Click on the (+) sign just to the left of the *Windows NT* folder. Additional folders appear as shown in Figure 4C. Find the folder labeled *Accessories*.

D. Click on the (+) sign just to the left of the *Accessories* folder. At last the WordPad file appears. Select the file *WordPad*.

11. Click on the *OK* button. This will close the *Browse for Folder* window and load the selected path and file name into the *Type the location of the item* text box of the *Create Shortcut* window. Now that you have selected the file, you are ready to actually modify the Start menu.

12. Press the *Next* button. The *Select Program Folder* window opens. It contains a list of all of the system folders associated with the Start menu.

    Windows assumes you want to place the WordPad shortcut icon in the Programs folder (this is where the menu list comes from when you open the Start menu and select *Programs*). That's why the *Programs* folder is selected (highlighted). However, you want to have WordPad accessible as soon as you open the Start menu.

13. As shown in Figure 5, select the Start Menu folder in the *Select a folder to place this shortcut in* window, and press the *Next* button. You are asked to *Type a name for this shortcut* icon. Windows suggests the name "WORDPAD."

14. Change the name so it's spelled the way Microsoft spells it. Enter the name: *WordPad* and press the *Finish* button. This will take you back to the *Taskbar and Start Menu Properties* window where you may make any additional changes before you close the window. But, not today.

15. Click on the *OK* button to complete the changes and close the window. Did your modification work?

16. Click on the *Start* button in the Taskbar. You should see a Start menu like the one shown in Figure 6, with the WordPad icon in the top section. Does the shortcut to WordPad work?

17. Click on the WordPad icon. The WordPad application will run. After you finish congratulating yourself, close WordPad. Now, doesn't that beat clicking on the *Start* button, selecting the *Programs* menu, selecting the *Accessories* menu, and clicking on the *WordPad* icon at the bottom of the *Accessories* menu?

    As fast as it is, this is still not the fastest way to run an application. We'll explore an even faster way in the next lab.

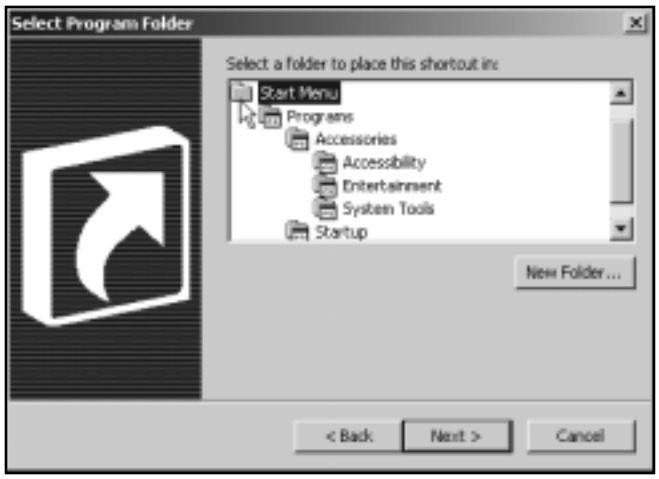


Figure 5
Selecting the Start Menu folder.

Figure 6
The Start menu modified with the addition of WordPad.

Exploring My Computer

This is where things get tricky. Your ability to customize the look of Windows is limited only by how much free time you have on your hands. Someone who used the computer before you may have customized some of the Windows viewing options already. We are going to try to stay with the default settings, which should be the simplest settings as well.

18. Double-click on the desktop icon, *My Computer*. The *My Computer* window will open, giving you a display similar to the one shown in Figure 7. If necessary, resize the window to resemble Figure 7.

Figure 7
Inside My Computer.

Since your display may have been customized, perform the following steps to restore default settings:

A. Open the View menu and choose the Large Icons view. Also make certain that the *Status Bar* option is checked.

B. Once more under the View menu, open the *Toolbars* submenu and make sure that *Standard Buttons*, *Address Bar*, and *Lock the Toolbars* are checked.

C. Open the Tools menu and select *Folder Options*. Under the *General* tab check the buttons as shown in Figure 8.

D. Next, click on the *View* tab. In the *Folder views* section, click the *Like Current Folder* button. Read the *Folder views* message and click the *Yes* button. Finally, click *OK* to close the window.

19. Notice that the *My Computer* window contains an icon for each of the disk drives and the Control Panel. These are what you might call *system objects*. They are fixed in this location, and you cannot copy them, move them, or delete them. You can, however, make *shortcut icons* that point to these system objects. And, you can copy, move, and delete shortcut icons.

Figure 8
Set the General tab options as shown here.

Figure 9
Detailed view of the WINNT folder on drive C.

20. Right now, let's examine the contents of your boot drive, Local Disk C. Double-click on the icon, *Local Disk* (C:). This will open a window that shows the contents of the Local Disk (C:). Double click on the folder labeled *Winnt*. Windows 2000 may display a message warning you that the contents of the folder should not be taken lightly. If so, read over the message and click on the highlighted words *Show Files*. Scroll down the list until you see a mixture of folders and files. Your display should be similar to the one shown in Figure 9.

21. Recall that you can view the contents of a window in four different ways. Right now, you should be looking at the Large Icons view. You change the appearance of the contents of a window in the pull-down menu View.

22. Open the pull-down menu View. The group of five display options—Large Icons, Small Icons, List, Details and Thumbnails—are an example of what we call *exclusive options*. You can only choose one of the options at a time. A dot identifies the selected option. Click on the *Small Icons* option. Notice that because the size of each icon is smaller, the icons fit into a smaller area.

23. Open the pull-down menu View. Click on the List option. What's the difference between the Small Icons view and the List view? _____
_____
_____

24. Open the pull-down menu View. Click on the Details option. This view displays the fewest number of files in the window, but it offers the most information about a file short of examining the properties of an individual file.

Resize the window and scroll so that your display resembles Figure 10. We scrolled past some of the folders so you could see how the *Details* view treats files and folders. This view doesn't tell you the size of a folder, but it does tell you when the folder was created. On the other hand, file sizes *are* displayed.

25. Look at the *Type* column. Notice that Windows states the obvious if it doesn't know the purpose of an item in the list. It calls a folder a folder. A file with a file extension is named by that extension, such as *application*, *bitmap image*, *video clip*, etc.

    Scroll through the list from top to bottom. Is there anything missing from this list? Well actually some files are missing. It turns out that there are hidden system files on drive C. How do we know? Because there is a message in the lower left corner of the window that says so. How do you view those files?

26. Click on the pull-down menu *Tools*, and select *Folder Options*.... This opens the window you looked at earlier where you can specify how the folder windows are displayed. The first page lets you choose the style of the view you want to use.

27. Click on the *View* tab. This is the tab where you determine what you see in the file and folder list. At the top you have a choice of making all your folders look the same. Below that are several *Advanced settings*, such as seeing all files on the drive, or hiding certain types of files.

Figure 10
Detailed view of the root directory on drive C.

28. The options in the *Advanced settings* pane gives you a wide range of options as to how Files and Folders are displayed. Among other things it allows you to hide or view additional file information. Another option allows you to replace the title of the window that you have open with the path information to that window. Another allows you to hide or display the file extensions that are registered in Windows. Extensions like .EXE, .COM, .BAT, .SYS, .TXT, and so on, are all registered. Extensions like .DOS, .ACR, .OLD, etc., are not registered. That's why you don't see the former attached to the files listed in the root directory, but you do see the latter attached to the listed files.

29. To get a better view of your hard disk drive, let's enable more options in the View page. First, under *Hidden files and folders*, select the option *Show hidden files and folders*. Then, put a check in the box to select the option *Display the full path in the title bar*. Uncheck the box to deselect the option *Hide file extensions for known file types*. When you are done, your selections should match those shown in Figure 11.

30. Click on the *File Types* tab. This is where you find out which file types and their extensions are registered in Windows. Scroll through the list of *Registered file types*. If you come to a file type that you don't recognize, you can learn more about it by selecting the file type. The *File type details* section below the list, gives additional information.

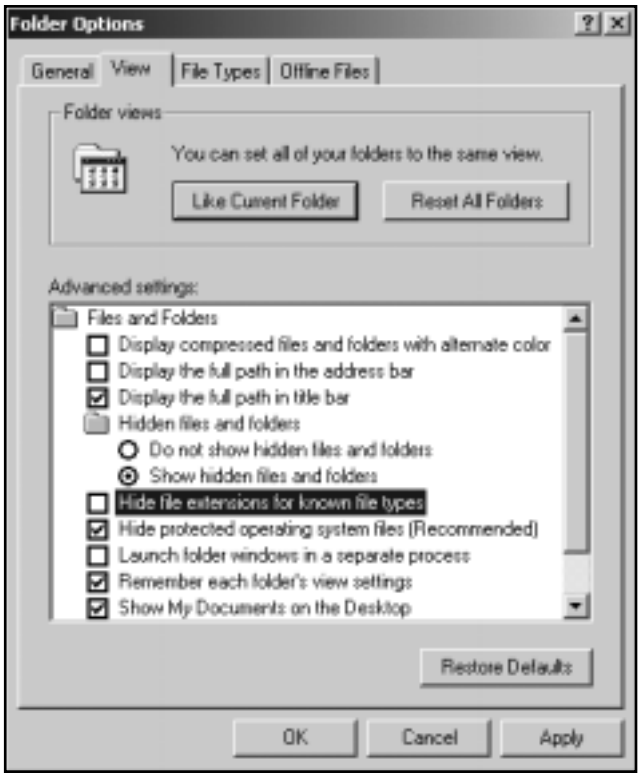


Figure 11
Folder Options custom settings choices.

31. Let's examine a file type that should be familiar because you have used it before. Scroll down to the file type, *TXT* for *Text Document*, and select it. Figure 12 is an example of what you should see.

    The Details section tells you that if you double-click on a text document it will automatically open in the Microsoft application Notepad. It also shows you the icon assigned to Notepad.

32. Before you close the Options window, find and select the file type, TIF Image Document. We're doing this because TIF images are used a lot in the computer world. Viewing a TIF image is difficult unless the computer has a sophisticated graphics program. Fortunately Windows 2000 comes with a program called *Imaging Preview*. It allows you to display and edit a TIF image. You can find the program in the Start > Program > Accessories folder, under the name *Imaging*, It is in the same menu with Notepad, Paint, WordPad, and several other useful applets.

    Many applications modify this list upon installation. For instance if you install Adobe Photoshop, this list is modified to launch Photoshop, rather than Imaging Preview, when you double-click on many types of graphics files. Photoshop also adds its own special file types to the list. If you want to continue to use Imaging Preview rather than Photoshop for certain file types, you select the file type and click the *Change...* button. You can explore this area later.

33. Close the Folder Options window by clicking on the *OK* button. Examine the display again. Read the message in the lower left corner. What is different? _____
    _____
    _____

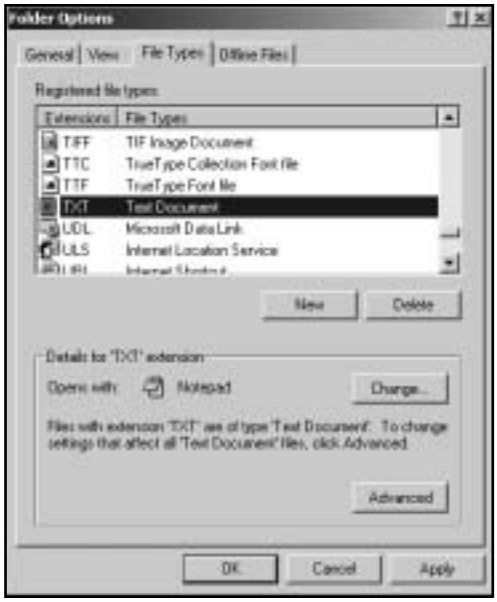


Figure 12
The Files and Folders view options.

34. What is the title in the Titlebar? _____ How many objects (files and folders) are in the window? _____ Note that most of the files now have a file extension.

35. Click on the pull-down menu *Tools* and select *Folder Options*.... Click on the *View* tab. Now let's restore the View page options to their original condition. You could make the changes individually, but instead click the button *Restore Defaults*.

36. Now that things are back to where they were, click the *Apply* button and close the *Folder Options* window by clicking on the *OK* button.

37. What is the title in the Titlebar? _____ How many files and folders are in the window? _____ Do most of the files still have a file extension? _____

    With the file extensions turned-off, and a display option other than *Details* selected, it's hard to tell much about an individual file. That's where the right mouse button comes in handy.

38. Right-click on the first file named *Discover*. This will open a special menu that lets you perform several file operations. At this time, you are interested in the file's properties. Select the option *Properties*. A Properties window will open for the selected file. Property windows may contain one or more pages of information, depending on the file type. In this case, there are four pages, as shown in Figure 13.

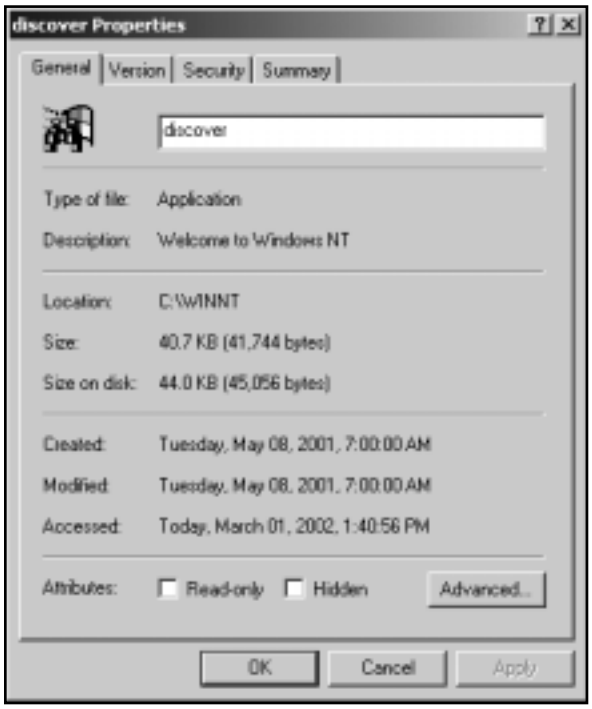


Figure 13
Properties window for the Discover file.

Every file has a *General* page that lists several facts about the file. It also provides you with a way to change the attributes of the file. However, notice that only the Read-only and Hidden attributes are shown. To see other options click on *Advanced…*. In the *Advanced Attributes* window, you can set or clear the Archive, Index, Compress, and encrypt attributes. Click *Cancel* to close the *Advanced Attributes* window.

Most file *Properties* windows also have a *Version* page. Select the *Version* page tab to see what's there. You can see the File version number, a Description of the file, and a Copyright notice from the file's manufacturer. At the bottom of the page there may be additional version information. It all depends on who created the file. Click on each of the *Item names* and you can learn more about the file. When you are finished, click on the *OK* button to close the window.

We will discuss the *Security* and *Summary* pages in a later lab.

Note that not all files contain this much information about their contents and manufacturer. However, Microsoft recommends that all files created to work with Windows contain all of the above data, just to make it easier for people to keep track of the files in their computer.

39. Once again, right-click on the first file named *Discover*. Examine the list of options in the special menu that opens. How many options are listed? _____ Press Esc to close the popup window.

40. Find and right-click on the folder named *Cursors*. Compare the special menu that opens to the one that opened when you right-clicked on *Discover*. What is the difference between the two menus? _____
_____
_____

Right-clicking allows lots of new ways to get information about the objects displayed on the screen. Most have right-click information available. After all, the mouse on a PC has had more than one button for many years, and it's about time the extras were put to good use. We'll explore several of the new menu options available with a right-click in future labs.

41. To remove the pop-up menu, you can either use the Esc key, or click in a blank space. The Esc method is probably safer, so do it now.

42. Before we end the lab, you need to reset the options that you changed. Under the View menu, select Large Icons. Make sure *Status Bar* is checked.

43. In the Tools menu open the *Folder Options...* window. Click on the View tab. Click the *Reset All Folders* button. Click *Yes* to confirm this action. Click on the *Restore Defaults* button.

44. Finally, click the *Like current folder* button, and the *Yes* button to confirm. Click *Apply* and then *OK*. Close the *Winnt* window. Unless you are going on to the next lab, shut down the computer.

Discussion

In this lab you worked on three different areas of the Windows 2000 environment. First, you learned how to modify the contents of the Start menu. You found that you could add shortcut icons to the Start menu to give you direct access control to often used applications.

Then, we had you open the My Computer icon and explore different parts of the folder/file system. You learned how to display hidden files and how to view detailed information about files and folders. You also learned where to go to change attributes and how to show and learn more about file extensions.

In the next lab, you will get an opportunity to modify the contents of the desktop and explore the inner workings of the Recycle Bin.

Lab 4-2

Working with Files and Folders

Windows 2000 provides a desktop that is more than a background where you can paste wallpaper or graphic images. It is actually a place where you can store applications, documents, and folders, and have them readily available at all times.

You learned a great deal about the desktop and the Start menu in earlier labs. In this lab you learn how to move objects like files and folders onto the desktop. You will also use the right mouse button to perform several different tasks.

Finally you will explore the operation of the Recycle Bin.

Objectives

At the end of this lab, you will be able to:

- Create shortcut icons of applications, documents, folders and drives.
- Place files, folders, and shortcuts on the desktop.
- Copy, move, delete, restore, and organize files and folders.
- Explore and adjust the properties of the Recycle Bin.

Materials Required

To complete this lab, you will need a computer with Windows 2000 Professional installed. A system that still retains most of the default installation settings will work best. You will also need a 3½-inch floppy disk. The disk may contain anything, and will be restored at the end of the lab.

Procedure

1. If necessary, turn on the computer. At the Windows 2000 Desktop, double-click the *My Computer* icon.

2. Open the hard drive, *Local Disk* (C:).

3. Open the folder labeled *WINNT*. If Windows 2000 displays a warning message, read it over and click on the highlighted words *Show Files* at the end of the message.

4. Scroll as necessary until you find the *Cursors* folder. Right-click on the *Cursors* folder.

5. In the popup menu, click on the option *Open*. That will open the *Cursors* folder window.

6. Select any two files in the Cursors window. There are several ways you can do this. You could select one file icon, then hold down the Ctrl key and select the other icon. However, it is faster to click on an open area of the window and drag a box around two icons. When you release the mouse button, both icons are selected. Figure 1 shows how you create a box when you click and drag the mouse. Try it, select the two files.

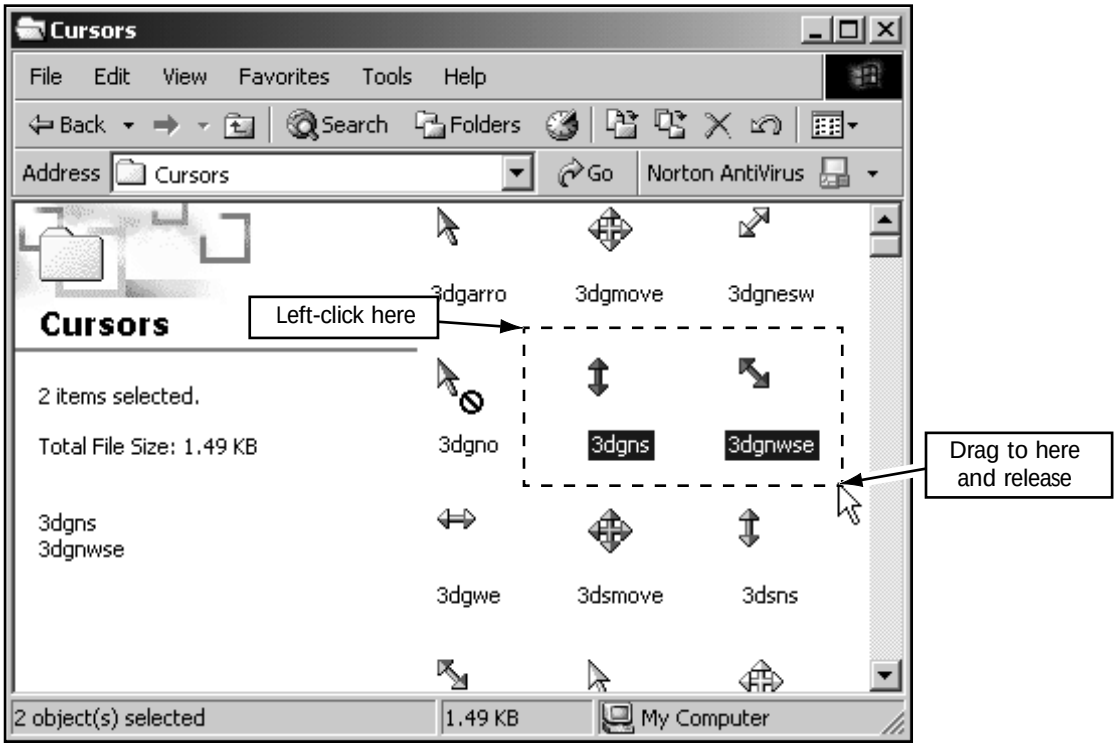


Figure 1
Selecting objects by dragging a box around them.

7. Now that you have the files selected, why not copy them to the desktop? There are three basic ways you can do that. Read through all three ways first. Then you will actually try them in later steps. The three methods are:

   A. First, you can left-click and drag on one of the selected file icons while you hold down the Ctrl key.

   B. Your second option is to depress the right mouse button and drag one of the selected file icons to the Desktop. When you release the mouse button, a menu with the options to move, copy, create shortcuts of the files, or cancel the whole operation will appear. You would then select the Copy option.

   C. The third way to copy the files is to right-click on one of the files. When the menu opens, select the option Copy. Then, right-click on the desktop where you want the file icons placed. When the menu opens, select the option Paste.

8. Let's make a copy of the selected Cursor window files using the first option. Left-click on one of the selected files and continue to hold the left button down. Then, press and hold the Ctrl key. Notice that as you start to drag the mouse, a small box with a plus (+) symbol appears next to the mouse pointer. This indicates that you are copying, rather than moving, the files. Before the pointer leaves the Cursors window, release the mouse button. What happened? _____ _____ If what happened is not obvious, scroll down to the bottom of the window. What do you see? _____

   Sometimes when you are dragging files, your finger slips off the mouse button. That action will deposit the files wherever the pointer happens to be located. If it's in the same folder as the original files, there is a problem. You can't have identical files in the same folder. To keep the operation legal, Windows automatically changed the names of the files to "Copies of…" the original names.

9. Rather than waste these nice file copies, let's move them to the desktop. The files may still be selected, if not, go ahead and select them again. Left-click on one of the files and drag them both to the top right corner of the desktop. Notice that as you drag the files, an outline of the file icons appears, so you can see where you are positioning the files. After you have released them, deselect the files by clicking on an empty area of the desktop.

10. Remember the second method for copying a file? Let's go through the steps together. First, select any two files in the Cursors window. Next, depress the right mouse button and continue to hold the mouse button down. Then, drag the files over to the desktop, just below the other two files, and release the mouse button. (We call this operation right-click and drag.) As soon as you release the button, a menu will appear. Select the Copy Here option.

11. You now have four files on the desktop, as shown in Figure 2. Generally, you put files on the desktop to make access easier—you don't even have to click on the *Start* button to open the Start menu. On the other hand, files that are placed on the desktop can be covered by open windows. So there are trade-offs to consider. You can also copy or move folders into other folders, or onto the desktop.

12. To see how that might work, let's make a copy of the Cursors folder and put it on the desktop. First, you need to back up to choose the Cursors folder—you can copy folders, but not windows. If you are a seasoned Internet Explorer user, you already know how to back up. If not, there are several methods, but first click anywhere in the *Cursors* window to make it the active window:

    A. Click the Back button in the toolbar to view the previously displayed window.

    B. Press Alt-left arrow.

    C. Click the small down arrow just to the right of the Back button and choose the object you wish to view from the menu.

    D. Click the Up button on the toolbar.

13. Well, you can't say Windows doesn't give you choices. Use whichever method you prefer and back up to the WINNT window. Make sure the *Cursors* folder is selected. Next, right-click on the *Cursors* folder. In the menu that appears, select the *Copy* option. Finally, right-click on the desktop, just below the four previously copied files. In the menu that opens, select the *Paste* option. A copy of the *Cursors* folder will appear where you clicked on the desktop.

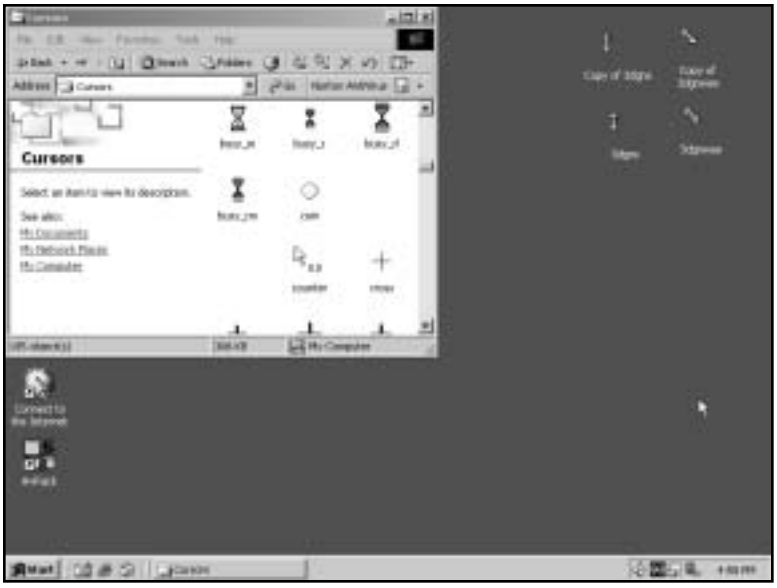


Figure 2
The desktop after copying files.

14. You copied the entire *Cursors* folder. Did you also copy the files in the folder? Open the folder and see if the files are there.

15. In addition to copying folders onto the desktop, you can create new folders anywhere you want. You do it by right-clicking where you want the folder, and telling Windows to put it there. Try it. Right-click on the desktop below the *Cursors* folder on the desktop. You may have to resize and move the open Cursors window to see the Cursors folder underneath. In the menu that appears, highlight the option, *New*. This will open a sub-menu. In the sub-menu, select the option, *Folder*. A folder icon called *New Folder* will appear where you clicked earlier. The icon name is highlighted so you can immediately type any name you choose. Type the name:

    ```
    My Own Folder
    ```

    and press the *Enter* key. You now have a brand new, empty folder to fill with whatever you want. Figure 3 shows an example of what you should see.

    When you opened that sub-menu, did you notice there were several options available? The bottom options allow you to create an empty file from one of the types listed. And then later, you could open the empty file with the appropriate application and add content to the file.

    The other menu option, the Shortcut option, puts a Shortcut icon where you clicked, and then opens the Create Shortcut window so you can identify the object that you want the shortcut to point to.

    Have you noticed your desktop is getting a little crowded? Why not put that empty folder to good use, and clean things up.

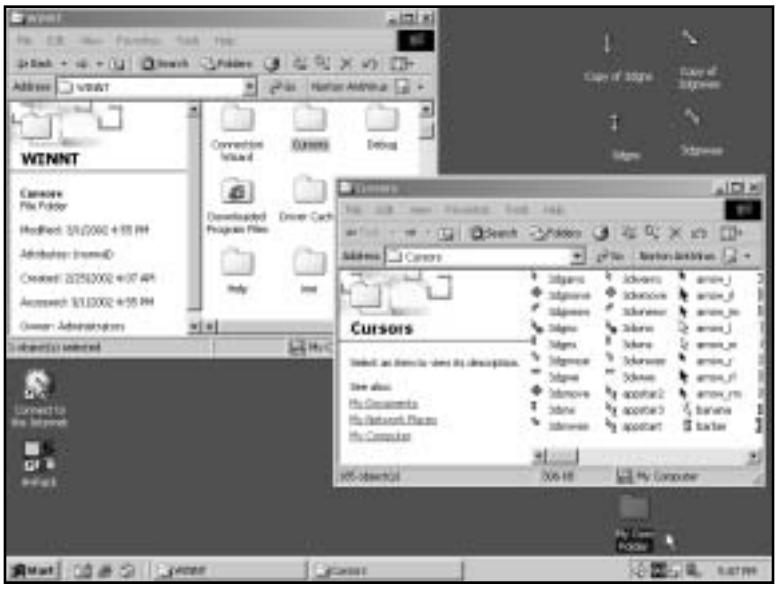


Figure 3
The desktop after creating a new folder.

16. Close the *Cursors* window. Use your mouse pointer to select the four icon files, and the *Cursors* folder. Then, left-click and drag the selected icons on top of the folder, *My Own Folder*. You can tell when you are over the folder, because it too becomes highlighted. Release the mouse button.

17. To finish the job of "cleaning up," left-click and drag the folder, *My Own Folder*, to the top right corner of the desktop. When you have it where you want it, release the mouse button.

18. In the WINNT window, back up until you see *My Computer*. Figure 4 shows an example of what you should see.

    While you are limited as to what you can move or copy to the desktop, you can make shortcut icons of everything. That includes all of the items in the My Computer window. A word of caution about moving files onto the desktop. Document files can go anywhere in the computer. Application files, on the other hand should remain where they were installed. That's because most applications assume certain files are in certain locations. Change the location of one of those critical files, and the application won't work. That's why you use shortcut icons to point to applications and other objects, such as disk drives, or the Control Panel. Let's put a shortcut to the floppy disk drive onto the desktop.

19. Click on the 3½" Floppy (A:) icon and drag it around the window. In particular, try moving it up into the toolbar area. Notice that as you move the icon to certain areas a slashed circle appears. The slashed circle tells you where you can't drop the icon.

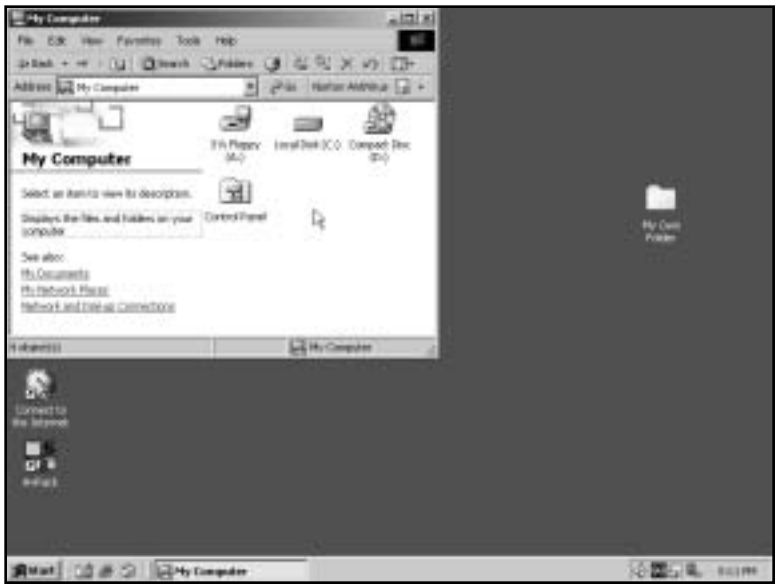


Figure 4
Your "cleaned-up" desktop.

Move the icon over one of the other drive icons, and the slashed circle is replaced by a bent arrow in a box. The bent arrow tells you this icon will become a shortcut icon if you release it over the hard disk drive. In this case, the shortcut to the floppy disk drive will go into the root directory of the hard disk drive. But don't release the mouse button just yet!

20. Drag the icon outside the window and move it around the desktop. Notice where you can drop the icon and where you can't. Drag the icon just below the folder, *My Own Folder*, and drop it. (Caution: If you see the *My Own Folder* icon become highlighted, you know you got too close to that icon, and the 3½" Floppy (A:) icon fell inside the folder. Abort the operation—click on the *No* button, when given the chance.)

    As soon as you release the icon, Windows will display a warning message telling you that you can't move or copy the icon, but that you can create a shortcut to the item. That's what you want, so click on the *Yes* button. Windows will create a shortcut icon to the floppy disk drive on the desktop. Now, if you want to look at the contents of a floppy disk, you can double-click on the shortcut icon instead of going through the routine of opening the My Computer icon, and then clicking on the 3½" Floppy (A:) icon.

21. Put a floppy disk into floppy disk drive A. Then, double-click on the floppy disk shortcut icon you just placed on the desktop. A window showing the contents of the disk will appear. If this disk hasn't been used the window will be empty.

22. Right now, you need to remove all of the files on the floppy disk if there are any, and place them onto the desktop for temporary storage. Select any files you see on the disk. Right-click and drag the files over to the desktop and drop them. When the menu opens, select the *Move Here* option.

    We've shown you several ways to move or copy files between folders, and between a folder and the desktop. There is one other way to copy files when you are copying them to a removable disk drive, such as a floppy disk drive. That method uses the *Send To* menu option that appears when you right-click on an object such as a file or folder. However, because the floppy drive is so slow, before you experiment with this method, you need to reduce the size of the folder you will be moving. Otherwise, it will waste several minutes of class time moving files. Open *My Own Folder*. Inside, open the *Cursors* folder. Select all the files in the *Cursors* folder except the first ten or so. Find and depress the *Delete* key on the keyboard. Click on *Yes* to confirm that you wish to delete these files. You should now only have about 10 or so files in the *Cursors* folder. Close the *Cursors* folder. Close *My Own Folder*.

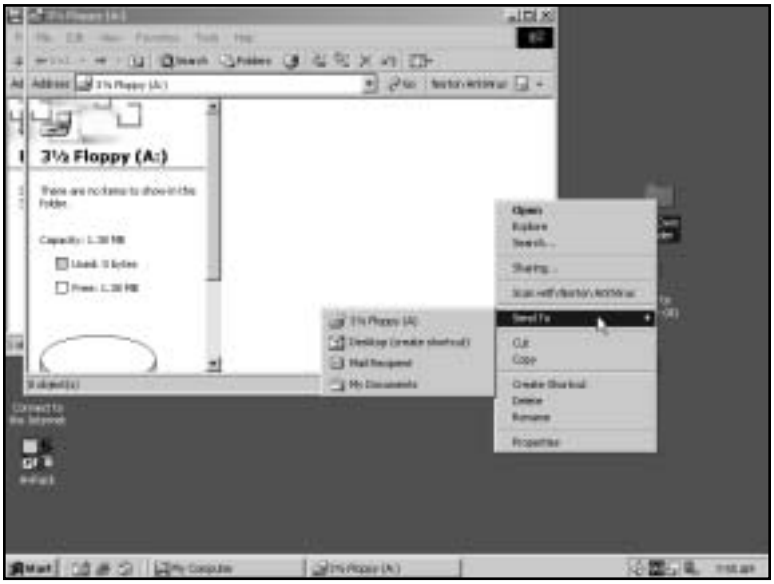


Figure 5
Send To menu options.

23. To see how the *Send to* option works, right-click on *My Own Folder* on your desktop. When the menu appears, highlight the *Send To* option as shown in Figure 5. You will see the 3½" Floppy (A:) listed. Click on the 3½" Floppy (A:) option to start the copy operation. Because the floppy drive is relatively slow, you will see the individual files being moved.

24. After everything is copied, right-click on the folder icon in the 3½" Floppy (A:) window. Then, select the *Properties* option to learn a little more about the folder you just created and the files you copied into it. Figure 6 shows an example of what you should see.

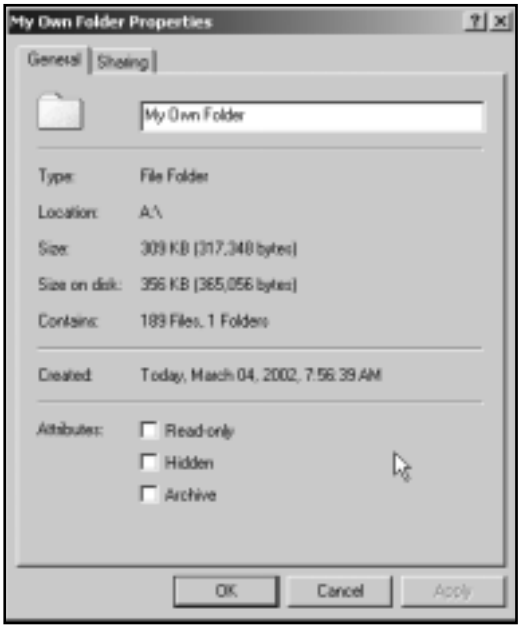


Figure 6
The Folder *Properties* window.

What is the size of the folder? _____ What does the folder contain? _____ What is the name assigned to the folder? _____ Notice that this *Properties* window has only two page. We will discuss the Sharing tab in a future lab.

25. Close the *Properties* window.

You have made, moved, and copied several objects in this lab. It's time to examine how Windows 2000 handles its trash.

The Recycle Bin

26. If necessary, move the open windows so that the Recycle Bin is visible. Right-click on the *Recycle Bin* icon. When the menu opens, select the *Properties* option. You will see a window like the one shown in Figure 7.

The number of drives in your system will determine the number of tabs in the window. The first tab controls whether the other tabs do anything. Right now, the option, *Use one setting for all drives*, disables the Recycle Bin controls on the other two pages. You can see that the control is set so that 10% of drive C is reserved for storing deleted files. When the number of files in the Recycle Bin on a drive exceeds 10% of that drive's space, the oldest deleted file is removed from the drive to make room for the latest deleted file.

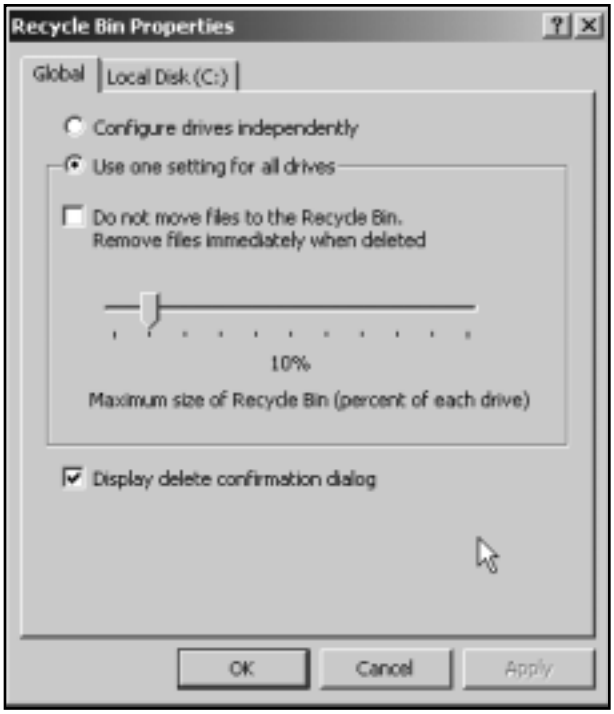


Figure 7
Recycle Bin properties

27. Click on the *Local Drive* (C:) page tab. There you are told the size of the drive and the amount of space reserved for the deleted files in the Recycle Bin. The control to change the size of the Recycle Bin is grayed-out. That's because of the option, *Use one setting for all drives*, is selected on the Global page.

28. If you had a second hard drive, you could click on the tab for the other drive to see its information.

29. Click on the *Global* page tab. There are two other options we haven't mentioned yet. The top check box (the square one) is labeled, in part: *Do not move files to the Recycle Bin*. This option is used to disable the Recycle Bin. Unless you absolutely need the disk space, do not select this option. The Recycle Bin is just too useful a tool to disable.

    The other option tells Windows to display a warning every time you delete a file, to make sure you really want to delete the file. For now, leave this option selected.

30. Close the *Recycle Bin Properties* window. Then, minimize the *My Computer* window. That leaves only the 3½" Floppy (A:) window open.

31. Look at the Recycle Bin icon. Is it empty, or does it contain some trash? Figure 8 shows the difference. If it is not empty, right click on the icon and select *Empty Recycle Bin*. Click on *Yes* to confirm.

    There are several ways to put files and folders in the Recycle Bin, including:

    A. Drag the object over and drop it on the Bin.

    B. Select the object and press the *Delete* key.

    C. Select the object, then select the menu option *File, Delete*.

Figure 8
The icon on the right shows that the Recycle Bin contains deleted files.

D. Right-click on the object and select the menu option *Delete*.

E. Right-click on the object and select the menu option *Cut*. Right-click on the *Recycle Bin* icon and select the menu option *Paste*.

32. Open the folder, *My Own Folder* that is still on the desktop. Using one of the techniques shown earlier, select the four files. At the keyboard, find and press the *Delete* key. Click on the *Yes* button when asked if you really want to delete the files. What happened to the Recycle Bin icon?

    _____

33. Click on the *Cursors* folder and drag it over and drop it on the Recycle Bin icon. Did Windows ask if you wanted to delete the folder and its files? _____ Why? _____

    _____

34. Close the *My Own Folder* window.

35. Right-click on the *My Own Folder* icon on the desktop. Select the menu option *Cut*. Nothing will happen to icon at this time. Right-click on the Recycle Bin icon and select the menu option *Paste*. Did Windows ask if you wanted to delete the folder and its files? _____ Why? _____

    _____

36. Right-click on the Recycle Bin. Select the menu option Open. The Recycle Bin window shows you what files have been deleted into the Bin.

    Open the *Cursors* folder that you placed in the Bin earlier. What happened? Folders get special treatment when it comes to recycling in Windows. You cannot open them, but you can copy or move them out of the Bin, and the contents of the folder remain intact. Close the *Cursors Properties* window.

    There are several things you can do with these files. You can delete them one at a time by selecting a file and pressing the *Delete* key. You can delete them all at once by making the recycle Bin window active and then selecting the menu *File* option, *Empty Recycle Bin*. Or, you can leave them in the Bin, just in case you need them at some future time.

37. Let's use a fourth method to delete the files. Close the Recycle Bin window. Right-click on the Recycle Bin icon. Then, select the menu option *Empty Recycle Bin*. Click on the *Yes* button when asked if you really want to delete the files. What happened to the Recycle Bin icon?

    _____

38. You still have one more object to delete. That's the folder, *My Own Folder*, on the floppy disk in drive A. In the 3½" Floppy (A:) window, select the icon *My Own Folder*. Then, press the *Delete* key. Click on the *Yes* button when asked if you really want to delete the folder, *My Own Folder*, and all of its contents. What happened to the Recycle Bin icon? _____ Explain why that happened.
_____
_____

39. Move (don't copy) the file, or files, you removed from the floppy disk earlier in the lab back onto the floppy disk. Then close the 3½"Floppy (A:) window. Finally, delete the *Shortcut to 3½"Floppy (A)* icon.

40. Close any and all open windows, and delete any additional icons you may have created during this exercise by dragging them to the Recycle Bin. Finally, empty the Recycle Bin.

41. That completes the lab. Shut down the computer.

Discussion

In this lab you worked on two different areas of the Windows 2000 environment. First, you modified the contents of the desktop to see how easily it could be done. In the process you learned several ways to move, copy, or create several different Windows objects.

Second, you explored the inner workings of the Recycle Bin. You learned how it occupies space on the hard disk drive, and that it isn't used by the floppy disk drives. You filled the Bin, examined the contents of the Bin, and emptied the Bin.

Unit 5

Windows 2000 History and Data Management

We began the discussion of Windows in Unit 3 by describing its evolution from MS-DOS and earlier versions of Windows. This unit continues that discussion by examining how Microsoft positioned and developed Windows NT into the operating systems you use today, Windows 2000 and Windows XP. The discussion then continues into basic strategies for managing the storage of your data

The History of Windows NT

In the 1980s, Microsoft was just one of several companies selling PC operating systems. You could choose from two or three versions of DOS, and many PC manufacturers developed customized versions of the standard MS-DOS. On top of DOS you could choose from a few different operating shells, Windows being just one of the bunch. But one area was being dominated, as the interconnected PC network belonged to Novell's Netware. This "network of PCs" was a new concept, one that traditional IT departments believed would be short-lived. Little did they know…

Objectives

- Understand the need for Microsoft's NT-series of operating systems.
- Describe the basic differences between Microsoft's NT-family of operating systems.

Windows New Technology

With Netware, you could build a super-powerful PC and load a special OS, the *Network Operating System*, or *NOS*. This NOS turned the PC into a new breed of network server, which slowly and surely replaced some IBM "minicomputers" and small mainframes. Initially, PCs weren't powerful enough to act as network servers, but as Intel built ever-faster CPUs, as hard drive and memory technologies evolved and their prices dropped, using PCs as servers became commonplace.

Netware was installed on a server, and connected to the network wiring system. You would then run any major operating system on your PC, and with the addition of a network interface card (NIC) and a driver or two, you could quickly be part of a much larger network. As Microsoft's operating systems became dominant, they contained built-in support for Netware, which allowed users to make easy and trouble-free network connections.

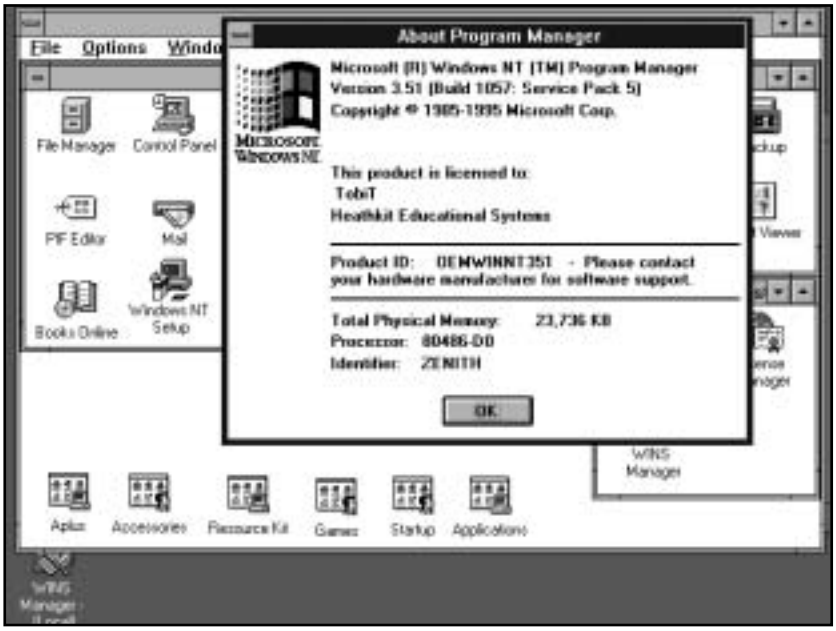


Figure 1
The Windows NT 3.51 GUI looks just like Windows 3.*x*.

Microsoft wasn't content with that; they planned to do much more than just provide support for somebody else's NOS. They started to build a new operating system intended for networked PCs, and they wanted to build the NOS, too. Microsoft saw that the future of business computing was going to be centered on interconnected networks, and that home and small office users had different needs than corporate and big business users. They planned to be the center of this new computing environment by developing a pair of operating systems that would work together; one for the server and one for the local workstation. With a single company building both the server and workstation operating systems, the benefits were endless and the system would be seamless.

Microsoft formed a partnership with IBM to develop OS/2, in an attempt to unseat Novell from its dominant NOS position. The relationship didn't work out very well. (That's an understatement. Books have been written about this relationship and how it fell apart, and how it was settled in the courts.) Microsoft, realizing that the project with IBM wasn't what they really wanted, gave up on OS/2 and began working on a brand-new NOS and a companion PC operating system.

After a lot of hard work the first version of Windows New Technology (NT) was released in 1993. NT wasn't just a new networkable version of DOS, or a modification of Windows 3, it was an entirely new system built from scratch. It was designed with the needs of the business network in mind, where security, stability, and administration are key features. The first version of NT didn't shake the earth, but it proved that Microsoft could indeed build, and more importantly *sell*, a different kind of operating system.

Microsoft initially released two versions, Windows NT 3.1 and Windows NT Advanced Server 3.1. As you might guess, NT 3.1 was intended for regular PCs, and the server version was loaded onto higher-powered machines that acted as servers. NT 3.1 didn't sell very well, but soon Microsoft released NT 3.51 and businesses started to catch on. Windows NT 3.51 was aimed directly at Novell, and slowly corporations began switching from Novell to Microsoft. In 1996, Microsoft released Windows NT4 Workstation and Windows NT4 Server. The trickle of conversions from Netware to NT became a flood, and soon Microsoft was king of the NOS and PC server world.

Windows NT was quite different than other PC operating systems. NT could handle power failures and disk crashes, where such an event under DOS or Windows 95 caused you to lose data. NT could take advantage of systems with multiple CPUs and multiple hard drives, where Windows 95 could handle just one CPU and only the standard master/slave hard drives. NT also offered an entirely new level of serious PC security, where Windows 9*x* had none.

What also happened was that Microsoft now had two different classes of operating systems. Windows 9*x* could be used by anybody, on virtually any PC. It was inexpensive, could work with all kinds of add-on hardware, and had full support for the older programs and hardware you might want to continue using. Windows 9*x* was sold as an extremely versatile and easy to use OS that can run on little memory and slow CPUs. Unfortunately, this versatility and ease of use comes at a price. That price is security and stability.

What Windows 9*x* also doesn't have is the ability to be *managed* in a large corporate or networked environment. The Information Services (IS) staff at a large company needs to have quite a bit of control over who is allowed to customize their systems, and who is allowed to add and remove software. The IS staff often needs to support hundreds of computers and users, and visiting every computer for a minor update is nearly impossible. Windows NT can implement updates remotely from the server, where Windows 9*x* doesn't allow the same level of control and access.

Windows NT allowed administrators to manage their systems, and provided strong security and stability. This was exactly what many companies needed from their IS systems. However, as a result of this tight security and rock-solid stability, NT had to sacrifice support for older software and hardware. Applications written for Windows 9*x* might run on NT or they might not, depending on how they were written. Hardware was even more critical, because drivers used for Windows 9*x* would rarely work in NT. Writing drivers for NT was more difficult and there were fewer users of NT. As a result, some hardware vendors didn't develop drivers and those devices don't work on NT machines.

One issue that kept many people from using NT was its need for lots of power. NT systems need a lot of memory and they need a faster CPU in order to move as quickly as a Windows 9x system. Until recently memory was expensive, often too expensive to justify the switch to NT. But that's changed now.

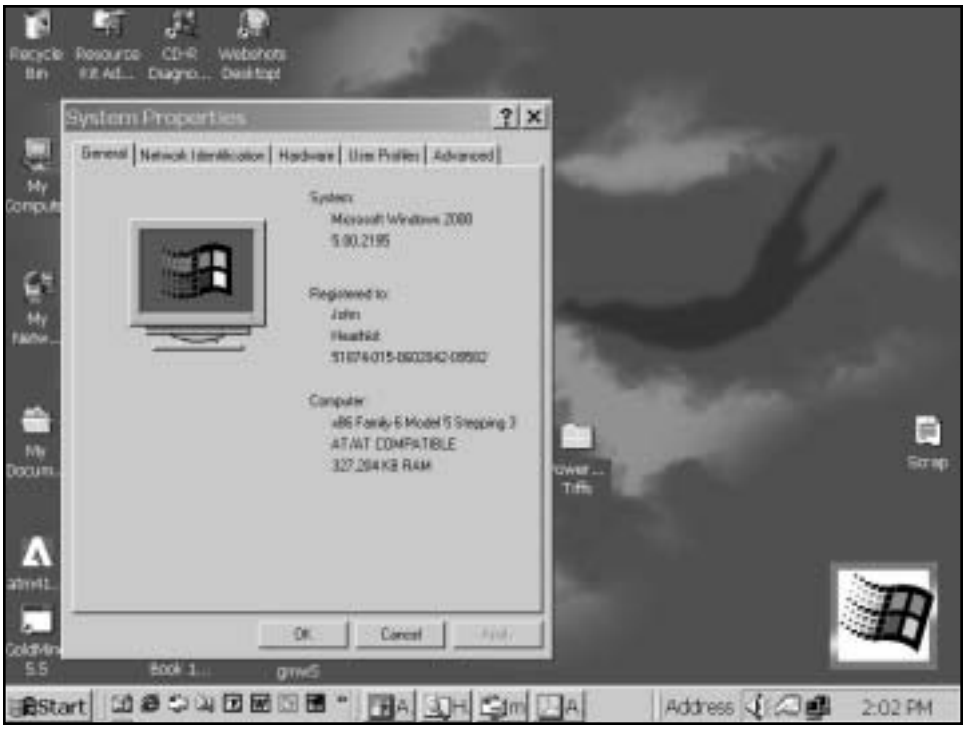


Figure 2
The Windows 2000 interface looks just like Windows 9.*x*.

Windows 2000

As Microsoft's prominence grew in the marketplace, Windows NT became more and more important. Microsoft was well on its way to releasing Windows NT5 when they shifted gears and renamed the product Windows 2000. (Microsoft has apparently given up sequentially numbering their products. We've moved from version numbers, such as 3.1 and 3.51, to years, such as 95 and 2000, to names such as Me and XP. Making matters even more confusing, the Microsoft Office products now share the same naming strategy and the same names.)

Windows 2000 is not just a single operating system; it's a family of operating systems and networking products. This family is designed to meet the needs of everyone from small businesses all the way up to the largest corporate enterprises. You can put a Windows 2000 server in your home and build a family network, and you'll find Windows 2000 powering some of the largest websites and corporations in the world.

Windows 2000 is also the first version of NT that can be seriously considered by all computer users. It runs on more hardware than NT, it handles more software and peripheral hardware, and can be configured to act just like Windows 9*x*. In many respects Windows 2000 is a major upgrade to NT4 that includes the best of 9*x*. Similarly, Windows XP is a major upgrade to Windows 2000 and also includes the best of Windows 9*x*. The difference is that Microsoft expects to offer no further releases in the 9x family. Windows XP is *it*, the final integration of both the needs of business and home users.

The Windows 2000 Family of Operating Systems consists of:

Windows 2000 Professional

Windows 2000 Server

Windows 2000 Advanced Server

Windows 2000 Datacenter Server

Windows 2000 Professional

Windows 2000 Professional is a solid and reliable operating system that combines the features of Windows 98 with the security and manageability of Windows NT. Windows 2000 Professional is the desktop operating system for businesses of all sizes. It replaces Windows 95, Windows 98, Windows Me, and Windows NT Workstation in the business environment. "Win 2k Pro" is the basic model, designed for a single PC and capable of basic network functions. It can act as a small server, but it doesn't have the power of its big brother.

Windows 2000 Professional begins to spread its wings as it becomes connected to a Windows 2000 Server. Make no mistake; Windows 2000 is an enormously powerful operating system loaded with features. So many features, in fact, that few of us ever get to use most of them.

Windows 2000 Server

Windows 2000 Server provides basic server functions for networks. Although it is the smallest member of the server group, this NOS is extremely powerful. "Win 2k Server" can run on a system containing four CPUs and up to 4 GB of RAM. There are dozens of additional features, but most of them appeal only to LAN administrators and engineers.

Windows 2000 Advanced Server

Windows 2000 Advanced Server provides increased scalability and system availability. It is designed for servers used in a large enterprise network and for database-intensive work. This version can utilize a system containing up to eight CPUs and 64 GB of RAM. (Who needs a hard drive when you have that much RAM!)

Just what is *scalability*? It's a two-dollar word that means the system can grow. As an example, you could use Windows 2000 Advanced Server for a small office, containing three employees and a few computers. As the company grows into 50 employees and 60 computers, Windows 2000 Advanced can grow in *scale* to meet the demands of a larger organization. Availability simply means it doesn't crash much. And truth be told, Windows 2000 doesn't crash much at all.

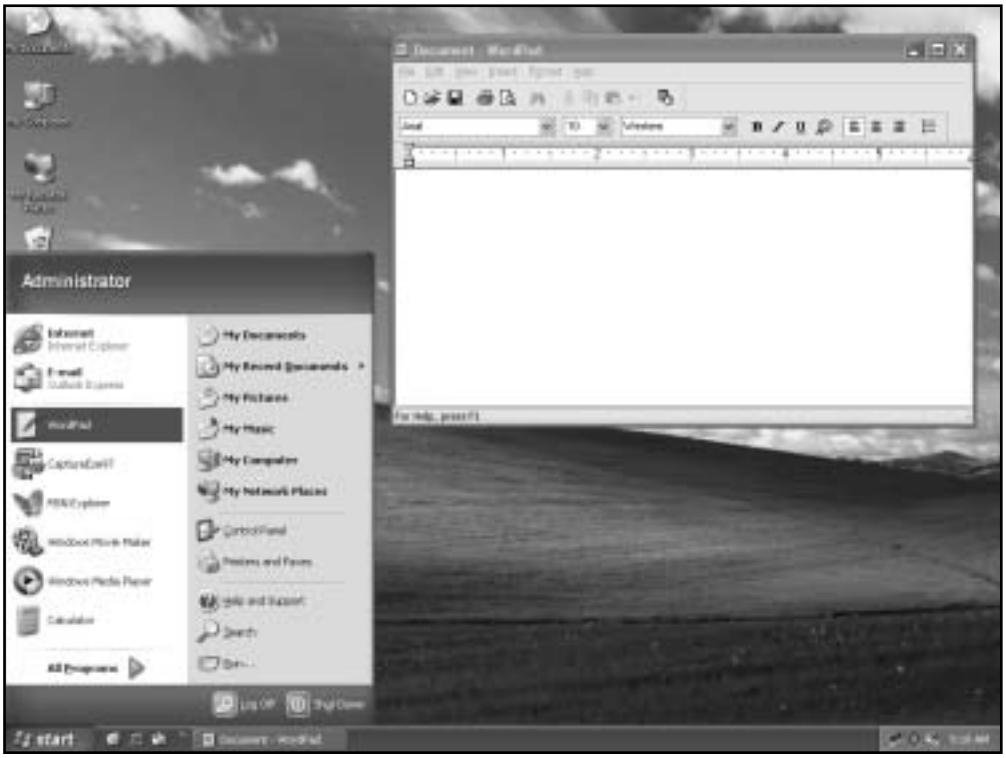


Figure 3
The Windows XP Pro interface is redesigned.

Windows 2000 Datacenter Server

Windows 2000 Datacenter Server also supports 64 GB of RAM and can utilize up to 32 CPUs in a single system. Datacenter is Microsoft's most powerful server operating system, and is designed for large data warehouses, online transaction processing, large-scale simulations, and server consolidation projects.

Windows XP

Windows 2000 had just begun to make its mark on the computer world when Microsoft threw another version of Windows at us. *Windows XP* is the latest generation of NT. It follows Microsoft's long-term plan of eventually offering just one operating system for all PC users. No longer will we choose between two distinctly different technologies, such as Windows 98SE or Windows NT. Now we choose between the *Home* version and the *Professional* versions of Windows XP, which are identical except for a few utilities and administration tools.

With Windows XP, you get all the benefits of an NT-based system at home without the management and installation troubles that were inherent in early versions of NT. On the other hand, as mentioned earlier, XP requires activation, which is a form of copy protection that is somewhat controversial.

What you'll notice about Windows XP first is the new user interface. As with any new interface, it will require some effort before you use it as efficiently as your favorite old OS. If you don't have the patience for learning a the new XP interface right now, you can always switch to the "Classic Windows 2000" interface which looks and works just like Windows 2000.

Windows XP Home

XP Home is the basic system. It's stable, crash resistant, fast, and a powerful OS for your PC. Microsoft added many new applications to the basic OS, such as CD-ROM creation software, video editing, and more.

Windows XP Professional

XP Pro is essentially the same as XP Home, with some additions specific to business users. For instance, Pro handles multiple-CPU systems and caters to the specific needs of businesses with robust remote administration tools. The Pro version also offers a remote access feature, which allows you to call your computer through a modem or the Internet. You'll get the file encryption tools, and a strong backup and restore system.

Which Operating System is Right for You?

Comparing Windows 2000/XP and Windows 9*X*

As you saw in Figure 2, Windows 2000 looks just like Windows 9*x* at first glance. If you plan to run basic applications, or use your computer for e-mail and web browsing you'll hardly notice the difference between the two. But this all changes if you expect to get "under the hood" of either system. The internal differences are tremendous, and we've discussed those just a bit. You're probably not interested in the deep technical details of these differences, so instead we will take a look at how each operating system might be best for a given situation.

Objectives

- Decide which operating system is generally more suitable for a given situation; Windows 9*x*, Windows NT/2000, or Windows XP.
- Describe the basic differences between Microsoft's business-level operating systems and its consumer-level operating systems.

Hardware

Windows 95 and Windows 98 were designed to run on as many different types of computers as possible. The idea was to make Windows available to everyone, no matter what kind of PC you owned. Windows 95 can run on a 386 system, and Windows 98 can run on a 486. Neither OS requires a huge stack of memory, although your performance will certainly suffer when you work with less than 16 MB.

Windows Me is more demanding, requiring more powerful hardware than Windows 95 or 98, but not so much as required by Windows NT or 2000.

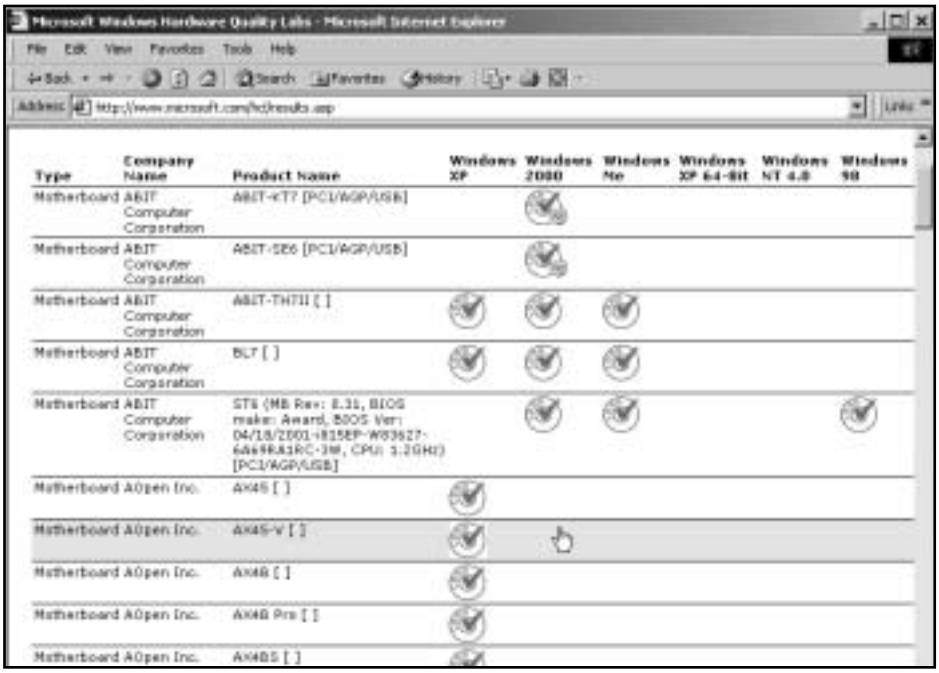


Figure 4
A partial listing of the Microsoft hardware compatibility list.

If you want to run Windows 2000 or XP "by the book," then you need to select a computer listed on Microsoft's *Windows 2000 Hardware Compatibility List* (*HCL*). The HCL is a list of hardware that has been tested and approved to work with Windows 2000 and/or XP. Microsoft created the HCL in part to reduce support costs. If you call them with a Windows 2000 problem and your hardware isn't on that list, you might not receive any support. The idea is that some low-cost manufacturers cut corners and offer hardware that doesn't work very well. In most cases, this hardware is simply designed inadequately. Microsoft can't make its OS work when the hardware is not designed or built properly, so they can't afford to waste time trying.

Fortunately, Windows 2000 and XP will run properly on many systems not listed on the HCL, but these will be the well-designed and well-built systems. If you are building or buying a system for a business, in the long run you won't save money by purchasing cheaper equipment that isn't listed on the HCL. Pay a few extra dollars and get the good hardware.

Windows 2000 and XP require more memory and hard drive space than any previous version of Windows. If you need to run a small system with a 2 GB hard drive and just 32 MB of RAM, you are better off with Windows 98. A good minimum for Windows 2000 Pro is 64 MB of RAM, a 350 MHz Pentium II CPU, and several gigabytes of available hard drive space. Windows XP has a lot more going on in the background, and the GUI is more complicated, requiring a faster CPU. Of course, you cannot buy machines with these slow CPUs today, but you might obtain one some day and wonder what OS might be best.

Where the Windows 2000/XP hardware requirements become difficult is when you start running large applications. For instance, Windows 9*x* can share memory space with several applications at once. Performance suffers

when you don't have sufficient RAM, but it isn't too bad. On the other hand, Windows NT/2000/XP keeps applications in separate memory spaces, each one protected from the other. Making this work requires plenty of RAM, but this is the main reason why Windows 2000/XP rarely crashes because of an application. If you don't have enough RAM in a 2000/XP system, the system slows down so much that it's almost unusable.

Device Support

Windows 95/98 was designed to work with as many different peripheral devices as possible. USB scanners, printers, cameras, memory devices of all kinds, old CD burners, and everything else you could ever attach, it will all work in Windows 9*x*.

On the other hand, Microsoft didn't consider device support their highest priority when Windows 2000 was first designed. Their priorities were stability, reliability, security, and management. Those four features tend to conflict with device support, because you can usually get one or the other. It's worth noting that Windows 2000 supports many more devices than Windows NT, which was renowned for its limited device support.

Keep in mind that Microsoft isn't the keeper of the hardware compatibility torch. The company that manufactures a device develops its own driver for a particular OS. They build these drivers to a series of specifications provided by Microsoft, and they have to follow the "rules for drivers." Essentially what this means is that the driver has to behave when it is running, and act a certain way when certain things happen, or Windows is going to shut it down unceremoniously. In contrast, Windows 9*x* can't stop a driver from accessing certain parts of the operating system, and a driver that misbehaves can crash the system, or at least force you to reboot to recover system stability. Windows NT/2000/XP simply doesn't allow certain behaviors.

The popularity of an operating system generally determines which devices are supported, and as Windows 2000 becomes more popular there are even more devices being supported, but the real old hardware will probably never work in Windows 2000 or XP.

Security

This one is easy: Windows 9*x* has no *real* security. The password screen you may see when launching Windows 9*x* provides nothing at all for security, it simply tells the OS who you are and what GUI settings it should use. There are a couple advantages to using a password to access Windows 9*x*, but in the end, anybody with a bootable floppy disk can get into your 9*x* system and do anything they want. You can purchase security software, and some hardware security devices as well, so security in Windows 9*x* isn't completely hopeless, but Windows 9*x* and security are not synonymous.

Windows NT/2000/XP can be easily configured with an extreme level of tight security. If you don't know the account name and password for a properly configured Win 2k machine, you're never going to get in. On top of that, the login you use may not allow access to certain areas of the system.

If you use the Windows 2000/XP login security, and if you use the NTFS file system (we'll cover that later) and implement folder encryption, nobody but you (or anybody who uses your login) can get to your files. You have to be careful here, because if you lose or forget your login, you can't get to your files either, and that means forever. This last situation is likely the reason the home version of XP does not contain encryption…it's a powerful and potentially dangerous tool.

Stability

We've mentioned stability before, but it's worth more discussion. You're a rare computer user if you've never had Windows 9*x* crash or lock-up while doing something important. In most cases, an application or driver does something wrong and causes a system problem, the entire system becomes unstable or locked up, and you need to reboot to make things work properly again. Some users experience this every day.

In contrast, when Windows 2000 or Windows XP is installed on a high-quality system from parts listed on the HCL, you may only reboot your system once per month, and only if you really want to reboot. There is little to compare between these two systems in terms of their crash potential.

In fairness to Windows 9*x*, it often becomes unstable because it will run on any old hardware. As discussed earlier, computer hardware *can* be built badly and have serious operational problems or design and/or manufacturing defects. A low-quality hard drive, cheap memory, or especially a bad motherboard, can all make Windows 9*x* unstable. Sometimes cost doesn't really determine what hardware is going to work properly, as the big manufactures sometimes build bad modules, too.

Windows 9*x* isn't perfect. But when you run an OS on bad hardware, that OS is going to perform badly no matter how well it was written. The intent of the HCL is to sort the junk from the well-built hardware. Microsoft is, in effect, asking the manufacturers to build higher quality hardware, then asking you to buy that high quality hardware in order to run the stable OS. It's worth the hassle and cost, unless you have lots of time to waste watching your system reboot two or three times each day.

It's also worth noting that if Windows 2000 or Windows XP won't run properly, or it locks up or crashes constantly or regularly, bad hardware is a real possibility. Naturally, you must eliminate software as a possible culprit first, but with name-brand software this usually isn't an issue.

Support

From everything you've read so far, Windows 2000/XP sounds like the best choice for many reasons. But there's one more consideration. When you install Windows 2000, you select an administrator. This user has complete control over most of the system, including who else can get into the system, when they can do it, as well as a dozen other options. This is good, unless the administrator makes a big mistake.

For instance, if the administrator password is lost, the system is going to be difficult or impossible to use. It's possible, although unlikely, that you could lose every bit of data on the hard drive. If the 2000/XP system requires a complex repair or restoration, you're might need someone with expertise in Windows 2000/XP, and that means it might cost you some real money.

Windows 9*x* is, generally, easier to fix when it breaks. You can always boot from a floppy, load some DOS drivers, and then copy your important data out to some other place before you reinstall the OS. That's an extreme repair, but it often works.

Windows 2000/XP doesn't break very often, but when it does you might have a lot of work or trouble ahead of you. If you use the NTFS file system (compare this to FAT or FAT32) and your system won't boot, you may be waving goodbye to your data and files—unless you locate an expert to help. Remember, the Windows NT/2000/XP security is strong, so if you blow something away there may be no way to get it back!

Data Storage Management

One of the fundamental tasks you have as a computer user is managing and organizing your information. To a large degree, this involves selecting and implementing a strategy for creating a hierarchy of folders. But if you are serious about your data, and if you happen to generate countless data files, you'll need to examine your storage strategies at a level one step higher. That is, you need to devote entire logical drives to data storage. This section explores those strategies and the methods for managing your data and hard drives.

Objectives

- Describe the process for examining the amount of free and used space on a hard drive.
- Explain the benefits of segregating your data files, applications, and system files.
- Describe the differences between the FAT and NTFS file systems.
- Explain the basic functions and issues associated with the use of file compression and encryption.

Hard Drive Partitions

Two things can make you frustrated while you're doing serious work on your Windows machine. Well, maybe there are a couple dozen things, but let's focus on two that we can do something about. The first frustration is losing a file or document. This one is bad because you just *know* you saved or downloaded the file, but it's not where it's supposed to be. In other words, it's lost. The other frustration, one that's a bit more serious, is running out of disk space. This can cause fatal problems on earlier versions of Windows, including the corruption of the entire hard drive. Running out of space isn't going to crash Windows 2000 or Windows XP, but it just might ruin your day.

Keeping your files, applications, and system organized is worth the time and effort required, especially when something goes wrong. One proven strategy is to keep all your creative work, documents, and downloaded files, in obviously-named folders on a separate drive letter. Part two of this strategy is to keep an eye on the drives to make sure you don't run out of space.

Notice the previous paragraph is says, "drive letter" as opposed to "drive." There's a big difference between the two, as a single hard drive can have more than one drive letter assignment. In effect, you can have several "drives" on the same physical disk. Let's look at how that's possible.

A single hard disk drive, or *HDD*, is always given a letter. Sometimes this drive/letter combination is called a *volume*, especially in Microsoft's documentation. Since they first appeared in PCs, the first hard drive in a system is assigned the letter "C." (Why C? Before hard drives, computers had a single floppy drive, which was called the A-drive. Eventually users added a second floppy, which was called the B-drive. Then hard disks appeared on the scene, and they acquired the next available letter.) Those first hard drives were small and expensive 5 MB drives, so your "C-drive" could store a total of about 5 MB of data, less some overhead. You couldn't just plunk it in the computer and the drive would be ready. No, first you had to prepare a hard drive for use in a PC, which, to this day consists of configuring the drive with a *partition* and then formatting the drive with the tools provided with the OS. When these first HDDs were being used there was a single type of partition, a scheme called the *File Allocation Table*, or *FAT*. The FAT kept track of files and directories; it acts like a directory the OS can use to locate files on the hard drive's disks.

The FAT scheme was fine for small drives, but it used a 16-bit addressing method. That eventually became a problem as hard drive capacities passed the 2 GB point, because a 16-bit address doesn't have enough bits to handle the amount of data stored on drives larger than 2 GB. A partition that uses the FAT, or as it is known today *FAT16*, cannot be larger than 2 GB. So, what do you do if you have a 4 GB drive?

The answer is to create two partitions on the same physical drive. Each partition has its own FAT, so you can create several partitions on a drive as long as none of them are larger than 2 GB. In addition, each partition also has its own drive letter assignment, making D-drives and E-drives commonplace. But drives keep getting bigger, and the idea of having five or six partitions for your 10 GB drive makes data storage a confusing mess!

FAT32 and NTFS

Late in the life of Windows 95, and along with the first version of Windows 98, Microsoft included a tool that could create a new type of FAT. This new FAT used 32-bit addressing, which allowed for partitions as large as 2,048 GB. (That's 2 terabytes, or 2 TB.) Naturally, this new FAT is called *FAT32*. FAT32 has several additional technical advantages, so today it's the type of partition usually used by Windows 98 and Windows Me. Drives can be converted from FAT16 to FAT32 with a special conversion tool included with Windows 98. It takes several hours to convert the average 2-4 GB drive, but when you're done you should end up with a drive containing a lot of additional free space, maybe a few hundred MB.

There's another type of partition used by Windows systems, one created specifically for Windows NT. The *NT File System*, or *NTFS*, has several features that make it the partition of choice. Unfortunately, NTFS partitions can only be used in systems running Windows NT, Windows 2000, or Windows XP.

NTFS is one of the reasons NT-based computers are so reliable and secure. NTFS uses a complicated system to keep track of your files, a system based on redundancy and constant double-checking. With a FAT16/32 system, it's possible to destroy the entire HDD data structure with a well-timed press of the computer's reset button. In contrast, you will have a hard time causing trouble on an NTFS disk, either accidentally or intentionally.

NTFS also provides for security by allowing files to have several new security-specific attributes. FAT always allowed a few file attributes, such as *hidden* or *read-only* (protected from erasure), and in addition NTFS can restrict access to files depending upon your login. It can also encrypt files, making them impossible to access without proper authorization.

All versions of Windows can read and use FAT16 partitions. Similarly, Windows 98, Windows Me, Windows 2000, Windows XP, and certain versions of Windows 95 can also read and use FAT32 partitions. But NTFS partitions can only be used under Windows NT, Windows 2000, and Windows XP.

How can you tell what type of partitions are used on your drives? There are several ways to get at this information, but here's a simple one: Open Windows Explorer, and right-click on any hard drive volume. Select Properties from the menu, and you'll see a Drive Properties dialog as shown in Figure 5.

Figure 5
Properties of a typical system drive in Windows 2000.

Using Partitions to Organize Your Work

With that vital background about partitions behind us, Windows 2000 systems can have several physical HDDs, each with as many partitions as necessary, and each with the partition type of your choice. The trick is to create enough partitions in a system to both save time and make easy backups, without having so many that you get confused when you search for your data.

Let's look at an example. Say you have a 20 GB hard drive in the system. A tried-and-true strategy is to separate this drive into two or three partitions. (PowerQuest has a tool called PartitionMagic, that can convert drives, and resize them without reinstalling the OS or removing the data.) The first partition could be around 5 GB. This partition, sometimes called the *system partition*, will contain the entire operating system and all your applications. The actual size of this partition depends upon how many applications you load and their size. The second partition, which can be any size, is reserved for all your data files and downloads.

What you end up with is a pair of drive volumes that separate the OS and applications from your data. This arrangement provides several benefits. First, keeping the data separate makes backups very simple; just point at the data partition and back up the whole thing. Second, if your operating system ever crashes or needs reinstalled or upgraded, you simply erase the system partition and reinstall it from scratch. Then you can reload your applications, and your data is safe and sound and ready when you are. Third, a separate data partition is the first step in organizing your work. Whenever you save a file or download a driver or update, you will soon be pointing automatically to that data partition. If you have to search for a file, you know it will be on that special partition.

Depending upon the type of work you do, sometimes a third partition can also be implemented as a long-term storage location. This way your data partition contains all your current work in a convenient location. As you complete projects or move onto other things, you can move the project data files into the storage drive, and begin a new project with a relatively clean drive.

Examining Drive Space Usage

There's an old saying in the computer business that goes "Data will expand to fill the available space." When you think about the fact that you can easily run MS-DOS on a 20 MB hard drive, that you can run Windows 95 on a 200 MB hard drive, and that you need at least 1.5 GB to load Windows XP, you'll see that even Microsoft is subject to this "law of data storage." And as you may be aware, some games and utilities can use hundreds of megabytes for data storage.

You need to be aware how much space is available on your drives. Running out of hard drive space can cause trouble, although in most cases it simply prevents you from doing work on your system. Checking the available space on a drive is a simple process. As shown in Figure 6, open Windows Explorer. In the left pane select any hard drive volume. Then make the window large

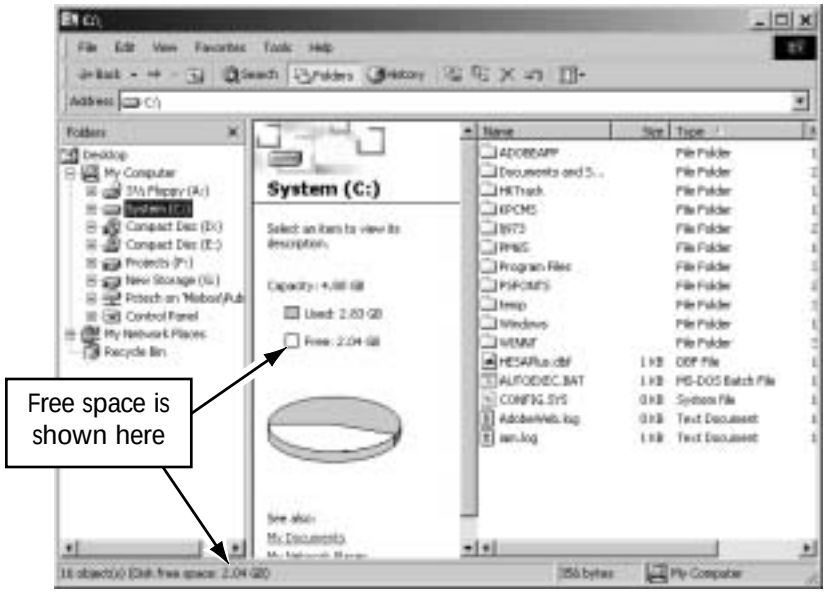


Figure 6
Checking hard drive free space in Windows Explorer.

enough that you can see the graphic display in the right pane. You should also notice that the free space is also shown at the bottom of the Window, in the Status Bar. The status bar shows this detail whenever you have selected a storage device in the left pane.

You can dig another level deeper by viewing the drive properties, just like you did to see the partition type. The Drive Properties dialog provides access to many different tools, most of which you'll probably never use.

Disk Defragmenter

When a hard drive is partitioned it is subdivided into smaller sections called *sectors*. Sectors can be various sizes depending upon the partition type and the size of the drive, but a 4 KB sector is typical for a 10 GB FAT32 volume. As you store a file on the hard drive it is divided and placed into these sectors. For example, a 23 KB file is split into five 4 KB pieces and one 3 KB piece, then placed into six consecutive, or *contiguous* sectors. Larger files are split into more pieces as necessary, and the FAT keeps track of where each piece belongs. (On NTFS volumes, the *MFT*, or *Master File Table* handles this function.) As you use your computer you will create and delete many files and folders. Along the way the OS will create dozens of temporary files, and create all sorts of permanent files used by the system itself. This file activity is almost continuous.

After a while the drive will have small group and individual sectors available all over the place. When a file needs to be saved the OS won't always search for a suitably sized group of contiguous sectors, instead it places the pieces of the file in the first available slots (sectors) it finds, wherever those slots happen to be. Then it looks for the next available slots and places all the parts that fit into that slot, and so on. A file could be split into parts located all over the hard drive, which happens all the time.

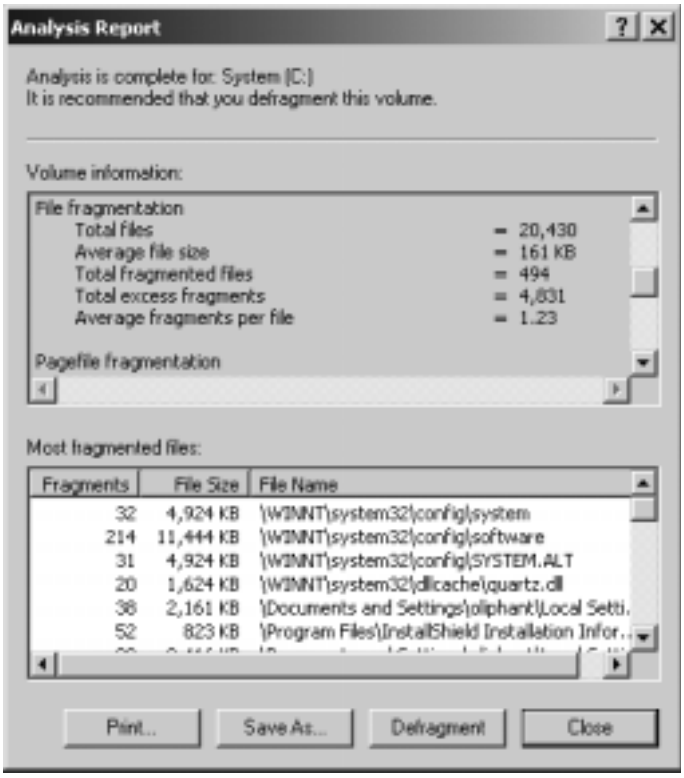


Figure 7
The drive defragmentation report.

When a file is split apart across a drive in this manner, a file is said to be *fragmented*. A fragmented file isn't a problem, in fact you cannot avoid having fragmented files nor is it worth the effort to prevent them. The FAT and MFT can handle this fragmentation without any trouble or complaints. However, as a drive becomes increasingly fragmented it will spend more time putting the file pieces together, and your drive will appear to be slower. Occasionally you need to *defragment* the hard drive, using a Windows tool called, obviously enough, *Disk Defragmenter*.

Defragmenting the drive is something you do every month, or even less frequently. The schedule depends upon how much the machine is used. Some computers have never been defragmented, and these systems will require several hours to be fully defragmented. In addition, Windows 98 and Windows Me offer a special option, where the files you use most often are moved to the fastest part of the disk. This option takes even longer, in some cases three or four hours depending upon the size of the drive.

Back at the Drive Properties dialog in Windows 2000/XP, shown in Figure 5, if you select the *Tools* tab the Defragment tool is at the bottom. From here you select the drive you wish to examine, then click the *Analyze* button. The defragmenter checks the drive to determine how many of the files are fragmented, and advises you whether it's a good idea to defragment or not. Before you choose to follow the advice or not, you can click a button labeled *View Report*, where you'll see a detailed analysis of the drive's fragmentation status, as shown in Figure 7.

The tools for defragmenting drives in Windows 9x are a bit different, but in general they work the same way. Regardless of the OS, here are some guidelines you should follow when defragmenting a drive.

- Turn off screen savers and any programs that run automatically.
- Shut down *all* open programs.
- Don't defrag too often, it's not necessary and may cause the drive to work harder than necessary.

Data Compression

NTFS includes two additional tools that can be extremely useful if you need more space or tight security. File compression tools have been around forever, starting with the legendary PKZip. PKZip was a DOS-based program with a difficult interface, but performed many valuable tasks—once you figured out how to use it. WinZip is the most popular Windows-based file compression tool, and you'll find WinZip on virtually every power-user's system. Stacker was a different type of compression tool that compressed your entire hard drive. Stacker was an amazing product during a time when hard drives were expensive and storage space was at a premium. It was eventually incorporated into MS-DOS, after a court battle between the two companies. Since Windows 95, all versions of Windows have included drive compression tools. They work, but one characteristic is shared among them all: compressing a drive can severely restrict the performance of your system. Hard drives are now so inexpensive that there is little need for full-drive compression tools and the headaches they create. However, compressing files and folders is often necessary in order to send them as e-mail attachments.

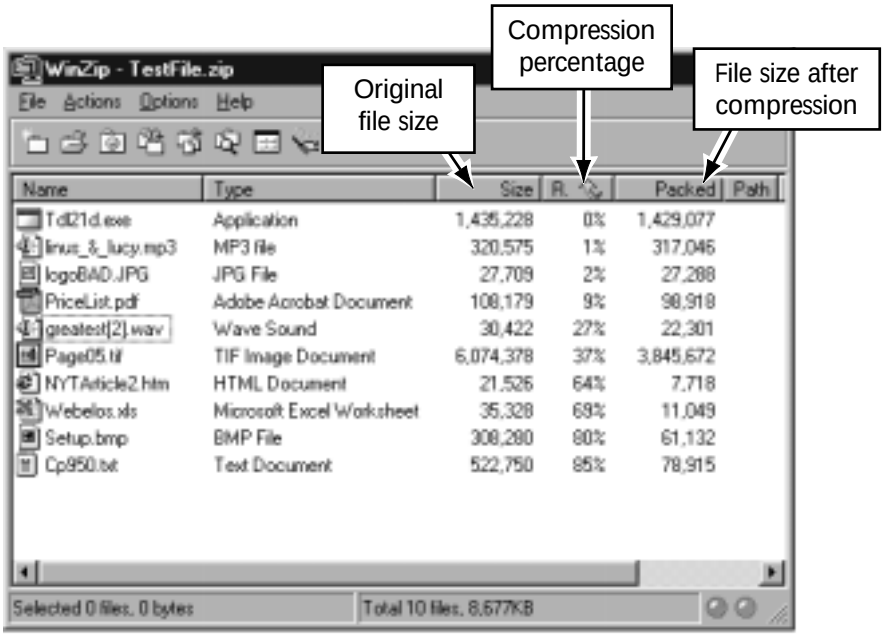


Figure 8
A collection of file types showing typical levels of compression.

On NTFS volumes with Windows 2000/XP, you can compress files or folders by opening the properties dialog for the object and clicking the *Advanced* button. Place a check-mark in the *Compress Contents...* box, and the object is automatically compressed. You can continue to use the file/folder just like nothing had changed, however the system has to uncompress and recompress a file every time it is accessed. This requires time, although on a fast system you might not notice the difference.

The amount of space you'll save by compressing files varies, depending on the type of file. Text files are highly compressible, as are certain graphics files. Some graphics files are already compressed, such as JPEG, GIF, PNG, and various TIF files. These formats will not compress much further. Other types of files that don't compress effectively are EXE and the Microsoft Office versions of DOC, XLS, and PPT files. Figure 8 shows the contents of a compressed file. As highlighted, some of the files compress well, and others compress little, if any at all. The results shown are typical of these file types. Occasionally you might compress a collection of files in order to make an e-mail or other transfer easier, where all the files are compressed into a single file. The recipient can then uncompress the file, expanding the data to its original form.

The integral Windows 2000/XP compression tools can't do that, but a compressed folder can save hard drive space if you store numerous compressible files.

Data Encryption

The NTFS file system, all by itself, adds a significant barrier to intruders. However, dedicated snoops can get through the basic NTFS security door. What stops them dead in their tracks is file encryption. An encrypted file cannot be opened or changed by anyone except those logged users with the proper permissions. A snoop who copies an encrypted file has no hope of ever viewing the contents of that file.

As with compression, folders are encrypted transparently; as a user you can't see this happen, or know that the file was encrypted unless you check its properties. Encryption is strong, and there's *no way* to break into an encrypted file. If you encrypt something, then lose that user login or forget the password for that user, you might as well delete the encrypted files and forget about them. Be careful with encryption and only use it where necessary. It is an extremely powerful tool, and as with all powerful tools you need to be aware of all the issues and risks.

Unit Summary

The choice of operating systems is largely determined by the manufacturer that builds your computer system. In other cases, Microsoft controls the availability of systems, leaving you with no choice at all. Once you have settled on an OS, then you can move forward and design a data management strategy that is efficient and organized.

Lab 5-1

Windows 2000 Configuration

The Control Panel in Windows 2000 allows you to configure virtually every computer function from a central location. Moreover, the Windows 2000 Control Panel changes to meet the requirements of the installed system. As the system grows, the number of managers increases.

You have already used some of the Control Panel managers in earlier labs. Although you may not have accessed them all directly through the Control Panel, they remain Control Panel managers. For example, the desktop properties menu option runs the Control Panel Display manager.

We will not describe all of the Control Panel managers in this lab. We'll save a few for later.

Objectives

At the end of this lab, you will be able to:

- Select and Configure the available options in several Control Panel managers including: Regional Settings, Keyboard, Mouse, Sounds and Multimedia, and Accessibility.
- Determine the version number of Device Drivers.
- Determine the resources used by a particular device.
- Access the Microsoft Troubleshooting procedure for a device.

Materials Required

To complete this lab, you will need a computer with Windows 2000 Professional installed. A system that still retains most of the default installation settings will work best.

Procedure

Accessing the Control Panel

1. Turn on the computer. You should now be looking at the Windows 2000 Desktop.

2. Double-click on the icon, *My Computer*. Then, double-click on the icon *Control Panel*. This is the first way to open the Control Panel.

3. Right-click on the *Start* button. In the menu that opens, click on the option, *Explore*. Find the *Control Panel* icon near the bottom of the left window pane. You may have to scroll to the bottom of the pane to see it. Double-click on the *Control Panel* icon. This is the second way to open the Control Panel. You now have two copies of the Control Panel open.

4. Look at the second copy of the Control Panel, the one with two window panes. Do the icons in the right window pane work like the icons in the Control Panel window you opened earlier? To find out, double-click on the icon, *Regional Options*. You will see a window similar to the one shown in Figure 1.

5. Go to the first Control Panel window. Then, double-click on the icon, *Regional Options*. Did the *Regional Options* window change? _____

Figure 1
The Regional Options Properties window.

6. Minimize all of the open windows except the *Regional Options* window. Drag the *Regional Options* window off to the side a little. Do you find a second *Regional Options* window hiding underneath? _____

   You shouldn't find a second window. That's because the first window replaced the second. You can't open multiple *Regional Options* windows.

7. Go to the Taskbar and restore the minimized Control Panel window that you opened from the icon, My Computer.

8. The third method of opening the Control Panel is the one you will probably use most often. Click on the *Start* menu, select the *Settings* option, and then click on the subordinate option *Control Pane*l. How many Control Panel windows are open on your desktop? _____

   Now that you know several ways to access the Control Panel, let's take a look at the Control Panel managers.

The Regional Settings Manager

9. Minimize the open Control Panel window.

10. In the *Regional Options* window, you identify the region where you are located in the first page. When you installed Windows, you told it the region of the world where you were located. The data in the rest of the pages of this window are preset to match the region. But just as before, you can make many changes to this data.

11. Select the *Numbers* page in the window. Open each of the text list boxes and checkout the optional choices for the number system. Close each box when you are finished with it.

12. Select the *Currency* page in the window. Open each of the text list boxes and checkout the optional choices for the currency system. Again, close each box when you are finished with it.

13. In similar fashion, select and examine the *Time* and *Date* pages in the window.

14. Select and examine the *Input Locales* page. This page allows you to add additional languages that are loaded each time the computer is turned on. It also allows you to set up a hot-key sequence for switching from one language to the other.

    As you can see, you can make global language properties changes, or individual language property changes. The first is through the General Regional Options page, the others are through the individual properties pages: Number, Currency, Time, Date, and Input Locales.

    Close the *Regional Options* window by clicking on *Cancel.*

The Mouse Manager

15. Restore the Control Panel window.

16. Double-click on the *Mouse* icon in the Control Panel window to open the *Mouse Properties* window. You should see a display similar to the one shown in Figure 2.

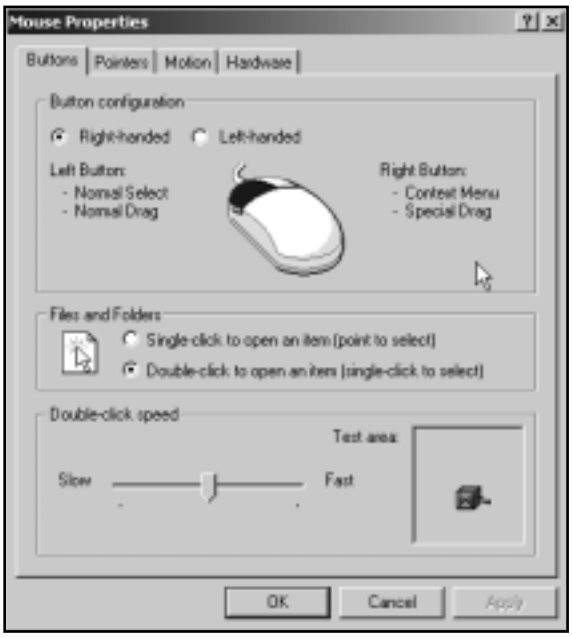


Figure 2
The Mouse Properties window.

17. This properties sheet is a good example of a Control Panel manager which is customized for a specific piece of hardware. Although this manager has many common attributes, some of the contents of the mouse manager are specific to this particular mouse. Other manufacturers may have more or fewer options. Figure 3 shows examples of Microsoft and Logitech Mouse Properties windows. Compare the three mouse managers.

18. These windows provide properties pages where you can define how the mouse works. On your computer, the Buttons page allow you to adjust several important characteristics of the mouse. Perhaps most important is the top option which allow you to configure the mouse for right-handed on left-handed operation. With the option *Right-handed* selected, the left mouse is used for *Normal Select* and *Normal Drag*. In other words the left mouse button is normally used for selecting and dragging items.

19. Select the *Left-handed* options and notice that the purpose of the left and right mouse buttons are reversed. Since this and most other books are written for the *Right-handed* option, be sure that the *Right-handed* option is once more selected before leaving this window.

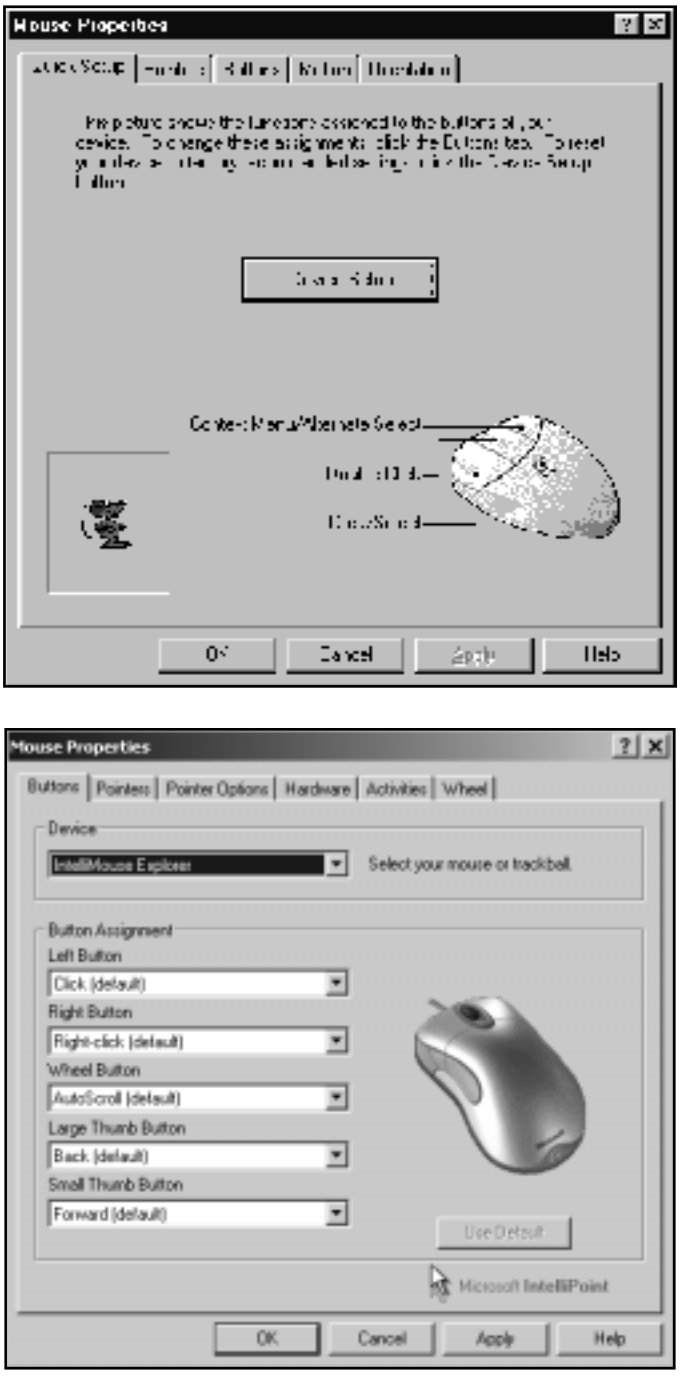


Figure 3
The Logitech (Top) and Microsoft (Bottom) Mouse Properties windows.

20. The *Files and Folders* section determines how you select and open files and folders. Read over the two options, then make certain that the *Double-click to open an item (single-click to select)* option is selected.

21. You may test and adjust how Windows responds to how fast you double-click your mouse button. The Test area contains an animation. If you double-click too fast, or too slow nothing happens. If your speed falls within the acceptable range, the "jack-in-the-box" opens. Double-click a second time and the "jack-in-the-box" closes again. You adjust the speed range with the slider control. Try adjusting the control and testing the result. When you are finished, adjust the control to whatever is most comfortable for you.

22. Select the *Pointers* page. You will see a list box near the top of the page, labeled *Scheme*. This is where you select a predefined Windows scheme, or label a pointer scheme that you have created. Right now, there is no scheme selected.

    Below the Scheme list box is a large scroll box. The scroll box shows all of the pointers that Windows uses in the selected configuration. It also describes the purpose of each pointer.

23. Select the *Motion* page. This is where you control how the mouse moves and how it looks as it moves. The first slider control allows you to regulate the distance the pointer moves for the distance you move the mouse. The *Fast* setting of the Speed slider makes the pointer move further for a given amount of mouse movement than the *Slow* setting. Experiment with different slider settings to see the effect. When you are done, put the slider where it feels most comfortable.

24. The second control on the Motion page adjusts how much the pointer accelerates as you move it faster. Alternately select the *Low* and *High* settings and try moving the mouse across the mouse pad. Start slow and accelerate as you move the mouse. See if you notice a difference in the way the pointer responds to the movement of the mouse. When you are done, select the *Low* setting.

25. The idea behind the *Snap to default* option is to save you time by having the pointer automatically go to the default button each time you open a new dialog box. Some people like it, others prefer that the pointer stay where it was placed. For now, make certain that the *Move pointer to the default button in dialog boxes* is **not** checked.

26. Select the *Hardware* page. Notice that it gives you some additional information about the mouse. In particular notice the *Device Status* statement that says: *This device is working properly*. Obviously this is what you would like to see. If the mouse does malfunction for some reason, you may have some luck with the built-in Troubleshooting procedure. Click on the *Troubleshoot...* button.

27. If you found your way here, Windows 2000 assumes that you are having problems with your mouse. Click on the *Next* button and quickly read over the procedure without clicking on any of the hot words. It gives you some simple advice about being certain you are using Windows 2000 drivers, etc. Close the *Windows 2000* window. Troubleshooting procedures like this are available for most of the devices on the computer.

28. Back at the *Hardware* page, click on the *Properties* button. The *PS/2 Compatible Mouse Properties* dialog box opens. While you need not examine all the pages now, the *Driver* and *Resources* pages are particularly important.

29. Select the *Drivers* page as shown in Figure 4. This tells you the provider and version number of the device driver for the mouse. The device driver is a small program that makes the mouse work with this particular computer. The buttons at the bottom of the page give you additional information, allow you to uninstall the current driver, and allow you to update to a new or better driver. A page like this is provided for every device that uses a device driver.

30. Select the *Resources* page as shown in Figure 5. We will talk more about resources later. For now notice that the mouse uses Interrupt Request (IRQ) number 12. Many devices require Interrupt Requests (IRQs) and only a limited number of IRQs are available. A very common cause of trouble is an *IRQ conflict* in which two devices attempt to use the same IRQ. When this happens neither device will work. Notice that the statement at the bottom of the page tells you that there are no conflicts.

Figure 4
The Mouse Driver Properties page.

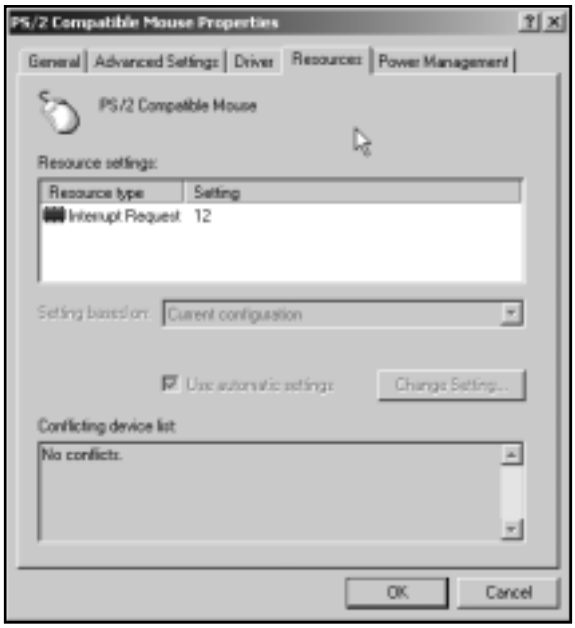


Figure 5
The Mouse Resources Properties page.

31. Close the *PS/2 Compatible Mouse Properties* dialog box.

32. Close the *Mouse Properties* window—click *Cancel*.

The Keyboard Manager

33. Double-click on the Keyboard icon in the Control Panel window to open the Keyboard Properties window. You should see a display similar to the one shown in Figure 6.

34 The Keyboard Properties window has three properties pages: *Speed*, *Input Locales*, and *Hardware*. The Speed page is divided into two sections. The top section uses two sliders to control the Character repeat functions. The first is the delay from the time when you press a key to the time when the key character, or function, begins to repeat. The second is the rate that a character, or function, is repeated. You can test the relationship between the two sliders in the text box just below the sliders.

35. The third slider on the Speed page regulates the cursor blink rate. Move the Cursor blink rate slider back and forth and observe the results. Then, adjust for a cursor blink rate that works for you.

36. Select the Input Locales page. This is where you tell Windows what language character set to use. You can see that English (United States) is the default, and only, character set in the Language list box. Because there is only one language listed, several of the options and buttons on the page are grayed-out. Add another language to the list, and that will change.

37. Select the *Hardware* page. Notice that it looks a lot like the Mouse Hardware page you examined earlier. It give you access to a Troubleshooting procedure. But for now click on the *Properties* button. What Interrupt Request number does the keyboard use? _____

39. Close the two Keyboard Properties windows without changing any of the current settings—click on the *Cancel* buttons.

The Accessibility Options Manager

40. Back at the Control Panel, double-click on the *Accessibility Options* icon. The *Accessibility Properties* window will open. This Control Panel manager allows you to modify the operation of the four interface areas of the computer to accommodate many different needs.

    There is much to explore in this area if you have time. Should you ever have the need to configure a system for a user who cannot press the various key combinations necessary to navigate through Windows 2000, this is the place to look.

41. Close the Accessibility Properties window—click on the *Cancel* button.

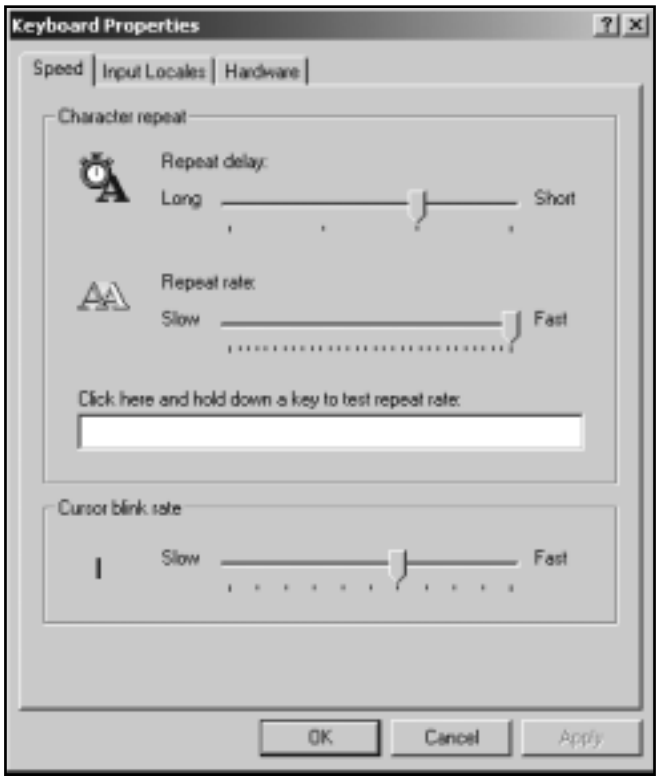


Figure 6
The Keyboard Properties window.

The Sounds and Multimedia Manager

42. Double-click on the *Sounds and Multimedia* icon in the Control Panel. You should see a display similar to the one shown in Figure 7. At the Sounds page notice the scroll box listing all of the Windows events and the associated sounds. Just below that is the area where you may change the sound associations. It's grayed-out right now because you don't have an event selected. Near the bottom of the window is the list box where you may change from one sound scheme to another, or name the sound scheme you just created.

    Right now, there is no sound scheme selected, because you do not have a sound card installed.

43. Open the Schemes text box list and look at the available choices.

    Ideally, if you are into sound schemes, you would select a scheme, use it a couple of days, choose another for a couple more days, and so on. After you listened to each scheme, you would install your favorite and possibly modify it.

44. Select the *Audio* page. Here you can select the best card for *Sound Playback*, *Sound Recording*, and *MIDI Music Playback*.

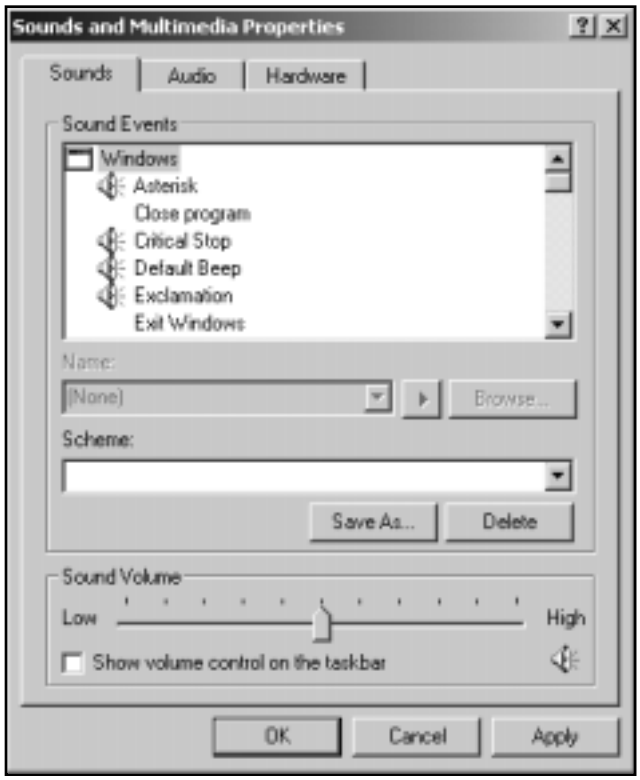


Figure 7
The Sounds Properties window.

45. Select the *Hardware* page. Here additional information is available about the sound and multimedia features that are built into this computer. If you have time you may investigate some of them.

46. This concludes the lab. Without making any changes, close all open windows, whether they are minimized or not. Then, shutdown the computer.

Discussion

This lab demonstrated and described the features and functions of several of the Control Panel managers that deal with the look, feel, and sounds in Windows 2000. You will study several more Control Panel Managers in future labs.

Lab 5-2

The Windows 2000 File System

This lab has two specific goals. First, you will look at the features and utilities found in the *Local Drive Properties* menus. Then you will demonstrate the unique capabilities of the Disk Manager. You will create a new logical drive partition, name and size it, mount it to an empty NTFS folder, hide it from the list of drive letters, and finally, delete the drive.

Objectives

At the end of this Exercise, you will be able to:

- Identify the purpose of the Check Disk and "Defrag" Utilities included with Windows 2000.
- Identify the purpose of the Backup, Restore, and Emergency Repair Disk utilities of Windows 2000 and explain where each is located.
- Describe two ways to access the Disk Manager in Windows 2000.
- Use the Disk Manager to create and delete a disk partition, format a partition, and change the partition name, drive letter, or path.

Materials Required

To complete this lab, you will need a computer with Windows 2000 Professional installed. A system that still retains most of the default installation settings will work best.

Procedure

Exploring the Disk Utilities

1. Turn on the computer. You should now be looking at the Windows 2000 Desktop.

2. Double-click *My Computer* to display the drives and system folders of your computer. Right-click on the Local Disk (C:) icon and select *Properties*. You will see a properties window similar to Figure 1. What is the file system? _____ How much drive space is used? _____

3. Note that there are six selection tabs in this window. We will discuss only the first two tabs in this lab. The first tab shows the general characteristics of the drive, the second provides access to some drive management tools.

4. Click on the *Tools* tab. You will see a window like the one shown in Figure 2. Let's see what you can do with these tools.

Figure 1
The Drive C Properties widow in Windows 2000.

5. Click on the *Check Now* button. What is the name of the application that provides error checking? _____
What tests may this application perform on a drive? _____
_____
_____
_____

6. Without placing a check mark in either of the option boxes, run the application by clicking the *Start* button. The program examines the file system for errors, but it does not fix them. If you want to fix any errors, you must put a check in the top option box. How many test phases were performed? _____ Close the *Disk Check Complete* message window by clicking *OK*.

7. Click on *Check Now* again. Look at the two check boxes and read what they do. We will not run these two repair functions because they require too much class time. However, when the computer is used regularly, you should occasionally run the *Check Disk* in order to repair the inevitable disk errors that occur.

   Close the *Check Disk* window by clicking on Cancel.

Figure 2
The Drive C Properties window Tools tab.

8. Back at the *Local Disk (C:) Properties* window, click on the *Backup Now* button. Read over the Welcome tab. Three tools are described here, the *Backup Wizard*, the *Restore Wizard*, and the *Emergency Repair Disk* option.

9. What is the purpose of the Backup Wizard? _____
_____

10. What is the purpose of the Restore Wizard? _____
_____

11. What is the purpose of the Emergency Repair Disk option? _____
_____

    It is a good idea to create a new Emergency Repair Disk (ERD) periodically as your system changes. The more recent your ERD, the more up-to-date representation you will have when calamity strikes.

12. If you had a large backup storage device attached to hold the backup, we could run the Backup and Restore Wizards. Since you don't have a backup storage device, let's look at the Backup tab instead. Click on the *Backup* tab. This is where you would select the drive, folders, or files that you want to backup. Here you have a little more control over your backup than the Backup Wizard gives you. Frequent backups are the best way to insure against permanent loss of valuable data.

13. Click on the *Restore* tab. This is the tab you use when you wish to restore the data that you backed up earlier. Here again, you have slightly more control than that provided by the Restore Wizard.

14. Click on the *Schedule Jobs* tab. A calendar showing the current month appears with today's date highlighted. Double-click on next Saturday's date. The Backup Wizard appears allowing you to schedule an automatic backup for next Saturday. We won't do it now, however. Close the Backup Wizard by clicking *Cancel*. Close the *Backup* window.

15. Back at the *Tools* tab of the *Local Disk (C:) Properties* window, click on the *Defragment Now* button. Over time disk drives become fragmented as files are broken into pieces to fill available disk spaces. Occasionally, you need to defragment drives to put the files back together so that they can be accessed more quickly. All versions of Windows provide tools for this purpose.

16. Click on the *Analyze* button. When the *Analysis Complete* message opens, click on the *View Report* button. The Analysis Report window provides information about Local Drive (C:). When the drive is fragmented, it lists the most fragmented files, the number of file fragments, and the size of the files.

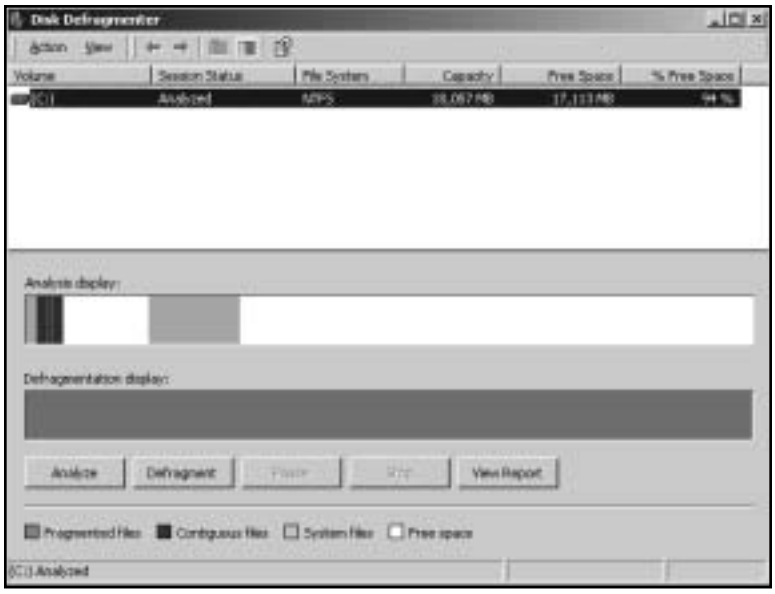


Figure 3
The Disk Defragmenter window.

17. Close the Analysis Report window. Now you can see a ribbon graph like that shown in Figure 3 that identifies the location of the fragmented and unfragmented files. There probably isn't enough fragmentation to warrant defragmenting drive C at this time. Close the application, then close all other open windows.

Using the Disk Manager

18. Windows 2000 has a wonderful graphical tool for managing disks, called *Disk Manager*. There are two basic ways to get to the Disk Manager. The first one involves the Start menu. With your mouse, select Start, Programs, Administrative Tools, Computer Management, Disk Management. This will open a window like the one shown in Figure 4.

19. If you can get to the *My Computer* icon on the Desktop, there is a faster way to open the Disk Manager. Close the currently open Disk Manager, and we'll show you how.

20. Right-click on *My Computer*, select *Manage*, and then *Disk Management*. Again, you should see a display similar to Figure 4, on the next page.

21. Drive C (also known as a partition or a volume) is represented by an icon at the top of the window and by a long narrow band at the bottom.

22. Right-click on the drive C icon at the top of the window. You will see a selection box similar to Figure 5. These are the functions you may perform on logical drive C. The first option displays the contents of the drive. The second opens an Explorer window with the focus on Drive C. The third is grayed-out at the moment. The fourth allows you to change the drive letter and path to the drive. The next two options are grayed-out because you aren't allowed to perform these functions on the boot drive. The Properties option is just like the drive Properties options you saw earlier—it's just another way to get to those options. The Help option opens Windows Help at the "Disk Management overview" location. These are only a few of the capabilities of the Disk Manager. Through it, you can also add, remove, and combine disk partitions and volumes.

23. Disk 0 is the physical hard drive that contains logical drive C. The graphic view of Disk 0 shows a block labeled drive C and another labeled *Free Space* or *Unallocated* space. We deliberately left some unused space on the drive to illustrate a point. This naming of unused drive space is controlled by how Windows 2000 was installed. If it is installed in the normal fashion from the Windows 2000 Professional CD, you will see *Free Space*. If the operating system was installed using the Restore Data CD, you will see *Unallocated* space. The differences are subtle and we need not belabor them here. No matter how your system is organized at this time, you can use that space to create one or more additional drives (volumes). To see what we mean, right-click on the graphic view of drive *Free Space*, or *Unallocated* space, as the case may be. This will display a menu with three options. If you are working with *Free Space* you will see the options Create a Logical Drive, Delete a Partition (option disabled because there is no partition to delete), or Help. If you are working with *Unallocated* space you will see the options Create Partition, Properties, and Help. Select the first option, *Create a Logical Drive* or *Create Partition*. This will start the *Create Partition Wizard* to assist you in the operation. The same wizard is run for either option.

24. After you read the opening window, click *Next*.

25. Read the contents of the window and click *Next*. Be sure that *Primary partition* is selected.

26. Read the contents of the window and click *Next*. In the next window, select a disk space of 1000 MB and click *Next*.

27. In this window you have several options as to how the drive may be accessed. Accept the default option of assigning a drive letter, and accept the drive letter *E*. Click *Next*.

28. Again, you have several options with regard to the drive format. You want the drive formatted NTFS. Keep the default allocation unit size. Change the volume label to *Alpha*. Ignore the other options. Click *Next*.

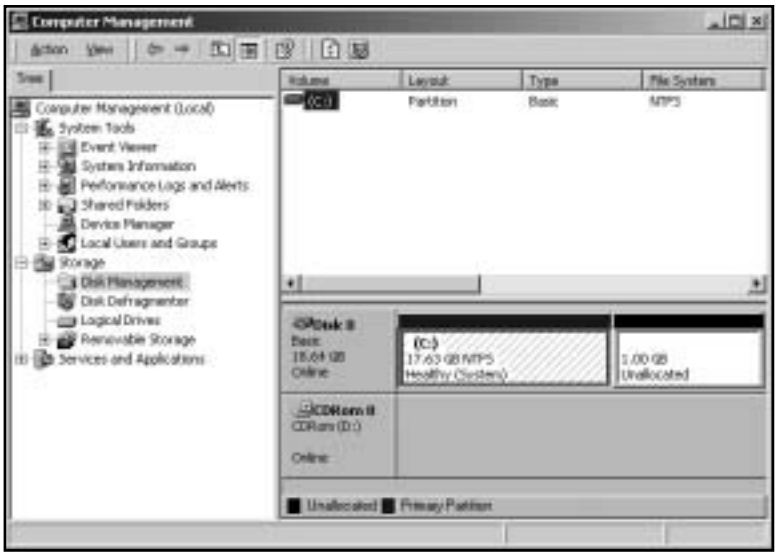


Figure 4
The Computer Management Disk Manager.

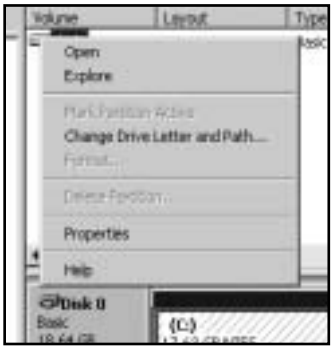


Figure 5
Drive specific Disk Manager functions.

29. This last page summarizes what you have done thus far. It's time to finish the job. Click *Finish*. (You may receive a warning message if you are creating a *Primary Partition*. Read the message, then click *Yes* to close the message box and finish the process.) This will take a few minutes. While the partition is being created, the cursor will show an hourglass. The hourglass will turn back into a cursor arrow after the partition is created. You may also be asked to allow a system restart, so you should allow that restart.

    The new drive letter and the drive size will also appear in the Disk Management display. But, the drive name and file format will not appear until after the new drive is formatted. The only indication that something is happening is that the "Formatting percent" will count up in the graphic image of the new partition. (About this time you may also get another warning message if you are creating a *Primary Partition*. Read the message, then click *Yes* to close the message and allow the process to finish.) Wait for the drive name to appear, and the word "Healthy" replaces the word "Formatting." That tells you the process is complete.

Every so often, the *format* process fails. This creates an error message telling you the request cannot be completed. If that should happen, click the *OK* button to close the message box. Then, right-click the graphic for logical drive E and select the menu option *Format*. Enter the Volume label *Alpha*, leave the File system set to *NTFS*, and the Allocation unit size set to *default*. Click *OK* to format the logical drive. Click *OK* to clear the message warning you that formatting a drive is dangerous.

After the format process is complete, you will have a new logical drive called *Alpha* that's formatted with the NT File System. Note that the two *Primary Partition* messages you may have received do not apply to your system because the partition you just created is after the partition that holds the Windows 2000 operating system. Therefore, the boot partition did not actually change.

30. Minimize Computer Management. Then, open My Computer. Notice that a new logical drive called Alpha (E:) appears as shown in Figure 6. Right-click on the new drive and select Properties. The Alpha (E:) Properties window opens as shown in Figure 7. Look over the characteristics of your new drive and then close the Properties window.

31. In order to show you one more handy trick, let's create a new folder in the root directory of Drive C. Open *Local Disk (C:)*. Open the *File* menu, select *New*, and then select *Folder*. Change the name of the *New Folder* to *Beta*. Finally, minimize the open *Local Disk (C:)* window.

Figure 6
The new logical drive *Alpha (E:)* shows up in *My Computer*.

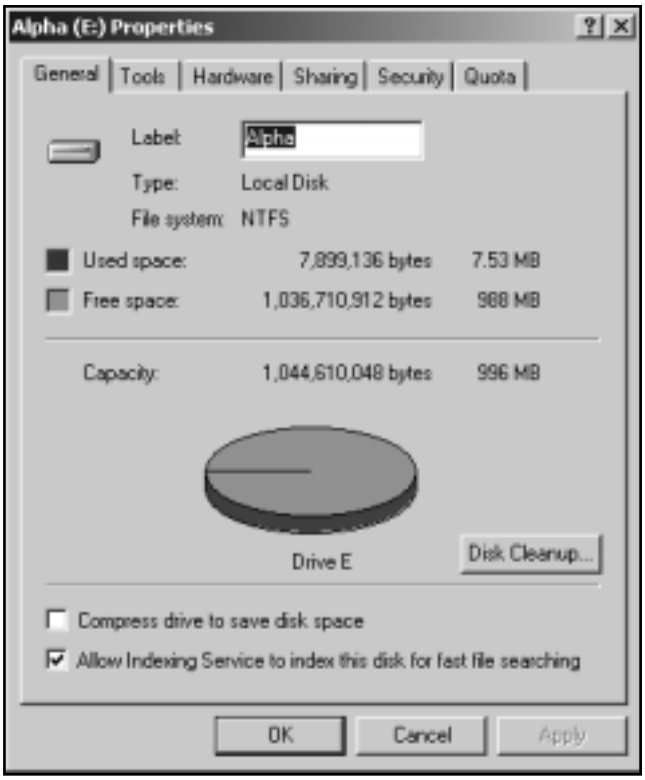


Figure 7
The *Alpha (E:) Properties* dialog box.

32. Restore the minimized Computer Management window. Right-click the volume called *Alpha*. Notice that this time all of the options are enabled and there are several additional options. Select the option *Change Drive Letter and Path*. A new window appears showing that the only way to access the volume called *Alpha* is through its drive letter. You can add another access method by clicking on the *Add* button, or you can edit the current access method by clicking on the *Edit* button. Let's add a second access method.

33. Click on the *Add* button. The volume already has a drive letter assigned to it, so that is no longer an option. What you can do is mount (attach) the volume to an empty NTFS folder like the one you just created. This will allow you to access the volume through that folder.

34. If you know the exact address, you can type it in the text box. The preferred method is to use the "Browse" function to make sure there are no typos in the entry. Click on the *Browse* button. You could add a new folder to one of the listed drives, but you already did that. Examine the list of folders in the root directory of drive C (click on the plus symbol to open the folder list). Select the folder called *Beta*. Then, click *OK*. That loads the address of the folder in the text box. Click *OK*. Did it work?

35. Minimize the Computer Management window. Then, restore the minimized Local Disk (C:) window. Open the *View* menu and select *Refresh*. What tells you that you accomplished your task? _____
_____
_____

36. Minimize the Local Disk (C:) window. Then, restore the Computer Management window. Right-click the volume called *Alpha*. Once again, select the option *Change Drive Letter and Path*. Notice that the "change" window now shows two methods for accessing the volume called *Alpha*. The first is through its drive letter. The second is through the folder to which it is mounted. Let's eliminate the drive letter access method.

37. Make sure the drive letter E is selected. Then click on the *Remove* button. Click *Yes* in the message window that opens. Do see any changes to the drive letter assignments in the Disk Management window, and if so, what? _____
_____

38. Right-click on the volume called Alpha and select the appropriate option *Delete Logical Drive* or *Delete Partition*, depending on your system. Click *Yes* after you read the warning message. You may receive a second warning message about the partition number. Click *Yes* to continue. Notice that after a few seconds, the volume (partition) *Alpha* is no longer listed in the Disk Management window.

39. Restore Local Disk (C:) from the Task Bar. Is the Beta folder displayed? _____ If so, what is it's icon? _____ Open the *View* menu and select *Refresh*. Is the Beta folder displayed? _____ If so, what is it's icon? _____

40. Close all of the open windows. This concludes the lab. Using the proper procedure, shut down the computer.

Discussion

In this lab, you learned the purpose and location of the Check Disk, Defrag, Backup, Restore, and Emergency Repair Disk Utilities included with Windows 2000. You also learned two ways to access the Disk Manager in Windows 2000. And finally, you used the Disk Manager to create a new logical drive partition, name and size it, mount it to an empty NTFS folder, hide it from the list of drive letters, and delete the drive.

Unit 6

Windows 2000 User Accounts and Networking

Through much of the previous decade PCs were stand-alone devices, in that they weren't connected to other computers. When we did attempt to connect computers together, the process was challenging, expensive, and too complicated for mere mortals. Why go to all this trouble and expense? The benefits of connected computers are obvious, and thanks to the Internet and the expansion of the small office network, connecting computers together is now a simple and inexpensive process. In fact, a computer that's never connect to a network is rare. In this Unit, we will discuss the software side of networks, such as user accounts, security, and how to share resources. The hardware aspects of networking will be discussed in a later Unit.

The Networked PC

If you have ever used a networked computer, the value of the network is obvious. You can access Files and hardware (resources) located on another computer, or even files on other continents. You are only limited by the quality of the connection and the type of network you are using. In this course we cannot possibly cover everything you need to know in order to be a networking expert. However, what we can do is discuss how Windows can be networked, and the issues you need to know as you build your own small networks.

Objectives

- Describe the basic types of Windows networks.
- Explain the benefits and drawbacks of Windows peer-to-peer networking.
- Explain the benefits and drawbacks of Windows client-server networking.

What Can You Do With a Network?

When computers cost more than $2500 each, few people had one at home, and few businesses had one at every employee's desk. As the price dropped the need for computers increased, or maybe that's backwards, but businesses soon realized they needed lots of computers to stay competitive and profitable. They also learned that with better computer-based systems, individual users (employees) could handle more day-to-day work than an army of workers using paper files and white-out.

As businesses added computers, connecting them together was an obvious next step. In fact, the need for a network often justified the purchase of the computers. It's also important to note that networks weren't invented after PC's became popular; on the contrary, IBM and others had been building networked systems for many years by the time we learned about Microsoft. The difference with the new PCs was that they had power of their own, where the networked IBM terminal was little more than a display and a keyboard connected to a huge mainframe.

The power offered by these new PCs provided individual users the freedom to use new tools, tools that were not yet available on the big mainframes. These new tools, such as spreadsheets, word processors, computer-aided drafting, and desktop publishers, were developed to meet the needs of changing businesses and economies. The people who administered the mainframes didn't like the new PCs coming into the offices, in many cases because they couldn't maintain the security of these systems, and because different departments obtained different types of computers, adding to the administrators' technical support burden.

The new PCs and software tools were an unstoppable force, and after a while, the need to interconnect them was obvious as well. After all, there isn't any sense in developing a complicated spreadsheet if you can't share the document with your colleagues. Actually, sharing wasn't a big problem until the documents grew larger than the capacity of a floppy disk. In addition, when a company obtained a new laser printer, it normally went to the highest-ranking employee, while other employees often needed it more.

The solution was to interconnect the PCs and share the resources. Once that was completed, the spreadsheet could be located somewhere that everybody could use it, and those who needed high-quality printed documents could use the laser printer. Other opportunities also came with the network, such as a user with Internet access being able to share that connection with other computers, and electronic communication (e-mail). By the way, the features are beneficial to the home-network, too.

Types of Networks

As with all things involving computers, there is no limit to the number of ways they can be interconnected. Fortunately, most networks use one of a few basic strategies, or combinations of these. The first strategy is the *standalone* computer. This system is not connected to any others, and is not even used for Internet access. The only network this computer could be a part of is a *sneakernet*, where files are copied to disk and carried (by a user wearing sneakers) to other computers. A standalone computer is often used to test new software or hardware, and the lack of an outside connection keeps the system in a simple configuration. The standalone computer is the ultimate in security, depending upon the level of sneakernet activity and whether the computer is behind a locked door or in a common space.

A standalone system steps up to the next network strategy level with the addition of a modem. Today, a modem is primarily used to establish a connection with the largest network ever conceived, the Internet. When connected to another network, such as the Internet or a company server, this computer is regarded as a *remote workstation*. In most cases the connection is temporary, and when disconnected the system returns to its status as a standalone. However, once a modem is added, the security promised by the standalone is lost. All kinds of nasty software can be downloaded, either intentionally, accidentally, or by someone else's intent, and if you're truly unlucky it's possible that an outsider could gain control of your computer. Obviously, security is now a consideration.

Beyond the remote workstation sits the *peer-to-peer network*. As its name implies, this network is a collection of similar computers (peers) with a common connection. This is the type of network created when several computers in an office or home are interconnected, typically between two and 12 machines. The key aspects of a peer-to-peer network are that no single computer is in charge of the others, and each computer is independent of the others. In some peer-to-peer networks, a single machine is assigned to be the "main storage depot," but even this configuration is optional. Peer networks are commonly used to share printers, Internet connections, system backup devices, and extra-large hard drives.

Peer-to-peer networks are well suited to small offices with mixed operating systems. Any version of Windows can be a part of a peer network, which is called a *workgroup*. Groups of workgroups can be organized, each with unique names, which adds to the organization of the network.

Security in a peer-to-peer network is a mixed bag. The primary purpose of this network is to allow you to share resources on your machine with others, and for them to share resources with you. In small offices and home networks, there are few issues with this approach. But the security of your system depends, to a large degree, on what you are sharing. Often it's easier to share your entire hard drive with the rest of the network than to create a dozen different shares to individual folders. But along with that action, everybody on the network can now delete your entire hard drive, if you haven't planned well. It is unlikely that the data on your hard drive will be completely deleted intentionally, but it only takes one accident to lose the entire drive.

Workgroup security is also an issue because one or more users may have direct Internet access, for instance through a modem. These users need to be aware of the security risks, because it's possible for a hacker to gain entry to a connected computer and then extend that entry to the other computers in the workgroup. There are also viruses and worms designed to infect workgroups and destroy various types of documents found within the group.

The next step up is the *client-server network*. This network requires that one computer, the *server*, is dedicated to acting as a central repository of account and login information, and usually files and applications. The server runs a special operating system, the NOS. Typically this is Windows NT Server, Windows 2000 Server, Netware, or a server version of Linux. The functions

handled by the server are only limited by the power of the NOS, the software utilities that can be loaded, and the amount of hardware that can be added to the server. Typically, the server maintains an e-mail system, a data backup system, special applications, and connections to a limitless number of additional resources.

The primary difference between a server and other types of systems is that the server is rarely used like a typical computer. Servers are not good at running word processors or presentation programs while at the same time being a server to numerous clients. A server is normally a dedicated machine, and often a super-charged PC with special high-reliability components.

The clients are your typical PCs under each desk. Except, they are connected to the server through the network wiring, and they have software loaded to allow communications with the specific type of server. In a Microsoft network, communication with the server requires the client to join a *domain*. A domain is the basic Microsoft client-server network. A domain may contain several servers handling myriad functions, but a single login allows access to all the domain's resources, providing the user has the proper permission. Larger networks may have several domains, usually interconnected.

The client-server network centralizes security, and all NOSes are designed to be guardians of your data and information. However, this security comes at a price. Unlike a peer network where you control your own security, a server requires much more effort to design, configure, and administer. Small companies can hire temporary staff to build their systems and make changes periodically, but larger companies have full time staff to handle their networks.

With the proper design, configuration, and administration, and a true network OS, a client-server network is the ultimate in security. The workstations can be configured to verify logins with the server, allowing the administrator to control access to the individual computers attached to the network, also called *workstations*. This control can extend so far as to prevent users from changing the configuration of their own workstations, too. Internet access may be handled through the server, which allows the administrator to control most aspects of security there, too. Additionally, the administrator can control a users' access to various network resources. This sounds like the administrator is a control freak, but these decisions are usually made by management and implemented by the network administrator.

These days only the rare client-server network isn't connected to other networks. The other networks may be different branches of the same company, or simply a direct connection to the Internet. These interconnected networks open up many new security and administration issues, which are beyond the scope of this course.

User Accounts

You already know that Windows NT/2000/XP requires user accounts. You can configure Windows 2000 so it always launches into the default Administrator account, without a password. In this case, you get all the stability of Windows

2000 without the security, and without security inconveniences. But unless you are using a true standalone Windows 2000 machine, you're advised to utilize the Windows security systems.

Windows security starts with a *user account*. When you install Windows NT/2000/XP the Administrator and Guest accounts are created automatically. Both of these are considered user accounts, however one is all-powerful and the other is useless at this point. (The guest account is disabled after installation, and you should leave it that way.) Before you are done installing Windows, you'll have an option to select a password. In this case, the account name is "Administrator" (you can change this) and you should enter a password. Y*ou must not forget this account name and password!* Write it down; save it in a secure place, somewhere you'll be sure to look when you need it again.

Once Windows is up and running, and all the extra hardware and drivers are loaded, you're going to want to create some additional user accounts. At this point, the Administrator account is the only active account, and this account has too much power for the security-minded individual user. Most experienced system administrators will change the name of the Administrator account, which effectively closes a potential security hole. (An amazing number of people use the default Administrator account with their first name as a password…and the hackers know this.)

Recall that the Administrator has complete access to the system. This user can add or remove software, change system setting at will, and do virtually anything to the system. Naturally, somebody needs this level of access and the administrator is just the right person. Maybe that person is you, but for most normal work days you won't be adding new software, you won't be adjusting system settings, and you won't be adding new hardware. For these days, you don't need the total access provided by the Administrator account, instead, a regular user account is a better choice.

You can create several different kinds of user accounts in a Windows NT/2000/XP system. When you create a new account, you can specify that it become a particular type of user, such as an administrator, power user, guest, or user. Each type of account has a different set of rights and permissions, which means they can access different file areas and perform different actions within the system. The account-type choice you make depends upon how your computer will be used, and whether you need to protect it from prying eyes or flying fingers. Most security experts agree that you should set up a new user account, and use that account for your daily work, rather than use the administrator account all the time.

You're probably asking, "What's the difference?" There are two good reasons to do all your day-to-day work as a regular user instead of as an Administrator. First, placing restrictions on yourself prevents you from making inadvertent configuration changes. (We all make mistakes, right?) Second, it also prevents Trojan horse viruses or scripts from damaging your system files, since a restricted user doesn't have direct access to them. If the user doesn't have access, then neither does the nasty software.

Local and Domain Accounts

So far, we have discussed accounts from the standpoint of the standalone workstation. This type of account is called a *local account*. All of the login information is located on the local computer, which is Microsoft's term for the machine you are sitting at right now. A successful login grants you access to the local system, based on the rights and permissions given to that account. The local account only lets you into the local machine; it doesn't grant access to the domain. (If you are a member of a peer-to-peer workgroup, all you need is local access.)

For access to the domain, you'll need a valid *domain account*. Domain accounts can be very powerful, from controlling your access to the local computer, to simply allowing access to files on a server, depending upon the complexity of the network. The domain account is located on the Windows server, and controlled by the system administrator.

Profiles

One of the benefits of using local user accounts is the ability to customize the GUI for each user. Jane uses the computer in the morning, and has her desktop settings just so, with commonly used programs and files in the corners of the desktop, and a series of files and folders in My Documents. Joe uses the same computer in the evening, and he has a different desktop with a completely different set of files and folders in his My Documents. Much of the system remains the same for both users, but each has an opportunity to personalize various aspects of the same computer. In addition, if account security is setup properly, Joe can't see Jane's documents, and Jane can't see Joe's documents. The accounts aren't always set up to prevent such access, but it is possible.

This magic is made possible with *profiles*. Profiles can be a powerful tool in a well-managed domain environment, or they can simply allow you to use a different desktop than your kids or little sister. They can also create some confusion for users who are used to the Windows 9*x* logins, and don't yet appreciate the power and control of a Windows NT account with its profiles system.

The Need for Security

By now, you have read repeatedly that security is a key feature of Windows NT-based systems. Unfortunately, the need to keep your system secure is real, and you should take computer security seriously. But why do you need to worry about computer security? What are you trying to prevent, and what can possibly happen if you don't pay attention to security? Are you skeptical of the dire warnings? In this section, let's look at the issues and explore basic strategies for preventing security problems.

Objectives

- List some types of information and data sought by hackers.
- Describe several ways that hackers can gain entry to a computer system or network.
- Describe the basic steps that help to prevent security breaches.

Why Do We Need All this Security?

If you use a true standalone computer, one never connected to other computers, then computer security is of little importance to you. As you add a modem, establish e-mail accounts, and browse the web, security immediately becomes an issue.

As we began to share data and information, operating systems have added new and more powerful information sharing tools. Today you can do your income taxes on your computer, then send the data to the IRS. You can examine your investment accounts and make adjustments, apply for loans, and buy products and services of all kinds. As you do these things, you are transferring personal information across the Internet, information that can possibly allow someone else to borrow your financial and personal secrets, or even steal your identity.

In many respects doing business over the Internet is more secure than previous methods. Our risks used to be that someone would break into the broker's office and steal your personal financial information. Or, that a clerk at the local mall steals your credit card number, or a theif steals the trash, which contains transaction records. This remains a risk, to be sure, and we live with it willingly. The risks involved with online business are similar, except that locking the doors and "tearing up the carbons" is a bit different. Today you can purchase products or services over the Internet and no human will ever see your credit card or other personal information.

Software companies are constantly adding new features to help us organize our lives and to be more efficient with our time. These are welcome advancements, but as with every new process, a new set of risks must be understood, accepted, and handled. For example, it's easy to send an e-mail message to all of your friends—at once—when you add them to mail lists. This is a useful, time saving feature, and one you wouldn't want to be without. But along the way, someone figured out that an e-mail message sitting in your inbox could exploit this feature by hijacking part of your system and sending its own messages, without your consent or knowledge. The software companies fix that security hole when they learn what it is, but the hackers will keep looking until they locate yet another hole. This process is ongoing, and may never end.

What Are the Hackers After?

There are primarily two different types of risks. First, someone might try to steal personal information about you or your company. This might happen in an effort to steal your money, your company's money, to gain a competitive business advantage, or simply to create some chaos. The other risk is that a hacker will attempt to destroy your data or prevent you from doing your job. Hackers gain entry to systems and simply look around, they steal data, or they can destroy data. A hacker may not explore your system personally, instead they might unleash a tool that pokes around all by itself. Viruses and worms are the primary tools of the hacker, and the objective often seems to be little more than the cheap thrill of snooping around in or taking down a big company.

Only the hacker himself can fully describe his motives, but some of the most common personal targets are:

Passwords and Account logins: Stealing your passwords and logins is like stealing your keys. Once a hacker has your keys, they can do whatever they want inside your system. This is often just the first step in a larger plan.

Credit Card Numbers: These are like cash to hackers, and each year credit card companies lose hundreds of millions of dollars due to the fraudulent use of personal credit cards. Your liability is limited with most credit cards, but if your debit card number is stolen, your account can be emptied and you get to fix the damage.

Identification Information: You've probably heard about identity theft, where not only does someone steal your credit card numbers, but also your Social Security, driver's license, and bank account numbers. With this information, new loans, accounts, and credit cards can be opened in your name. Once that happens, huge amounts of money can be spent against these new accounts without your knowledge. Since this is done using otherwise valid information—however stolen—you may end up with a lot of damage to repair.

E-mail and online-chat archives: You're not likely to end up in financial ruin if someone steals your e-mail, but the text of your personal messages and conversations could be embarrassing if publicized or used against you.

True, the risk of someone stealing your personal information is low. The news is full of these thefts, and clearly some criminals are successful for a while. If you are careful with your vitals, your risks are limited.

Businesses and corporations face similar risks, with one significant difference: more criminals might want to hack into a large company. Hackers go after businesses for reasons such as revenge for a perceived or real problem, in order to acquire competitive information, or just to cause trouble. The list of specific targets is huge, but here are a few of the common information targets favored by hackers:

Customer Information: Hackers may be after a list of credit card numbers, or even the personal information about customers. Lists of customers and their buying habits are extremely valuable to competitors, as well.

Pricing and Product Costs: Hackers may attempt to acquire this data in an effort to sell it to a competitor, or to embarrass the company by making the information public.

Software Source Codes: This category actually includes all types of proprietary product information, including blueprints and plans. In 2000, Microsoft itself was hacked and Windows 2000 source codes were reportedly compromised.

Personnel Information: Some companies maintain more information about employees than you might imagine, which is clearly valuable to certain hackers.

Free Rides: Hackers are looking for ways to get free Internet access. If they can hack into a company's dial-up connection, and then get out to the Internet, the connection is then free. Of course, the hacker doesn't stop there. The damage caused through the use of that connection is blamed on the company who's system was used by the hacker.

Knowledge is Prevention: How Do the Hackers Get My Private Information?

There are many ways that thieves can steal your personal information or data. Passwords help, but security truly begins with locking the door to the room where you keep your computer. For instance, one of the primary security measures for servers is physical security, and it applies to your computer as well. Many of us work in "cubicle farms" these days, which don't have doors. If you go to lunch or go home and leave the computer running, conceivably anyone could sit down and do whatever they want on your machine. A quick fix is to configure your screen saver to run after just a few minutes of inactivity, and then require a password to return to the desktop. Or, in Windows NT-based systems you can simply logoff, which requires you to log back on to restart your Windows session.

But what if the surreptitious office visitor can guess your password? Or even worse, what if you have it written on a sticky note attached to the side of your monitor? First, it's okay to document your passwords, but keep them in a safe and secure location. You can usually disguise passwords so the casual observer has no idea what they are. Guessing passwords works too well, most of the time. Your first name is the worst password to use, followed by the name of your significant other, kids, parents, and then pets. Choose a password that is at least five characters, contains a number, and possibly even upper and lowercase letters. Hackers use tools that guess names, and words from dictionaries. A misspelled word, or even a nonsense word, is better than an obscure word that can be found in a regular dictionary. For example, "whazzup" is better than "sophism."

We mentioned Trojan Horses before, but they are worth mentioning again. Most Trojans are unable to run on their own; they require *you* to do something, such as run an executable program or a Visual Basic script. The trick is convincing you to run the program. Naturally, if you received an e-mail stating "I'm a virus, open me now!" you would quickly erase it. But what if a friend sends a message that says "Hi! Here's the file you asked for. It's awesome, how kool is that?" would you run it? Remember that some viruses send e-mail automatically, so the friend may not know about this message. This type of approach is a called *social engineering*, and it's an effective method to make you relax your defenses. Don't feel bad if you said yes, nearly the entire Windows-world fell for the Love Bug in 2000.

Once the virus or script runs, anything can happen. For example, it might look for your password data and send it to someone else via email. It might delete system files, specific types of data files, or parts of your Registry. Or, it might turn off the security in your system, allowing a hacker to access your system through your Internet connection. Once the hacker's tools are inside your system, anything can happen.

This last approach is actually a form of a *back door*. The back door is a technique where you have the main entry points secured, but there is an unlocked and usually hidden opening. The back door was originally designed as a secret entry point for programmers or specialists. Unfortunately, once a back door is no longer secret, it becomes a security risk. In many companies, programmers are forbidden from creating backdoors.

A related approach is for a hacker to gain entry through an unintentional back door, one that is usually considered a bug in the program. Microsoft regularly releases security fixes and patches to close these bugs, and a cottage industry has sprung up in an attempt to locate new ones. Remember, Windows is a tremendously large series of interacting programs, and fixing every bug and closing every potential entry point will probably never happen. The software is just too big and complicated, so the known problems are quietly fixed with patches. Hackers have developed ways to determine what patches are loaded, and what known holes are available to be exploited.

There are many more types of attacks from hackers. It's also unfortunate that regular computers users, trying to use their systems normally and make a living or be entertained, must be on the alert for the sociopath and malcontent who are simply determined to cause trouble for no good reason

Becoming Secure

Can you make your computer immune from attacks? Sure, if you never connect it to another computer, never load any new software, learn all you can about security, and never let anyone else use it. That's not realistic, so the answer is no, you cannot make your system immune. You can, however, take several steps that improve your chances.

Before making recommendations, it's important to note that convenience and security are mutually exclusive. You have to ask yourself if you can tolerate

a tight security process and the inconvenience of being secure to that level. Conversely, you can have a completely convenient system if security inconveniences (loss of data and viruses) are tolerable. Generally you try to be at a point in the middle that's both comfortable and not too complicated.

Most of the first steps have been discussed, things such as the need for secure passwords, and preventing unauthorized users from accessing your system. Limit yourself and the users of your system to the necessary amount of access, for example, don't allow all users to have administrators' rights. In addition, you should consider removing software, utilities, and Windows components that you don't use.

Obviously, you need an anti-virus system. Any of the systems that have been around for several years should work well for you. Be sure to periodically update the virus definitions, every two weeks is about the longest you should go before checking for updates. Most of these programs will do the checking for you, on a schedule you set. They will also check your e-mail as it arrives, depending upon the program you use.

If you use a cable-modem, DSL router, or other high-speed Internet access point, be sure you use an appropriate *firewall*. Firewalls are designed to block unauthorized access, and they tend to be good at what they do.

At some point, you're going to be hit by a virus, worm, or hacker. With careful planning your anti-virus will take care of it, or your firewall will let you know is has defended the system. If not, hopefully it will only cost you some embarrassment, and some time to learn how to protect yourself better next time. Some of us won't be so lucky. There are viruses out there that destroy your hard drive, and all that data it contains. And what's even worse, you don't even need a virus or hacker to lose all your data. Hard drives fail all by themselves, due to the inevitable manufacturing defect or poor handling, or poor environment. Regardless how it happens, when you lose your data, will you have a backup? Be sure you can answer that question affirmatively. If you take nothing else from this section, be sure to explore the methods available to create reliable backups of your valuable and irreplaceable data.

Sharing Resources

You're networking your computers for two reasons: to communicate between them and to share or obtain access to network resources. When you are a part of a client-server network, such as a Windows NT-based domain, the resources you need are available through the domain. That is, you have an account on the domain and the resources (printers, file servers, Internet access, etc.) are only available after a successful login. The network administrator establishes these shared resources, as well as the user accounts that provide access to them.

Typically, a domain provides a file server, which is essentially just a big hard drive for storing your data and documents. As a user with an account on the domain, you may have your own folder on the server where you can stash your files. If others need access to your data, they can get to it through these folders, too.

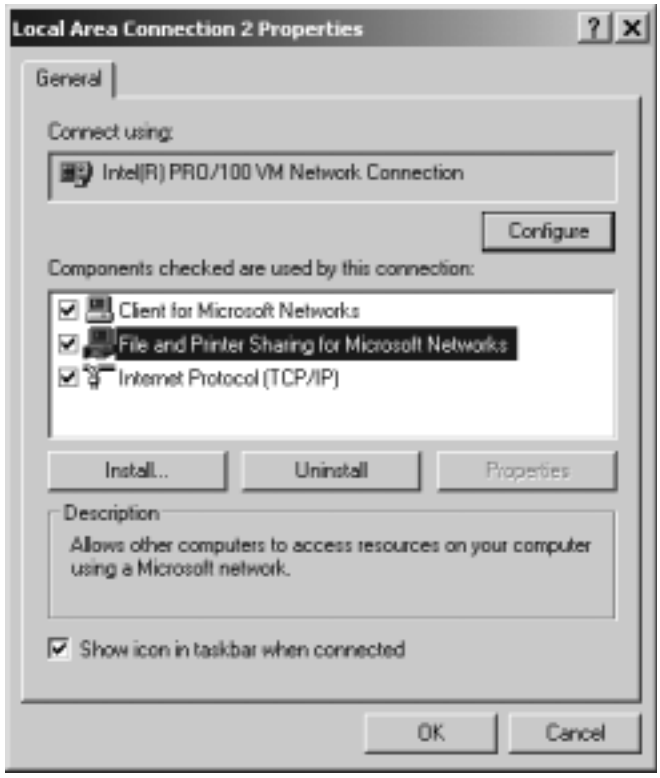


Figure 1
Installing File and Printer Sharing in Windows 2000.

The same holds true for printers. The administrator physically attaches the printer to the network, typically with a small device called a printer server, and then configures the domain to make the printer available to all (or just some) of the users. Domains are great this way; the administrator handles installations and configuration and you just login and locate the resources.

Workgroups act a bit differently. Since there is no server, and in most cases no administrator, a user attaches a printer and then "shares" the printer with the rest of the workgroup. The actual process for sharing a folder or printer in a workgroup is simple. Before you follow these steps, it is assumed that you are already a part of a workgroup.

First, you need to install *File and Printer Sharing for Microsoft Networks*. (Note: if you use a cable modem at home, be sure to consult the security documentation that accompanies your hardware before you install this tool.) To install the sharing tools, right-click My Network Places on the desktop, and select properties. Then double-click the Local Area Connection. Click Properties and, finally, you'll see a dialog as shown in Figure 1. Click the Install button, then select Services and click Add. Here you are shown a list of services available to be installed. Choose File and Printer Sharing for Microsoft Networks, and OK. Click your way back out of this dialog with the OK buttons. Whew, that seems a lot harder than it really is.

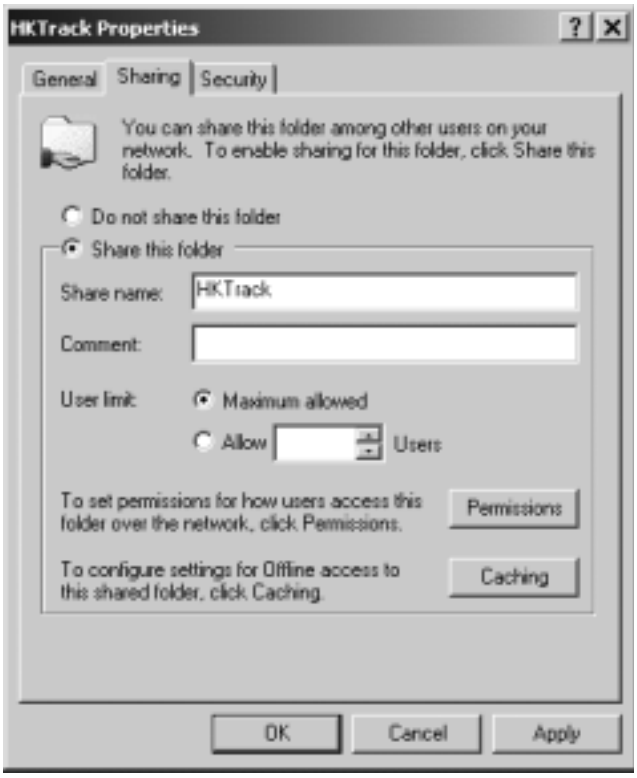


Figure 2
Sharing a folder in Windows 2000.

Once you have the sharing tool installed, you can open Windows Explorer and right-click on any folder, then select Sharing from the menu. This brings up the Sharing dialog, as shown in Figure 2. From here, you can add a comment, such as a brief description of the contents of the folder. Click the OK button, and the folder and all its contents are shared.

Printers can be shared too, open the Printers folder, Start > Settings > Printers, and right-click on a printer. Select Sharing from the menu, and highlight the Shared As button. Click OK, and the printer is now available to the workgroup.

Accessing shared folders in your workgroup is as simple as opening Windows Explorer, expanding My Network Places, and then expanding Computers Near Me. A list of workgroup computers is shown, and if you expand one of the computers, any available shared folders will be shown.

You might have noticed the Security tab on the Sharing dialog boxes. Workgroup security in Windows 2000/XP is a complicated affair, if you plan to limit access to certain users. Your options depend upon the file system used by the disk drive where the folders are located. If the folder is on an NTFS partition, you have several security options. If the folder is on a FAT partition, your options are limited, but you can still provide rudimentary security. If you truly need security, then you should reconsider your use of a workgroup.

Unit Summary

You will be building small networks later in this course, but discussing Windows NT-based systems without discussing networks is impossible. This is largely due to the Windows security features and the need for logins and accounts. Many Windows support issues are related to misunderstandings surrounding user accounts and restricted access to the system areas of the operating system. As a user these restrictions can be problematic. If you are ever working as a system administrator responsible for the support of many computers, you are likely to learn that these restrictions keep you happy and sane.

Lab 6-1

Controlling Windows Access

In earlier versions of Windows, virtually anyone can boot and access the operating system. Even password protection was of limited value—it's a simple operation to bypass all of the system passwords and install your own. Windows NT 4.0 and 2000 are not that generous. Passwords created within either of those operating systems are virtually impossible to bypass.

Windows 2000 was designed with multiple users in mind. Different user can be given passwords that limit access to certain areas of the computer. The degree of access is controlled by the *Administrator*. Right now, the system is wide open. No password is required and anyone using the system has all the rights and privileges of an administrator. In this lab you will learn how to implement password protection. Then you will see how the Administrator determines who has access to a computer, and what that access entails. You will also look at several other functions and utilities that assist the Administrator in controlling Windows access.

Objectives

At the end of this lab, you will be able to:

- Implement password protection.
- Identify the properties of every local user on the computer.
- Add a new local user to the operating system.
- Identify where user information and resources are stored on the local computer.
- Identify the current users and groups on the local computer.

Materials Required

To complete this lab, you will need a computer with Windows 2000 Professional installed. A system that still retains most of the default installation settings will work best.

Procedure

Implementing Password Protection

1. Turn on the computer. You should now be looking at the Windows 2000 Desktop—and that is not good! It means that anyone who turns on this computer has access to everything inside. If you are the only person who has physical access to the computer, you may prefer this wide-open atmosphere. But in the business world, most people prefer to control access to their computer through *password* protection.

2. Go to the *Control Panel* and open the applet called *Users and Passwords*. You should see a window like that shown in Figure 1.

3. Look at the check box entitled *Users must enter a user name and password to use this computer*. Notice that the box is **not** checked. This is why you are able to access the computer without a password.

4. Look in the box entitle *Users for this computer*. Notice that three users are listed. Two of these, *Administrator* and *Guest*, are always included with Windows 2000 installations. The third, *Customer*, was added by the vendor of this computer after the operating system was installed.

5. Try clicking on *Customer* and *Guest*. Also notice that most of the buttons are grayed-out. You have no control over these functions because the top box is not checked.

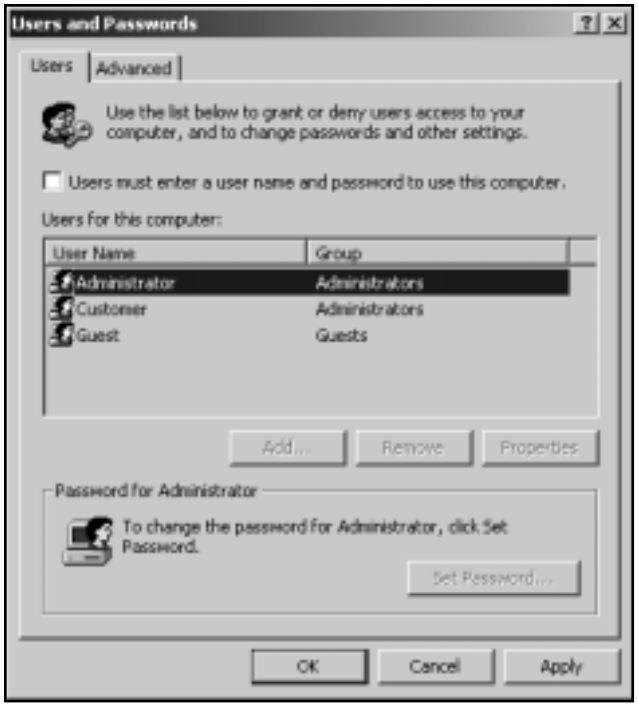


Figure 1
The *Users and Passwords* window.

6. Check the box entitled *Users must enter a user name and password to use this computer*. Notice that you can now select the User Name from the list and that the button are now active.

7. In the list box, select *Administrator* then read the *Password for Administrator* message at the bottom of the window. To set an Administrator password click on the *Set Password* button. The *Set password* dialog box opens.

8. Notice that the cursor is in the *New password* box. Now using only lower-case letters, very carefully type:

   password

9. Click in the *Confirm new password* box. Once again, very carefully type:

   password

   Click on *OK*. Ordinarily, *password* would be a terrible choice for a password. But here in the classroom we want something that everyone can remember.

10. Now, let's log off. To log off press *Ctrl-Alt-Del*. This is a short hand way of saying: Press and hold the *Ctrl* key; then press and hold the *Alt* key; and then press and release the *Del* key.

11. At the *Windows Security* window, click on the *Log Off* button. Read the confirm message and click on *Yes*.

12. At the *Log On to Windows* dialog box. In the box labeled *User name* delete the name *Customer* and type:

    Administrator

    In the box labeled *Password* type:

    password

    and click on *OK*. Once again use only lower case letters. Windows 2000 is case sensitive. Because *password* was entered in lower case originally, it must be duplicated exactly as originally entered. If necessary, clear the *Getting Started with Windows 2000* window and any other start-up messages that appear after you log on. Those messages may appear because this may be the first time the user *Administrator* has logged on.

Creating and Examining User Accounts

13. Now let's look at another way to find out what user accounts are installed in your computer. You will use a utility called the *Computer Manager*. Right-click on *My Computer* and select *Manage* from the popup menu. In the left pane of the *Computer Management* window, find and select the directory *Local Users and Groups*. Select the *Users* folder. In the right pane of the window, double-click on the *Users* folder. That will produce a display like the one shown in Figure 2. Notice that the *Guest* user account has a small red and white X over its icon.

14. Right-click on the *Guest* icon and select *Properties*. You can see that five options are provided to control how an account may be accessed. Two of the options are grayed-out because they don't apply to this type of user account. The other three options are pre-selected. Two of those control the account password. The other is used to enable or disable the account. Right now, the account is disabled. That's why you saw that red and white X on the *Guest* account icon.

15. Let's enable the *Guest* account. Clear the check mark in the *Account is disabled* option line.

16. Click the *OK* button to close the *Properties* window.

17. What happened to the red and white X on the *Guest* account icon?

    _____

    _____

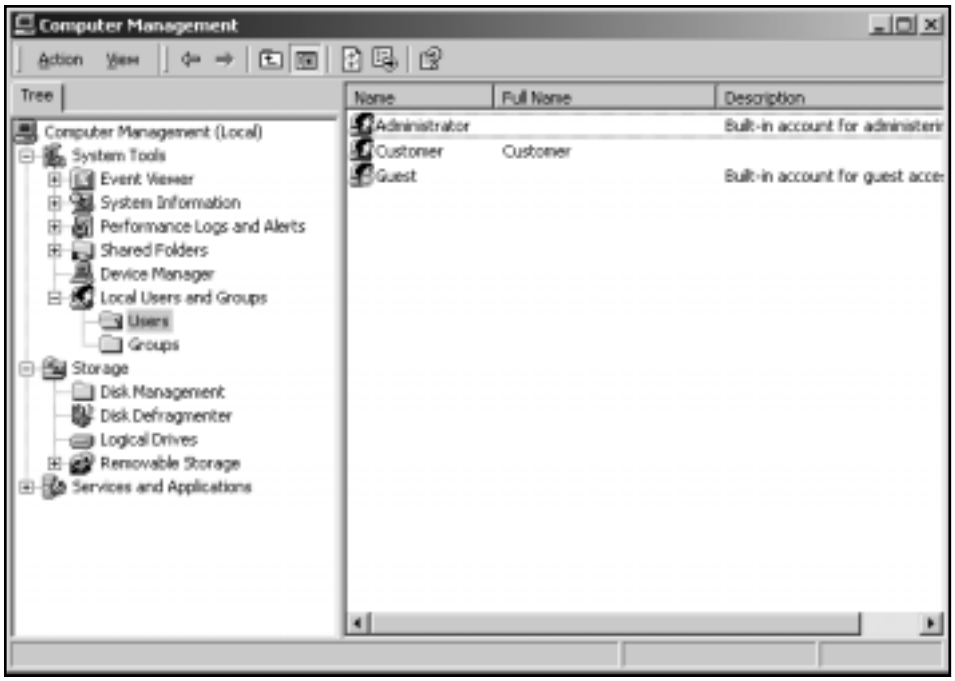


Figure 2
Three user accounts currently exist.

18. Does the *Guest* account have access to the computer? Let's find out. Log off the computer. You do that by pressing the *Ctrl-Alt-Del* keys. When the Windows Security window opens, click on the *Log Off...* button. Read the message box that opens, then click on the *Yes* button. You will be logged-off. Then, the *Log On to Windows* dialog box will appear.

19. In the dialog box, change the User name to *guest*. Then, press the *Enter* key—the *Guest* account doesn't have a password assigned to it yet, so there is nothing else to enter. Once again, if necessary, clear the *Getting Started with Windows 2000* window and any other start-up messages that appear after you log on.

20. Right-click on the *Start* button and select *Explore*. This opens Windows Explorer. In the left pane of the window, select Local disk (C:) and open the *Documents and Settings* folder. You will see a window like the one shown in Figure 3. This is where information specific to a user is stored. To see what we mean, open the *guest* folder. There you will find several folders—one to store Internet Explorer *Cookies*; one to store Internet Explorer *Favorites* (note the blue star in the center of the folder); one to store unique files, folders, or shortcuts on the *Desktop*; one to store unique *Start Menu* items; and one to store *My Documents* created by *Guest*. If anything is stored in any of these folders, it will only be available to the user *Guest*. Note that as you add hardware and software to the computer, additional folders will be added to the user folder in the *Documents and Settings* folder. It's not uncommon to have 12 or more folders in a user folder

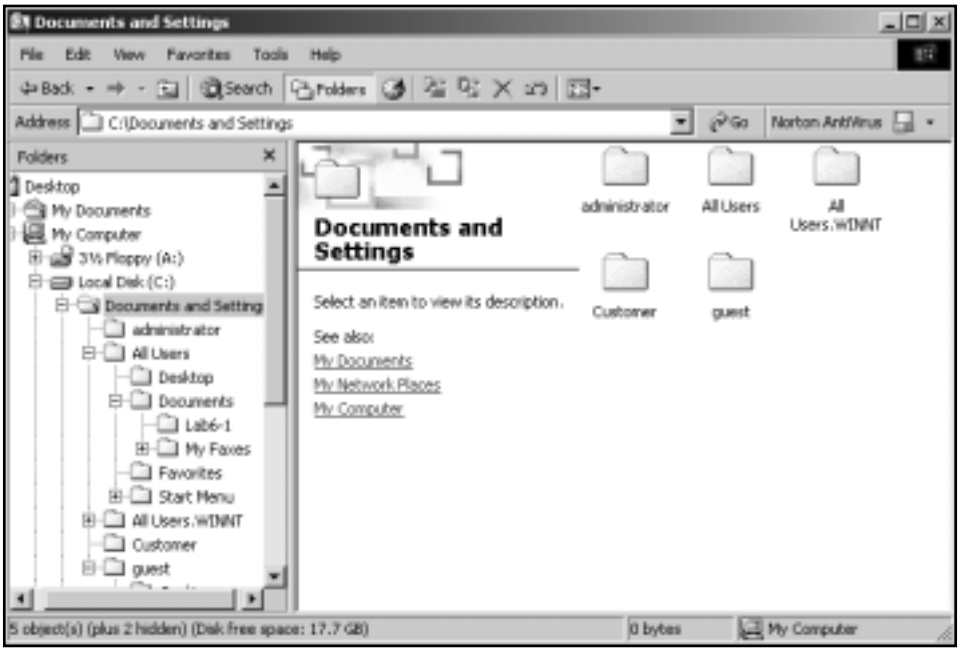


Figure 3
The *Documents and Settings* folder contents for the user account *guest.*

21. Refer to the left pane of the window again and open the *All Users* folder. Again, you will find several folders. This time, one is used to store Internet Explorer *Favorites*; one is used to store unique files, folders, or shortcuts on the *Desktop*; one is used to store unique *Start Menu* items; and one is used to store *Documents*. Everything common to *all* users of this computer are stored in these folders, and they will be available to *all* of the users. Notice two things about these folders. The *Documents* folder is not called *My Documents*, and the *Favorites* folder does not have a blue star in its middle. That's because they are not personal (user) folders.

22. Refer to the left pane of the window again and attempt to open the *Administrator* folder. Can't do it, can you. That's because you don't have authorization (the proper security clearance) to open the folder. Strong security control is the main reason why you use NTFS. And, we plan on giving you a thorough review of NTFS security. However, before we do so, we need you to create another user account.

23. Log off the computer. Then, the log back on as the *Administrator*. You're doing this because you need to have administrative authority before you can create a user account. At the *Log On to Windows* dialog box, you will have to change the *User name* to *administrator* and enter the administrator's password: *password*. Use all lower case letters. When done, click on *OK*. Clear any start-up messages if necessary.

24. Open the *Computer Management* window by right-clicking on *My Computer* and selecting *Manage*. Then, open the directory *Local Users and Groups*. Finally, open the *Groups* folder. This presents a list of the default user groups available in Windows 2000. This is not to say you can't create a custom group for a specific purpose, because you can. But for now, this list is a good starting place, and it's what you will use today to create a new user account. The account will be added to the *Users* group.

25. From the left pane, select the *Users* folder. Then, open the *Action* pull-down menu and select the option *New User*. A dialog box like the one shown in Figure 4 will open. Fill-in the new account information as follows.

26. In the User name box enter:

    Tiger

    The idea is to use a name that represents you the user, or what you do, and it doesn't offend too many people. So that you don't forget what you have chosen, write your User name in Figure 4 as well.

27. As a general rule, it's always a good idea to record the full name of the user you are creating. That way, there is no confusion later on as to who that person is. So, enter your full name, since you will be the user of this account. Enter it in Figure 4 as well.

28. While not critical to the user account, it's often helpful to enter a description of the user. For example, you could say "student" or "assistant to the Accounts Manager," or whatever illustrates who the user is or what the user does. Enter a short description of yourself. Enter it in Figure 4 as well.

29. Next, enter the password:

    password

    Then confirm the password by entering it again. Just in case you forget, enter the password in Figure 4 as well. Of course in the real world you would use your own unique password. But because we will require it in the next lab, we need something you can remember.

30. Finally, leave the line "User must change password at next logon" selected, and the line "Account is disabled" unselected.

31. Click on the *Create* button to create the user account. All of the data is cleared from the New User dialog box in preparation for entering another account. You're done, so close the dialog box.

32. Notice that your new account has been added to the list of Local Users.

Figure 4
The create a *New User* account dialog box.

33. Log off the computer, then log back on using your new user account, *Tiger*. If necessary refer back to Figure 4 to get the information. What happen after you entered your user name and password, and attempted to log onto the computer? _____
_____

34. Close the *Logon Message* by clicking *OK*. Enter your new password in the dialog box provided by the OS, then confirm your new password. To keep things simple, use the same password you used when you created this account. Normally, you would use a completely new password, one that nobody else will know, including the Administrator, but not today. Click on *OK*.

35. Close the message telling you that: *Your password has been changed*. After the OS finishes loading, clear the start-up messages if necessary. Then, open the Windows Explorer by right-clicking on the *Start* button and selecting *Explore*. Examine the contents of the Local Disk\Documents and Settings folder. What are the names of the account folders?
_____

36. Examine the contents of your user account folder, *Tiger*. Is it the same as the Guest folder you examined earlier? _____ Can you open the Administrator folder in the left pane of the window? _____

37. Now let's create a new folder in the root directory of drive C. In the left pane of the window, open *Local Disk (C:)*. From the *File* menu select *New*, then select *Folder*. Change the name of the new folder to Tiger*Test*. You did this simply to give yourself a folder to work with in later steps, and to show that your user account has the rights to create folders.

38. Open *Computer Management* by right-clicking on *My Computer* and selecting *Manage*. Then, open the *Disk Management* folder. What happened? _____
_____

39. Close the *Disk Management* message by clicking on *OK*.

40. Log off the computer, then log back on as the Administrator. Get rid of any start up screens if necessary.

41. Go to the *Control Panel* and open the applet *Users and Passwords*. This is where you set the group level of file access privileges.

42. If necessary, place a check in the box labeled: *Users must enter a user name and password to use this computer*. Select the User Name, *Tiger*. Then, click the *Properties* button. The *General* tab lists information about the user. Select the *Group Membership* tab and read the descriptions. By default, all members of the User group are *Restricted Users*. This is usually the best

place to leave a user unless he or she understands computers and has a genuine need to be able to modify the computer software. Let's up-level Tiger's account to the *Power User Group* level. Select the *Standard User* radio button. Then click *OK*.

43. Examine the properties of *Guest, Customer* and *Administrator*. Don't make any changes, just note the restrictions imposed.

44. Before you close this dialog box, note that as each user is selected, the *Password* dialog at the bottom of the window changes to identify that user. The Administrator can change any of the user passwords from this dialog box without knowing the current password. That is, all of the users except the Administrator. To change the Administrator password, you need to know the current password.

45. Close the *Users and Passwords* dialog box—click *OK*. You may get a message box warning you that you made changes to your user account and must log off and back on again. Click *No*. You didn't make changes to the Administrator account, you just looked at it. Therefore, you don't need to log back on as the Administrator. Having said that, it's time to change users again.

46. Log off, then log back on as *Tiger*. Once again, go to the *Control Panel* and open the applet *Users and Passwords*. This time, you can't get into the applet—you don't have the rights. Read the information in the message box.

47. Click on the *Cancel* button to close the message box—clicking *OK* generates an error message. Close any open windows.

48. This concludes the lab. Leave the computer configured as it is now for the next lab, otherwise you will have to reenter some of the data you entered in this lab.

Discussion

In this lab you learned how to implement password protection. Then you saw how the Administrator determines who has access to a computer, and what that access entails. You learned that the *administrator* and *quest* accounts are built-in to Windows 2000 and that a customer account is provided as a convenience by the computer vendor. However, it's never a good idea to open a computer to outside users until it is fully configured for its task. Therefore, to make sure no one may use the Guest account until its time, the account is disabled. It is a good idea to keep this account disabled unless you specifically need it.

After configuring a new User account, you examined the *Documents and Settings* folder. There, you discovered that all of the user information and resources are stored in that folder. Every new user gets its own unique resource folder, and each user also shares another common folder with all the other users.

You discovered that without Administrator privileges, other user accounts cannot access folders assigned to the Administrator, or to applications that are reserved for the Administrator's personal use, such as the Disk Manager. You also discovered that some user accounts begin life with more access privileges than others. You will explore several of these issues in more detail in the next lab.

Lab 6-2

Windows Security

In the last lab you learned how to create a user. But, you didn't do anything to control that user's access to files and folders other than requiring a password to access the computer. In this lab you will learn how to use the *properties* of a file, folder, or computer to regulate who has access to those objects and how they may use that access. You will also learn how to assign Security Permissions, and discover how those may be used to control access to computers, folders, and files.

Objectives

At the end of this lab, you will be able to:

- Describe the purpose of the Security and Sharing tabs of the Windows 2000 Properties dialog box.
- Explain why sharing is only useful on a network of computers.
- Use a Properties dialog box to regulate how a user may access the contents of a file, folder, or computer.
- Explain why different users and groups would have different permissions for the same file, folder, or computer.

Materials Required

To complete this lab, you will need a computer with Windows 2000 Professional installed. A system that still retains most of the default installation settings will work best.

Procedure

Examining Folder Properties

NOTE: We assume that you still have the User account, *Tiger,* that you created in the previous lab *Controlling Windows Access.* If this account no longer exists, you will have to recreate the account and enable the *Guest* account as well. You will also have to recreate the *TigerTest* folder on drive C.

1. Turn on the computer and log on as *Tiger*. If necessary, get rid of any start up screens. You should now be looking at the Windows 2000 Desktop.

2. Let's begin by creating a text file using *WordPad* and saving it to several locations. Click the *Start* button and select *Programs* from the Start Menu. From the *Programs* sub-menu select *Accessories*. From the *Accessories* sub-menu open WordPad by clicking on *WordPad* or its icon.

3. Create a simple file by typing in the sentence:

   This is Tiger's test file.

4. Now let's save the file. Click on the pull-down menu *File*. Click on the *Save As* option. This opens the *Save As* dialog window. In the *File name* box type, *Tiger'sTest*. In the *Save as type* box select *Word for Windows 6.0*. Click on the large *My Document* icon on the left side of the *Save As* window. Finally, click on the *Save* button. This saves the file to Tiger's *My Document* folder.

5. Now let's save the file in a second location. Click on the pull-down menu *File*. Click on the *Save As* option. In the *Save As* dialog window notice that the file name is still, *Tiger'sTest* and that the *Save as type* is still *Word for Windows 6.0*. Click on the large *Desktop* icon on the left side of the *Save As* window. Finally, click on the *Save* button. This saves the file to Tiger's Desktop. In fact, if you move the WordPad window over, you will see the *Tiger'sTest* file on the Desktop as shown in Figure 1.

6. Finally, let's save the file to the *TigerTest* folder that you created in the prior lab. Click on the pull-down menu *File*. Click on the *Save As* option. Click on the large *My Computer* icon on the left side of the *Save As* window. In the *Save in* dialog box, open the *Local Disk (C:)*, then open the *TigerTest* folder. Finally, click on the *Save* button. This saves the file to the TigerTest folder.

7. Close WordPad. Once again, notice that a copy of the *Tiger'sTest* file is on the desktop.

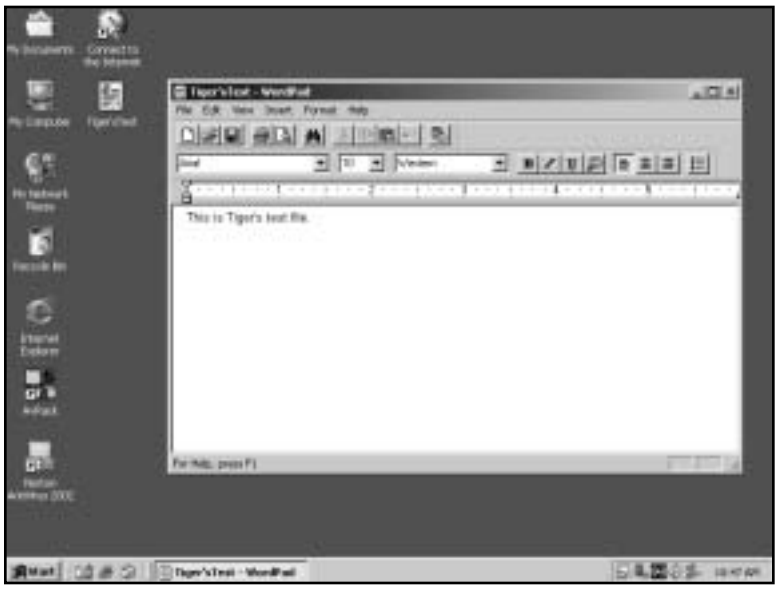


Figure 1
The Tiger'sTest file can be seen on the desktop.

8. Double-click on the *My Documents* icon. Is there a copy of the *Tiger'sTest* file inside? _____ Close *My Documents*.

9. Double-click on *My Computer*. Open *Local Disk (C:)*. Open the *TigerTest* folder. Is there a copy of the *Tiger'sTest* file inside? _____ Double-click on the *Tiger'sTest* file. Does it open? _____

10. Log off the computer. Then log on as the *Administrator*. Is the *Tiger'sTest* file on the Desktop? _____

11. Open *My Documents*. Is the *Tiger'sTest* file in *My Documents*? _____ Close *My Documents*.

12. Open *My Computer*. Open *Local Disk (C:)*. Open the *TigerTest* folder. Can the Administrator see the *Tiger'sTest* file. _____

13. Double-click on *Tiger'sTest* file. Does it open? _____ Close all the open windows.

14. While you are logged on as the *Administrator* let's create another User's account.

15. Open the *Computer Management* window by right-clicking on *My Computer* and selecting *Manage*. Then, open the directory *Local Users and Groups*. Finally, open the *Users* folder so that you see the four User accounts.

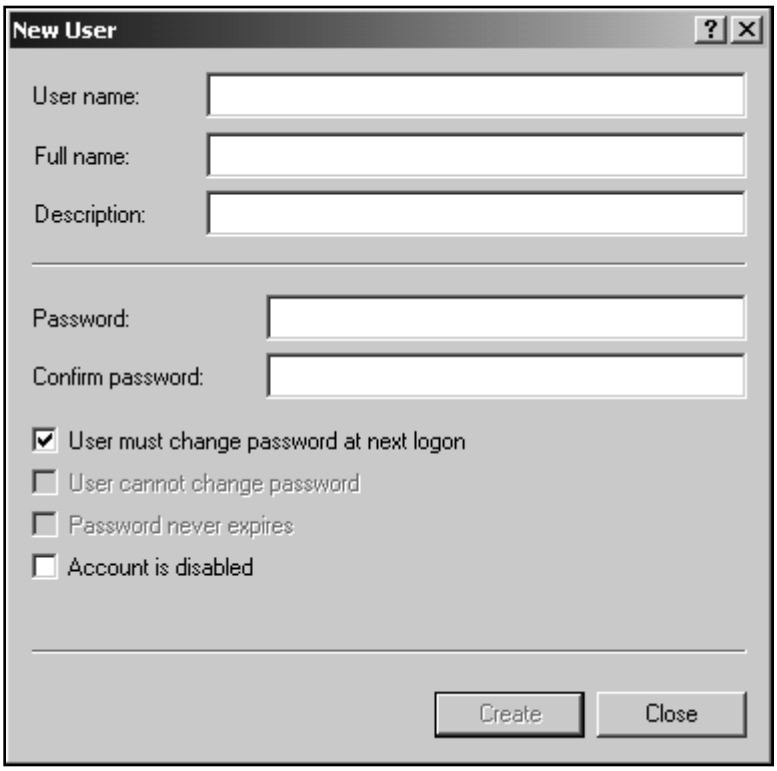


Figure 2
The create a *New User* account dialog box.

16. Open the *Action* pull-down menu and select the option *New User*. A dialog box like the one shown in Figure 2 will open. Fill-in the new account information as follows.

17. In the User name box enter:

    Rhino

    So that you don't forget, enter *Rhino* in the *User name* box in Figure 2 as well.

18. Enter something in the *Full name* and *Description* boxes as well.

19. Next, enter the password:

    password

    Then confirm the password by entering it again.

20. Finally, leave the line "User must change password at next logon" selected, and the line "Account is disabled" unselected.

21. Click on the *Create* button to create the user account. Close the dialog box.

22. Log off the computer and log on as *Rhino*.

23. Close the *Logon Message* by clicking *OK*. Go through the motions of entering and confirming a new password. But again, to keep things simple, use the same password. Click on *OK*.

24. Close the message telling you that: *Your password has been changed*. Clear the start-up messages if necessary. Is the *Tiger'sTest* file on the Desktop? _____

25. Open *My Documents*. Is the *Tiger'sTest* file in *My Documents*? _____

26. Open *My Computer*. Open *Local Disk (C:)*. Open the *TigerTest* folder. Can *Rhino* see the *Tiger'sTest* file. _____

27. Double-click on *Tiger'sTest* file. Does it open? _____ Close all the open windows.

28. Open WordPad.

29. Create a simple file by typing in the sentence:

    This is Rhino's test file.

30. Name the file *Rhino'sTest* and save it as a *Word for Windows 6.0* file in *My Document*s and on the *Desktop*.

31. Close WordPad. Notice that a copy of the *Rhino'sTest* file is on the desktop.

32. Log off the computer. Then log on as the *Tiger*. Is the *Rhino'sTest* file still on the Desktop? _____ Is *Tiger'sTest* file on the desktop? _____

33. Open *My Documents*. Is the *Rhino'sTest* file still in *My Documents*? _____ _____ Is *Tiger'sTest* file in My Documents? _____ How do you account for this? _____ _____ _____ Close all the open windows.

Discussion

Let's stop for a moment and review what you have discovered so far. We saw that Tiger can create a file and save it in a wide variety of locations. If Tiger goes back in later, he/she can access the file and open it just as one would expect.

You then discovered that when the Administrator or Rhino logs on, they cannot see files that Tiger left on Tiger's Desktop. In other words, they are looking at their own *Desktop*, not Tiger's *Desktop*. In the same way, when they looked in *My Documents* they could not see the file Tiger saved. Once again, they are looking at their own *My Documents*, not Tiger's *My Documents*. Thus, each user has its own *Desktop* and its own *My Documents*. This is also the reason that Tiger could not the files Rhino saved to the *Desktop* or to *My Documents*.

In this way Windows 2000 can allow several users to use the same computer without interfering with or even seeing each others data.

However, remember that both the Administrator and Rhino could see and open the *Tiger'sTest* file saved in the *TigerTest* folder on Local Disk (C:). So there must be something special about that folder that allows everyone to have access to it. If you are familiar with computer networking, the idea of file sharing may come to mind. Let's take a brief look at Sharing and see if the answer lies there.

Procedure (continued)

Sharing

34. Remember, you are still logged on as Tiger. To help sort things out, let's look at the *properties* dialog box of the *TigerTest* folder. Open the *Windows Explorer* by right clicking on *Start* and selecting *Explore*. In the left window pane, open the *Local Drive (C:)* directory. Right-click on the *TigerTest* folder, and select the option *Properties*. Figure 3 is similar to what you should see.

35. Select the *Sharing* tab. What you see will look similar to Figure 4. The *Sharing* tab is where you select sharing permissions for individual files, folders, and drives. But it really has no meaning if you're not connected to a network of computers. That's because *sharing* is used to control access to files and folders on drives across a network. While you aren't running in a network at this time, the *Sharing* option is still available. You will explore *sharing* in a later lab once you connect this computer to a network. For now, it is enough that you know that because sharing involves *networked* computer, this is not the reason that Rhino can open Tiger's files.

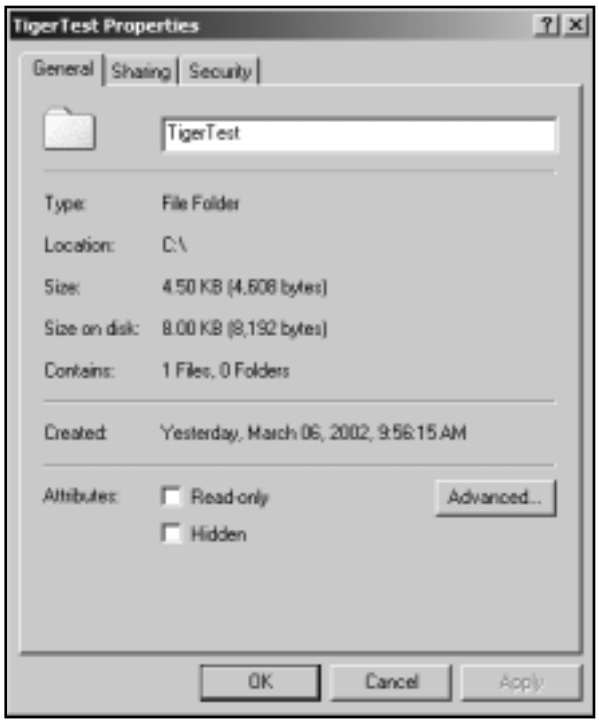


Figure 3
The *TigerTest Properties*.

Figure 4
The *Sharing* Tab of *TigerTest Properties*.

Security

36. Select the *Security* tab. This will open a dialog box similar to Figure 5. The *Security* tab is where you specify the *access rights* granted for a file or folder. Notice that right now the rights assigned to this folder affect *Everyone*. That is, *every* user of this computer and *anyone* who may have *share* access to this folder over a network have these access rights. This is an important distinction. *Security permissions* determine how a file or folder on the local computer is treated whether or not the computer is networked. *Sharing permissions*, on the other hand, only affect how a user on the network may access a file or folder over the network. This is the reason that Rhino can access Tiger's files.

37. Let's assume that Tiger does not wish Rhino to have access to his/her files. Let's modify the *Security permissions* to this folder. The first step is to select the group, or groups, you wish to grant or deny access to specific permission categories. Click on the *Add* button. This will open a dialog box listing all of the known users, groups, and computers as shown in Figure 6.

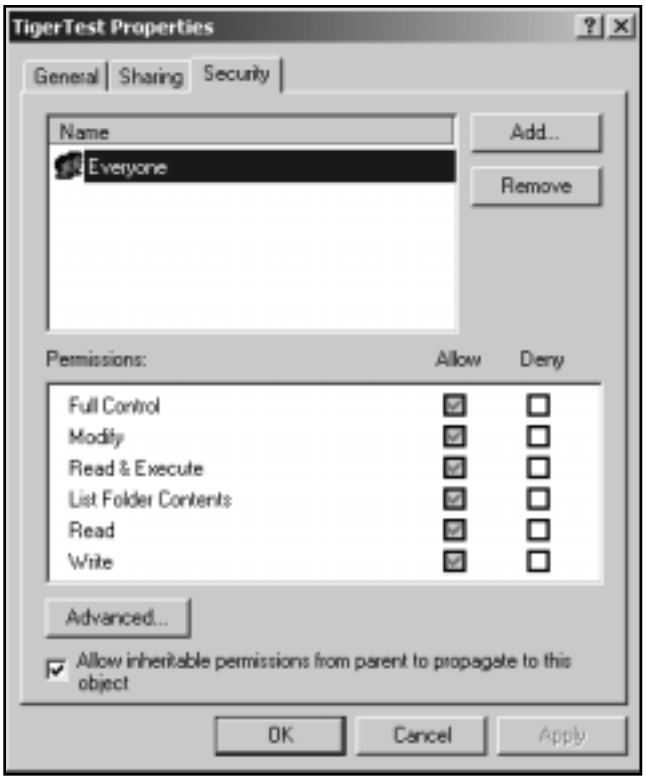


Figure 5
The *Security* tab.

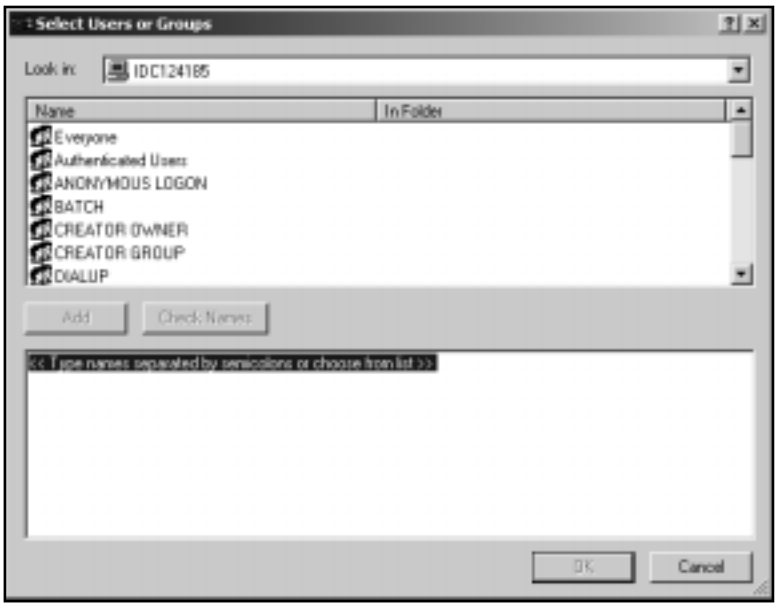


Figure 6
The *Select Users or Groups* dialog box.

38. Scroll down the *Name* list. Notice that about half the names have icons with two heads. Then, there are several names that have icons with only one head. And finally, there are icons with two smaller heads sitting on the representation of a computer. The two-headed names are groups that are used across the network. By default, they are considered part of every computer. The single-headed names and the smaller two-headed names belong to the local computer. The single-head icons identify active users. The smaller two-headed icons are common groups that may be used by the local computer.

39. Click on the *Guest* icon. Then, click on the *Add* button. Do the same for *Administrator, Rhino* and *Tiger*. Then, click *OK*.

40. One at a time, select each name and look at the permissions assigned to that name. *Everyone* has unlimited permissions, while the local users have, by default, limited permissions. Let's redistribute the wealth, and in the process, make this folder and any folder inside it fully accessible to *Tiger*, while denying access to *Rhino* and *Guest* and limiting access to the *Administrator*.

41. Select *Tiger*. Then look in the *Permissions* list box. To the right of the *Full Control* option place a check in the *Allow* box. Click on the *Apply* button to enter the changes.

42. Select *Rhino*. Then place a check in the *Deny* box to the right of the *Full Control* option. Click on the *Apply* button. Because you selected a *Deny* option you received a warning message telling you that what you did may cause you problems. For this reason you should use the *Deny* option with great care. Click the *Yes* button to close the message box.

43. Select the *Guest* name. Then select the *Deny Full Control* option. Click on the *Apply* button.

44. Select *Administrator*. Then deselect all of the *Allow* options except for *List Folder Contents*. Click on the *Apply* button.

45. Now let's get rid of the *Everyone* group, altogether. Select *Everyone*. Click on the *Remove* button. This will bring up a warning message box. Read the message, then click *OK*. Follow the instructions—unselect the "Allow Inheritable permissions..." option near the bottom of the *Security* dialog box. This presents you with another warning message box. (Do you get the feeling you are messing with critical stuff? Well you are, so pay attention.) Read the message, then click *Remove*. *Everyone* will go away. To make sure it doesn't try to come back, click on the *Apply* button.

46. One last time, review the permissions assigned to each name. Then click the *OK* button to close the *TigerTest Properties* dialog box.

47. Use the *Windows Explorer* to locate and open the *TigerTest* folder on drive C. Double-click the *Tiger'sTest* file to open it in *WordPad*. Change the message to read:

    This is Tiger's test file after changing permissions.

    Save the file, and exit *WordPad*.

48. Log off, then log back on as *Administrator*. Use *Windows Explorer* to locate and open the *TigerTest* folder on drive C. Then, double-click the *Tiger'sTest* file to open it. What happened? _____
    _____
    Why did that happen? _____
    _____
    Close the error message box, then close the open windows.

49. Log off, then log back on as *Rhino*. Use the *Windows Explorer* to open the Tiger*Test* folder on drive C. Is the *Tiger'sTest* file visible? _____ Open the *Tiger'sTest* file. What happened? _____
    _____
    Why did that happen? _____
    _____
    Close the error message box.

50. Log off, then log back on as *Tiger*. Use the *Windows Explorer* to open the Tiger*Test* folder on drive C. Is the *Tiger'sTest* file visible? _____ Open the *Tiger'sTest* file. What happened? _____
    _____
    Why did that happen? _____
    _____

51. If time allows log on as Guest and see if you can access the file. Otherwise, this concludes the lab except for restoring the computer to its original condition.

52. While passwords are absolutely necessary in the business world, they can be a bother in the classroom. To get rid of the passwords, new accounts and folders that you added, you could go back in and change everything manually. But a faster and surer solution is to return the computer to its original state by using the Restore CD provided by your instructor.

Discussion

In this part of the lab, you learned that *sharing* permissions only affect users that access the share over the network. This will be demonstrated in a later lab.

You also learned that access can be controlled by *security permissions*. You modified the *security permissions* and saw that the activities of the various users were limited by the permissions granted to those users.

Unit 7

Floppy Drive Systems

When you talk about memory in a computer, you have to be careful to describe exactly what kind of memory you wish to discuss. Earlier we discussed memory, and in this section we will discuss a different kind of memory. Other than the hardware they are made of, what is the difference? In a nutshell, the difference is the length of time the data stays in each type.

The memory discussed earlier is usually cleared every time the computer is reset or turned off. This is short-term memory. Mass storage is memory too, but the data is stored for a long time, regardless if the power is on or off. So while both forms are truly memory, in this course long-term memory will be called *mass storage*. Floppy drives were the first inexpensive mass storage devices used in PCs, and they are still used today.

What made the floppy drive so popular was its speed and the ability to randomly access any files or data stored on them. Earlier technologies, such as magnetic tape, were slow and difficult to use. The ability for users to carry disks around and insert and access them quickly was a major improvement over tape and punch cards. The floppy disk is perhaps the only computer component that has retained its original technology from the 8088 to the present. Other than increased storage capacity, the floppy disk drive still works the same as it did in 1986.

Objectives

- Briefly describe the physical sizes and data storage capacities of floppy disks.
- Describe the installation and configuration of floppy disk drives.

IBM developed the first floppy disk drives around 1972. These drives used 8-inch floppy disks. The 5¼-inch floppies that were common on the early PCs came later, shortly followed by today's 3½-inch format. Floppies were included in personal computers before hard drives, but mostly because they were much cheaper than hard drives and many programs didn't need a hard drive to work properly. Just try to imagine running a word processor from a floppy today!

Floppy Disk Drive Basics

A floppy disk is made of a flexible plastic disk, coated with a magnetic material. To protect it from dust and physical damage, disks are packaged in a plastic case. The main advantage of using a floppy disk drive and a floppy disk is that it is a removable media. The data stored on a floppy disk can be moved from one computer to another as long as both have the same type of drives. It is a

good idea to always keep two copies of any data file that you create (original and a backup). The floppy disk is the perfect media for sharing smaller files like graphic images or small documents.

As mentioned earlier, floppy disks have several different physical sizes and capacities. There are so many that we have included them in the following table.

Diskette Size	Capacity	Description
5¼"	160 KB	Single-Sided Single-Density. The original, these are obsolete and never seen today.
5¼"	360 KB	Double-Sided Single-Density. These were standard on the 8088, but obsolete today.
5¼"	720 KB	Double-Sided Double-Density. These never really caught on, you are unlikely to see one.
5¼"	1.2 MB	Double-Sided High-Density. If you encounter a 5¼" drive, it is likely to be this format. But again, they are obsolete.
3½"	720 KB	Double-Sided Single-Density. This is the original 3½" drive, found in many 286 PCs.
3½"	1.44 MB	Double-Sided Double-Density. The standard, they can read and write on 720 K disks, too.
3½"	2.88 MB	Dual-Sided Quad. Not very common.

Today all floppy drives are connected to the motherboard using a standard 34-conductor floppy interface cable.

If the cable has more than two drive connectors, a seven-wire twist in lines 10 through 16 will be found between each connector. This twist determines which drive is the "A:" drive and which is the "B:" drive. The "A:" drive connector is on the end of the cable, past the twist, and the "B:" drive connector is in the middle.

Some cables have four drive connectors, allowing you to have a mixture of drive types. But you can only use two, one for the "A:" drive and one for the "B:" drive. It does not matter whether or not the drive is 3½ or 5¼ inches.

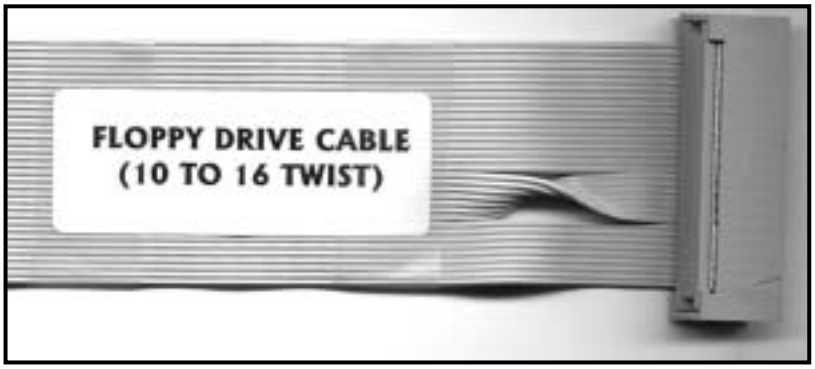


Figure 1
Floppy Disk Drive Cable with a "twist."

Installation

Installing a floppy drive is a three-step process:

1. Physically install the drive.
2. Connect the cables.
3. Configure the drive.

You are unlikely to ever install a floppy drive into a computer as an upgrade these days. More likely, you will replace a bad drive with an exact replacement. Replacing the drive is easy; you simply put the new one in exactly like the old one.

The drive will have side-mount screws that match holes in the chassis. The biggest problem that you may encounter is installing special brackets to accommodate for physical differences in size between the 3½ inch drive if it is installed into a universal bay that will also hold a CD-ROM drive. You may also have problems with access to the mounting screws on some case designs.

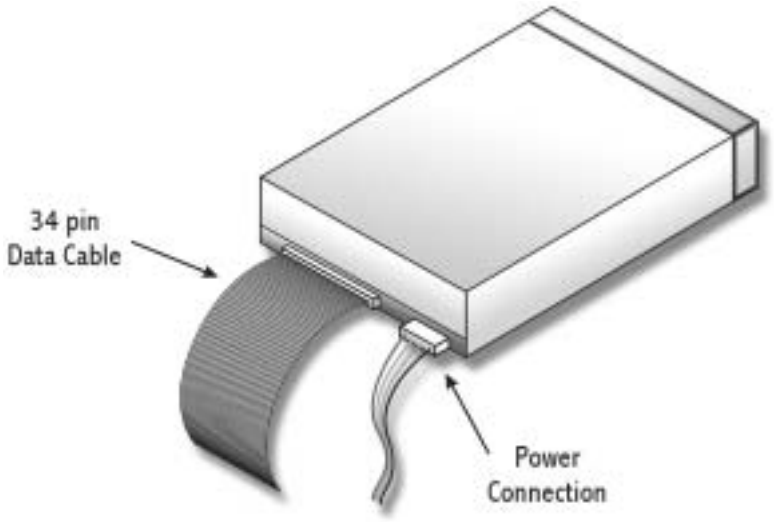


Figure 2
Floppy drive cable connections.

Attaching cables is as simple as making sure that you use the right connector for the drive. You must also be sure to connect the number one pin on the cable to the number one pin on the drive. The cable has a red or blue wire on one edge, which designates the number one pin. You will need to be very careful with the pin connectors; they are keyed, but you could still install the connector backwards if you force it. The good news is that if a connector is backwards, it will not damage anything. If you install a new drive and you notice that the indicator light comes on and stays on, the cable is backwards. And any data on a disk in the drive is destroyed.

Configuration of floppy drives is also easy. You need to know only two things. First, if you have only one drive, it must be the "A:" drive. Second, floppy drives must be enabled in the BIOS setup. In Setup, you will see a listing for each floppy (or diskette). Just change it to the appropriate setting. Make sure that you choose both the drive and diskette size that match the drive you installed.

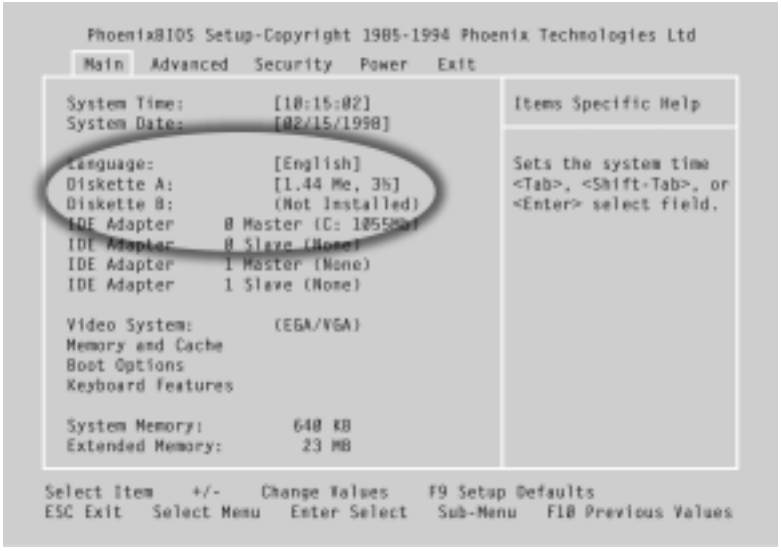


Figure 3
Floppy options in BIOS setup.

The power connectors for 5¼-inch and 3½-inch drives are different. 5¼-inch drives use the larger Molex connector and the 3½-inch drives use the smaller Molex connector. The best method to determine what you need is to look. Both of these connectors are keyed to prevent improper installation, but the smaller one can be forced on backwards so you will have to be careful. By the way, on most drives the data cable pin number one is located towards the power connector.

Maintaining Floppy Drives

If you treat floppy disks or drives badly they will return the favor by losing data or just going bad. With a little maintenance they will provide years of problem-free service.

Failures come from two sources. First is mechanical abuse, for example, when an operator forces a disk in backwards or inserts one with a damaged dust cover (the metal or plastic sliding-door on the disk). Exposure to foreign debris through the disk slot can cause deterioration of the read/write heads. .

The second cause of failure is cable connections. Occasionally, when servicing other components, floppy drives suddenly stop running. Normally the cable has been pulled loose or re-installed backwards.

The bottom line with floppy drives is to keep them clean. There are many cleaning kits available in your local computer store. If a floppy fails, replace it because they're too cheap to waste time trying to fix them. The first thing to check when a floppy drive fails is the disk itself. Floppy disks are fragile and often fail.

Troubleshooting Floppy Disks and Drives

Solving problems with floppy disks is easy; when they fail throw them away. If the data on the disk is critical, there are advanced techniques that *might* save some of the data, but don't count on it. The key is that you should never store critical data on a floppy. They are not reliable over long periods of time, and they are easily damaged if mishandled.

Problems with floppy drives can be divided into two categories. The first is when they don't work at all, and the second is when you cannot read the disk.

When they don't work at all, either you can't hear it spinning and the light doesn't come on, or the light is on and stays on. Floppy drive errors will show up during the POST portion of the boot cycle. Typically you will see "*FDD Controller Failure*" or "*Drive A: Not Ready*" errors.

When you encounter these types of errors look in three places:

- The cables
- BIOS/CMOS
- The drive

When the light is on and stays on, the cable connection is backwards. Check both ends of the cable and be sure pin one is connected to the number one wire (the red one). Sometimes the floppy will fail when you do unrelated work in the computer and accidentally pull the drive cable loose. Since most of us don't use the floppy drive every day, the problem isn't noticed right away. A week or even a month later the problem arises as you use the drive for the first time.

Next, check the CMOS setup. This procedure takes only a few moments and is easy. It is possible for this to have changed back to the default setting or to simply be corrupted. With the simple problems out of the way, the work begins. Next check the drive itself. The best way to do this is to replace the drive with a known good one. Floppy disk drives are cheap and it always pays to have a good one around for these occasions.

Frequently, floppy drives seem to fail right in the middle of a project. You will get an error that the software cannot access the drive. When these errors occur, they are symptomatic of either the floppy disk or an operating system problem. There are several approaches you can take to resolve problems when you suspect a bad disk.

- Always suspect a bad disk. They are magnetic and if placed in a magnetic field, their stored data can be lost. Magnetic fields exist on top of monitors, around electric motors, printers, and speakers.
- The easiest way to check a disk is to substitute it with a known good one (it must be a formatted disk). If you suspect a bad drive, never test with a disk that has critical data. If the problem is the drive, it could damage the good disk.
- The problem may also be that the disk is good, but was formatted with a different file system. For example, if you try to read a disk that was formatted for Macintosh on a DOS-based operating system, you will receive a disk error.

Another common floppy drive error is the "*non-system disk*" or "*No Operating System*." This usually occurs when you try to boot a computer, and you need to remove a non-bootable disk from the floppy drive. The next step is to configure the BIOS setup to skip the floppy when looking for system startup files, because most disks used to hold data do not contain the files necessary to boot the operating system.

Unit Summary

Virtually every PC ever built contained at least one floppy disk drive, and most of the pre-IBM computers had them, too. Apple no longer provides computers with floppies, and soon PC manufacturers will eliminate them, too. The days of the floppy disk are numbered, but the fact remain that they are everywhere.

Lab 7-1

Hard Disk Recovery

When installing or repairing a Windows 2000 Professional system, you have to be able to boot from an alternative drive like a floppy drive or CD-ROM drive. If you have a bootable CD-ROM drive, you can just change the BIOS settings on your system to boot from CD and boot off the Windows 2000 Professional CD. For this lab you are going to create the floppy disks needed to boot your system even if you have a BIOS that will not allow you to boot from a CD-ROM.

You are going to create the four floppy disks required to boot a Windows 2000 Professional system from a floppy drive. The program to create these disks are on the original Windows 2000 Professional CD that came with your system. There are two versions of the program, MAKEBOOT.EXE and MAKEBT32.EXE.

MAKEBOOT.EXE is the 16-bit version that you would use if you were using a version of DOS or Windows 98 as your computer's OS. MAKEBT32.EXE is the 32 bit version that you would use on a computer with Windows NT or 2000 installed.

In addition to the boot floppy disks, you will create an Emergency Repair Disk, or ERD, from the Backup and Recovery Tools program. This is located in the hard disk drive Properties Tools tab page. You will evaluate both the boot disks and the ERD to see what they can do for you. On the way, you will install and explore the Recovery Console and the Advanced Options boot menus. You will find they are very helpful when troubleshooting a hard disk drive problem.

Objectives

When you complete this lab, you will be able to:

- Use the Backup and Restore Tools to build an ERD.
- Describe the contents of the ERD.
- Create a set of Windows 2000 floppy disk start-up disks.
- Boot the Windows 2000 Setup program from floppy disks.
- Install and use the Recovery Console.
- Use the Advanced Startup Options to boot into Safe Mode.

Materials Required

Computer trainer with video monitor, mouse, and keyboard attached.

Original Windows 2000 Professional Installation CD

Five blank, formatted, high-density floppy disks labeled:

Emergency Repair Disk

Windows 2000 Setup Boot Disk

Windows 2000 Setup Disk #2

Windows 2000 Setup Disk #3

Windows 2000 Setup Disk #4

Procedure

Creating the Setup Disks

1. Switch on power to monitor and computer and allow the computer to boot to Windows 2000.

2. Place your Original Windows 2000 Professional Installation CD into your CD-ROM drive. If Autorun is enabled, the *Microsoft Windows 2000 CD* window will open and provide you with several options. You're not interested, so *Exit* the window. If, for some reason, Autorun is not enabled you won't have to exit the window—it simply won't appear.

3. Open the *Windows Explorer*.

4. Expand your CD-ROM drive directory. Then, expand the *BOOTDISK* folder. How many images files are there in the folder? _____ Note that each image file represents the contents of a floppy disk.

5. Double click on MAKEBT32.EXE. This will open a DOS window similar to Figure 1.

6. Read the message in the window, do what it says—type the letter *a*. Then, follow the program directions to make the four setup disks. Remember to allow the floppy drive activity light to go out before ejecting a disk. The DOS window will close after the last disk is copied. You now have the four floppy disks needed to recover or install Windows 2000. But, you still need to build the ERD.

7. Remove the fourth disk from the floppy disk drive.

Creating the ERD (Emergency Repair Disk)

8. There are two ways to get to the Backup program. One way is through the Properties window of the hard or floppy disk drive. The other way is through the Start menu? Lets use this second way. Click *Start, Programs, Accessories, System Tools,* and *Backup*. This will open a window like Figure 2.

9. Read the messages in the window, then click on the *Emergency Repair Disk* button. A message box will appear telling you what to do. It will also give you the opportunity to save the contents of the system Registry when the ERD is created. It's always a good idea to take advantage of every opportunity like this, so select the option, load the floppy disk, then click *OK*.

10. Another message window will appear telling you the job was completed successfully, and how to label the disk. Remove the floppy disk and click *OK*.

Evaluating the Setup disks and ERD

11. Close the *Backup* and *Windows Explorer* windows.

12. Place Setup Boot Disk into your floppy drive and remove the Windows 2000 CD from the CD-ROM drive.

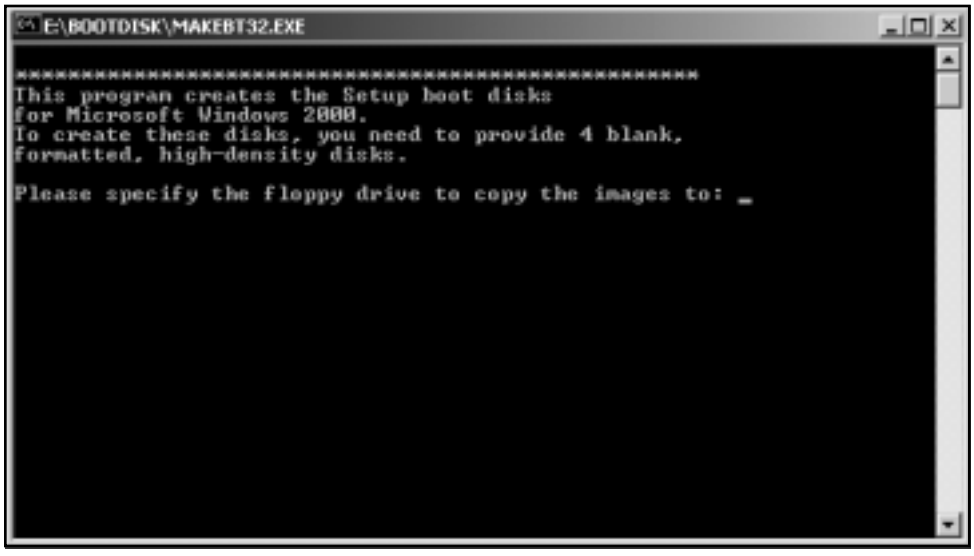


Figure 1
The BOOTDISK\MAKEBT32.EXE window.

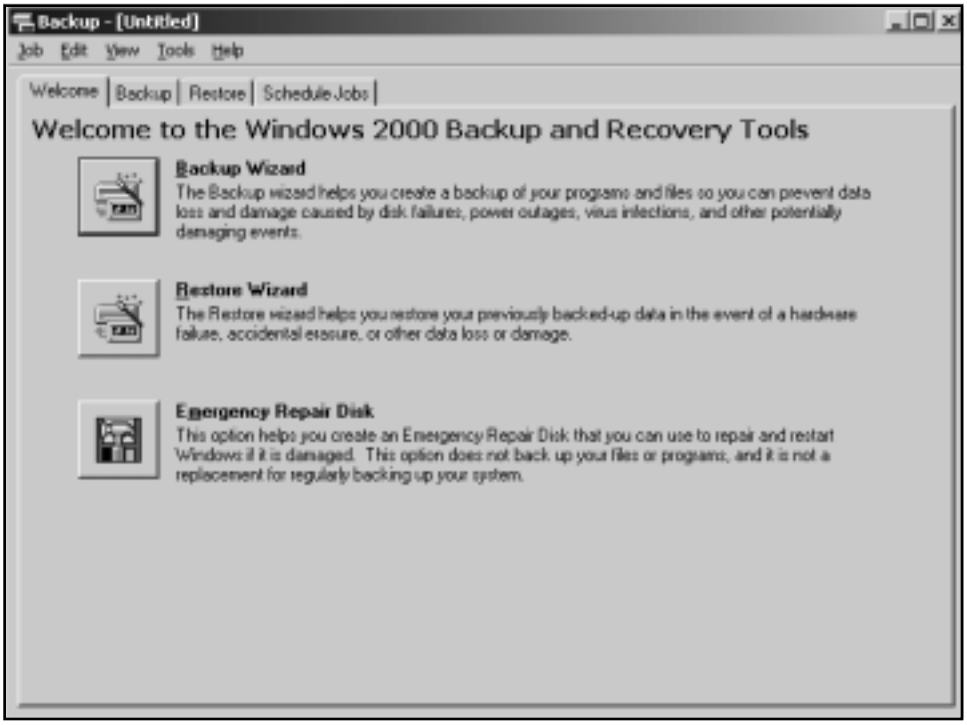


Figure 2
The Windows 2000 *Backup* window.

13. Restart the computer. When the BIOS start-up screen appears, press the *Del* key to run the CMOS Setup Utility program. Go to the *Advanced BIOS Features* window and change the *First Boot Device* to *A:* (don't be concerned at this time if another boot device is also set to A:). Press the *Esc* key to return to the main menu. Select *Save & Exit Setup*. Then, press the *Enter* key, the *Y* key, and the *Enter* key one last time to exit and save the change you just made.

14. As the computer begins to boot from the floppy, the blue Windows 2000 Setup screen will appear. What do you see on the white status bar at the bottom of the blue page? _____
_____
_____ Follow the on-screen directions, swapping each Setup disk as instructed. At the completion of the installation, the Windows 2000 Professional Setup screen will appear. Figure 3 is an example of what you will see. What three options are you offered? _____
_____
_____
_____

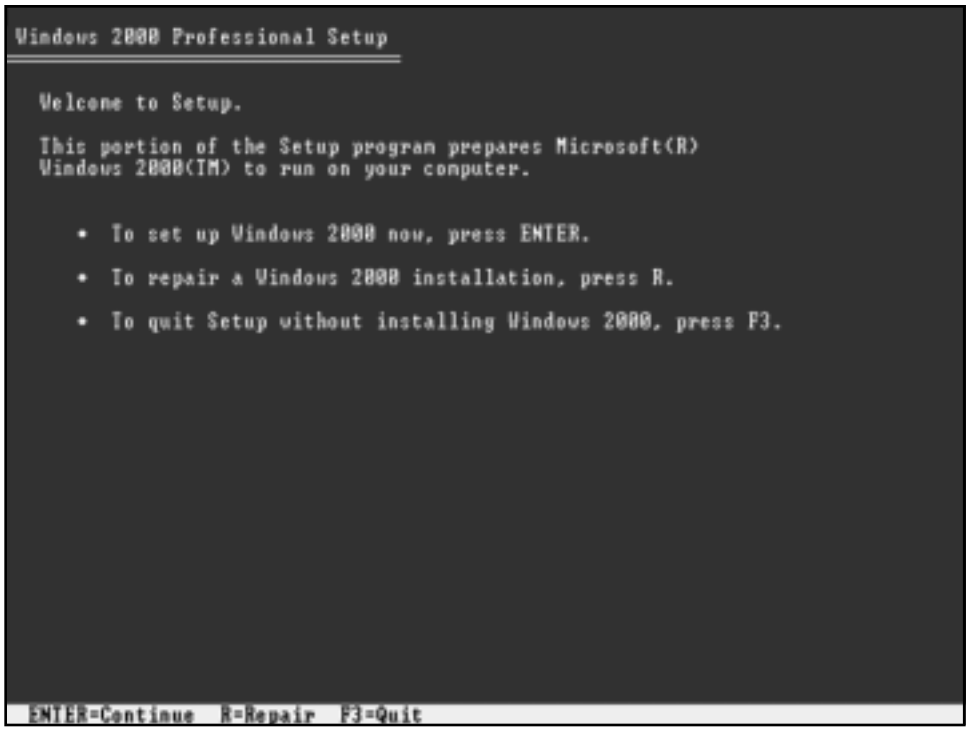


Figure 3
The Windows 2000 main Setup window.

15. Press the *R* key to select the Windows 2000 Repair option. A second window will open asking how to proceed with the repair. Again, press the *R* key to select the Emergency Repair option. This will open a third window asking the type of repair. Press the *M* key to select the Manual Repair option. This will open a window like the one shown in Figure 4 on the next page.

16. Here, you are asking Windows to perform several preliminary repair tasks. You should see all three tasks selected and the bottom line highlighted, as in Figure 4. Therefore, you may press the *Enter* key to continue.

17. In this window you are asked if you have the ERD. Because you do, press the *Enter* key. Remove Setup Disk #4 and load the ERD as instructed in the window. Then, press the *Enter* key to start the repair process.

18. You wish to have Setup examine your drives, so place the Windows 2000 Professional CD in the CD-ROM drive and press the *Enter* key. Setup will examine your disks.

19. Follow the prompts on the screen; remove the CD and floppy disk and allow your system to reboot. Great job, you have successfully tested your ERD, Setup disks, and the hard disk drives in your computer.

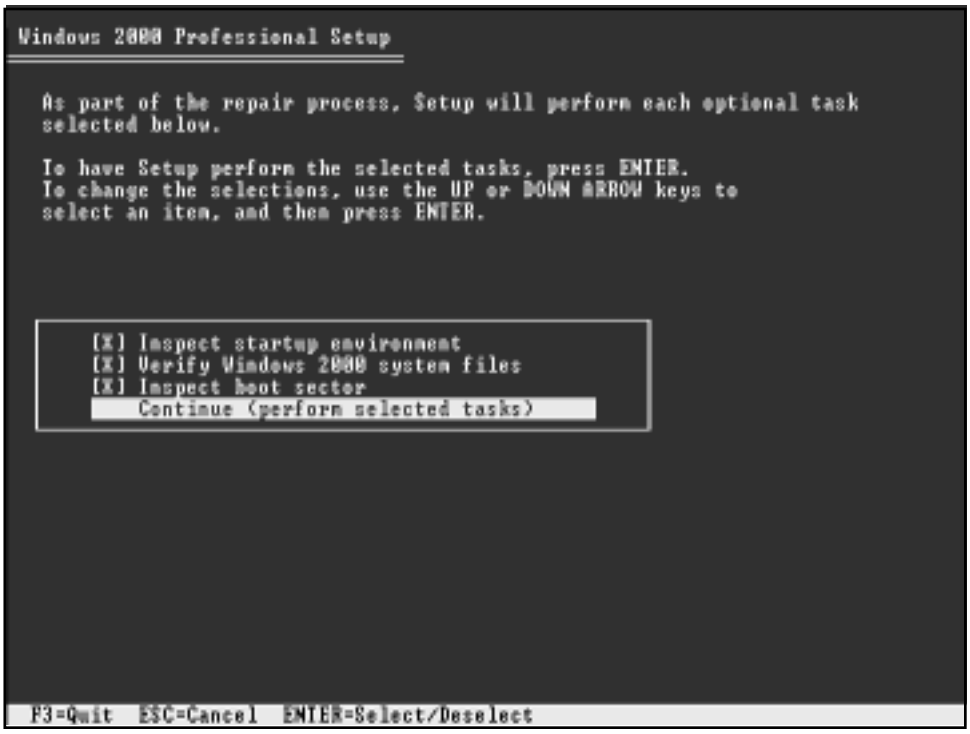


Figure 4
The Windows 2000 Setup repair task window.

20. After Windows 2000 is up and running, put the *ERD* back into floppy drive A. Open *Windows Explorer* and examine the contents of the *ERD*. The *autoexec.nt* and *config.nt* files are provided to support DOS mode operations. The *setup.log* file is a snapshot of the Windows 2000 installation. This tells Windows 2000 what files are installed, and where they are installed. With that information, missing or damaged system files are quickly reinstalled. Of course, this only works for system files. A damaged application may need to be cleaned from the drive and reinstalled.

21. Select the *Desktop* icon in the left pane of the *Windows Explorer*, then close the window. Remove the *ERD*.

Installing the Recovery Console

22. Place the Windows 2000 Professional CD into the CD-ROM drive. If the Autorun feature opens the *Windows 2000 CD* window, *Exit* the window.

23. You are about to install the Recovery Console. In the Taskbar, click *Start, Run*. In the *Run* textbox, type: *d:\i386\winnt32.exe /cmdcons*. (In this case *d:* is the CD-ROM drive.) Then, click *OK*.

24. Read the *Windows 2000 Setup* message box, then click *Yes*. Don't try to respond to any of the Setup Wizard prompts. The installation will run automatically. At the end of the installation, the *Microsoft Windows 2000 Professional Setup* message box will appear. Read its message, then click *OK*.

Running the Recovery Console

25. Restart the computer. When the BIOS start-up screen appears, press the *Del* key to run the CMOS Setup Utility program. Go to the *Advanced BIOS Features* window and change the *First Boot Device* to *CD-ROM*. Exit and save the change you just made.

26. When the boot menu appears press the spacebar to turn off the count-down counter. Examine the display. How many boot options do you now have, and why? _____
_____

27. Select the *Microsoft Windows 2000 Recovery Console* and press the *Enter* key. Wait while the Recovery Console loads, this will take a couple of minutes.

28. When prompted, select the Windows Installation to log onto by typing *1* and pressing the *Enter* key—it's your only option other than quitting.

29. When prompted for the Administrator's password, press the *Enter* key.

30. Type the word *help* at the c:\WINNT prompt and press the *Enter* key to display the available Recovery Console commands. Read the messages at the top and bottom of the display. Do you recognize any of the commands? _____ Which ones don't you recognize (use the *Enter* key to scroll through the list)? _____
_____
_____
_____
_____

31. How many lines do you scroll through when you press the *Enter* key? _____

32. Type *dir*, then press the *Enter* key. What is your computer displaying?
_____

33. Press the spacebar, how many lines did you scroll through? _____

34. Page through the directory until you get the prompt back.

35. The computer is operating in a DOS-like window. When you typed *help*, you displayed only the Recovery Console commands. While many of the commands are similar to the DOS commands available in Windows 2000, several are unique to the Recovery Console. Change the display focus to the Parent directory—type *CD ..* (CD dot dot) and press the *Enter* key. Note that because the Parent directory is also the Root directory, you could have typed *CD*.

36. Type *dir*, then press the *Enter* key. What did your computer display?
_____

37. In the directory just displayed, how do you know that WINNT is a directory? _____
_____

38. At the display prompt, type *help dir* and press the *Enter* key. Read the help information. In the following blanks, fill-in the meanings of the symbols.

D	_____	R	_____
H	_____	A	_____
S	_____	C	_____
E	_____	P	_____

39. Type *exit* and press the *Enter* key to quit the Recovery Console and restart the computer.

Using the Advanced Options Menu

40. Press the *F8* key when the boot menu appears. This will open the *Windows 2000 Advanced Options Menu*.

41. What are the options listed?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

42. Select the option *Safe Mode with Command Prompt* and press the *Enter* key. You will be shown the boot menu again, only this time a message at the bottom of the display tells you the computer will boot into Safe Mode with command prompt.

43. Select *Microsoft Windows 2000 Professional* and press the *Enter* key. You will see a listing of the program files that are being installed while the computer boots into Safe Mode. After several minutes, the display will open into a DOS window running the command interpreter *cmd.exe*.

44. At the command prompt, type the word *help* and press the *Enter* key. This will present you with a list of available DOS commands. Did you see the whole list? Probably not. But that's okay. Recall that the DOS window in Windows 2000 keeps track of the last 300 lines of text that it displayed. A scroll bar on the right-hand side allows you to scroll up and down through the text. Notice that this time, the command list contains a short description for each command. For a detailed listing, you can type the command followed by */?*.

45. Press the minimize button near the top right corner of your display. Where are your icons on the desktop? For that matter, where is the desktop? _____
_____
_____

46. Restore your DOS window. Then, at the command prompt, type *explorer* and press the *Enter* key. A *Desktop* warning message box will appear, reminding you that Windows is running in Safe Mode.

47. Click *OK*. The Windows Taskbar will appear at the bottom of the display. Minimize the DOS window and you will discover the Windows Desktop and its missing icons. Notice that the Windows Explorer shell did not appear. Typing the command got you into Windows, but that's all it got you.

48. Does the *Windows Explorer* actually work? Right-click *My Computer* and select *Explore*. Windows Explorer does work. Close the *Start Menu* window. Other than the messages plastered around the edges of the display and the poor quality of the display, it's difficult to tell you are in Safe Mode. It would be more evident if you had additional hardware devices installed in the computer. That's because their drivers wouldn't load in Safe Mode, and they would fail to run. Even a serial mouse won't work in Safe Mode.

49. Congratulations you now know how to use both the Recovery Console and Advance Startup Options. This concludes the main portion of the lab.

50. Remove the Windows 2000 Professional CD from the CD-ROM drive and store it in a safe place.

51. Shut down Windows 2000. Then, switch off power to the computer and monitor. Read the following Description.

Discussion

You created a set of Windows 2000 Setup disks for emergency booting purposes. Then, you verified they actually work. You then created an Emergency Repair Disk and verified it worked as well. You should make it a habit to create a new ERD whenever you change the hardware or software configuration of your computer.

After you installed the Recovery Console on your Windows boot drive, you discovered that the Recovery Console option was added to the boot menu. When you ran the Recovery Console, you found that it operated in a DOS-like mode, but that it used its own set of commands.

The Advanced Options Menu offers several alternatives to booting Windows 2000 in a normal fashion. Use these options when trying to recover from a system problem. They will help you to isolate different areas of Windows to zero-in on the difficulty.

Lab 7-2

Removing and Installing Floppy Disk Drives

Except for the hard disk drive, floppy disk drives probably fail more than any other part of the computer. Because people rely on floppy disk drives to provide a fast, reliable, and sometimes the only way to transfer data from one computer to the next, you must be ready to evaluate, remove, configure, and install a floppy disk drive. Today, you will remove, examine, and reinstall your floppy disk drive.

Objectives

When you complete this lab, you will be able to:

- Remove the floppy disk drive from a PC.
- Identify the major components of a floppy disk drive.
- Configure a floppy disk drive.
- Install a floppy disk drive.

Materials Required

To complete this lab you will need your computer, any 3½-inch floppy disk that contains data, and the anti-static wrist strap.

Procedure—3½-inch Floppy Drive Removal

1. If you have not already done so, switch off power to the computer and monitor.

2. Remove the left and right side panels from the computer.

3. Slip the antistatic wrist strap onto your wrist.

4. Connect the ground lead of the antistatic wrist strap to ground on the computer.

Refer to Figure 1 while you perform the following steps:

5. Note the location of the color stripe on the flat-ribbon cable going to the 3½-inch floppy drive. Write a cable/strip location reference that you can use to reattach the cable later: _____

   _____

   Unplug the flat-ribbon cable and the power supply cable from the drive.

6. Remove the four screws that secure the drive to the chassis. Two are shown; the other two are on the opposite side.

7. Carefully remove the drive by sliding it out through the front panel of the computer.

   Your computer can contain one of several different floppy drives. Several of these drives have circuit boards with exposed components. Try to avoid touching any of those components when you remove the drive.

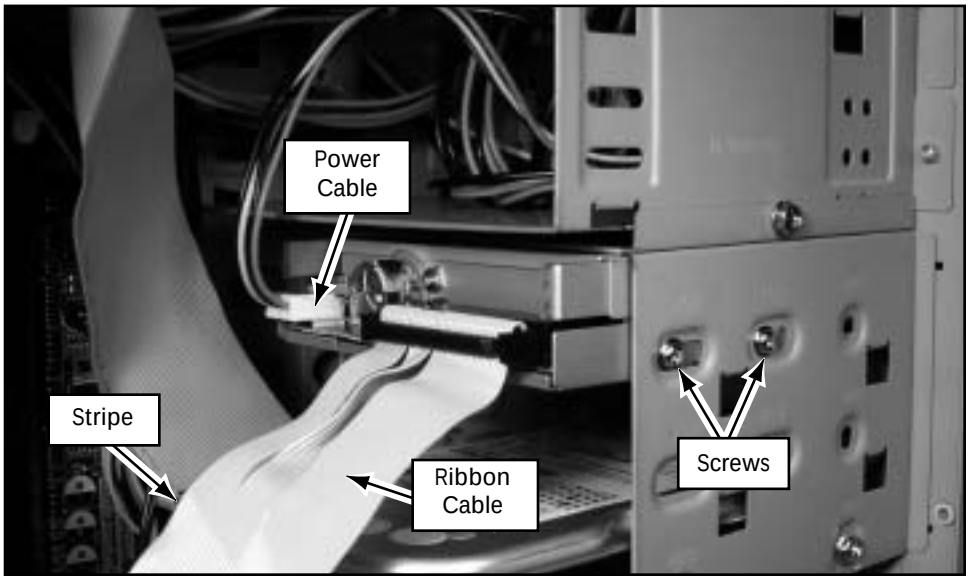


Figure 1
Remove the floppy disk drive from the computer.

IMPORTANT NOTE ABOUT COMPUTER HARDWARE

Computers contain a combination of metric and common (U.S. Standard) screws as shown in Figure 2. It is important that you do not get these two types mixed up. Doing so will likely cause damage to either the screw, or the mating hardware.

Metric hardware generally has finer (more closely spaced) threads than common hardware. In addition, metric screws are slightly smaller diameter than their common cousin.

CD-ROM drives and floppy disk drives use metric screws, while hard disk and most other computer devices use common screws. As a general rule when you remove the chassis screws, store them in the chassis where they were originally attached.

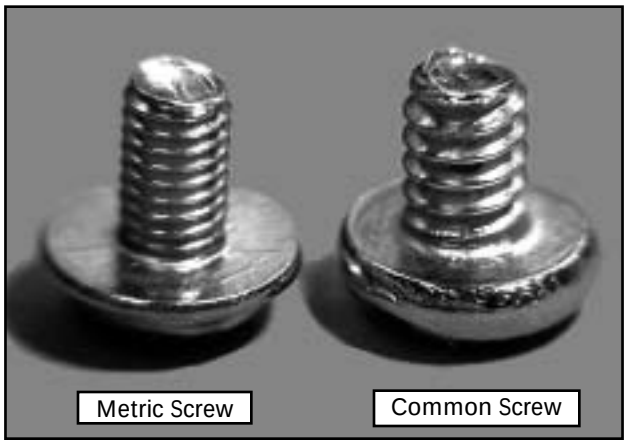


Figure 2
Metric vs. standard screws.

8. Look for the drive select switch or jumper on your drive. Are there any switches or jumpers at all on your floppy drive? _____ PnP has taken the fun (some would say, the drudgery) out of floppy drive installation. There are no switches to set and no jumpers to move. But even this situation can cause some confusion. Figure 3 shows the circuit board on the bottom of a Panasonic floppy disk drive which may or may not be like the one you just removed. If you look closely at the circuit board, you will see a place for many switches. The switch locations are there; the switch labels are there; but the switches aren't there. In this case, this single circuit board is used on both PnP and non-PnP floppy drives. When a plug-and-play-only drive is required, the switch locations are not populated.

As was the case earlier with the hard drive, we can not be sure exactly which version of floppy drive you received with your computer. Therefore, we will describe several different floppy drive types. You should look carefully at each one and compare its features with the drive you have.

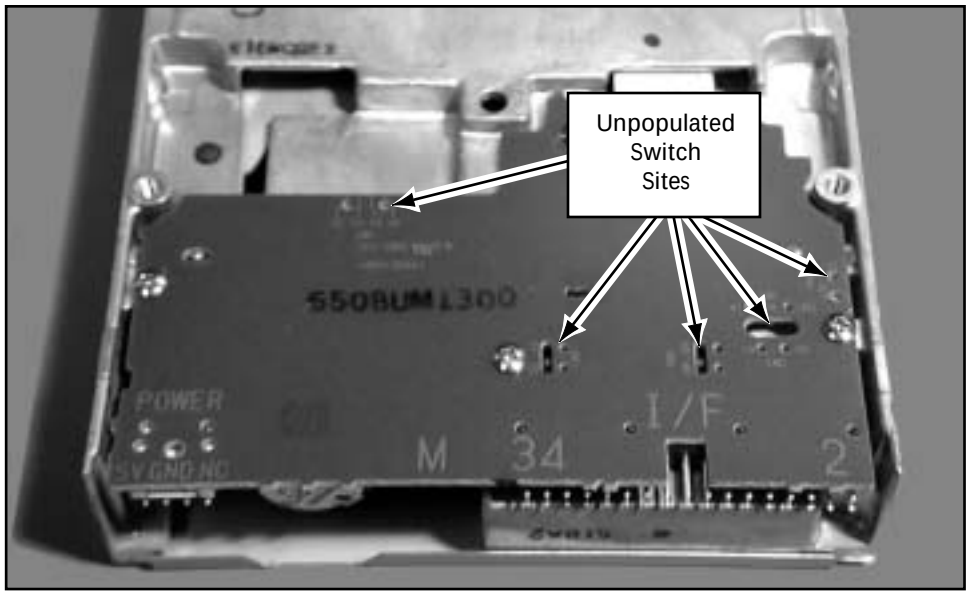


Figure 3
Bottom view of the floppy disk drive.

9. The drive cover is generally secured to the drive chassis by a pair of small tabs or screws. Figure 4 shows the two cover screws on one type of Panasonic drive. It also shows one of the two tabs that secure the cover to the front of the drive. To remove the cover from this drive, remove the two screws, lift the end of the cover up a small amount; then, gently pry the sides of the cover out just far enough to release the tabs at the front, so you can remove the cover.

10. Figure 5 shows a Sony drive that uses only tabs to hold the cover on. There is another tab on the other side of the drive. To remove the cover from this drive, gently pry the sides of the cover out far enough to release the tabs, lift the end of the cover up a half-inch or so, and slide it back far enough to free it from the front panel.

11. Examine your floppy disk drive closely and determine how the cover is attached. At the time this course was being written, the cover of floppy disk drive supplied with the computer was held on with four tabs. If your cover is held on with small screws, be very careful to match the screwdriver to the size of the screw. Too large a screwdriver will strip the slots. Carefully remove the cover.

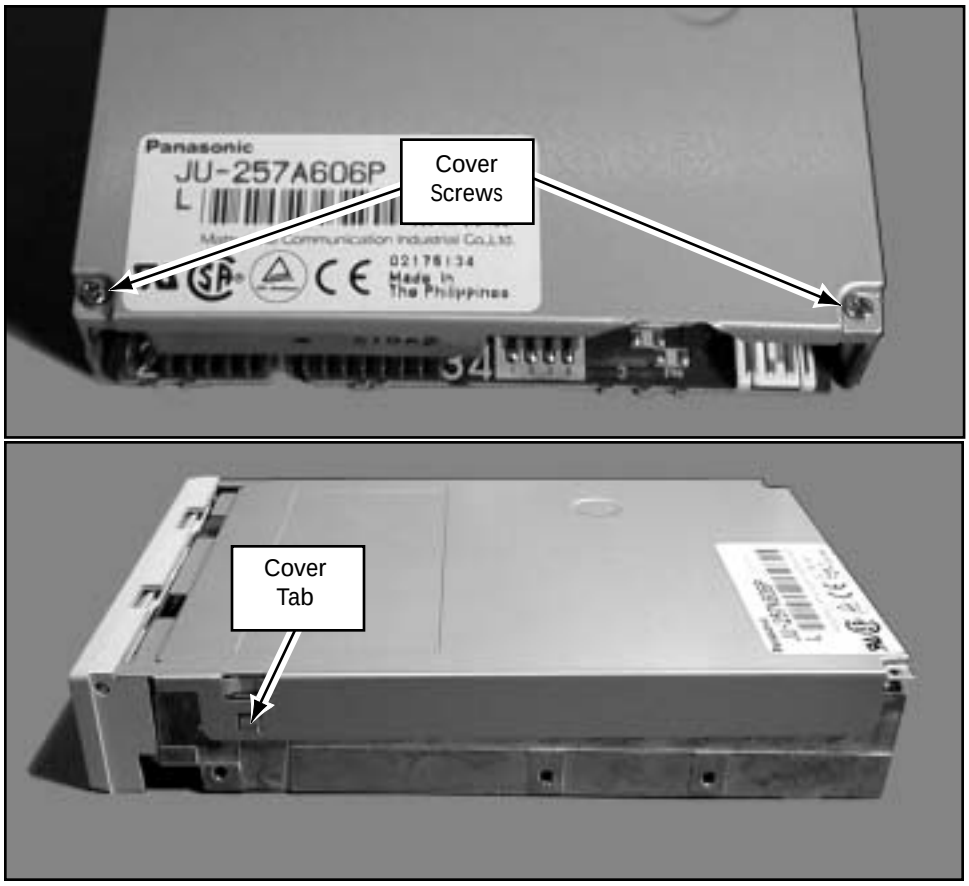


Figure 4
Removing the cover from a Panasonic floppy disk drive.

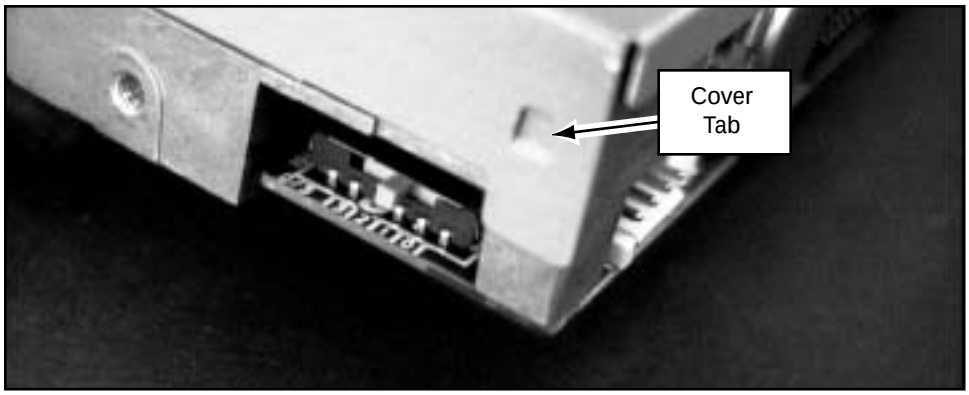


Figure 5
On this Sony drive, the cover is held in place with tabs only.

12. Set the drive on a flat surface so the circuit board components on the bottom of the drive are protected (if they are exposed), and examine the disk drive mechanism. Figure 6 identifies several components inside the drive. This is typical of 3½-inch floppy disk drives. While the following steps pertain specifically to this particular Panasonic disk drive, the drive you have is probably quite similar.

13. Insert a 3½-inch floppy disk into the disk drive and watch what happens. As the disk is inserted, a lever near the front of the drive hits the leading edge of the disk case. Because that part of the case is beveled, the lever slides out of the way and allows you to insert the disk further. To see how that works, flip the disk over and try to insert it. You can't because the lever won't move out of the way.

14. Flip the disk back over to its original position and push it further into the drive. Notice how the disk door opener lever slides the spring-loaded disk door sideways until it is fully open. At the same time, the back end of the lever rotates past a tab attached to the movable subchassis. When the lever clears the tab, the spring-loaded subchassis closes on the disk and clamps the disk hub to the disk drive motor beneath the subchassis. This also lowers the read/write head assembly onto the disk surface. Push the disk release button on the front of the drive and you force the subchassis up, releasing the disk. The spring-loaded disk door opener lever pushes the disk out of the drive far enough for you to grab it. The lever also locks the subchassis in the "up" position.

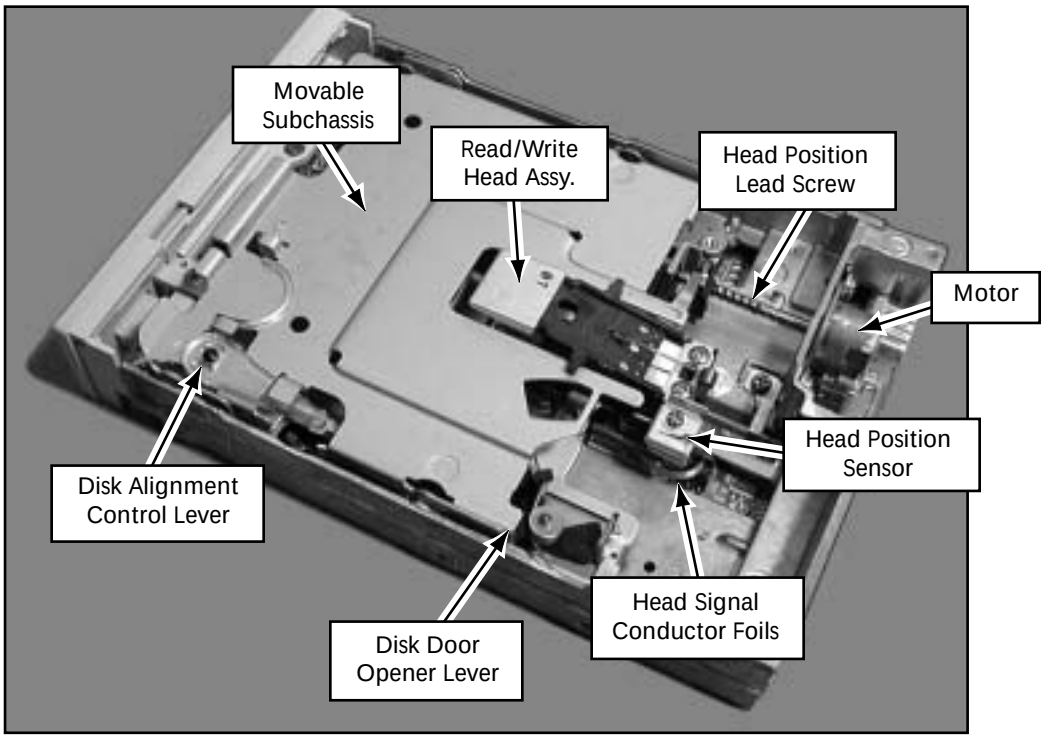


Figure 6
A typical 3½-inch floppy drive mechanism.

15. Find the motor at the rear of the drive. The read/write head assembly motion is controlled by a lead screw attached to this motor. The FDD controller determines head position by moving the head toward the rear of the drive until a tab on the head assembly activates the head position sensor. This tells the controller the location of track zero. Signals to and from the head assembly are conducted over the small ribbon cables.

16. Remove the floppy disk from the drive mechanism. Reinstall the cover onto the drive. If your drive cover is held on with two small screws, be very careful when you reinstall the screws. You can easily cross-thread or overtighten a screw and strip its threads.

17. Insert the drive back into the chassis through the front panel. Line up the front of the drive with the front panel. Use the screws you removed earlier to resecure the floppy disk drive to the computer. What type of screws are used to secure the floppy drive to the chassis?

    _____

18. Plug the power cable into the floppy disk drive.

19. Plug the flat-ribbon signal cable into the floppy disk drive. Remember, the edge of the cable with the color stripe always goes to pin 1 of the connector. If you do get it backwards, you'll know it as soon as you apply power to the computer. The disk drive LED will light and stay lit.

20. Switch on the power to the computer and monitor and allow the computer to boot. Any error messages? Unless you did something really nasty, there should be no problems.

21. To make sure everything is okay, put a disk that contains data into the floppy disk drive.

22. Open the *Windows Explorer*. Then look at the directory of drive A:.

23. Close *Windows Explorer* and remove the disk from the drive.

24. Shut down Windows and switch off the power to the computer and monitor.

25. Reinstall the left and right side panels onto the computer.

Discussion

In this part of the lab you removed, examined, and reinstalled the floppy disk drive. Because the disk drive is a PnP device, there were no switches or jumpers to configure.

Troubleshooting floppy drives is a straightforward process. The system can be broken down into four distinct areas, all of which are simple to isolate. That is, if you have a "known good" spare drive and cable to use for testing. You simply substitute parts. The last area to troubleshoot is the BIOS setup, where settings can be changed accidentally. Many problems, in fact, are due to bad media. That is, the floppy disks themselves fail.

The floppy system in a PC is often regarded as the least reliable section of the PC system. Why? I'll guess at two reasons: First, the media and drive itself are too easily damaged. Despite the best efforts of disk manufacturers, dust and dirt will get into the disk and onto the magnetic media when it is out of the drive. This dirt transfers into the drive when the disk is used, which in turn damages the heads and mechanisms. Hard disks are more reliable in part because they are sealed tight. Also consider that the drives themselves are prone to collect dust because they are not sealed. Second, because floppy drives are never used for "mission critical" applications, they are not designed to be bulletproof. Nobody wants a super-reliable floppy, so they are only built as good as they need to be.

Unit 8

Hard Drive Technologies

Hard drives are the most common mass storage devices. Virtually all computers today have at least one hard drive. Early hard drives were small in capacity (10 MB), big, and expensive compared to today's drives. At the time, the capacity was not a problem as the size of programs, and the work requirements put on them, was small by today's standards. The first hard drive was about 4 inches tall, six inches wide, eight inches long and weighed almost ten pounds. The newest hard drives are just bigger than a quarter and can fit into a small digital camera, with several hundred MB to boot. Of course, bigger drives have passed the 80 GB mark. In this section, we will study hard drives from the early versions to today's monsters.

Fixed Disk Fundamentals

The concept for the hard drive was to have a storage media that not only held large amounts of data, but also was fast and allowed easy (random) access to that data. Using the floppy as a model, designers created a disk drive that could hold up to 10 megabytes of data. At the time this was a phenomenal amount of data. Since the diskette was not removable, or flexible, it became known as a "fixed disk" or hard disk drive (HDD).

Objectives

- Describe the basic operating characteristics of a hard disk drive.
- Describe how a hard disk drive is divided into cylinders and sectors.
- Describe the logical geometry of data on a hard disk drive.

Hard Drive History

The first IBM hard drives came out in the late 1970s and early 1980s and were code-named "Winchester." The original design concept included two 30 MB units in one enclosure: 30-30 (hence "Winchester"). The PC-XT was the first personal computer to include a hard disk. They were called "fixed disks" because they were not removable. The Winchester technology is the direct ancestor of all PC fixed disks.

A hard disk operates on the same principle as a floppy disk. It has a spinning platter with a pair of read/write heads that traverse perpendicular to the rotation of the platter. Two things make hard drives different from floppies. First is that the platters are made of an aluminum alloy and have a thin magnetic media coating on both sides. Second is that they are in a sealed enclosure, free of dust, dirt, and any contaminants.

Hard disks have always had a much larger capacity than floppies, for several reasons. First, hard drives often have more than one platter per drive, providing for more surface area and thus more storage. Additionally, the hard disk material can handle more data per given area, increasing the storage density. Second, they have more accurate control over the read/write heads. This increased accuracy and greater surface area and density allow for capacities in the gigabyte range instead of the 1.44 megabytes of a floppy.

How Does a Hard Drive Work?

The goal of a hard drive is to achieve fast, random access to data stored on a flat surface. This is accomplished by utilizing motion in two directions. The disk spins somewhere between 3,600 RPM and 10,000 RPM, and the read/write heads are moved across the platter perpendicular to the motion of the disk. It should be obvious that the heads should not (and in fact do not) touch the surface of the platters while running. This would no doubt cause a catastrophic failure commonly known as a head crash. When this happens, the only solution is to throw the drive away and start over.

Based on the Bernoulli principle (in any horizontally moving fluid the pressure increases as the velocity of flow decreases), the heads "ride" on a cushion of air. The interaction between the air in the chamber and the surface of the moving disk creates an interface of disturbed air that the heads ride on. Some designers in the hard drive business call this cushion of air an *air bearing*.

Magnetically Storing Data

As we discussed previously, data is stored in binary language. In the case of memory, a voltage represents the binary one in each memory cell and a lack of voltage represents binary zero. With magnetic media, the ones and zeros can be stored as either magnetic or non-magnetic areas on the drive surface. The binary data is not stored as magnetic poles (positive or negative) but as "flux reversals." The term *flux* defines a magnetic field that has a specific direction. A flux reversal is the change in polarity, or the positive to negative transition. Each bit written on the drive creates a pattern of positive-to-negative or negative-to-positive flux reversals on the medium.

The read/write heads are made of U-shaped conductive material wrapped with coils of wire. Passing current through the coils and rapidly changing its direction produces magnetic fields, thus writing to the disk. When passing the read head over the magnetic fields on the surface of the disk, current is generated in the coils and data is read.

Hard Disk Geometry

In order for data to be stored and retrieved from the surface of a hard disk, the data must be organized. This organization will determine two things. First is the maximum amount of data that can be stored and second how that data is retrieved. As we learned, hard drives are composed of one or more disks or

platters on which data is stored. The physical organization of data on these platters if often referred to as the *logical geometry* of a hard drive. It is this logical arrangement of data that determines the maximum storage capacity of the drive.

The logical arrangement of data on a hard drive is based on five numerical values.

- Heads
- Cylinders
- Sectors
- Landing Zone
- Write Precomp

Write Precomp and Landing Zone are obsolete, but are often seen on older drives.

Basic knowledge of the physical layout of data is useful to be able to install and configure a hard drive. If you look at the documentation that comes with a new hard drive, you will find information regarding the cylinders, heads and sectors. These values are commonly called *CHS* values (Cylinders, Heads, Sectors). Also, many drives will have this information printed on the label.

Next, let's look at the individual components that make up a hard disk drive and see how they affect data storage.

Cylinders

Data is stored in concentric circles on the surface of each platter. Each concentric circle is called a track. A set of tracks (all tracks of the same diameter) through a stack of heads, is called a "cylinder." The number of cylinders is the logical number used to describe the drive (not the number of tracks). BIOS limitations set the maximum number of cylinders at 1024.

Heads

The number of heads equals the total number of sides of all the platters. If a hard drive has 6 platters it could have up to 12 heads. Sometimes a platter side is not used for storing data, so it isn't counted. For example, some hard drives must reserve a head for navigation (accuracy of the arm position). Since platters are two-sided it is logical to always have an even number of heads. However, if one is used for navigation, the reported number of heads will be an odd number. Again, the BIOS limitations set the maximum number of heads to 16.

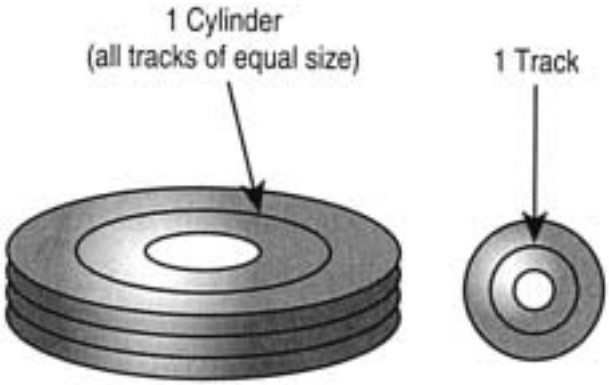


Figure 1
Cylinders are a logical grouping of all the tracks on all the platters.

Remember, CHS numbers are *logical* values. This has allowed some hard drive manufacturers to use a technology called *sector translation* to create more than one logical head on a single side of a platter. Sector translation is a software conversion of the actual values into values that the BIOS will accept.

Sectors

The third element of CHS values is *sectors*. A hard drive is cut (figuratively) into small arcs (like a pie). Each arc is called a sector and holds 512 bytes of data. The BIOS needs to know how many sectors are in each track. As with the other CHS values, the BIOS sets a limit on this one, too. BIOS limitations set the number of sectors per track (spt) at 63.

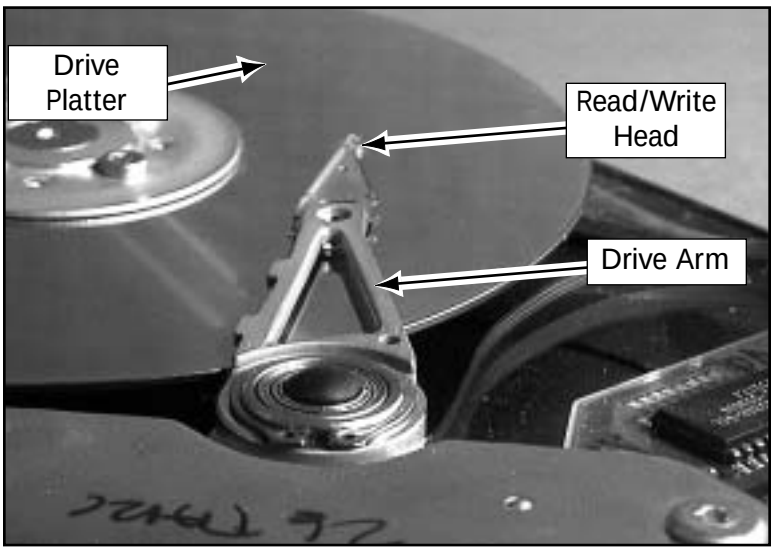


Figure 2
This single-disk drive has two platters, and another on the bottom platter.

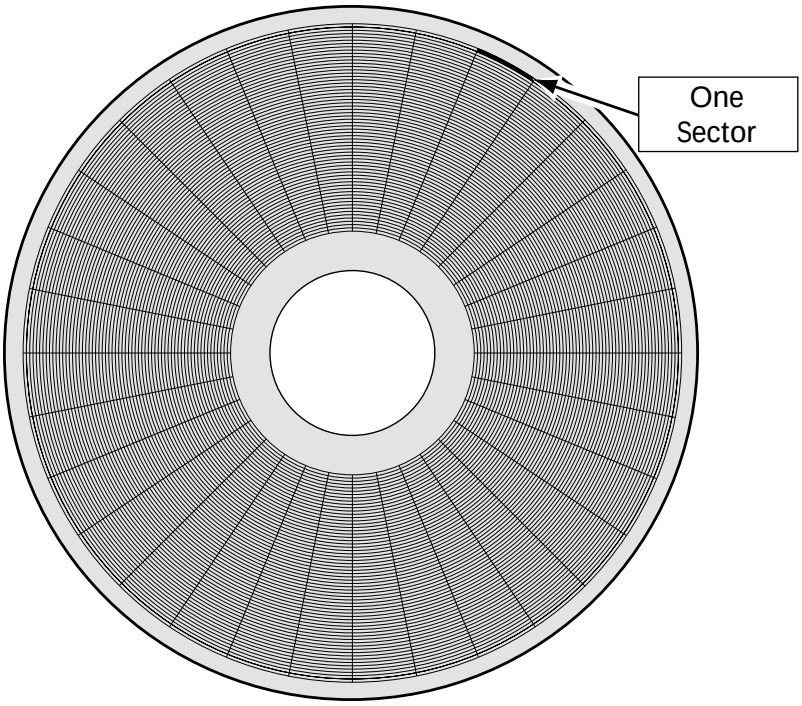


Figure 3
A single drive platter divided into sectors.

Write Precomp

If you look at the figure describing a sector, it is obvious that the outside sectors are larger than the inside sectors. The technology of early drives needed a method of compensating for this anomaly. This method was called "write-precomp." It literally means a point (the cylinder) at which the drive needs to compensate for the size difference of sectors.

Today's standard drives far exceed the early BIOS limits. Larger drives manage to exceed this limitation in two different ways. We mentioned sector translation as a method of converting logical values into values that the BIOS can understand. Other translation methods can be employed that allow the BIOS, the CPU and the drive controller to report and see the CHS values that they need to run. The other method is to replace the BIOS with a version that can properly recognize larger hard drives.

Hard Drive Types

As hard drives were introduced into the personal computer market, a large variety of drives became available each with their own CHS values. To simplify installation, IBM created standard "types" of drives. To configure a drive, all the technician had to do was enter the drive number into the BIOS setup. The correct CHS values would then be properly configured. This system worked for some time, but as more drives entered the market, more drive types had to be added to the list. This created an additional problem in that BIOS's were

outdated because they did not contain the latest list of types. So at Type 46, the decision was made to stop adding new types and use Type 47 as "User". From this point on, the BIOS did not need to be updated, but the technician had to select Type 47 and manually configure the CHS value.

Today, the process is even more simplified. A 48th type has been assigned. That type is "auto". With auto, the BIOS information is stored on the hard drive itself. When running the BIOS setup, a ROM chip on the hard drive will be queried and all the important data will be collected.

Hard Drive Interfaces

The development of hard drives followed two paths. The first and most obvious was the ability to store more and more data in a smaller and smaller place. This growth was based on the ability to miniaturize the read/write heads and how close together data could be stored and still retrieved reliably.

The second path was around the interface. A hard drive interface determines how the drive communicates with the motherboard and CPU. In fact, hard drives are categorized by their interface. Let's now look at hard drive interface technology as it progressed from the early drives to today's behemoths.

Objective

- Describe the common types of hard disk drive interfaces, and their basic strengths and weaknesses.

IDE

The *IDE* or *Integrated Drive Electronics* (pronounced eye-dee-e) drive came on the scene in the early 1990s. IDE drives incorporated the benefits of both of its predecessors and quickly became the standard for desktop computers.

Western Digital and Compaq developed the first ATA IDE drives and established the 40-pin IDE connector specification that is now standard. With this standard, drives started using a single cable with no twist. Since two drives can be connected to one cable, each drive must be individually configured as either a master or a slave. Switches or jumpers on the drive are used to complete the configuration. This is now a standard method for installing drives.

EIDE

The successor to the very popular IDE drive is today's standard known as the *Enhanced IDE* (*EIDE*). It has several improvements:

- Increased drive capacity.
- Increased speed for data transfer.
- A secondary channel allowing support for up to 4 devices.

- ATAPI (AT Attachment Packet Interface) to support non-hard drive storage devices such as CD-ROMs and ZIP drives.

IDE drives are now obsolete. However, in industry and throughout this course the terms “IDE” and EIDE” are often used interchangeably.

SCSI

The *Small Computer System Interface* (*SCSI*, pronounced *scuzzy*) is actually not a disk interface, but a systems interface. The SCSI bus provides a communication path between the SCSI device controller and the computer’s system bus. Using a SCSI bus, up to seven peripheral devices can be attached to a single adapter.

Hard Drive Installation and Setup

All boot devices must be configured outside of the operating system regardless of the level of Plug and Play compatibility. Devices that are used to boot must be configured at the BIOS and hardware level since they typically contain the operating system and must run properly before the operating systems can be started.

Installation of a hard drive is simple and requires four steps:

1. Physical Installation and Cabling
2. BIOS Setup
3. Partitioning
4. High-Level Formatting

Objectives

- Define the steps necessary to prepare a hard disk drive for installation.
- Describe the physical installation and BIOS configuration of a hard disk drive.

Physical Installation

The most important consideration when installing any drive is to correctly install the cabling. The figure below shows a standard IDE drive. Note the alignment of pin number one and the power connector.

Unlike the twisted cable provided with floppy drives to identify one drive from the other, hard drives use a flat cable with no twist. Therefore, each drive must be designated as either the master or slave so that the BIOS can identify them on the cable. The documentation supplied with the drive should provide the necessary information for configuration, which is accomplished by placing jumpers onto specific pins, as shown in Figure 5. Often this information is printed on the label on the drive, as shown in Figure 6 . If the drives are not properly configured they won’t work.

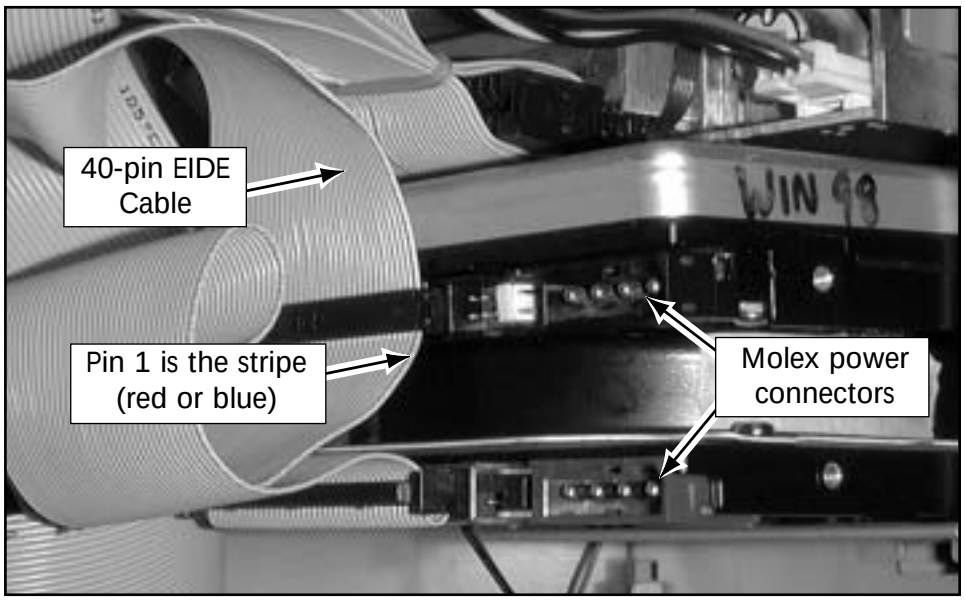


Figure 4
Typical IDE hard drive connections when using two drives. The power cables are removed for clarity.

There are two different drive-naming conventions. The one we are most familiar with is A:, B:, C:, D:, etc. These *logical* drive names apply to how the drive is formatted and how it is seen by the operating system. At this point, we are not interested in these logical names; we are working at the physical level where the drives are numbers. If only one hard drive is installed, it must be configured as Drive 0 or Master. A second drive on the same cable is installed as Hard Drive 1 or Slave.

Today most drives have this configuration information attached to the top of the drive itself. The drives are also shipped with a sheet documenting the settings. If this information is lost, go to the drive manufacturer's website. All the drive makers have comprehensive data available for every drive they ever sold. These sites also contain great troubleshooting and installation information.

BIOS and Hard Drives

After physically installing a hard drive, the geometry of the hard drive must be entered into the BIOS through the BIOS setup.

Setup is easy with IDE drives. As mentioned earlier, new drives contain their own BIOS information. By using the auto-detect option in the setup program, the correct information is read from the drive.

Tip: If a BIOS with the IDE Autodetect feature is not available, there are utility programs available that will read the geometry of a hard drive. *The data still has to be entered into the CMOS.* If you can detect the drive using the Autodetect feature, you have the drive installed properly.

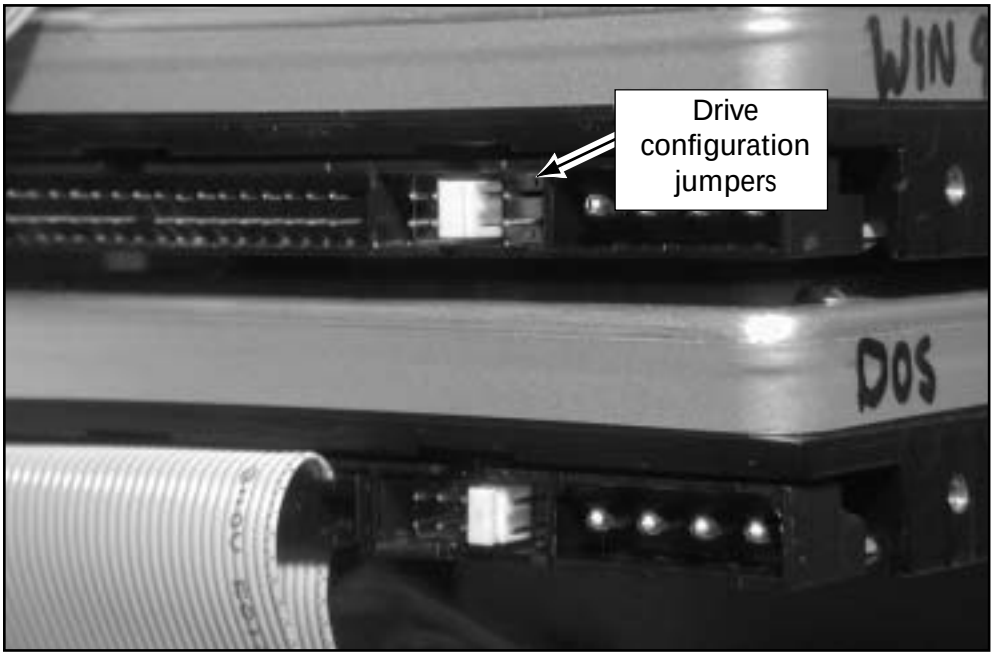


Figure 5
The master/slave jumpers configure the drive. Unlike a floppy, the cable plays no role in the drive's configuration.

What happens if the wrong data is entered into the BIOS? For example, a 1.2 GB hard drive is installed and the CMOS was setup to make it a 504 MB hard drive. When you boot the computer, you will see a perfect 504 MB hard drive. The BIOS can be reset back to the proper settings, but all the data on the drive will be lost! Be careful and always keep a backup copy of your BIOS information.

Low-Level Formatting

Low-level formatting once was the third step. However, EIDE drives can only be low-level formatted at the manufacturing plant. Low-level formatting means to create all the sectors, tracks, cylinders and head information on the drive. Floppy disks need low-level formatting, but it is included as part of the high-level format.

Bootable Disks

Once you have correctly installed the hard drive and set up the partitions (We'll discuss that shortly.) you will need to have a bootable floppy disk to complete the installation. The bootable floppy will be used to partition the new hard disk and make it bootable. You will also have to copy some files that will allow you to complete the installation of a hard drive. There are two ways to create a bootable disk depending on whether or not you are using DOS or Windows 9*x*.

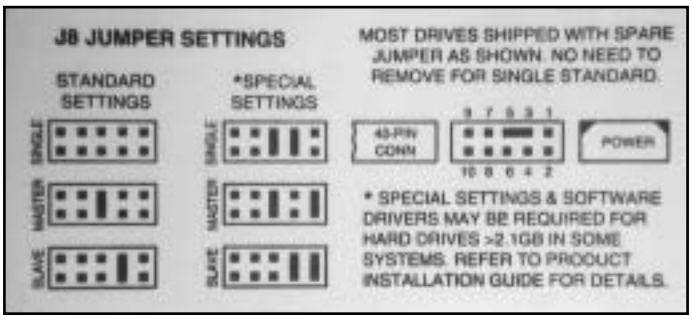


Figure 6
Typical configuration label attached to the drive.

To make a bootable disk, insert a blank floppy into the A: drive. From the command prompt, type: `FORMAT A: /S`. This makes the floppy bootable by copying system files to the diskette. Now you will need to copy two files from the C:\DOS\ directory. These files are:

- FORMAT.COM (or FORMAT.EXE)
- FDISK.COM

Once you boot to the floppy, FDISK.COM is used to partition the drive. This must be done before you can format the drive with FORMAT.COM. After the drive is formatted, you can make the drive bootable and/or load the operating system. Your options here depend upon what OS you intend to load.

Note: With Windows 95/98, these DOS commands are located in the C:\WINDOWS\COMMAND directory).

In Windows 95/98 a boot disk is also called a startup disk. If you open the Add/Remove Programs icon in the control panel, you will find a tab called startup disk. By selecting the *Create Disk...* button and following the instructions you will create a start-up disk with all the necessary files.

Hard Drive Partitions

Partitions are used to divide a physical hard drive into logical units. You will need at least one partition on every drive, but you may want to create more. Also, if you have a large hard drive (larger than your BIOS will support), you can divide the drive into smaller logical units. Your system will see each of the smaller units, which allows you to use the entire drive.

Objectives

- Describe the most common types of hard disk drive partitions, and tell which operating systems use them.
- Describe how a hard disk drive is partitioned using the FDISK program.
- Describe how logical drive letters are assigned to partitions.

Partition Types

Within each partition you create is a file system. There are several choices these days, and each is based on how files are stored and indexed for retrieval.

FAT (File Allocation Table) – This is the standard file system for DOS, Windows 95 and Windows NT. It is commonly known as FAT16. You can only create two FAT partitions on a single drive. One is the primary and the other is the extended. The extended partition can be further divided into as many as 23 logical drives (D:-Z:).

FAT can only support partitions up to 2 GB. If a drive is any larger than 2 GB, then you must create a second partition in order to use the space beyond 2 GB. If the drive is larger than 4 GB, then you must create two logical drives (Such as D: and E:, see Figure 8.) within the extended partition to use all the available space.

FAT32 – This is a newer system supported by Windows 98, Me, and Windows 2000. This system allows a maximum volume size of 2 terabytes (a terabyte is 1,000 gigabytes).

This business of creating multiple partitions and logical drives became too difficult to manage, and as a result nearly all Windows 9*x* computers have FAT32 file systems.

NTFS (Windows NT File System) – This is the native file system for Windows NT, Windows 2000, and Windows XP. It will support up to 16 exabytes (an exabyte is 1,000 terabytes). This file system also supports many advanced security features that are applicable to networking operations.

How to Partition a Hard Drive

The FDISK utility is used to partition a drive. After the drive is installed and BIOS is updated, run FDISK to partition the drive(s). You will see a screen similar to Figure 7.

First a note of caution. Never run FDISK on a drive that contains valuable information you wish to keep. This utility can wipe out a hard drive in just a few quick keystrokes. The worst part is that there is no recovery from this action; once you've deleted a partition it is gone forever.

The functions of lines 1, 3 and 4 are clear. Line 2 sets the active partition. The active partition is the partition where the BIOS will look for an operating system when the computer is booted.

Don't confuse *primary partition* with *active partition*. On a computer with a single operating system, the primary and active partitions are normally the same partition. A computer with dual-boot capability may have separate partitions for each operating system. In this case, the active and primary partitions may not be the same.

The primary partition is where the operating system (OS) is stored on the hard drive. The active partition is where a second operating system may be stored on the hard drive. If Windows is on the primary partition, and another operating system (such as Linux) is on an extended partition, there must be a mechanism to switch the active partition to the operating system's partition.

Advanced operating systems can create a special partition called a boot partition. When the computer boots, a menu appears which prompts the user to pick which operating system to use. The boot manager then sets the chosen partition as active, which starts the operating system located in that partition.

Naming Partitions

The main reason for partitioning came about because of limits imposed by DOS. Originally, 32 MB was the largest drive DOS could use. With the release of DOS 3.3, and the new tool to allow partitioning, a drive could be sub-divided into logical units small enough for DOS to handle. With time and improvements in DOS, larger partitions could be recognized but the practice of naming the partitions stayed the same.

A *primary* partition is a bootable partition where the operating system is stored. When a computer boots from a hard drive, it looks for a special sector in the primary partition called the Boot Sector that tells it where the operating system is located. The name of the primary partition is "C:".

The *extended* partition is for the rest of the hard drive. The extended partition can be one drive or be logically partitioned into several drives. Each of the drives will be assigned a drive letter starting with the letter "D:" and progressing until drive letter "Z:" is created (remember, "A:" and "B:" are reserved for floppy disk drives).

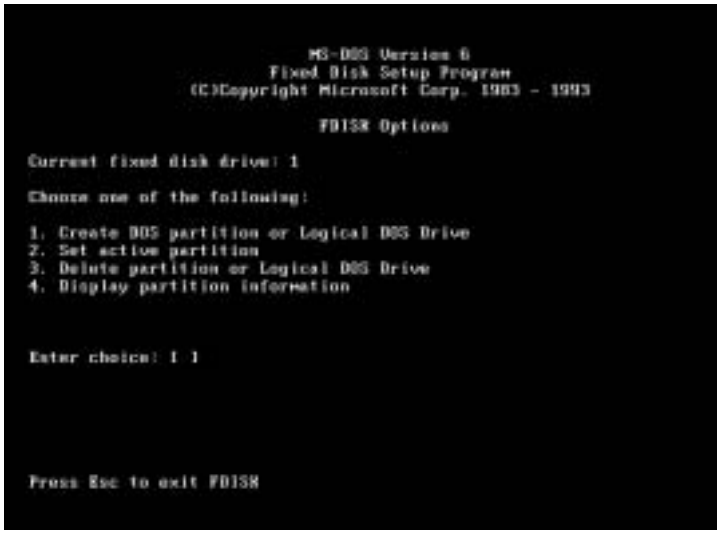
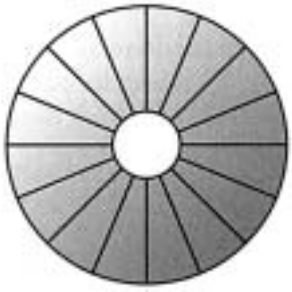


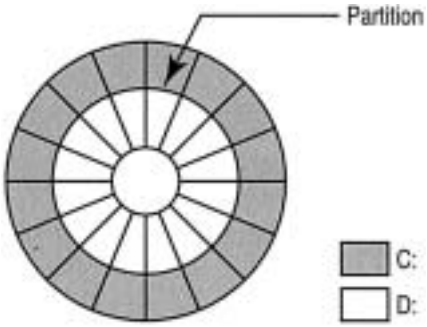
Figure 7
FDISK main options.



One 500 MB drive with one partition

C: 500 MB single partition

One physical – one logical drive

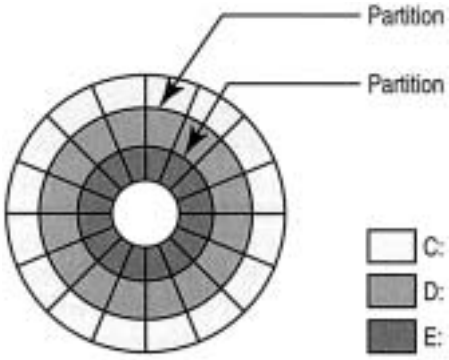


One 1.0 GB drive with two partitions

C: 400 MB primary partition

D: 600 MB logical drive in the extended partition

One physical – two logical drives



One 4.3 GB drive with two partitions.

C: 1.0 GB primary drive

D: 1.6 GB 1st logical drive in the extended partition

E: 1.7 GB 2nd logical drive in the extended partition

One physical – three logical drives

Figure 8
Logical drive assignments on multiple-partition drives.

High-Level Formatting

The final step in installing a hard drive is to format the drive. During formatting, the operating system writes the structures for managing data and files on the hard disk. This does not physically alter the drive, but creates a table of contents for the disk. After you have formatted the disk, you are ready to load the operating system.

Maintaining a Hard Drive

Hard drives are rugged devices when handled properly. They are completely enclosed and have no user serviceable parts. In fact, if you attempt to open one you will damage it (contaminated air gets in) and destroy the drive. The only practical way to repair a drive that has suffered a mechanical failure is to replace it.

The problem of maintaining a hard drive really revolves around protecting yourself from loss of data and at least being able to recover the data if possible. Being prepared before a hard drive fails can save lost data and time. How prepared you need to be depends on two things.

1. How much can you afford to lose?
2. How much time do you have to start over?

With this in mind you can reduce the impact of a hard drive crash by performing regular backups. Several software programs will do this for you, including tools built into Windows. Just remember that you will have to save this information before you crash.

You normally don't need to backup applications because you can always just reinstall them. On the other hand, data files and documents that you have created will be lost permanently if you have no backup.

Objectives

- Describe the importance and needs for hard disk drive backups.
- Describe the basic functions of disk defragmenters and SCANDISK.

Microsoft to the Rescue

A long time ago, Microsoft recognized the need for some form of disk maintenance. To help maintain hard drives, two programs were included as part of their operating system. These programs are Defrag and ScanDisk.

The process of saving, deleting and creating new files can cause data to be scattered all over the drive. Your files will become split up among widely spaced sectors. This isn't necessarily a problem, but occasionally pulling all your files together into contiguous sectors is a good idea. The best way to do this is to run a program that eliminates this *file fragmentation*. The process is

called *defragmenting*, or simply *defragging* a drive. There are several programs designed to defragment hard drives, including DOS's DEFRAG and Windows' Disk Defragmenter.

Note: Never run a defrag program designed to run in DOS on a Windows 9*x* system. It will not understand the Windows long file names and your OS will be destroyed.

All Microsoft operating systems contain versions of the ScanDisk program. ScanDisk performs a battery of tests on a hard disk, including looking for invalid filenames, invalid file dates and times, and bad sectors. Regular use of ScanDisk can help prevent problems as well as resolve them. Windows 9*x*-based computers will automatically run ScanDisk any time the operating system is improperly shut down (when the power is turned off before the system is allowed to complete its shut-down procedures). ScanDisk probably won't recover a badly damaged drive. However it will find lost clusters and bad sectors, two common data storage problems.

While these two tools are not a cure for all hard drive problems, regular use of them can prevent many failures and increase the performance of a computer. Microsoft is so confident in this that Windows 98 has a scheduler program that will allow you to schedule maintenance (Defrag and ScanDisk) for off-hours.

When All Else Fails

When a drive goes bad and you have expended all efforts to recover your data you have only two choices left. The first is to start over. This means to re-partition and re-format the drive. It is possible that starting all over will work on a failed drive, however all your data will be lost. If the problem was more than just a data storage problem, the second choice is to replace the drive.

Most hard drives carry very long warranties, so any time you encounter a drive that has failed be sure to contact the manufacturer to find out if you are entitled to a replacement.

Optical Disk Drives

IDE or EIDE drives are standard equipment on virtually every computer sold today. (Even Macintosh computers are using EIDE.) But most computers also come with CD-ROM drives, which are the most popular form of optical drives. The other major hard disk interface technology, SCSI, is primarily used in servers. SCSI performance is slightly better than EIDE, (how slightly depends on who you ask) but the cost of a SCSI system can be twice as high as EIDE. Let's look at these two systems.

The latest technology for storing data belongs to the family of optical drives. Most of us are familiar with the CD-ROMs that we use for playing audio or installing software. The advantages of these drives are that they can store large amounts of data, are inexpensive to produce, and are unaffected by en-

vironmental influences. CD-ROMs are only one part of this family of drives used with computers, but by far the most popular. This section will explore the CD-ROM as an essential part of today's computers and look at what is in store for the future.

Objectives

- Describe the advantages of optical data storage over floppy disk drives.
- Describe how data is stored on and retrieved from a compact disk.

CD-ROMs

The *CD-ROM* (*Compact Disk - Read Only Memory*) is a technology taken directly from the audio world and is now standard equipment in all computers. If a hard drive holds more information, accesses the information faster and reads and writes information, then why do we need CD-ROMs? The answer is simple; a CD can hold lots of data (650 MB) and can be mass-produced at a very low cost.

The CD has become the media of choice for software manufacturers. For example, early versions of the Microsoft Office Suite were supplied on 32 floppy disks. Today, the entire program with manuals and many extras is stored on

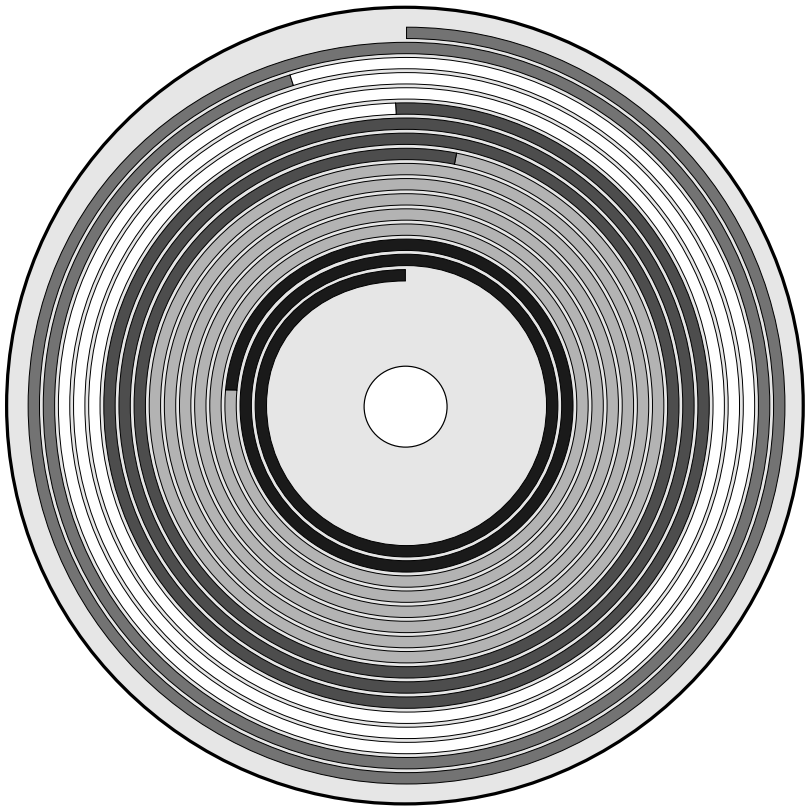


Figure 9
A CD-ROM track spirals out from the center.

one CD. Installation from a CD is faster and easier, and the disks don't go bad at random. (If Disk 2 of that 32-disk Office set failed, you had to wait for a replacement in the mail, and probably pay for it, too.)

CD Technology

The compact disk was originally conceived as a way to store music in a digital format. Because the designers were dealing with music, it seemed reasonable to store that digital information in a spiral track much like the groove in a vinyl record, rather than in concentric rings, as found on a platter in a hard disk drive. Just like a vinyl record, a compact disk can hold one large selection of music, or several shorter selections. Each music selection is called a *track*. Look at a music CD label and you will see that each song is identified by a track number. That doesn't mean a music CD with eight music tracks has eight separate tracks of information; there is still only one physical track, just like there is only one groove in a vinyl record. The dual use of the term "track" can be confusing, but it's a done deal, and we have to live with it.

Figure 9 is a graphic illustration of how the music/data tracks might appear on the physical spiral track of a compact disk (magnified a whole bunch). A compact disk can have up to 99 separate data tracks.

Let's see where CD-ROM disk drives fit into the scheme of things. There are two areas where a CD-ROM differs from a hard disk drive. First is the way the

Figure 10
A CD-ROM Disk

data on a CD-ROM is recorded. The hard disk drive uses a magnetic media arranged in concentric tracks on several platter surfaces. The CD-ROM uses a series of pits (tiny potholes) and lands (smooth surfaces between the pits) arranged in a single spiral track.

Figure 10 shows how the track is arranged on the disk. Of course, the tracks are much closer together on a real CD-ROM. In fact, a CD-ROM has approximately 16,000 tracks per inch.

Figure 11 represents a magnified cross-section of the disk to show how the track looks as it spirals around the disk. Notice that the disk is made up of three different parts. The bottom part, the "polycarbonate layer," is molded from a master disk. The surface contains an impression of the track. In the figure, the track cross-sections look like a series of saw teeth. The valleys between the teeth form the track surface.

The disk surface is covered with a thin layer, about 75 nanometers thick, of reflective metal. Aluminum is normally used on prerecorded CD-ROM disks. This metallic layer acts as a mirror to reflect the laser beam that's used to read the data on the track surface.

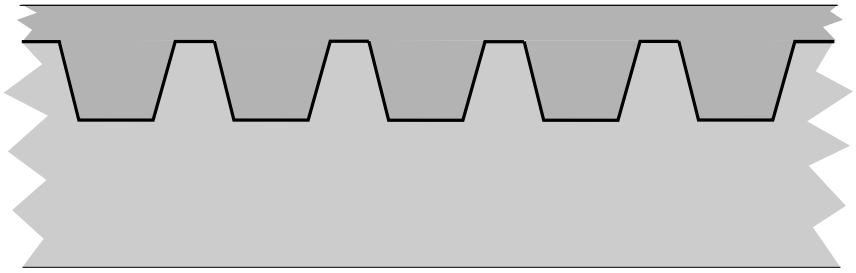


Figure 11
A CD-ROM Profile

The metallic layer is sealed with a layer of lacquer so it won't oxidize and lose its reflective qualities. The disk label is printed on the lacquer surface.

Figure 12 represents an edge view of a CD-ROM disk that has been sliced through along a portion of the data track. It shows how the data is composed of a series of pits and lands on the surface of the track. These are created in the following manner.

When the master disk is made, the track starts out as a smooth surface covered with a photoresist material. It looks something like the illustration in Figure 11 without the lacquer layer. The polycarbonate layer would represent the master disk with its spiral track. The metallic layer would represent the photoresist material. Data is written onto the master disk using a laser beam. The recording laser is placed above the disk where it exposes a series of spots in the photoresist on the surface of the track. When the disk is chemically processed, the exposed areas are removed. This leaves a series of pits about 0.5 micrometers wide, and between 0.833 and 3.054 micrometers long. This combination of pits and lands represents the data stored on the disk.

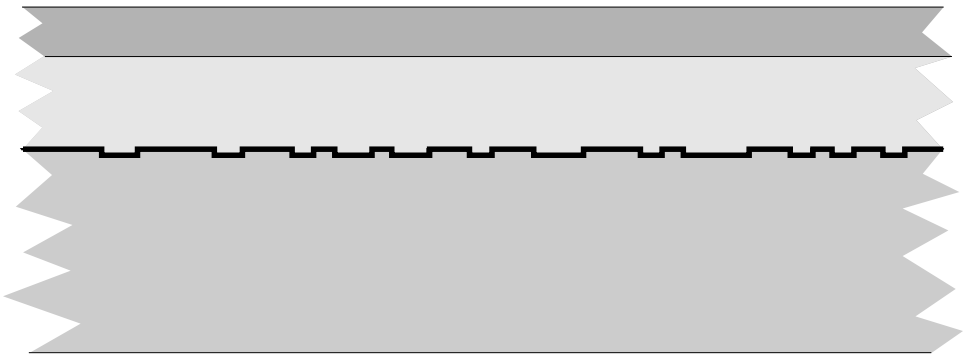


Figure 12
A CD-ROM Data Pattern

The processed master disk is used to create a number of press masters. A press master is then used in a plastic injection molding machine to form impressions of the master disk—similar to the way vinyl records are molded. Each disk impression is coated with a thin layer of aluminum to create a reflective surface. The metallic layer is then sealed, the disk is labeled, and it's ready to use.

To retrieve the data stored on a CD-ROM disk, the CD-ROM player shines a laser beam on the track surface from beneath the disk—the clear (polycarbonate) side of the disk. The metallic layer reflects the beam back to a detector next to the laser beam emitter. As the beam moves along the track, it will eventually come to a pit, actually the bottom of a pit, as you can see in Figure 12. The leading edge of the pit causes the reflected beam to break up, which is sensed by the detector. Then, as the beam leaves the pit, the second edge causes the reflected beam to break up once again. These changes in reflected beam intensity at the detector are used to signal logic level changes in the data stored on the track.

Storing Data

However, don't assume the pattern of pits and lands corresponds directly to the binary data that is stored on the disk. Rather, that data is converted into a modulation code that is easier to read and write using laser beam technology. Figure 13 shows how the data is represented by the pits and lands.

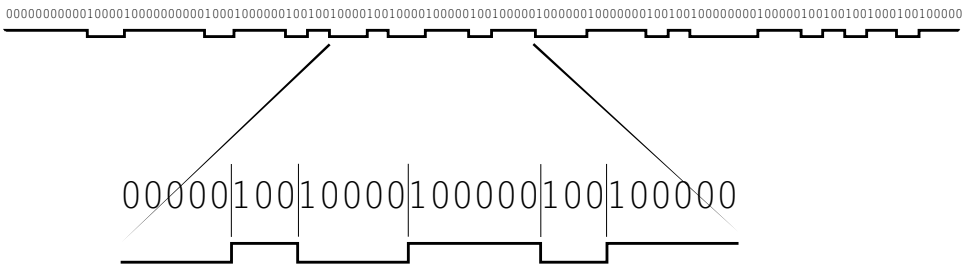


Figure 13
A CD-ROM Data Code

Notice that the only time the data changes from a logic 0 to a logic 1 is at the edge of a pit. To make sure the laser beam detector has time to respond to an edge, the encoded data always places a minimum of two 0s between every 1. On the other hand, the encoded data is limited to a maximum of ten 0s between every 1. That's because the data is also used to synchronize the demodulation circuitry. Too many 0s will cause the circuit to lose sync.

Connections and Specifications

A CD-ROM is a peripheral device and must be connected to a bus through a controller. There are several options for installing a CD-ROM on the various buses.

Objectives

- Define the typical CD-ROM drive interfaces, along with their basic advantages.
- Define the two major CD-ROM performance specifications; data transfer rate and access time.

Some older CD-ROM drive manufacturers provided a proprietary adapter board made specifically for their product. These boards are supplied with the drive and are not usually interchangeable. This type of interface was common for 486 and earlier computers. Many sound cards also had built-in CD-ROM controllers, which were often proprietary or a version of a SCSI interface.

The use of a SCSI interface was once popular with CD-ROM drives, primarily with Macintosh computers. A SCSI interface is still popular among users who create their own CDs with CD-ROM writers, but a SCSI CD-ROM drive is not common anymore. A SCSI interface is expensive, often costing more than the drive itself. Even in the Macintosh world, SCSI has been replaced by EIDE, and the USB and IEEE-1384 buses.

Attaching a CD-ROM to a parallel port was once popular, but again, not common today. The idea was that the drive was completely portable and could be easily attached to any computer that didn't have a CD drive, such as a laptop computer. These drives can be very handy if you work around older computer systems.

By far the most popular interface for CD drives is the EIDE port. Virtually all new PCs with a CD drive have EIDE interfaces. Installing and configuring these drives is the same as installing a hard disk drive, except that you don't have to fool around with partitions and formatting. This makes them easy to install and configure on a Windows-based system.

With the cost of hard drives falling, and the amount of data storage available rising, the hard drive is still the king of storage media. Optical data storage (CD) holds its place as *removable* media and as the media of choice for archival data storage. It is also the choice of developers for distributing their programs. Possibly many of them prefer the Internet, because they don't even have to make a disk when the software is downloaded.

Speed and Access Times

When purchasing or specifying a CD-ROM, two values need to be considered. The first is the *data transfer rate*. The long-time standard for transfer rate has been 150 KB/s (kilobytes per second). This value is the basis for measuring CDs today. A 2× CD operates at 300 KB/s, a 4× at 600 KB/s and so on. Current hard drives typically operate at 20 MB/s to 50 MB/s, several times faster than the fastest CD drives.

CD-ROM transfer rates have passed all previous expectations. Many drives now boast transfer rates in excess of 50×. But don't be fooled by these advertised rates, because a drive only uses that fast transfer rate under special conditions. For example, a 50× drive only transfers at 50× when reading the outermost data at the edge of the disk. And then, only in short bursts. What this means is that a 16× drive is just as fast as a 50× drive in everyday use, such as loading software, which is always near the inside of the disk.

The second value to look at is *mean access time*. This is the time it takes the head to move over half of the tracks. Typical access time is 75 to 200 ms (milliseconds). Although the transfer rate increases in multiples, the mean access time does not. This is where hard disks outperform CD-ROM drives by a wide margin. Access times for a hard disk are usually under 10 ms. Also note that CD-ROMs need to get started when you access them.

Installing and Maintaining a CD-ROM

Installing a CD-ROM is very similar to installing a hard drive. Newer computers have primary and secondary EIDE connectors as part of the motherboard and BIOS setup. Normally you install CD-ROMs as a master drive on the secondary port.

Objectives

- Describe the steps for installing a CD-ROM in a computer.
- Describe the appropriate maintenance and handling of CD-ROM drives and disks.
- Describe other major optical data storage technologies.

A CD-ROM drive will mount easily into any computer that has an open bay for a 5¼" disk drive. Physical installation is as simple as installing a hard disk drive. Most new CD-ROMs come with a hardware kit, which usually includes a combination of screws and brackets.

Make sure you have all the tools and parts before beginning:

- The CD-ROM drive.
- The correct cables.

- The appropriate hardware.
- The appropriate tools: flat head and Phillips-head screwdrivers, needle nose pliers or tweezers (for jumper settings).

There will be three cables: a flat ribbon cable for data, a standard power cable, and a cable to carry audio signals to the sound card. Be sure to connect wire number 1 to the correct location on both the controller and the CD. The audio connection will allow you to take full advantage of the audio capabilities of the CD-ROM. If this cable is missing, you will not be able to listen to audio CDs through the computer's sound system.

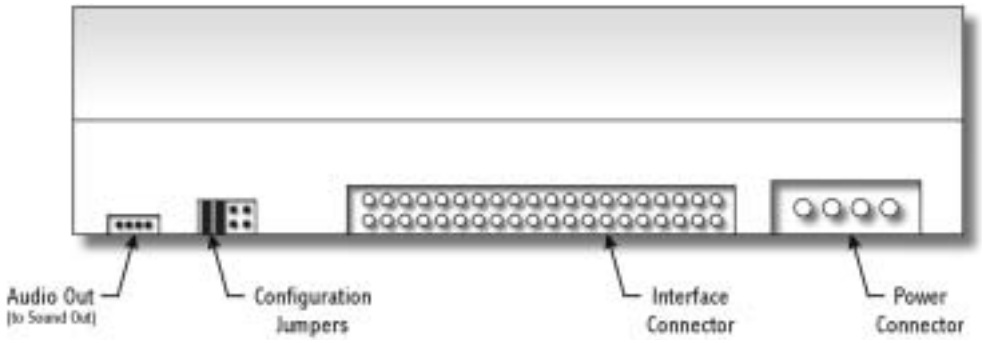


Figure 13
Cable Connections to back of Typical CD-ROM

A CD drive is installed just like an EIDE hard drive. The only difference is that you don't need to format or partition the drive. You do, however, need to set the master/slave jumper. Normally the drive is installed as a master on the secondary EIDE port.

Maintaining a CD-ROM

CD-ROM drives have a reputation for being trouble free. This doesn't mean that they never fail, just that you should not expect to have any problems. Troubleshooting a CD-ROM is the same as troubleshooting a floppy drive.

CD-ROM drives can fail, although not frequently. Most problems with CD drives are mechanical, such as a user breaking the tray that holds the CD, or the smallest member of the family feeding the CD with food. (Don't laugh, this happens…) Cleaning kits for CD drives are also available. These are a good investment if you use the computer in a dusty environment.

Today's CD drives spin at extremely high rates, in fact so high that minor imbalances in the disk can cause the CD to wobble or even bang the interior of the drive. This usually happens when paper labels are not properly centered or other stickers are applied to the disks. So you don't have to wonder anymore why those odd devices are used to apply CD labels; without them many CDs would simply not work properly.

Although the disks themselves are dramatically more durable then their predecessors, vinyl records and cassette tapes, they are still somewhat fragile. High heat, such as the interior of a car on a hot sunny day, will quickly warp a disk.

The surface can be easily scratched, although an audio CD seems to be able to handle minor scratches with little difficulty. When playing scratched audio CDs, the player can replace small amounts of missing data that might be obliterated by scratches. In practice, the better players can replace quite a bit of data before they skip or generate an error. All that is lost is a bit of audio, which usually goes unnoticed. Polishing kits are available that will let you remove small and moderate scratches with a fair amount of work and patience.

Data CDs present another story. A data CD stores programs, and each byte of data in a program is important. Some bytes are more important than others, but a missing or bad byte of data will ultimately result in a program failure, or crash. With that in mind, scratches on data CDs are much more serious. While an audio CD may survive big scratches, a single scratch in the wrong place can destroy a data CD. Make sure you treat data CDs properly.

Other Optical Drives

We have discussed the use of a CD-ROM in terms of computers. You may encounter several other optical devices as well. The term optical drive is a generic term for several devices. Optical technology involves the storing of data on a rigid disk by altering the disk's physical characteristics with a laser beam. Once the disk is altered, the differences in reflectivity or polarization can be "read" as a binary "1" or "0." The use of laser color, power, or a combination of both, determines whether it is a read or a write operation. Any device that uses this technology, including the CD, is considered optical. The following is a description of some of the newer optical technologies.

CD-R (CD-Recordable)

CD-R uses laser technology to permanently alter sectors of the disk thereby permanently writing files onto the media. These drives are often called CD writers, or CD burners. With a CD-R drive, a computer operator can create CDs. Since this alteration is permanent, the device can only write once to each disk.

CD-R is the common format we now see available everywhere. Burners are becoming faster all the time, and the software for controlling the recording process is easy to use.

CD-RW

Most CD burners that are available today are actually CD-RW drives. CD-RW, or CD-Rewritable, is a technology that allows you to erase and rewrite data to the same CD-RW disk repeatedly. This process is slow, and CD-RW disks

are several times the cost of a regular CD-R disk. Despite the drawbacks, CD-RW can be more convenient than CD-R, in part because a CD-RW drive can create CD-R disks, too.

Digital Versatile Disk (DVD)

The DVD family of formats may replace CD-ROM the next few years. DVD is newer and relatively immature. DVD has five formats: DVD-ROM, DVD-Video, DVD-Audio, DVD-R and DVD-RAM. DVD-R is the format for write-once. It specifies 3.95 GB for single-sided and 7.9 GB for double-sided. DVD-RAM is the format for rewritable disks. It specifies 2.6 GB for single-sided and 5.2 GB for double-sided, with a disk cartridge as an option. DVD-ROM (read-only disks) are similar to CD-ROMs and have a 4.7GB (single-sided, single-layer), 9.4 GB (double-sided, single-layer), 8.5 GB (double-layer, single-sided), 17 GB (dual-layer, double-sided). These are backward compatible with CD-audio and CD-ROM. DVD-ROM drives can play DVD-R, in fact, all of the DVD formats.

Rewritable Optical

Two technologies are being employed which utilize rewritable optical technology. These technologies are called MO (Magneto-Optical) and PCR (Phase Change Rewritable). MO drives are more widely accepted because the media and drive manufacturers use the same standards and are cross compatible. PCR devices, on the other hand, come from one manufacturer (Matsushita/Panasonic) and the media comes from two manufacturers (Panasonic and Plasmon).

Unit Summary

Hard drive design has reached a point where major advances in speed and data storage aren't likely to occur. What is likely is that newer technologies will provide faster data reads and writes and more reliable long-term storage. If you could change a single device in a PC and see major performance gains, the hard drive is that device. These performance gains may come from entirely new technologies, such as new solid-state memory, however their cost-per-megabyte is still several times higher than any hard drive.

Pundits predicted the demise of the CD-ROM several years ago, but the technology works too well for us to abandon it just yet.

Lab 8-1

Hard Disk Drive Interfaces

The hard disk drive is a mechanical module, and it has a tendency to fail sooner than many strictly-electrical modules. Even so, hard drives often have long warranty periods; three years is typical. When a drive fails you call the manufacturer's toll-free hotline, provide the serial number, and make arrangements for a replacement drive. Still, you should know how to safely remove the drive, identify the type of drive, and determine whether it is configured properly. When you receive the replacement drive, you should also be able to install and configure it.

Probably the most common hard drive failure is due to a physical shock. As you work through this lab, use caution when handling the drive. You should avoid any unnecessary handling of the drive, and always place it in an anti-static bag when it is out of your hands. Don't drop it, *even an inch*!

Even a hard drive that does not fail may still need to be replaced in a few years due to its limited storage capacity. A drive that seemed huge five years ago may not even hold the latest version of Windows today. If you work around computers, it will not be long before you have to remove an old hard drive and replace it with a new one. In this lab you will remove, examine, and reinstall the hard disk drive in your computer. Remember, these things are delicate—treat them that way!

Note: This Lab and the next are designed to be completed one after the other in a single two-hour lab period. Make sure that you have enough time to complete both labs before you start removing the hard drive.

Objectives

When you complete this lab, you will be able to:

- Safely remove a hard disk drive and a CD-ROM drive.
- Use the BIOS Setup Utility to determine the configuration of hard drives and CD-ROM drives.
- Replace a hard drive ribbon cable.
- Properly configure hard disk drives and CD-ROM drives using the Cable Select method.
- Install a hard disk drive.

Materials Required

To complete this lab, you'll need:

- Computer and monitor
- 24-inch hard drive ribbon cable
- Antistatic wrist strap
- A #2 Phillips screwdriver

Procedure

Determining the Current Drive Configuration

1. In preparation for entering the BIOS Setup Utility, find the *Del* key on the keyboard. Turn on the computer and monitor. As soon as you see the opening BIOS screen, depress the *Del* key. The *BIOS Setup* screen should appear. If you miss it, allow the computer to boot to the desktop, shut down the computer, and try again.

2. Press *Enter* to view the *Standard CMOS Features* screen. Among other things, this screen tells you how the drives in the computer are currently configured. Refer to the screen and fill in the following:

   IDE Primary Master [_____]
   IDE Primary Slave [_____]
   IDE Secondary Master [_____]
   IDE Secondary Slave [_____]

3. Press the *Esc* key to return to the opening BIOS Setup Utility screen, and then press *Esc* again to Exit Setup. At the *Quit Without Saving (Y/N)?* message, press *Y* then *Enter*.

4. Prove that the computer is working properly by allowing it to boot to the Windows 2000 Desktop. Then shut down the computer and monitor.

5. Make certain the computer and monitor are turned off and then unplug the power cord from the back of the computer.

6. Remove the left and right side panels from the computer.

7. Slip the antistatic wrist strap on your wrist.

8. Connect the ground clip of the antistatic wrist strap to ground on the computer

9. Inside the computer find the hard disk drive as shown in Figure 1. Without disconnecting anything, follow the wide ribbon cable to the motherboard. How many connectors are on this cable? _____

10. Inside the computer, find the CD-ROM drive at the top front. Without disconnecting anything, follow the wide ribbon cable to the motherboard. How many connectors are on this cable? _____

11. Are the hard drive and CD-ROM drive attached to separate cables? _____

Discussion

In this part of the Lab, you used the Setup Utility to determine how the hard drive and CD-ROM drive are configured. If prior students followed directions, the hard drive should be configured as a primary master, while the CD-ROM drive should be configured as a secondary master. The hard drive and the CD-ROM drive should be connected to the last connector on their respective cables. The hard drive is on a three-connector cable while the CD-ROM drive is on a two-connector cable. With a single hard drive and a single CD-ROM drive, this is a common configuration. The motherboard has only two ribbon cable connectors to accommodate all hard drives and CD-ROM drives. One is called the Primary and the other is called the Secondary. If you add an additional hard drive or CD-ROM drive it will have to share one of the cables. In the next part of the Lab you will demonstrate this by connecting both the hard drive and the CD-ROM drive to the same cable.

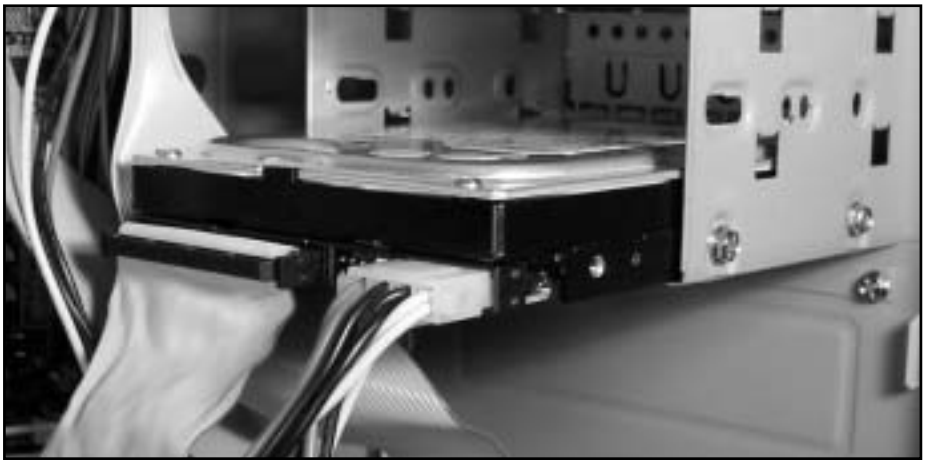


Figure 1
The hard drive has a power cable and a ribbon cable attached.

Procedure (continued)

Remove the Hard Disk Drive

12. Before removing anything, you need to make notes about the current condition of the system. The computer is working properly, so the current configuration seems fine. We will want to return it to this configuration later. The easiest way to do this is to make good notes before we change things. Looking at the ribbon cable attached to the hard drive, the stripe is nearest the _____ (power connector or motherboard?)

13. Grasp the white power connector shell as shown on the left in Figure 2. ***Do not pull on the wires!*** Because the connector is normally very tight, you may have to rock it from side-to-side as you pull on the connector. Once the connector is unplugged, look at the end of the shell. Notice that two of the corners are square and two of the corners are beveled. Could this cable be attached backwards, by accident? _____

14. Now unplug the ribbon cable. Making sure you grab the connector, ***not just the cable***, unplug the flat-ribbon cable from the hard disk drive. The proper method is shown on the right in Figure 2.

15. Look closely at the 40-pin connector and the matching pins on the drive. Notice that a pin is missing on the drive, as shown in Figure 3. Why do you think this pin is missing? _____ _____ _____ Could this cable be attached backwards, by accident? _____

16. Find the screws on the sides of the hard drive that secure it to its support bracket. There should be two screws on each side. Make a sketch of which holes the screws are in so that you can reinstall the drive later at the same location.

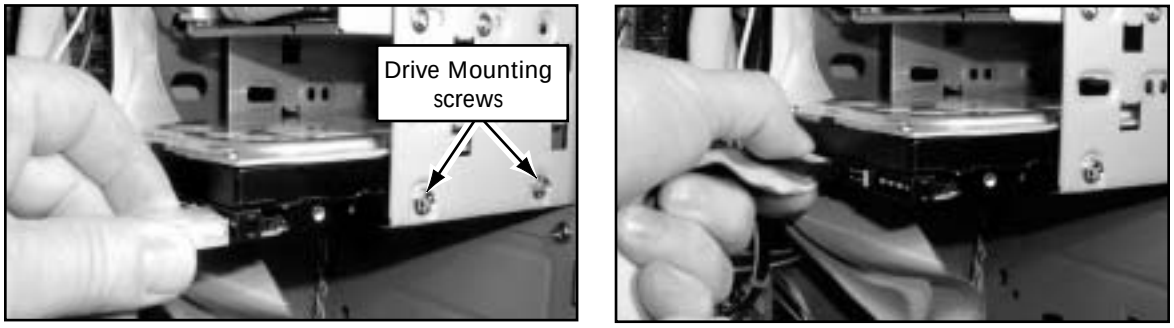


Figure 2
Be sure you pull the connector, not the cable.

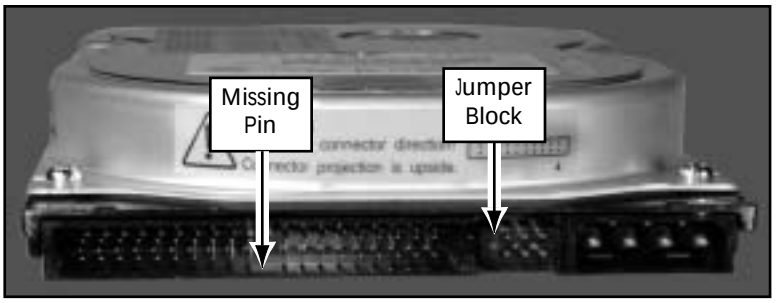


Figure 3
On this drive the jumper block is located between the two connectors.

17. Carefully remove the screws holding the drive in place. When you remove and install the drive screws, be careful not to strip the head of the screws.

18. Being careful not to touch the delicate and open electronics underneath, slide the hard drive toward the rear of the chassis and gently lift the drive out of the chassis. If the drive seems to be squeezed too tight, loosen the screws attached to the floppy drive. Just a turn or two will do it—don't remove the screws.

19. You can see that the drive is made up of a sealed disk pack assembly with motor, and a controller circuit board. Do not attempt to disassemble the drive. There is nothing inside that is repairable and opening the drive will immediately void the warranty.

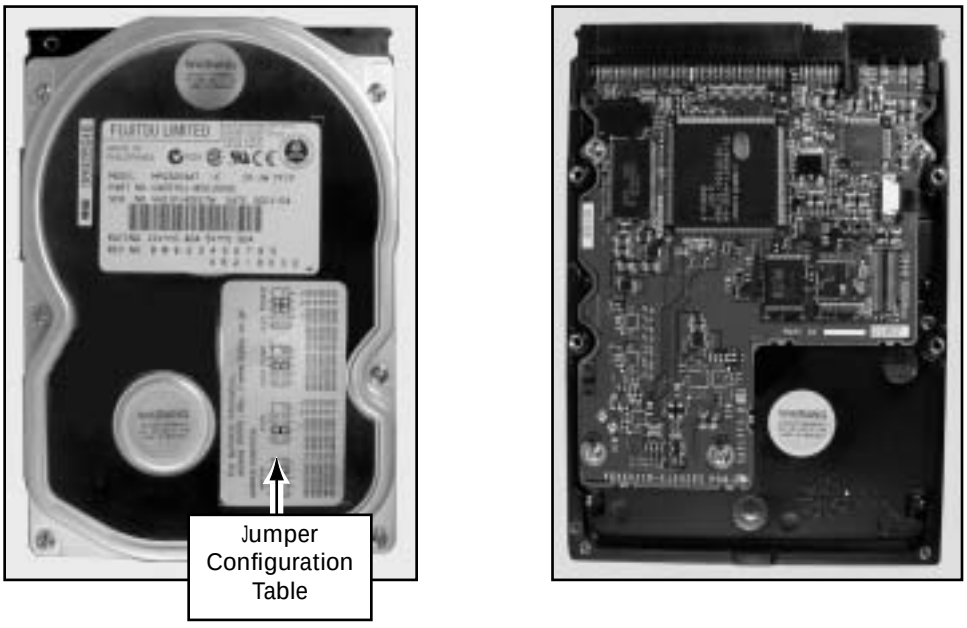


Figure 4
A typical EIDE hard drive.

20. Hard drives contain jumper pins that configure the controller/drive interface. Frequently the drive has a label showing how the jumpers should be configured. If the label doesn't provide the jumper information, it is usually provided with the drive documentation, or it can be downloaded from the web site of the drive manufacturer. The storage capacity may also be indicated on the label.

21. Figure 4 shows a typical hard drive. Your drive is not exactly like this one, but it does share some of the same characteristics. The photo on the left shows the top view of the hard drive. If you look closely at the label you will notice that it contains a small table showing how the jumpers should be configured. Also notice the labels warning you that the warranty is void if you open the sealed drive.

22. The photo on the right in Figure 5 shows the bottom view of the drive. Here, you can see the circuit board that holds the controller/drive interface.

    Most IDE and EIDE drives have four modes of operation—single-drive mode, master mode, slave mode, and cable-select mode. Also, most hard disk drives can be daisy-chained. IDE and EIDE drives must be configured so that one is the master and the other is the slave. The jumpers for configuring the hardware are shown in Figure 3. The jumper block is on the end of the drive with the connectors so that you can access it without removing the drive from the computer.

23. Now refer to Figure 5. It shows the top, bottom, and end view of a hard drive like the one used in your computer. Here again, the jumper block is between the two connectors.

24. Compare your own drive to Figure 5. Who is the manufacturer, and what is the model number of the hard drive in your computer? _____ From the information on the label, what is the capacity of the drive? _____ Look closely at the jumper information on the drive's label. Compare the label to the actual position of the jumpers. How is this drive configured? _____

25. Make a sketch of the jumper configuration table. Pay particular attention to the *Master* and *Cable Select* positions. In future steps you will be moving the jumpers to these positions with the drive still installed in the computer.

26. There are two methods of configuring hard drives: *Drive Select* and *Cable Select*.

    With the *Drive Select* method, jumpers on the hard drive determine whether the drive is the Master or Slave. The drive's position (end or middle) on the cable does not matter. Although, when using a single drive, it is preferred to connect the drive to the end connector.

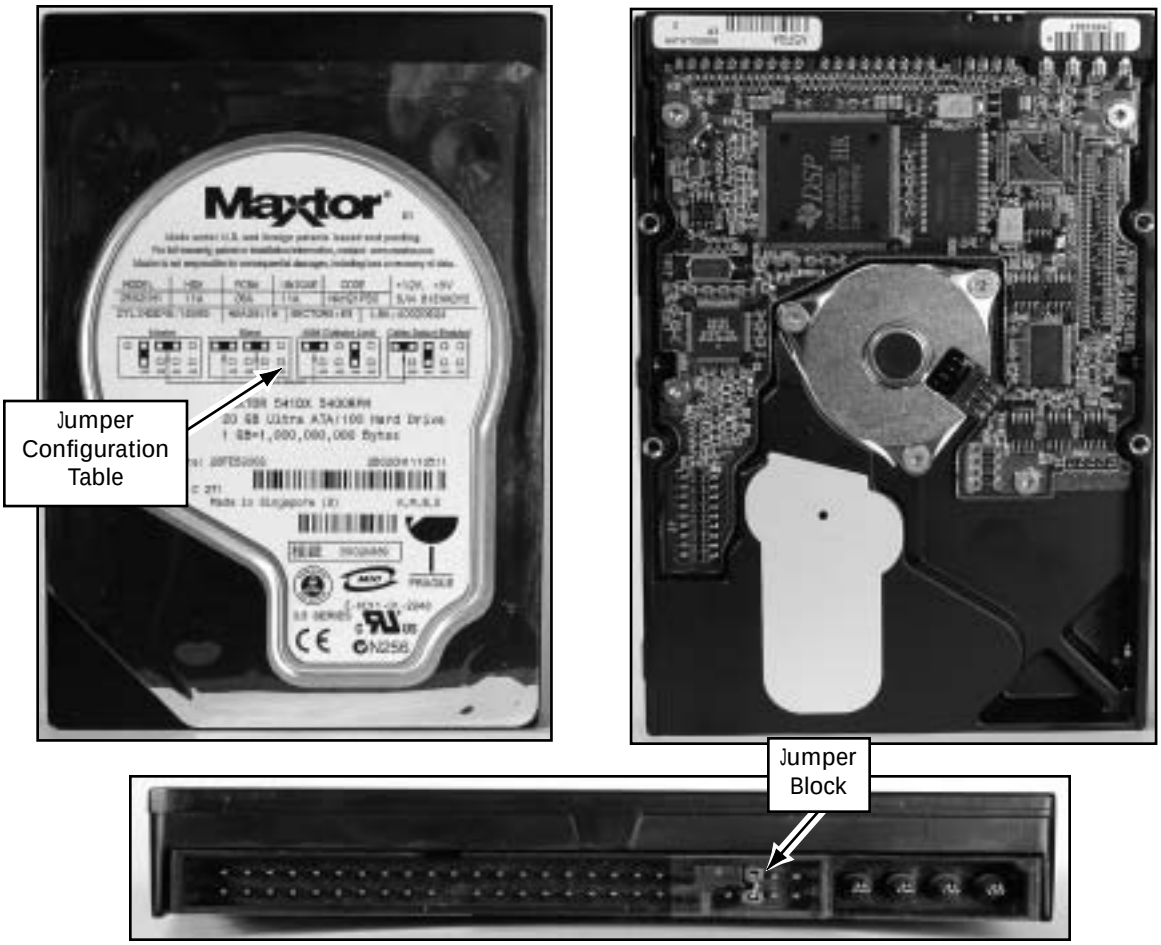


Figure 5
The Maxtor HDD used in your computer.

With *Cable Select*, and the drive's position on the cable determines whether it is the Master or the Slave. The drive connected to the end of the cable is the Master, and the drive connected to the middle of the cable is the Slave. The drive in your computer should have been configured for *Cable Select* but may have been configured otherwise by a prior student.

27. If the jumpers are not in the *Cable Select* position, then move them to the *Cable Select* position at this time.

Replacing the Hard Drive Cable

In the next few steps you will replace the hard drive ribbon cable that is currently installed in the computer with a longer cable. You are doing this because the longer cable is much easier to work with here in the classroom and it saves wear and tear on the real (but shorter) ribbon cable.

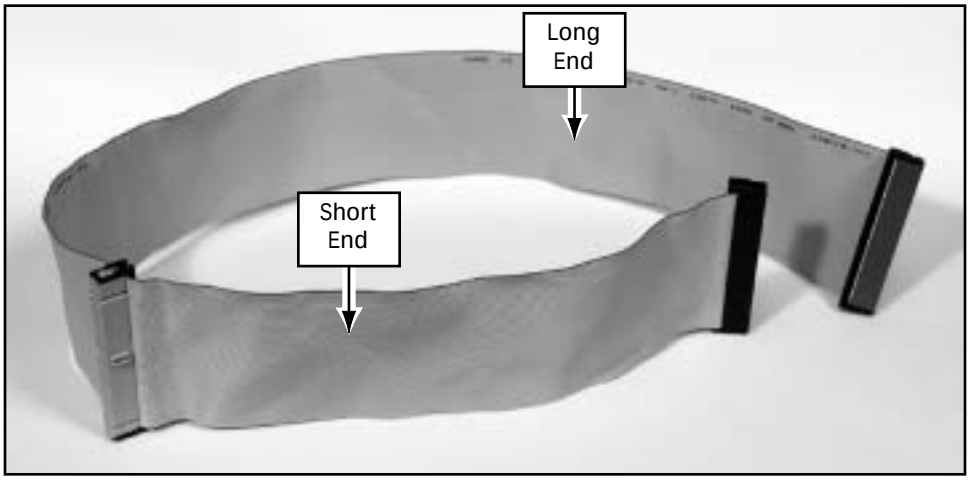


Figure 6
The hard drive ribbon cable.

28. Find the 24-inch hard drive ribbon cable provided by your Instructor. Compare it to the photograph shown in Figure 6. Notice that it has three connectors that divide the cable into a long end and a short end.

29. Inside the computer find the ribbon cable that you disconnected earlier from the hard drive. Trace the ribbon cable back to the motherboard. Notice that it too has a long run and a short run. Which end connects to the motherboard? _____ (long end or short end)

30. Notice the stripe on the cable where it plugs into the motherboard. The stripe is at the _____ (top/bottom) side of the cable.

31. Grasp the cable by its connector, gently unplug it from the motherboard. Notice that the cable is shorter than the ribbon cable provided by your Instructor. Set the shorter ribbon cable aside.

32. Find the connector on the long end of the ribbon cable that was provided by your Instructor. Turn the connector so that the stripe is pointing down toward the bottom on the computer. Align the connector with the blue connector on the motherboard from which you just unplugged the short ribbon cable. Push the cable down until it is securely connected to the motherboard.

Reinstalling the Drive

In the next few steps you will reinstall the hard drive. Refer to Figure 7 as you do the installation.

33. Hold the drive level when you slide it into place (do not tip it). Some hard drives (including this one) have components mounted on the bottom which may become damaged if they hit the support bracket.

34. Using the four screws you removed earlier, secure the drive to the support bracket. The screws should not require any force when you turn them...*if any force is required then back the screw out and try again.*

35. Connect the data cable to the drive. Use the connector at the short *end* of the cable, not the one in the middle of the cable. Be sure the stripe on the flat-ribbon cable is correctly positioned, refer to your notes taken earlier. The stripe should be toward you.

36. Connect the power cable to the drive.

37. Reattach the power cord to the back of the computer. Switch power on and allow the computer to boot. If you have any problems, such as the computer will not boot, check the following:

    - Ribbon cable connected properly at both ends.
    - Power cable attached properly, and all the way in.
    - Drive configuration jumpers set properly to the Cable Select position.
    - Video card still fully inserted.

38. When you are satisfied that the computer is working properly, shut down the computer and switch off the power to the computer and monitor.

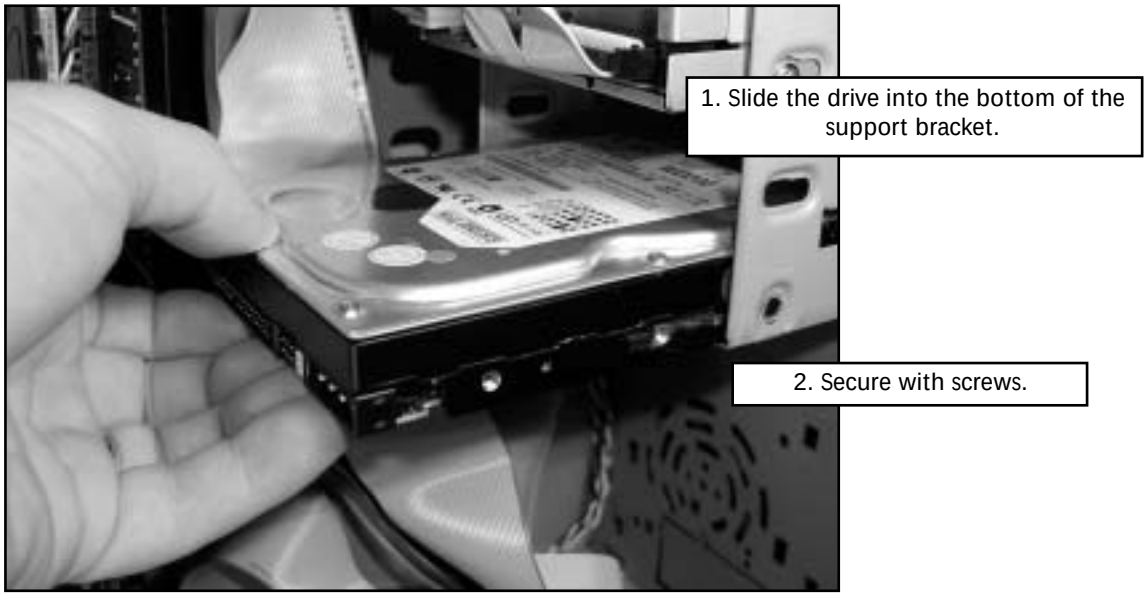


Figure 7
Reinstalling the hard drive.

Discussion

In this part of the lab you removed the hard drive to determine the proper jumper settings and to see how the jumpers are currently set. You should have made notes of the proper jumper positions for configuring the hard drives as a Master, a Slave, or in the Cable Select mode.

You then replaced the short hard drive ribbon cable with a longer one that will be easier to work with.

Finally, you reinstalled the hard drive in its original position and verified that the new cable works by booting the computer.

In the next part of the Lab you will examine the CD-ROM drive and move it to a more convenient location for performing some experiments.

Procedure (continued)

Examining the CD-ROM drive

39. Make sure the computer is turned off then unplug the power cord from the back of the computer. Find the CD-ROM drive at the top, front of the computer. Make a brief sketch of how the three cables are connected. Look at the ribbon cable attached to the CD-ROM drive. The stripe is nearest the _____ (power connector or motherboard?)

40. Look at the 3-wire audio cable near the motherboard. The red conductor is nearest the _____ (ribbon connector or motherboard?)

41. Grasp the white power connector shell. ***Do not pull on the wires!*** Unplug the power connector from the CD-ROM drive.

42. Making sure you grab the connector, ***not just the cable***, unplug the flat-ribbon cable from the CD-ROM drive. Look closely at the 40-pin connector and the matching pins on the drive. Could this cable be attached backwards, by accident? _____

43. Unplug the remaining audio cable. Look at the connector and the matching pins on the CD-ROM drive. Could this cable be attached backwards, by accident? _____

44. Find the screws on the sides of the CD-ROM drive. There should be two screws on each side. Make a sketch of which holes the screws are in so that you can reinstall the drive later at the same location.

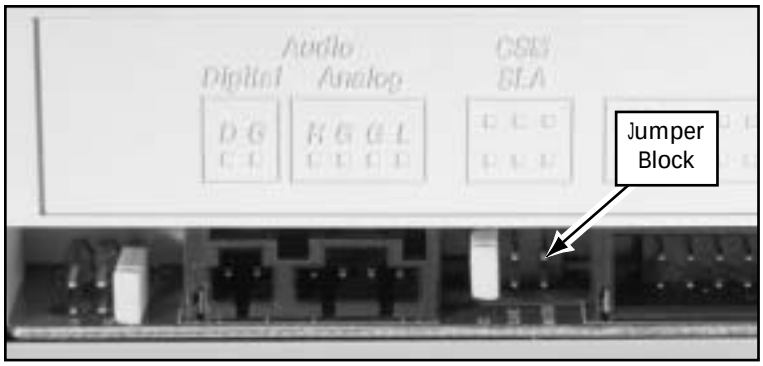


Figure 8
The jumper block on the CD-ROM drive.

45. Carefully remove the screws holding the CD-ROM drive in place. Notice that these are metric screws like those you saw earlier on the floppy drive. Slide the CD-ROM drive out the front of the chassis and set it on the work surface.

46. Refer to Figure 8 and find the jumper block on the back of the drive. Notice the position of the jumper for Cable Select (CS), Slave (SL), and Master (MA). At present the jumper should be in the Cable Select (CS) position, although a prior user may have changed it. Move the jumper to the *Cable Select* position if necessary.

47. Refer to Figure 9 and find the plastic cover plate just below the now empty location where you removed the CD-ROM drive. Insert your index finger behind and in the center of the cover plate. Gently flex the center of the cover plate toward you until the plate snaps free. Using the same procedure remove the lower cover plate.

Figure 9
Removing the cover plate.

48. **Caution:** In the next step you will slide the CD-ROM drive into the lowest open drive bay. However, you must **not** slide the drive all the way in. If you do, the DIMM sockets on the motherboard may be damaged. So read and follow the instructions carefully.

49. Carefully and slowly slide the CD-ROM drive into the bottom drive bay. Refer to Figure 10. Watch the back of the drive as you slide it into the bay. Stop when the back of the drive is about ¼-inch from the DIMM socket upper latch.

50. Without letting the drive touch the DIMM socket, line up a screw hole in the drive with the front screw hole in the bracket. Note that the front of the drive will protrude slightly out the front of the computer's front panel. Using one of the *metric* screws that you removed earlier, temporarily attache the drive to the bracket. Attach a second *metric* screw to the other side of the drive immediately opposite the one you just installed. Since this is a temporary setup, these two screws will be enough to hold the drive in place.

51. Find the long ribbon cable that you attached earlier to the hard drive and motherboard. Find the connector in the middle of the cable and compare it to the ribbon connector on the back of the CD-ROM drive.

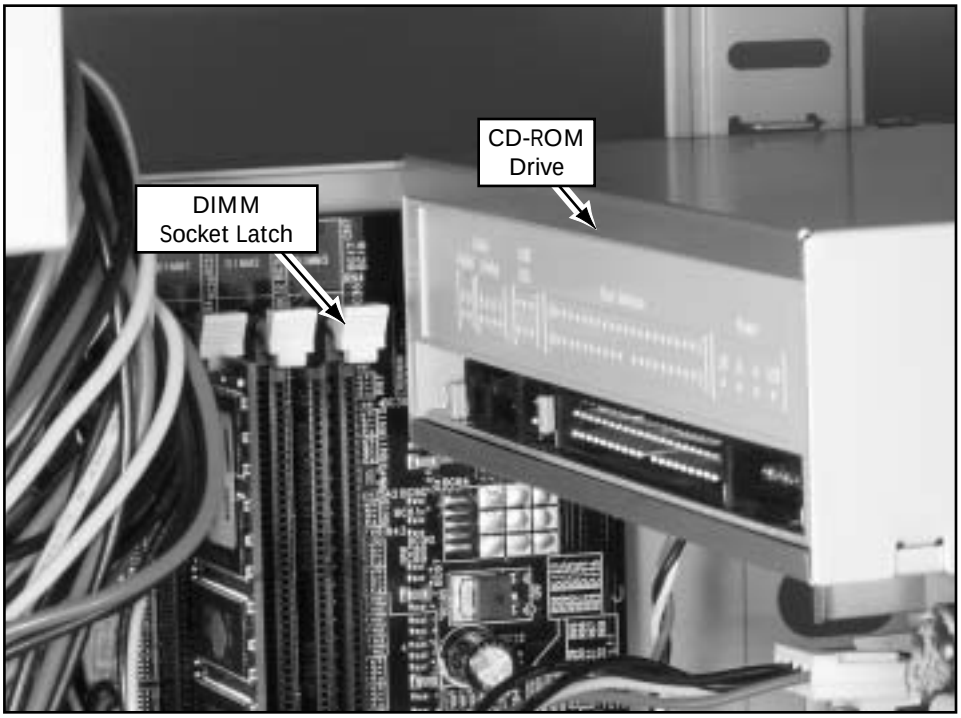


Figure 10
Don't let the CD-ROM drive touch the DIMM socket latch.

52. Position the middle connector so that the stripe is near the power connector on the CD-ROM drive. Plug the ribbon connector into the connector on the back of the CD-ROM drive.

53. Plug the power connector into the CD-ROM drive. Leave the four-wire audio connector unplugged for now. Recheck your connections and make certain that the ribbon cable did not pull loose from the hard drive or motherboard.

54. Reconnect the power cord to the back of the computer. Switch the power on and allow the computer to boot to make sure the new configuration works. If you have any problems, such as the computer will not boot, recheck all connections and the position of the jumper on the CD-ROM drive.

55. When you are satisfied that the computer is working properly, shut down the computer.

Determining the New Drive Configuration

56. Find the *Del* key on the keyboard in preparation for entering BIOS. Turn on the computer. As soon as you see the opening BIOS screen, depress the *Del* key. The *BIOS Setup* screen should appear.

57. Press *Enter* to view the *Standard CMOS Features* screen. Refer to the screen and fill in the following information:

    IDE Primary Master [_____]
    IDE Primary Slave [_____]
    IDE Secondary Master [_____]
    IDE Secondary Slave [_____]

58. Press the *Esc* key to return to the opening BIOS Setup screen, and then press *Esc* again to Exit Setup. At the *Quit Without Saving (Y/N)?* message, press *Y* then *Enter*.

59. Allow the computer to boot to the Windows 2000 Desktop. Then shut down the computer and monitor. Leave the computer configured just as it now for the next Lab.

Discussion

In this part of the Lab, you moved the CD-ROM drive to a temporary location to make the cable connections easier. You also set the jumper to the *Cable Select* position on the CD-ROM drive. Recall that in an earlier part of the Lab you positioned the jumpers on the hard drive to the *Cable Select* position as well. In the Cable Select position the drive does not determine

its own status, but rather its position on the cable determines whether it is the master or slave. The drive at the end of the cable is the master, the drive in the middle is the slave.

You verified this by going into the Setup Utility and looking at the status of the hard drive and the CD-ROM drive.

Hard drive failures are usually dramatic and hard to miss. There are a variety of causes, but some "failures" are repairable. Before you replace a drive, always run a virus check. Many viruses destroy data in such a way that the drive appears to have failed. Some severe viruses can actually damage the drive, where the only solution is to replace the drive. A hard drive expert may be able to remove the virus and restore the drive, but the data is almost always lost.

Other common failures are related to activities taking place inside the PC. If the cable was temporarily removed during an unrelated upgrade or repair, it may have been reattached incorrectly. Also, because the cables are not designed for heavy-duty use, they sometimes break when twisted or pulled. Both of these problems are preventable and easily cured by a good technician.

Lab 8-2

Installing Hard Disk Drives

This Lab is a continuation of the prior one. In it you will learn more about installing and configuring hard drives and CD-ROM drives. In the prior Lab, you saw that drives can be installed on separate ribbon cables or on the same ribbon cable. You demonstrated the Cable Select settings of the drive jumpers in which the position of the drive on the cable determines if the drive is a master or a slave.

In this Lab you will experiment with the *Drive Select* jumper settings in which you dictate which drive is to be the master and which is to be the slave regardless of the drives positions on the cable.

Objectives

When you complete this lab, you will be able to:

- Explain why the *Cable Select* method of configuring drives may not always be appropriate.
- Configure hard disk drives and CD-ROM drives using the *Drive Select* method.
- Properly install hard drives and CD-ROM drives.

Materials Required

To complete this Lab, you will need:

- Your computer system configured as it was at the end of Lab 8-1
- The anti-static wrist strap
- The parts that you removed from the computer during the last Lab.
- #2 Phillips screwdriver.
- CD with one or more files or folders on it.

Finally, a pair of needle-nose pliers will be helpful, but is not required.

Procedure

Determining Why Cable Select is not Always Appropriate

First, let's quickly review where we are. In the prior Lab, you installed a longer ribbon cable and moved the CD-ROM drive to a location that was easily accessible. You verified that the jumpers were in the *Cable Select* position (or moved them there, if necessary) on both the hard drive and on the CD-ROM drive. You connected the hard drive to the end of the ribbon cable and the CD-ROM drive to the middle of the same cable. You then used the Setup Utility to verify that the hard drive was configured as the Master and the CD-ROM drive was configured as the Slave.

Cable Select is an easy way to configure two drives on the same cable. You simple set the jumpers to *Cable Select* on both drives and let the computer sort things out. In this part of the Lab, you will see why this isn't always appropriate.

1. Make sure the computer is turned off and that the power cord is unplugged from the back.

2. Slip the anti-static wrist band onto your wrist, and connect the ground clip to the computer case.

3. Find the ribbon cable that connects the hard drive and CD-ROM drive to the motherboard. Recall that you are using a longer than normal cable and that you moved the CD-ROM drive closer to the hard drive in order to ease the physical installation of the cable. Even so, the cable is still somewhat contorted in order to install the CD-ROM drive in the middle connector.

4. Remove the ribbon cable from the back of the CD-ROM drive. Now visualize the CD-ROM drive in its original position at the top of the computer. Is the cable long enough to plug the middle connector into a drive installed in the original top position? _____

5. Of course, there is a way to make the ribbon cable reach the top of the computer. Unplug the ribbon cable from the back of the hard drive.

6. Plug the middle connector into the back of the hard drive. Make sure the stripe on the cable is toward you.

7. Notice that the free end of the cable can now reach the top position. Plug the free end of the cable into the CD-ROM drive.

8. Reattach the power cord to the back of the computer. Switch power on and allow the computer to boot. Did the computer boot to the Desktop? _____ If you receive a warning message, read the message and then press the F1 key. Did the computer boot to the Desktop? _____

9. Turn off the computer by pressing the front panel power switch.

10. Turn the computer and on and press the *Del* key during the boot process to enter the CMOS Setup Utility.

11. Highlight *Standard CMOS Features*, if it is not already highlighted, and press the *Enter* key to open the Standard CMOS Features screen. Refer to the screen and fill in the following:

    IDE Primary Master [_____]
    IDE Primary Slave [_____]
    IDE Secondary Master [_____]
    IDE Secondary Slave [_____]

12. Press the *Esc* key to return to the opening BIOS Setup Utility screen, and then press *Esc* again to Exit Setup. At the *Quit Without Saving (Y/N)?* message, press *Y* then *Enter*.

13. Turn off the computer by pressing the front panel power switch.

Discussion

In this part of the Lab, you saw why the *Cable Select* method is not always appropriate. Often because of cable lengths you will want a configuration that does not work with *Cable Select*. When you connected the CD-ROM drive to the end of the cable and the hard drive to the middle, *Cable Select* made the CD-ROM drive the master and the hard drive the slave. The problem is the operating system is on the hard drive, but the computer is trying to boot from the CD-ROM drive because it is now the master.

But even if the hard drive were not the boot drive, it is not a good idea to configure the CD-ROM as the master and the hard drive as the slave. Because the CD-ROM drive is much slower than the hard drive, such an arrangement would slow the overall speed to the system.

Procedure (continued)

Configuring Drive Select

As you have seen, the *Cable Select* method, while easy to implement, does not always let us do what we want to do. It's insistence on forcing the middle device to be the slave is often inconvenient. Fortunately, there is another way to configure two drives on a single cable. It is the *Drive Select* method, in which we tell the computer which drive is to be the master and which is to be the slave.

In this part of the Lab, you will configure the hard drive to be the master and the CD-ROM drive to be the slave by using the *Drive Select* method. To do this you will have to move the jumpers on both the hard drive and the CD-ROM drive. In both cases, this can be done without removing the drives from their current position by using needle-nose pliers or long finger nails. If you have neither needle-nose pliers nor long finger nails, you may have to remove the drives to change the jumpers.

14. Make sure the computer is turned off and then disconnect the power cord from the back of the computer.

15. Remove the power connector from the hard drive in order to reach the jumper block.

16. Refer to Figure 1 (or the notes that you made in the earlier Lab) and note how the jumpers on the hard drive must be configured in order to make the hard drive the master.

17. Move the two jumpers on the hard drive to the *Master* position as shown in Figure 1.

18. Reconnect the power connector to the hard drive.

19. Without disconnecting anything, move the ribbon cable that is connected to the back of the CD-ROM drive out of your way so that you can see and get to the jumper block.

20. Refer to Figure 2 (or the notes that you made in the earlier Lab) and note how the jumper on the CD-ROM drive must be configured in order to make the CD-ROM drive the slave.

21. Move the jumper on the CD-ROM drive to the *Slave* position as shown in Figure 2.

22. Reattach the power cord to the back of the computer. Switch power on and allow the computer to boot. Did the computer boot to the Desktop? _____ If you receive a warning message, read the message and then press the F1 key. Did the computer boot to the Desktop? _____

23. Shutdown the computer.

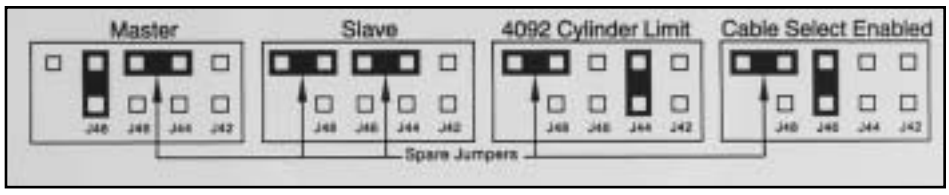


Figure 1
Jumper Settings for the Hard Drive.

24. Turn the computer on and press the *Del* key during the boot process to enter the CMOS Setup Utility.

25. Highlight *Standard CMOS Features*, if it is not already highlighted, and press the *Enter* key to open the Standard CMOS Features screen. Refer to the screen and fill in the following:

    IDE Primary Master [_____]
    IDE Primary Slave [_____]
    IDE Secondary Master [_____]
    IDE Secondary Slave [_____]

26. Press the *Esc* key to return to the opening BIOS Setup Utility screen, and then press *Esc* again to Exit Setup. At the *Quit Without Saving (Y/N)?* message, press *Y* then *Enter*.

27. Allow the computer to boot to the Desktop. Did you receive a warning message this time? _____ Shut down the computer.

Discussion

In this part of the Lab you configured the drives using the *Drive Select* method. You saw that, unlike the *Cable Select* method, you could configure the hard drive as the master even though it is in the middle of the cable.

Procedure

In this part of the Lab you will return the computer to its original configuration. You will remove the long ribbon cable; reset the jumpers for *Cable Select*; return the CD-ROM drive to its original position; reconnect the original ribbon cable: and verify that everything is working.

28. Make sure the computer is turned off and then disconnect the power cord from the back of the computer.

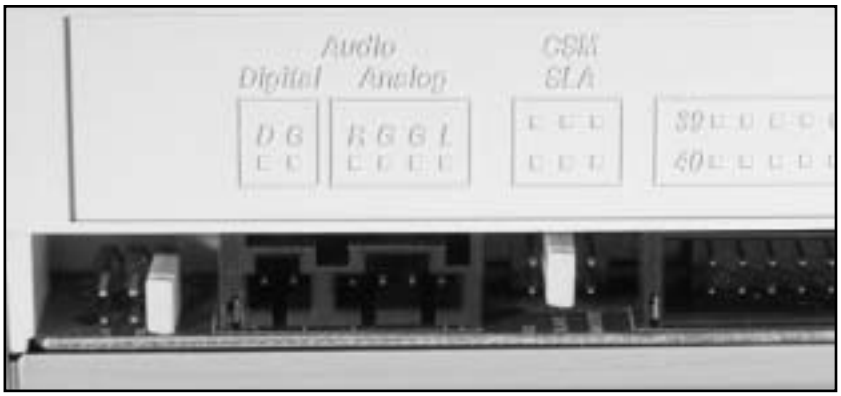


Figure 2
CD-ROM Drive with Jumper in Slave Position.

29. Unplug the long 3-connector ribbon cable from the CD-ROM drive, the hard drive and the motherboard and set it aside.

30. Unplug the power connectors from the CD-ROM drive and from the hard drive.

31. Find the screws on the sides of the CD-ROM drive. There should be one screw on each side.

32. Carefully remove the screws holding the CD-ROM drive in place. Slide the CD-ROM drive out the front of the chassis and set it on the work surface.

33. Find the jumper block on the back of the CD-ROM drive. Move the jumper to the *Cable Select* position as shown in Figure 3.

34. Return the CD-ROM drive to its original position at the top, front of the computer. Slide the drive in from the front until the screw holes on the drive align with the screw holes in the support bracket.

35. Using the four *metric* screws you removed originally, secure the CD-ROM drive to the support bracket. The screws should not require any force when you turn them...*if any force is required then back the screw out and try again.*

36. Refer to Figure 4 and note how the jumpers on the hard drive should be configured for *Cable Select*.

37. Move the two jumpers on the hard drive to the *Cable Select* position as shown in Figure 4.

38. Find the short ribbon cable that you removed in the prior Lab.

39. Plug the long end of the ribbon cable into the blue connector on the motherboard. The stripe should be pointed down.

40. Plug the connector at the other end of the ribbon cable into the back of the hard drive. The stripe should be toward you. Leave the middle connector on the ribbon cable disconnected.

Figure 3
CD-ROM Drive with Jumper in Cable Select Position

41. Plug the power connector into the back of the hard drive.

42. Find the end of the 3-wire audio cable that you disconnected in the prior lab. If you have trouble finding it, the other end of the cable should still be plugged into the motherboard just to the left of the PCI sockets. Start there and follow the wires until you find the 4-hole connector its free end. So that it will be out of the way, thread the cable between the hard drive and the back of the computer and then up to the CD-ROM drive.

43. Refer to Figure 3 and plug the audio cable into the jack labeled *Analog* on the back of the CD-ROM drive. Be sure that the white wire is toward you.

44. Find the free end of the 2-connector ribbon cable. So that it will be out of the way, thread the ribbon cable between the hard drive and the back of the computer and then up to the CD-ROM drive. Plug the free end of the ribbon cable into the back of the CD-ROM drive. Be sure the stripe is toward you.

45. Plug the power connector into the back of the CD-ROM drive.

46. Find one of the plastic drive cover plates that you removed in the prior Lab. Align the cover with the lower slot from which you just removed the CD-ROM drive. Gently push the cover plate into the slot until it snaps in place.

47. Find the other plastic cover plate and snap it into place just above the one you just installed.

48. Reattach the power cord to the back of the computer. Switch power on and allow the computer to boot. If you have any problems, such as the computer will not boot, check the usual suspects:

    - Ribbon cable connected properly at both ends.

    - Power cable attached properly, and all the way in.

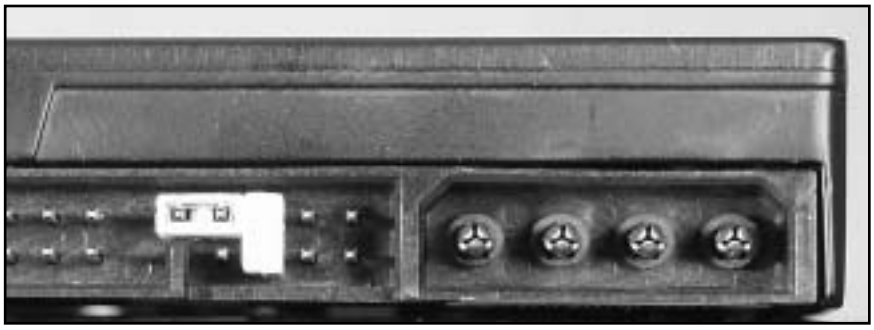


Figure 4
Hard Drive with Jumpers in Cable Select Position.

- Drive configuration jumpers set properly to the Cable Select position on both the hard drive and the CD-ROM drive.

- Video card still fully inserted.

49. Once the computer boots to the Desktop you are assured that the hard drive is connected properly. To insure that the CD-ROM drive works, place any CD in the drive and try viewing its contents using My Computer. If you can list the contents of the CD, you have installed the CD-ROM drive correctly.

50. Shutdown the computer again.

51. Turn the computer on and press the *Del* key during the boot process to enter the CMOS Setup Utility.

52. Highlight *Standard CMOS Features*, if it is not already highlighted, and press the *Enter* key.

53. Refer to the screen and fill in the following:

IDE Primary Master [_____]
IDE Primary Slave [_____]
IDE Secondary Master [_____]
IDE Secondary Slave [_____]

54. Exit Setup without saving.

55. After the computer finishes booting, shut down the computer. Then turn off the power to the computer and monitor.

56. Reattach the left and right side panels to the computer. Return the long ribbon cable to its proper location. This concludes this Lab.

Discussion

In this part of the Lab you returned the computer to its original configuration. The hard drive and the CD-ROM drive are now on separate ribbon cables as before. Both are set for *Cable Select* and both are at the ends of their respective cables. Therefore, both are once again configured as masters.

Unit 9

Buses, Video, and Upgrades

The success of the computer is due largely to its ability to expand and grow to meet the changing needs and/or economics of its user. In the Unit, we will discuss the ways a motherboard can be expanded to work with an ever growing number of devices.

Expansion Buses

Expansion buses are used to connect devices to the motherboard (via the data bus) and therefore allow the flow of data between that device and other devices in the computer. Early computers moved data between devices and the processor at about the same rate as the processor. As processor speeds increased, the movement of data on the bus became a bottleneck. Therefore the design capability of the buses needed to evolve too. This lesson discusses that evolution.

Objectives

- Define the purpose of an expansion bus.
- Describe the different types of common expansion buses, and their major features.
- Describe the purpose of the local bus, and the universal serial bus.

Development of the Expansion Bus

Every device in the computer (RAM, keyboard, network card, sound card, etc.) is connected to the external data bus. For this to work properly, a common method of attaching many different types of devices to the motherboard is required. The solution is the development of the expansion bus, which provides a common access point through a standard connector.

To provide this solution, the PC industry divided the external data bus into two parts, each with their own clock. This approach allows for the development of the CPU to be somewhat independent of the development of the expansion devices. The two buses are called the system bus and the expansion bus.

System bus—Supports the CPU, RAM and other motherboard components. The system bus runs at speeds that support the CPU, typically hundreds of MHz.

Expansion bus—Supports any add-ons via the expansion slots and runs slower than the CPU, at a speed that supports external devices.

Dividing the bus provides the best of both worlds. Upgrading a CPU only requires that the system bus clock is adjusted, while the existing expansion cards continue to run as before without any changes. Let's look at the development of the expansion bus. We will start with the first 8-bit bus and work our way to the new high-speed buses used today.

ISA (Industry Standard Architecture)

The original PC bus was invented and patented by IBM, and designed to work on the 8088 machine with an 8-bit bus architecture. A bus speed of 4.77 MHz was used, which was also the same speed as the CPU. This 8-bit bus design was accepted as the industry standard and called, naturally, *ISA* (Industry Standard Architecture). The ISA bus standard allowed many manufacturers to design and sell thousands of expansion cards, knowing that they would work in all computers with an ISA bus.

With the introduction of 16-bit AT computers came the 16-bit ISA slot. The 16-bit version ran at an 8.33 MHz maximum speed, which again matched up with the CPUs of the day. This expansion slot is actually just an extension of the earlier 8-bit slot. It is configured so that it will receive either an 8-bit or 16-bit expansion card, as shown in Figures 1 and 2.

When working with the today's computers you might encounter one or two 16-bit ISA slots. The computer industry is slowly eliminating the ISA bus from future motherboard designs. Other than an occasional modem, you're not going to find many ISA-based expansion cards available. By removing the ISA slots, CPU and chipset manufacturers to eliminate the need to support older hardware, which allows them to build smarter and faster systems. Most motherboards sold today do not have any ISA slots, but be aware that millions of computers have them, and you're sure to see them eventually.

Figure 1
An 8-bit ISA card being installed into a 16-bit ISA bus slot.

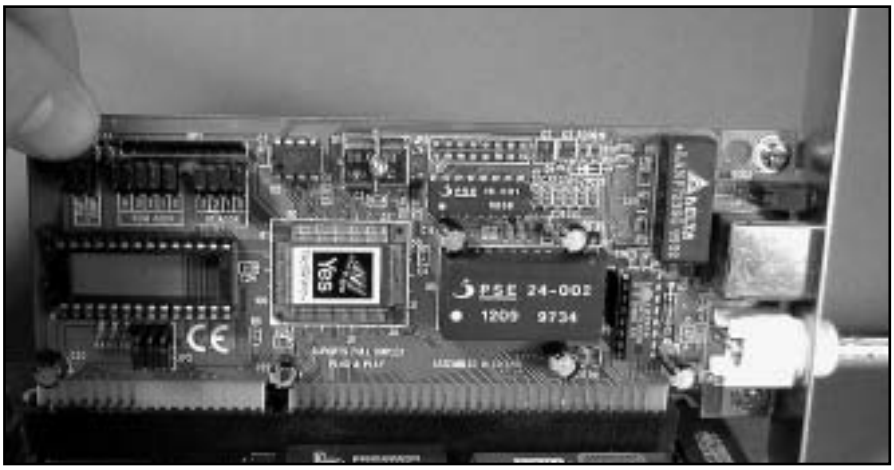


Figure 2
A 16-bit ISA card being installed in a 16-bit ISA slot.

MCA (Micro Channel Architecture)

Processor speeds soon went well past the ISA bus speeds, so in 1986 IBM created a 32-bit expansion slot and called it *MCA* or *Micro Channel Architecture*. MCA made the installation and configuration of expansion devices simple, and was much faster than ISA. Unlike the ISA standard, IBM didn't make it easy for other companies to build expansion devices for MCA.

You're not likely to see these anymore, but they are important because the lack of industry-wide support for MCA signaled the beginning of the end of IBM's dominance in the PC industry.

EISA (Enhanced ISA)

The rest of the computer industry decided they could do without IBM's new standard and MCA. An alternative to MCA, called *Enhanced ISA*, or *EISA* was released in 1988 and has all the improvements of MCA and could handle ISA cards, too. Most importantly, it was much less expensive.

Physically the EISA bus looks the same as the ISA. The difference is in the number of contacts and the depth of the slot. With close inspection, you can see a "double" set of contacts (one above the other). Both ISA and EISA cards can be used in these slots. When inserting an ISA card, the contacts on the

Figure 3
A side-view of the ISA & EISA bus connectors.

card are restricted from reaching all the way to the lower set of contacts in the slot. EISA cards, on the other hand, have longer "fingers" and will reach all the way to the bottom of the slot, allowing all the contacts to be made. EISA buses were mostly used in servers and high-end workstations, but just like MCA their time has come and gone.

Local Buses

ISA, EISA and MCA were excellent systems. However, as CPUs passed the 100 MHz mark and as GUIs demanded powerful video systems, the need for faster expansion buses was clear. Compared to CPU speeds, expansion bus speeds fell well behind. For example, a video card using an EISA bus running at 8.33 MHz was no match for a CPU running at 100 MHz. These new high-speed peripherals *could* run at the speed of the processor, but the bus was a bottleneck.

On the original 4.77 MHz ISA bus the CPU was directly connected to the bus itself. Peripherals could transfer data directly to and from the CPU, with no obstacles. But as CPU speeds increased the expansion bus had to be disconnected from the CPU bus, and this separate CPU bus was called the *local bus*. The local bus usually runs at the same speed as the CPU, and only chipset devices such as memory and disk controllers were attached. PCs had two buses, but only the slow one was available for new external peripherals, which were now running at speeds well beyond the sloth-like expansion buses.

The answer was to tap into the local bus for high-speed devices and use the ISA bus for other devices such as sound cards and modems. This provided the best of both worlds, a standard low-speed bus to meet the needs of the installed base of existing expansion cards and a high-speed connection as well.

VESA Local-Bus

While the need for a faster bus design was critically important to many manufacturers, video devices needed an entirely new design. One solution for increasing video speed was to install a co-processor on the video card. While this improved the performance by decreasing the amount of data to move, moving data between the CPU and the video processor was still a problem. The solution was to connect video adapters directly into the local.

The *VESA Local-Bus*, or *VL-Bus* was designed as an extension of ISA, 16-bit EISA and MCA. Just like the original 4.77 MHz ISA, it was essentially a direct connection to the 486-processor bus. When the next generation of CPUs was launched, the original Pentiums, the VL-bus hit a wall. Running a VL-Bus at speeds greater than 33 MHz caused too many problems, enough to limit the use of the bus to the 486 line of processors.

With the introduction of the PCI bus, VL-Bus technology has all but disappeared. Don't expect to find it in anything other than a 486 machine.

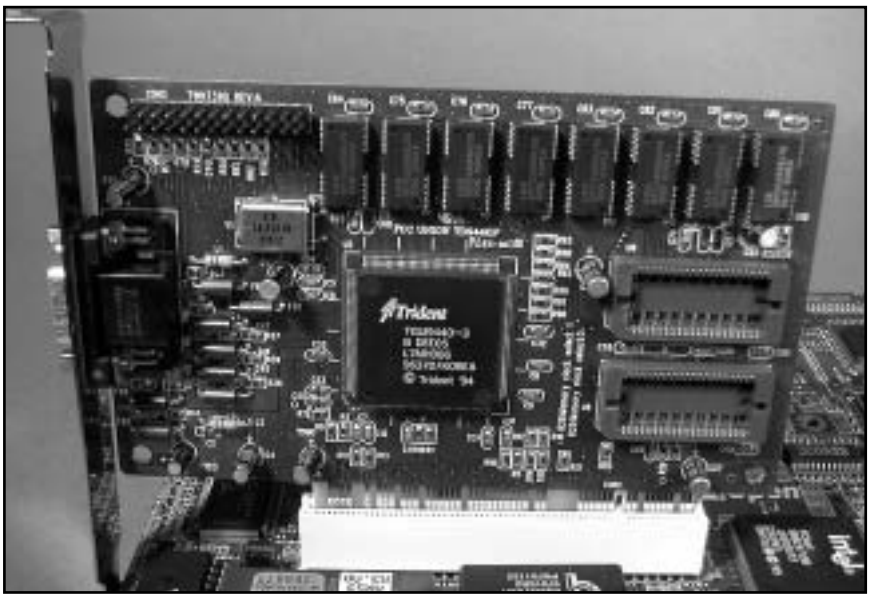


Figure 4
A PCI video card being installed in the PCI bus.

PCI

In 1992, a group of designers were intent on moving past the limitations of the ISA, EISA and MCA bus designs. They designed the *Peripheral Component Interconnect*, or *PCI* bus. The new bus provides high performance, automatic configuration, and expandability. PCI isn't an expansion of a previous bus, but rather an entirely new bus. The PCI bus incorporates a new set of controller chips that provide a bridge between the CPU and local bus, the PCI bus and the expansion bus. PCI is designed for operation with 32 and 64-bit systems and is the choice for all Pentium and Pentium-equivalent platforms.

Today, PCI is the primary expansion bus in all computers, and it's even used in many of the current Macintosh systems. The success of plug-and-play is largely due to the PCI bus, which is expected to remain the standard for several years. PCI is limited to internal expansion cards, such as video, SCSI adapters, and network interface cards.

AGP

Intel created *AGP*, the *Accelerated Graphics Port*, in 1996 as a way to enhance the performance of graphics display devices. Finally, the industry used a name that tells us what the technology does! All of today's PCs contain a single AGP port, which handles the primary video adapter in the system. Naturally, most of the video adapter cards you can buy use the AGP port, but a few are available as PCI.

The AGP port provides the video processor with direct access to system RAM, allowing extremely fast data transfers from the CPU to your monitor. AGP is also completely separated from the PCI bus, allowing each to run independently. AGP is becoming faster all the time, with newer versions being released regularly. As with PCI, you can expect AGP to be around for a while.

USB

A newer introduction to the line of expansion buses is called the *Universal Serial Bus* or *USB*. It is a mid-speed bus that can be used for a variety of peripherals, including mouse devices, keyboards, joysticks, printers, scanners, audio devices and digital cameras, just to mention a few.

USB is unique in several ways, primarily because it is designed for external computer connections. It's possible that in the future most, if not all of your external connections will be USB.

USB is also a serial data interface. This is a new idea, where historically bus designers were focused on building massive parallel systems, such as SCSI. What the USB pioneers learned was that they could send more data through a super-fast serial cable, more reliably and for longer distances, than any parallel interface could handle. This fact doesn't necessarily mean the end for parallel interfaces, but it does mean fewer devices will be built with them.

Another super-fast serial technology is also being used today, although not as widely. The IEEE-1394 system, known as i.Link by Sony and Firewire by Apple, has the potential to be twice as fast as USB. These are competing technologies, but so far USB has already carved out a notch in every PC built this century. Eventually you may see these newer serial interfaces replace some of the other expansion systems we use today.

Configuring Expansion Cards

The purpose of a bus is to connect devices to the motherboard by installing an expansion card. That is, you can connect a whole bunch of devices at the same time. The expansion bus is like a large party line, with all devices connected to the same line(s). This configuration presents two problems. First, the CPU must know how to contact each individual device on the bus and second, it must be able to control which device is allowed to communicate on the bus. The first issue is identifying individual devices, and that's done with addresses. Lets start by taking a look at I/O addresses.

Objectives

- Describe the purpose and basic operation of I/O addresses.
- Describe the purpose and basic operation of interrupts, and how IRQs are configured.
- Describe the purpose and basic operation of direct memory addressing.
- Describe the installation of a Plug-and-Play device.

I/O Addressing – Where is that Card?

The bus system establishes a connection between the CPU and the expansion devices and provides a path for the flow of data. A means of controlling who's "talking" and who's "listening" is required; otherwise there would be complete chaos. First, we have to assign a unique number to each device, which is called the Input/Output Address, or simply the *I/O address*. Every device in a computer, requires a unique address, otherwise the CPU could not keep track of what is going on and what is available.

I/O addresses are binary numbers placed on the *address bus* by the CPU or the system controller. The address bus is a special set of connections that allows the CPU and system controller to get the attention of the other devices. Each device on the motherboard or on the expansion bus will listen to the address bus for its assigned number. When the CPU places a number on the bus, *one* device will recognize the number and respond accordingly. All other devices ignore that number.

As an example, let's say the CPU wants the current time from the real-time clock. The CPU performs many related actions to get the information, but the important part is that it places the I/O address of the clock on the address bus. So far the clock has been watching the address bus, but it has not seen its own address. So it just sits and waits, keeping time all the while but telling nobody about it. Once the clock finally detects its own address on the bus it jumps into action, sending the time out across the local bus for all devices who may be listening.

This description is a greatly simplified way of describing how the CPU tells all the other devices in the system to be quiet for a moment while it has a private conversation with a specific device. The important thing to remember about I/O addresses is that no two devices can have the same I/O address. If this were to happen, a conflict would exist and the system would crash or lock up.

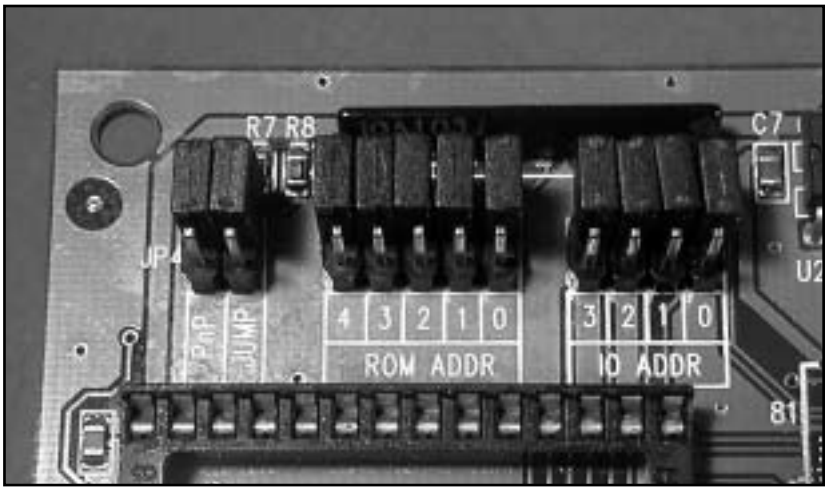


Figure 5
I/O address jumpers on a non-PnP board.

For consistency, the most common devices have preset I/O addresses that cannot be changed. For devices that are not Plug-n-Play or preset, the documentation that comes with the device will explain how to set the I/O address for that device. Normally, all that is required is changing jumpers or switches, as shown in Figure 5. Some cards will provide software that resets the I/O address that is stored in an EEPROM on the device. Plug-and-Play devices are automatically configured by the operating system.

Interrupting—Who's Turn to Talk?

We have seen how the CPU uses the I/O address to send instructions to the devices in the computer. We have also seen that the external data bus is a party line. The problem is how does the CPU know when a device needs its attention? It works the same way a student gets the attention of the instructor. Each device will "raise its hand" and wait for the CPU to respond. Each device will use a the electrical version of raising its hand, a *hardware interrupt*. These interrupts just a wire assigned to the device. These wires are either connected directly to a standard device, such as a keyboard or system timer, or connected to the bus slots, making them available to any device installed in the slot. When the device needs the attention of the CPU, it places a signal on the wire. The CPU recognizes the interrupt and knows who sent it, then will respond to the device via the device's I/O address.

Configuring IRQs

With today's PCI expansion cards, configuring IRQs is soon to become a lost art. This is a good thing, because trying to configure all the devices in a system is a lot of trouble and work, and plug-and-play makes it all so easy. However, non-PnP devices lacking a fixed or standard IRQ must be set during installation. Read the manual to learn about the specific settings for the device. IRQs are configured just like I/O addresses, with jumpers as shown in Figure 6, or with switches, software drivers, or of course automatically with Plug-and-Play.

The problem with manual configuration is that some devices have a limited number of IRQ settings and you may need to change the IRQs of other devices in order to free one of these IRQs. For instance, if a customer recently installed a sound card that locks up when a parallel port tape backup is used on the system, there is probably an IRQ conflict. Check the sound card and the tape backup IRQ settings and change one if necessary.

With Windows' plug-and-play, IRQs are assigned automatically, and in fact several devices may be assigned the same IRQ if they are on the PCI bus. The PCI controller can sort out the devices internally, and send the appropriate signal back to the CPU.

IRQ Conflicts

Aside from the PnP exception noted previously, there are only a few IRQs in a computer and no two manually-configured devices can have the same IRQ assignment and be expected to work properly. If two devices have the same

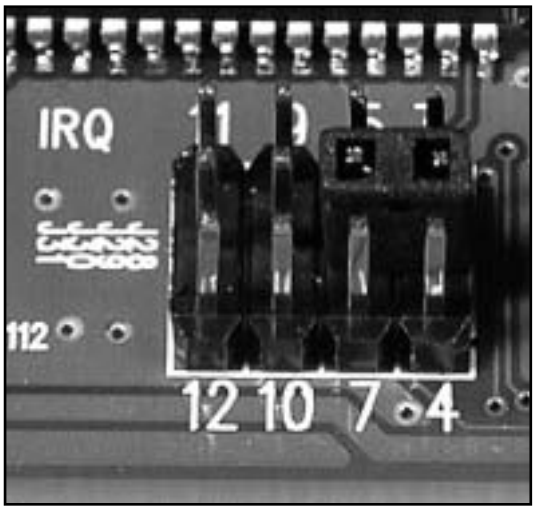


Figure 6
IRQ jumpers on a non-PnP board.

IRQ, the CPU will not know which one is calling and will become confused, leading directly to a system lockup. Perhaps the most common problem encountered after installing and configuring a new device is an IRQ conflict. This will be immediately noticed as the device or the entire system will lock-up. Older sound cards are well known for causing IRQ problems.

DMA Channels

In addition to configuration of IRQs, a less common and similar configuration will cause the same problems as IRQ conflicts. Some devices have the ability to communicate directly with memory, which is called *DMA* or *Direct Memory Access*.

Devices that use DMA usually move large amounts of data very fast. Sound cards and hard drives are examples of devices that will use DMA. Working with DMA is the same as working with IRQs, including the automatic control of DMA resources by the plug-and-play system

Installing an Expansion Card

Installing expansion cards is simple as long as you follow four basic guidelines:

- Make sure that you have a slot available and that the card you purchased fits the available slot.
- Read the documentation.
- Keep the IRQs, DMAs and I/O addresses unique.
- Write down what you did, how you did it, and why.

PnP cards only need physically installed and the computer turned on. Windows will find the card and guide you through the set up. Windows Device Manager also does a good job of identifying and allowing changes to these settings. To see what Windows has found, go to the desktop and right-click *My Computer*. From the menu select *Properties* and then *Hardware*, and click the *Device Manager* button.

Video Systems and Monitors

The majority of our discussion so far has been focused on what goes on inside the computer. In this section we are going to look at an output device. The focus will be on the most prominent output device attached to every computer, the video monitor.

When we speak of displays, we are generally speaking about monitors. Every computer will have some form of display, either a standard video monitor or an LCD (liquid crystal display). In this section, we are going to look at three aspects of displays—the displays themselves (monitors), the video cards that drive them, and the memory required to gain the performance we need from them.

Display and Image Technologies

Just like computers, monitors have developed over time. The early 8088 computers were designed to process data in the form of text. Some of these early monitors were considered color because they were black and green or black and amber instead of black and white. The function of these "colors" was to make it easier on the operator's eyes. In today's world with Windows and multimedia, choosing a monitor is not so simple. In this section, we are going to look at the development of monitor technology.

Objectives

- Describe the basic operation of a cathode-ray tube.
- Describe the major differences between CRT and LCD displays.
- Define the term resolution, and the difference between pixels and dot pitch.

The most common of all displays is the video monitor. For most of us it looks like a television screen. In many ways, the computer monitor is nothing more than an enhanced TV screen. While it operates on the same principle as a TV, the specifications are quite different. Since the main feature of a monitor is the screen itself, lets start by taking a closer look at the cathode ray tube that is the screen.

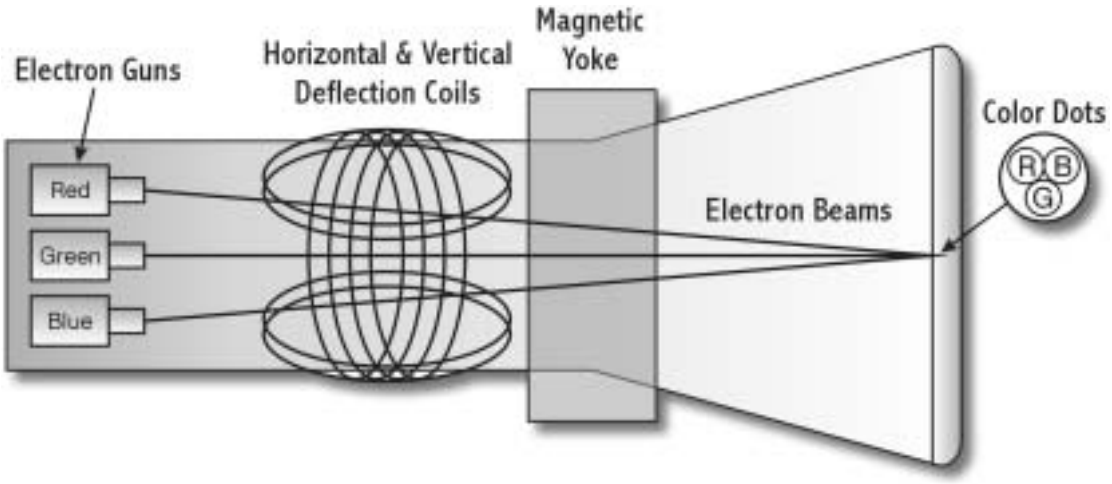


Figure 7
An inside view of a CRT.

CRTs

The *cathode ray tube*, or *CRT* is a conical shaped glass tube on which one end has been elongated. On the large flat end of the cone is the screen that we watch. The other end contains the electron guns that create the lighted image on the screen. In the middle are various coils and electronic circuitry that control the formation of the image.

Fortunately, we do not have to know how this works, but it does help if we have an understanding of the principles of image generation. With this knowledge, we can effectively select the right monitor for the job.

A CRT works like this. An electron gun at the long narrow end is heated and emits a stream of high-speed electrons in the direction of the large end of the tube. When they hit the other end of the tube they contact a phosphorous material that gets excited and glows, forming a dot that we can see from the screen side of the tube.

In between the electron gun and the end of the tube are the controlling coils. These coils (called the yoke) generate magnetic fields that can deflect the flow of electrons emitted by the electron guns. By varying the current in these coils, the beam can be directed to any point on the screen. By also varying the power to the electron gun, the intensity of the electron stream can be controlled, thus providing various shades of intensity. By putting all this together, and by scanning the surface of the screen in a pattern while varying the intensity of the beam, an image is formed on the screen. This is how a monochrome or black and white monitor works.

A color monitor is simply three times as complex. Instead of one electron gun and beam, it has three. Each beam is aimed at a different dot of phosphorous that will emit red, green or blue colors. By combining these three colors (and

varying the intensity of each beam) almost any color can be generated. It sounds complicated and it is. Fortunately we do not have to know how it works, just the effects of how it works. We will do this by reviewing some common terms.

Persistence vs. Scanning Frequency

These are two concepts that work against each other and therefore must be balanced. *Persistence* is the time that a phosphorous dot will continue to glow after it has been excited by an electron beam. Scanning frequency is the amount of time it takes for an electron beam to scan the entire screen and return to a dot. We commonly call this *refresh*. The proper balancing of these two items will eliminate any flicker and ghosting of images, which strains our eyes. If the persistence is too low compared to the frequency, the dot will not retain enough light and the image will flicker. If the persistence is too high, there will be too much light and a ghost image will appear.

Sweeping and Refresh Rates

As we said, the electron beams are controlled so that they energize every dot on the screen. This is done through a sweeping action. As we look at the screen from the front, the electron guns are swept from the upper left corner horizontally across the screen, turned off and moved to the left and down one dot (this is called horizontal retracing), turned on and then swept horizontally again. When the beam gets to the lower right corner, it is turned off and moved back to the starting point (this is called the vertical retrace).

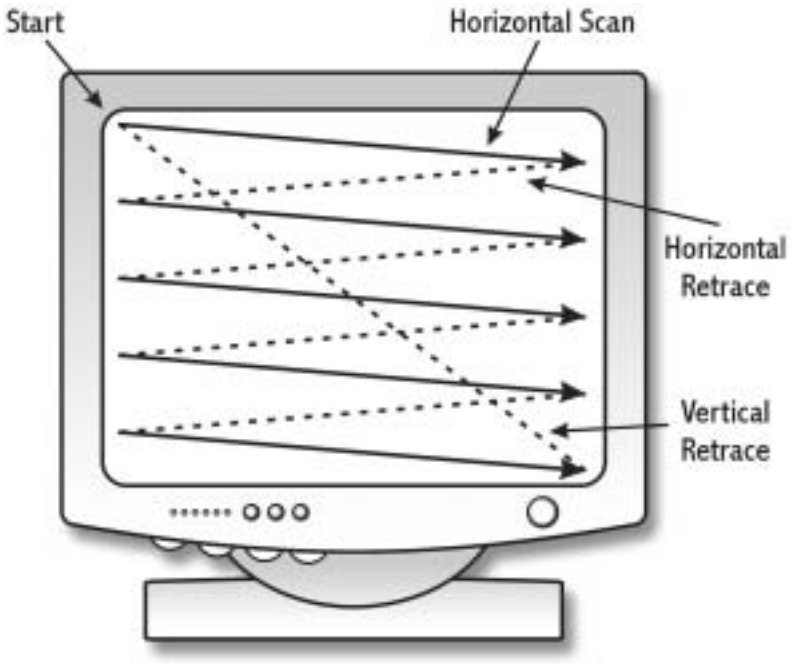


Figure 8
CRT Sweeping

The frequency of these sweeping actions is called the *refresh rate*. The time to scan one line is called the horizontal refresh rate (HRR). The time to scan an entire screen is called the vertical refresh rate (VRR).

The important number to us is the VRR. When evaluating the specifications of a monitor, the specification for refresh rate normally refers to this number. Typical refresh rates are between 60 Hz and 100 Hz. A monitor with a higher refresh rate is usually easier on your eyes, and generally more expensive. A refresh rate that is too low will cause flicker that can lead to eyestrain and headaches. If the refresh rate is too high for the monitor, the image can become distorted and damage the CRT. Keep in mind that the refresh rate is often controlled from the operating system, and that you must configure the OS so the capabilities of the monitor are not exceeded.

Interlacing

Interlacing is a way of arranging a video display so that the CRT sweeps all the odd-numbered rows then all the even-numbered rows (or vice versa). The intention of interlacing is to reduce the flicker on the screen by increasing the refresh rate (scan the screen twice as often). In practice, interlacing reduces flicker only when adjacent rows of colors are similar. Interlacing on computer screens can lead to eyestrain and headaches. Interlacing works well on TVs, but not computer monitors, and should be avoided for normal computer use.

LCDs

A common alternative to the standard CRT is *LCD* or *liquid crystal display*. While mostly used with laptop computers, they are becoming common on desktops as their prices fall. You will find them as the new thin-line or flat panel displays. The difference between these and the standard monitor is that instead of exciting phosphorous to emit light, they apply power to crystals.

The LCD is designed to operate at a specific resolution because the size of the pixels on an LCD is fixed and cannot be changed. For instance, a typical 15-inch LCD panel display is designed for 1024 × 768 pixels. At that resolution the image is sharp and clear. But if you need to switch this display to 800 × 600 pixels, the display becomes fuzzy.

The two major types of LCD displays used in portable systems today (*dual scan* and *active matrix*) are defined by their arrangement of transistors.

Dual Scan Displays

The *dual scan* display (also known as a *passive matrix* display) has transistors running down the top and side edge, or the x- and y-axis of the screen. Each pixel on the screen is controlled by the two transistors that intersect on the x- and y-axis.

Dual scan screens work by modifying the properties of reflected light rather than generating light. They are more prone to ghost images and are difficult for two people to share, as they don't view well from many angles. They are much cheaper to produce than active matrix LCDs, making them a good choice for a low-budget laptop.

Active Matrix Displays

Active matrix displays differ from dual scan displays in that they have a transistor for every pixel on the screen rather than just at the edges. Since each pixel is powered individually, each one generates its own light with its appropriate color. This creates a much brighter and vivid picture, as well as a wider viewing angle, which will allow multiple viewers to see the screen. Active displays are faster and don't have the fuzziness associated with dual scan systems.

Naturally, the added cost of having 480,000 transistors, instead of merely 1,400 (on an 800 × 600 screen) makes the active matrix screen more expensive. Another drawback is that it also requires a lot more power and will drain batteries on portable computers faster. Active matrix displays are they only type used on desktop LCD panels. As more and more LCD panels are used on desktops, their price is dropping rapidly, and fewer passive LCDs are being made.

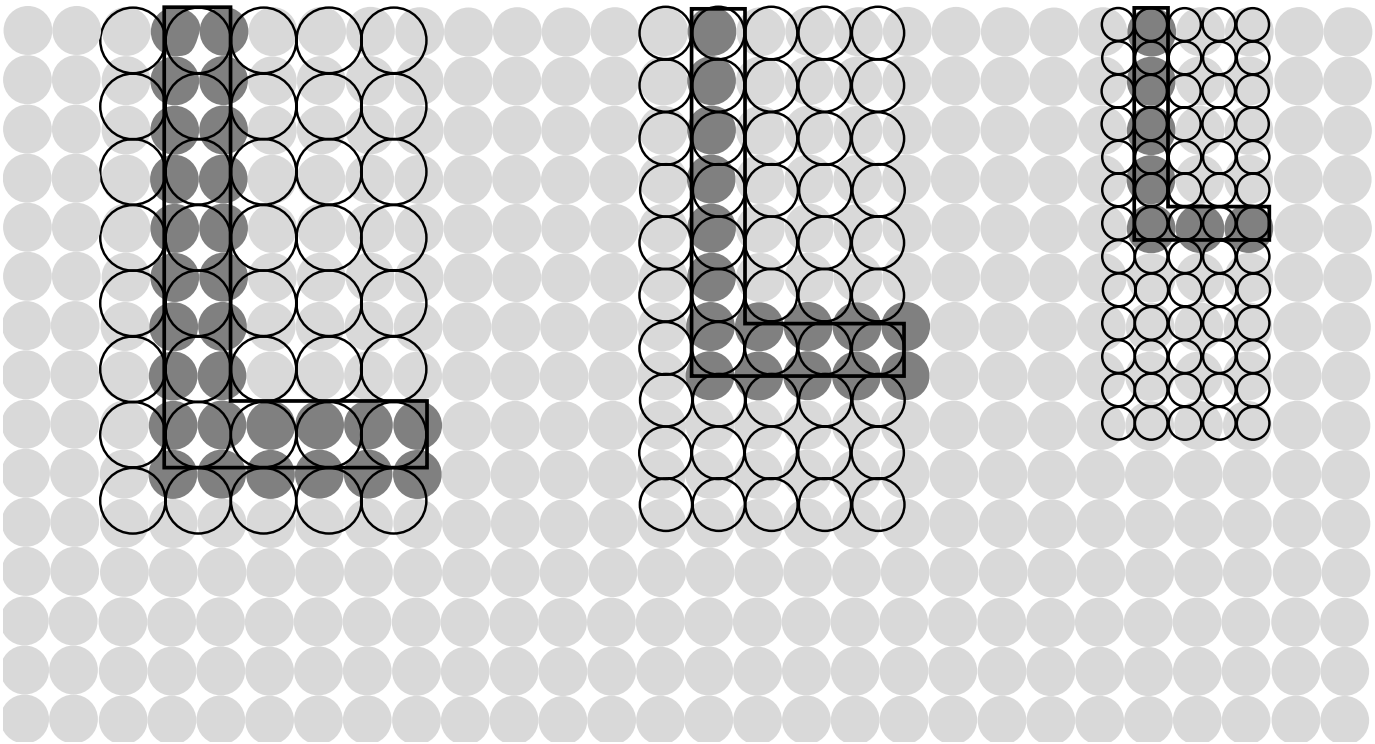


Figure 9
The relationship between pixels and dot pitch.

Resolution

You may be wondering how it is possible to change the display resolution on a CRT monitor when the size of the phosphor dots can never change. To see how that works, let's look at what the display is presenting.

The image produced by a video display monitor is made up of many small dots of light. In a color display, each dot is actually composed of three different color phosphors—red, green, and blue—just like a color television. The term *dot pitch* is a way of specifying the size, in millimeters, of the 3-phosphor dots. If you have a 15-inch monitor, it probably has a dot pitch of 0.28 mm. That means there are approximately 964 3-phosphor dots in each row of the display. This number cannot ever be changed for a given monitor.

The image you see in the monitor is made up of spots of light we call *pixels.* A 640x480 display has 640 pixels per row and 480 rows of pixels. An 800 × 600 display has 800 pixels per row and 600 rows of pixels, and so on. These spots of light represent the video data output by the computer's display circuit. *The number of pixels in the display has nothing to do with the monitor's dot pitch. Pixel count is determined by software; dot pitch is determined by hardware.*

To see what this means to the image displayed, consider this. The area of a 15-inch monitor that actually shows an image is approximately 270mm wide and 202mm high. Therefore, a 640 × 480 display contains approximately 2.37 pixels per millimeter, while an 800 × 600 display contains approximately 3 pixels per millimeter, and a 1024 × 768 display contains approximately 3.8 pixels per millimeter. Because the monitor has a dot pitch of 0.28mm, there are approximately 3.57 3-phosphor dots per millimeter.

Now, look at Figure 9. It shows the relationship between the 3-phosphor dots and the image pixels. The light gray dots in the figure represent the 0.28mm 3-phosphor dots, which are a physical attribute of the monitor and cannot be modified. The circles represent the software-generated pixels—the group on the left is for a 640 × 480 display, the group in the middle is for an 800 × 600 display, and the group on the right is for a 1024x768 display.

When the pixels for an L-shaped character are switched on, the 3-phosphor dots that are aligned with the pixels are lighted. The lit phosphor dots are represented by the dark gray dots in the figure. Those dark gray dots show the image you actually see when a character is sent to the video display monitor.

You can see that even though the dot pitch is fixed, you can change the pixel count, and thus change the size of the displayed image. There is, however, a limit to how small you can make the size of each pixel. Anything smaller than that produced by an 800 × 600 pixel array on a 15-inch monitor and you will strain your eyes trying to view the image. If you need to clearly see more information than that provided by a 14" or even a 15" monitor, switch to a 17" or 20" monitor and a 1024 × 768 pixel array. That will give you a readable image.

Working with Monitors

Objectives

- Describe the purpose and basic operation of APM.
- Describe the various external monitor adjustments.
- Identify common monitor malfunctions, and safe methods to resolve monitor problems.

Saving Power

Monitors consume more than half of all power used by a computer system (typically 80-100 watts). To deal with power savings issues, the *Video Electronics Standards Association* (*VESA*) has created specifications for *Display Power-Management Signaling* (*DPMS*). These standards define the signals that a computer can send to a monitor during idle times.

In addition, Microsoft and Intel jointly developed the *Advanced Power Management* (*APM*) specification. These specifications define the BIOS-level interface between the hardware and the operating system. In order for a computer to provide power management it must comply with both of these standards, DPMS on the monitor side and APM on the computer side.

The concept here is simple, if the explanation is not. When you walk away from your computer for an extended period, the monitor is wasting power displaying bright images while nobody is looking at the display. APM checks the computer for user activity, such as keyboard or mouse action, and makes decisions based upon settings made in Windows and in your BIOS Setup. For instance, you can configure the system to turn off the monitor when it detects that you have not touched the mouse or keyboard for 30 minutes.

The monitor isn't actually turned off, just the circuits that use a lot of power. Then when you touch a key or move the mouse, the system detects that you have returned and the monitor is restored to full power.

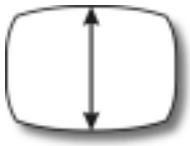
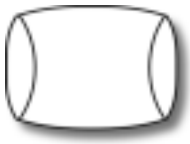
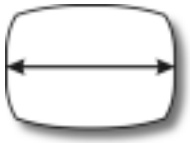
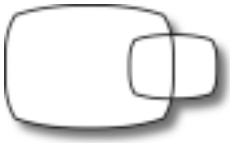
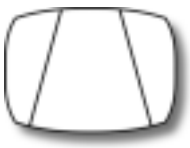
Working together, the DPMS and APM standards provide four levels of operation.

1. On—Normal operation at 100% power.
2. Stand-by—Reduce power a minimal amount while allowing for a quick recovery. Could be considered short-term power savings.
3. Suspend—Reduce the power to a bare minimum. Recovery time will be substantially longer than from stand-by. This should be considered long-term power savings.
4. Off—This level is the ultimate in power savings. Power is removed from the monitor and it will have to be restarted.

The key to monitor power management is that a system shutting off its monitor does not have a problem; rather it is attempting to save power. The variety of delay settings is more than you would ever need; for instance you can configure the monitor to stand-by after just one minute of inactivity. If you ever try this, you'll see that this setting causes more trouble than it is worth.

Display Adjustments

A few common adjustments can increase the clarity and viewability of the screen. Normally you will find a control panel on the front of the monitor. You will be able to make the adjustment directly or enter a menu on the screen to lead you through the adjustments. The table on the facing page is a summary of the most common adjustments and the symbols to designate them.

	**Vertical Height**	Allows adjustment of the top and bottom of the image. Image height changes.
	Vertical Center	Allows adjustment of the location of the image relative to the top and bottom. Image moves up and down.
	**Pincushion**	Adjusts the center of the image (vertically) so that it is square.
	**Horizontal Width**	Allows adjustment of the left and right sides of the image. Image width changes.
	**Horizontal Center**	Allows adjustment of the image to be horizontally centered. Image moves side-to-side.
	**Keystone**	Allows adjustment of the top and bottom edge widths so that the image is square.
	Degaussing	Available on newer, larger monitors. Demagnetize the CRT thus preventing an electron beam from bleeding over to an adjacent dot, causing shadowing and or loss of color control.

When a Monitor Goes Bad

When it comes to monitors, there are no internal serviceable parts.

CAUTION—Monitors contain dangers inherent to the high frequency/ high voltage power needed to generate a display. This voltage can exceed 50,000 volts on larger monitors. Servicing and adjustment of the internal components should be left to a monitor specialist!

There are only two kinds of display problems. Either it doesn't work or the image is bad. Let's first look at the monitor that doesn't work. You know when a monitor is not working because the computer is on and the screen is blank. When this happens, there are only three places to check:

Power – Is it turned on? Is it plugged in? Is there power to the power strip or outlet? Sounds simple, but power strips frequently cause problems. Most monitors will have a status indicator light to show that it has power. If all is well the light will be green. If there is power, but the monitor is in a power saving mode, the light will be yellow.

Data Cable – Is the data cable connected securely and to the right connector? If you have a yellow status indicator light, this connection is most likely the problem. The small pins in the connector can be broken or bent. High-end monitors often have replaceable cables, but low-end monitors normally do not.

Brightness and Contrast – These controls are used to adjust the intensity of the screen. This can be embarrassing for the user, but the controls can be simply set all the way down.

If none of these solutions work, the problem is the video card or the monitor. You can connect a known good monitor to this computer or connect this monitor to a known good computer to isolate the problem.

When the picture is bad, you have a few solutions. Some adjustments can be made from the outside of the monitor. There are also some inside adjustments, but they are best left to a specialist. The external ones include brightness and contrast. Check the documentation that comes with the monitor to determine the adjustment limits for the monitor.

The cable connection is a common cause of poor picture. An improper connection can cause poor edges and missing colors.

Monitors operate by using magnetic fields to control the movement of the electrons on the screen. Since they rely on magnetic fields, they are also subject to interference from outside magnetic fields. Most have automatic internal circuitry to correct these problems. These are called degaussing coils. If you notice swirls or fuzziness, the monitor might need degaussing. If you push the degaussing button, the image on the screen will shake and roll for a few seconds, then stabilize.

The following are a few tips to keep in mind for maintaining a quality image on a monitor:

- Clean the screen on a regular basis.
- Use high-quality cables and ensure that the connections are secure.
- Keep the ventilation slots free from obstruction. The monitor produces a excess heat and needs to have adequate cooling.
- Use only the refresh rate(s) recommended by the manufacturer.
- Keep magnetic objects away from the monitor screen.

Video Display Adapters

The second key component of a display system is the *video display adapter*, often simply known as the *video card* or *video adapter*. This device is the interface between the monitor and the CPU.

Objectives

- Describe the main computer monitor standards.
- Describe basic video adapter troubleshooting techniques.

Display Adapter Types

Many different types of display adapters have been used over the years. As technology gets better, faster, and cheaper, the early systems quickly became obsolete. As with CPUs, this is also true of video technologies. Let's take a brief look at a few of the more common technologies.

Color Graphics Adapter (CGA): CGA provides medium-resolution (320 × 200) with four colors or high-resolution (640 × 200) with two colors. CGA also uses a 9-pin connector. This system is obsolete and rarely seen today.

Enhanced Graphics Adapter (EGA): With 16 colors; you could achieve 320 × 200 or 640 × 200 pixels. In monochrome mode you could achieve 640 × 350 pixels. EGA was expensive and short-lived.

MultiColor Graphic Array (MCGA): This was a proprietary adapter used in IBM's PS/2 line. One of its unique attributes was that it could display up to 64 shades of gray. This format is also obsolete.

Video Graphics Array (VGA): VGA introduced a new method of operating video. Previously all video cards were digital, but VGA introduced an analog system. With an analog signal, color can be produced at 64 distinct levels for each of the red, blue, and green signals. This gives us a maximum of 64^3 or 262,144 colors.

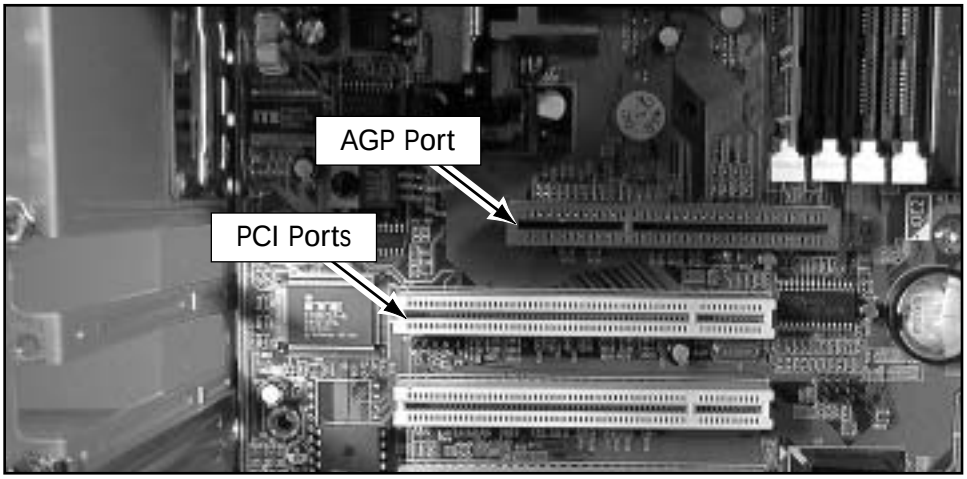


Figure 10
Most of today's video adapters use the AGP port.

VGA also introduced what is now the standard video connection, the 15-pin, three-row *DB connector*. On newer computers, the connection is color-coded as blue. VGA is typically the display resolution and color depth referred to on many software packages as a minimum display requirement.

Super Video Graphics Array (SVGA): SVGA is today's video "standard." The standard covers every resolution and color depth up to 1280 × 1024 with 16,777,216 colors. When a specification requires "standard SVGA" they mean 800 × 600 with 256 colors.

You may have seen additional standards, such as XGA, SXGA, and others ending in "GA." The *x*GA standard designations have been misused forever, various companies and authors using the terms to mean different things. As a result, these designators are often more confusing than helpful. In the end, you are better off referring to the actual resolution than any of the acronyms.

Adapter Troubleshooting and Maintenance

There isn't much you can do to troubleshoot adapter cards. Either they work or they don't work. The best technique is to replace a suspect card with a known good one.

There is one type of problem you are likely to encounter some day, but it has nothing to do with a hardware problem. Often an application, or even Windows itself, will have trouble with the software driver that controls the video card. The driver could have been corrupted, or a new application won't work as expected. This can show up as bad colors, completely unreadable displays, scrambled graphics on buttons, or any of a number of odd problems. In most cases these problems can be fixed by updating the video driver to a newer version. Driver updates are often available from the manufacturer's website, as well as video BIOS updates and the instructions to install them.

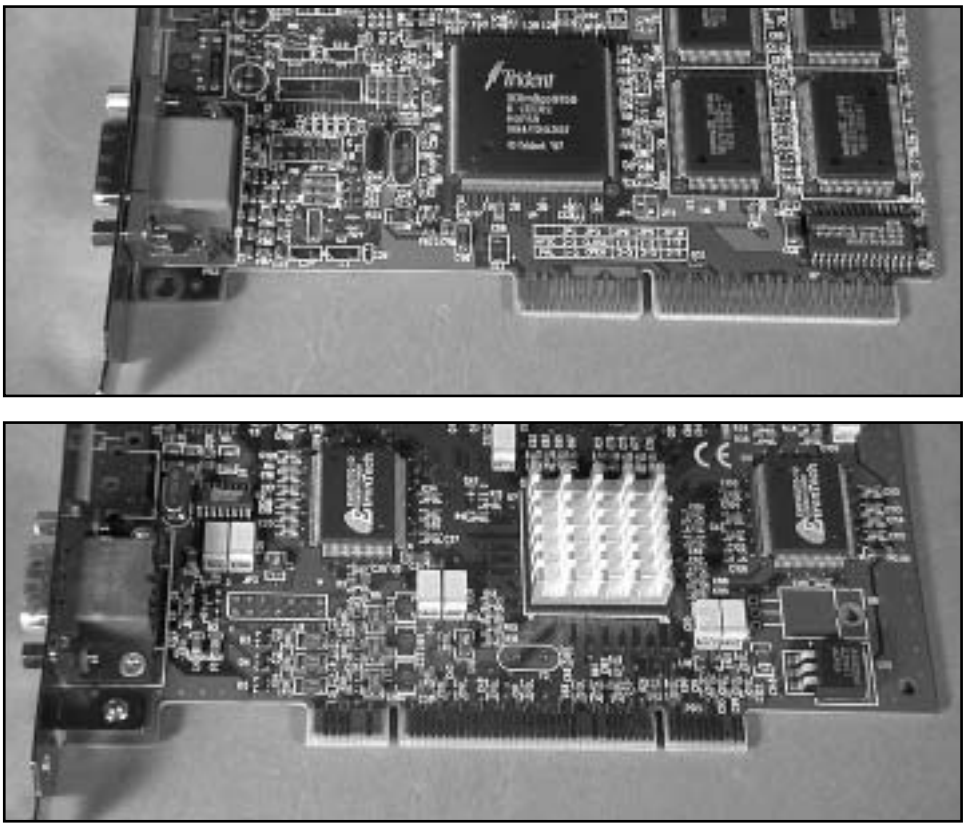


Figure 11
A comparison of two video adapters: the AGP adapter is on the top, the PCI adapter is on the bottom. Compare these photos to Figure 10.

Upgrading a Computer

The concept of upgrading a computer is based on the ability to expand and update, therefore getting longer life and more use out of one system. However, a simple software installation can sometimes lead to hardware problems and the need for an upgrade, as computer owners try to squeeze one more year out of "old faithful." Before you begin to upgrade any computer, you need to document the system. You should create and maintain files on all computers for which you are responsible.

Objectives

- Describe how to select the proper type of memory when upgrading a computer.
- Describe the considerations when upgrading a CPU.
- Describe the process for adding expansion cards and drives to a PC.
- Define the process for determining if a new motherboard can be installed into a given computer.

Memory!

Does this system have enough memory? No single upgrade gets more attention, and no single upgrade creates a bigger performance bang for a buck. As programs get bigger, and hardware becomes faster and is required to handle more graphics and animation, the need for memory is just as important as the need for speed.

Memory upgrades are simple to perform, but can be confusing without proper planning. Purchasing the right memory for the job is the biggest part of the job. Before installing memory, there are several things to consider:

- Memory module format (SIMM, DIMM, DDR-SDRAM, RDRAM)
- Memory Speed
- Number of free memory slots
- No parity, parity, or ECC

The best source of information to check before obtaining memory is the documentation that comes with the computer or motherboard. This source will generally list the type of memory required, how many SIMMs are required, and how to install them on the motherboard. Some documentation will even provide a chart that tells exactly what memory is already there and what is needed to upgrade to a given level. If this information is not available**,** open the case and look. If you still cannot tell what is needed, visit the computer or motherboard manufacturer's website.

Memory Modules

The type of module in the computer is the first information you need. Incorrect memory types simply don't fit in the motherboard's memory slots.

Memory Speed

This is the rate at which data can be input and output from the module without errors. All motherboard documentation specifies the speed rating for a memory upgrade. Today you are primarily looking for PC-66, PC-100 or PC-133 memory for DIMMs, or PC 1600 and PC2100 for DDR-SDRAM modules. The number designates the speed of the motherboard. If a DIMM is not rated for PC-100 or PC-133, it is probably an early PC-100 module, or more likely rated for a 66 MHz motherboard.

In almost all cases you can use a memory device that has a faster rating than your motherboard requires. On the other hand, you should never use memory that is rated slower than your motherboard.

Free Memory Slots

Motherboards have a finite number of memory slots, typically they can receive two, three, or four modules. The more slots you have available, the more versatile you can be with upgrades. Obviously, you will have more trouble upgrading memory if all the slots on the motherboard are filled. Before you ever purchase memory for a computer, be sure you open the case and look at what's inside. Sometimes the BIOS Setup can tell you what is in each slot, but seeing for yourself is the best guide. Check the documentation, because most motherboards have a maximum amount of RAM they can handle.

If empty slots are available the upgrade is a simple affair. If the slots are all filled, then you will have to replace modules with larger versions. For instance, you can remove a 32 MB module and replace it with a 64 MB or 128 MB module, adding 32 MB and 96 MB, respectively.

You can only buy memory as 1 MB, 4MB, 8MB, 16 MB, 32 MB, 64 MB, 128 MB, 256 MB, and 512 MB, and 1 GB modules. The sizes available depend on the module type and the popular sizes. As you dig through the memory retailer's web sites and the catalogs, you'll find that anything less than 128 MB is scarce, and that minimum number keeps getting bigger.

Parity/ECC

Parity is a mechanism that detects errors, such as a lost bit when reading from a specific memory location. These errors can go undetected, and result in improper program execution. If the motherboard uses parity memory the error is detected and the system usually halts. If the motherboard uses ECC memory, errors can be detected and corrected, with a small sacrifice in processing time. The motherboard manual will tell you if the system requires parity memory or ECC memory.

CPU Upgrades

Upgrading a CPU requires you to think seriously about the role of the computer, the cost of the upgrade, and the cost of a new system as the alternative. A CPU upgrade might get you a 75% faster CPU, but a new PC gets you the latest and greatest (faster) entire system. Every manufacturer of computer components is making faster parts than they did a year ago. Putting a fast CPU in a system with a slow hard drive, slow video, and slow motherboard may not be your best move. Many PC industry magazines run articles on this subject, you should search them out and see what these experts advise.

Expansion Cards

Just like installing memory, the installation of expansion cards is a common upgrade practice. The addition of expansion cards is a means of adding many peripheral devices such as modems, networks, scanners and sound cards. Before installing (or purchasing) an expansion card, it is a good idea to make sure that it will work in the system to be upgraded.

Ask these questions first:

- Are any expansion slots available?
- Will the card fit in the available slot ?
- Is there enough memory (RAM and hard disk space) available to run the device and its software?
- Will the operating system support this card? If so, are all the necessary drivers provided with the operating system or will they have to be provided with the card?

After determining that the expansion card will work, the installation is a simple three-step process:

1. Set any jumpers or switches for IRQ and I/O addresses.
2. Install the card and cables.
3. Install any software for the card.

The first step (IRQ and I/O setup) is perhaps the most confusing and frustrating part if you are installing non Plug-n-Play (PnP) hardware.

Drives

Installing a new drive is not difficult, however, a few things must be considered before purchasing a new drive:

- Will the drive physically fit inside the computer? Some desktop cases only have enough space for one hard drive, or the available space may be occupied by another device (CD or floppy).
- Will the computer's BIOS and operating system support the size (capacity in MB) of the drive?
- Are there sufficient cables (data and power) to install the drive?

Installing an IDE drive will require some preparation of the hardware, and some additional software necessary to get it running properly. Hardware preparation includes ensuring that you have the correct drive, a place to physically install it, and the proper cables to connect it. The software preparation includes at least a bootable DOS disk with a minimum of FORMAT and FDISK. A Windows 95/98 startup disk will do the job. If you don't already have such a disk, be sure to make one before removing the old drive.

You'll have to establish the disk partition type, such as FAT32 or NTFS, but Windows 2000 can do that when you're ready. Otherwise, a utility such as PartitionMagic can be your best friend when installing new hard drives, as it can do just about anything to new/old/existing drives, anytime you want.

The website each drive manufacturer maintains can be your best source of information and help. All of the companies have drive configuration utilities, diagnostics, installation guides, lists of every drive ever made and its jumper settings, and other tools and tips available.

Motherboards

Installing a new motherboard is one way to do a complete overhaul of a computer. In many cases, it is the most cost-effective method of getting a new computer. Some of the larger PC manufacturers have proprietary motherboards that can only be replaced with identical boards, so look out for those. Before deciding to undertake this major overhaul, there are several things to consider:

- Will the motherboard fit into the existing case? Check the size and alignment of mounting holes.
- Will the front-panel connectors (power switch, HDD activity light, etc.) work with the new motherboard?
- Does the motherboard have the same built-in COM and LPT ports?
- Does the motherboard have a built-in video card or sound card?
- Will the existing expansion cards fit the motherboard (correct bus and number of slots)?
- Is the power connector on the same side as the power supply?
- Will the existing drives (CD, EIDE or SCSI) work with the controllers on the motherboard?
- Will the memory on the old motherboard work on the new one?
- Will the upgrade meet your current and future requirements?

Installing a new motherboard is a major task and requires complete disassembly, reassembly and setup of the computer, all of its devices, and normally the operating system, too. Everything learned in this course, plus a lot more, will be put into practice during a motherboard replacement. The best advice is to prepare everything ahead of time and take good notes while disassembling the old motherboard.

Modems

When you need to connect a home computer to the Internet, in most cases you install a modem and attach it to your home phone lines. A regular computer modem—the type that connects to a regular phone line—is designed to convert digital computer data into an analog format suitable for transmission over standard phone lines. These days they are simple to install, and you're not going to find many computers without a modem.

In the early 90's, the manufacturers raced to sell the fastest modems. The technology was relatively young, and every year there was a faster transmission

standard that allowed you to send and receive more data in less time. After a while the manufacturers hit a wall; there wasn't any way to cram more data into the phone's analog signals.

Fortunately, the digital revolution was also having an impact on the telephone companies. They were quickly updating their infrastructure with new digital circuits. Aside from a converter at the end of the line, telephone calls were only analog between your phone and the local phone company. The modem manufacturers figured out a way to take advantage of these new digital circuits, and the 56k modem, often called a V.90 modem, soon became a standard. For regular phone lines, this is still what we use today.

The digital systems installed by the phone companies allowed additional technologies to become available. If you live close enough to the phone company's equipment, you can get special all-digital phone lines which allow you to connect to the Internet and transfer data at very fast speeds. The first of these technologies was *ISDN*. The original ISDN has been around since the early 90's, and it was just a bit faster than a current 56k modem. A later version of ISDN was twice this fast. A newer form of digital connection, called *DSL* or *Digital Subscriber Line*, is a very fast and fairly inexpensive connection. Most homes with this connection use a form of DSL called *ASDL*, where downloads are faster than uploads.

Along the way, the cable TV companies figured out how they could use the cable already in your home to provide internet access. The cost and speed of a cable modem connection varies widely, and is determined by the cable company itself.

Of course, even bigger connections are available if you have the resources to pay for them. A *T1* line is extremely reliable and very fast. It's also very expensive, and only used by larger businesses. On top of that is the *T3* line, which is about 30 times faster, and at least ten times as expensive. Only the biggest companies and Internet service providers need these connections.

The following table lists a few of the available connection types and their speeds. You should note that any speed listing is subject to many conditions, such as modem quality, the type of data being transmitted, and the operating system itself.

Connection Type	Bits per Second	Bytes per second	KB per minute
33.6 Modem	33,600	4,200	246
56k modem	~50,000	6,250	366
ISDN Modem	64,000	8000	468
ADSL Router	256,000	32,000	1,875
T1 Router	1,500,000	1,875,000	109,863
T3 Router	45,000,000	360,000,000	21,093,750

Installation and Troubleshooting

Modems are fairly simple to install and configure. All of today's modems are Plug-and-Play, and in some cases you don't even have to restart the system after the installation. Troubleshooting a modem is equally simple. Typically you start by removing the phone cable from the modem and attaching it to a regular phone. If the phone works, the problem is in the computer or modem. If the phone doesn't work, then the problem is probably the cable or somewhere else in the phone system, but it's definitely not in the modem or computer.

Modem problems in the computer can be difficult to diagnose. A problem could be due to a hardware failure, but problems can also occur in the OS configuration or the modem driver itself. Hardware failures are common, one reason is because the modem is directly connected to phone lines which are susceptible to lightning and other outdoor events. Software problems usually occur after loading a new Internet tool, such as a new browser, an update for a client such as AOL, or any of a dozen other tools designed to enhance your connection or online experience. In the end, if your modem quits working you should look back at what you have recently added to the system.

Unit Summary

In this Unit you learned about the different types of expansion buses, how peripherals communicate with the CPU, and how video systems are installed and operate. Since few of us ever use a computer without adding peripherals of some sort, this Unit also described several common upgrades and the issues you must consider when implementing these upgrades.

Lab 9-1

Hard Drive Maintenance

If computer systems never failed or changed, you probably wouldn't be taking this course. But they do fail, and the computer industry has redefined the term "upgrade." When you enter the workforce, you will not need to create job security for yourself, there will be more PCs needing your skill than you could ever hope to repair. One of the strategies you need to employ in order to survive and succeed is system maintenance.

As we define it here, system maintenance involves all aspects of the preparation for, and prevention of, problems. Your future employer, whatever field you ultimately pursue, will expect you to prevent problems and to be prepared for those that happen anyway.

You cannot expect to prevent all the problems that occur with computers, that just isn't possible. But you can prevent quite a few of them, and you can certainly be prepared for problems when they do happen. The key to successful system maintenance is keeping the system clean and organized. That includes the physical computer, as well as the data contained within the computer.

In this lab, you will explore some of the most common Windows 2000 system maintenance tools and techniques.

Objectives

When you complete this lab, you will be able to:

- Define the term fragmentation as it relates to computer data files.
- Defragment the system hard drive.
- Schedule a task to run automatically.

Materials Required

The computer trainer with video monitor, mouse, and keyboard attached.

Procedure

Let's begin this lab by defragmenting the hard drive. The amount of time required to defrag a hard drive depends upon several factors in Windows 2000, including the size of the drive, the elapsed time since the last defrag, and whether the drive has ever been defragged since installation of the OS.

1. Turn the computer and monitor on and allow the computer to boot to Windows 2000.

2. Click *Start*, *Programs*, *Accessories*, *System Tools*, and *Disk Defragmenter* to start the Disk Defragmenter program. A Disk Defragmenter window like the one shown in Figure 1 should appear on your screen.

3. The top part of the Disk Defragmenter window indicates the hard disk drives which may be defragmented. Since there is only one hard disk drive in your computer at this time, there should be only one entry. Notice that the screen indicates several particulars about the drive, including the file system, the capacity, and the amount of free space. How much free space is left on your hard disk? _____

4. Select your computer's hard drive (C:) in the top portion of the window. Then click on the *Analyze* button. An Analysis Complete dialog box will appear, which may or may not indicate that the drive (volume) needs to be defragmented.

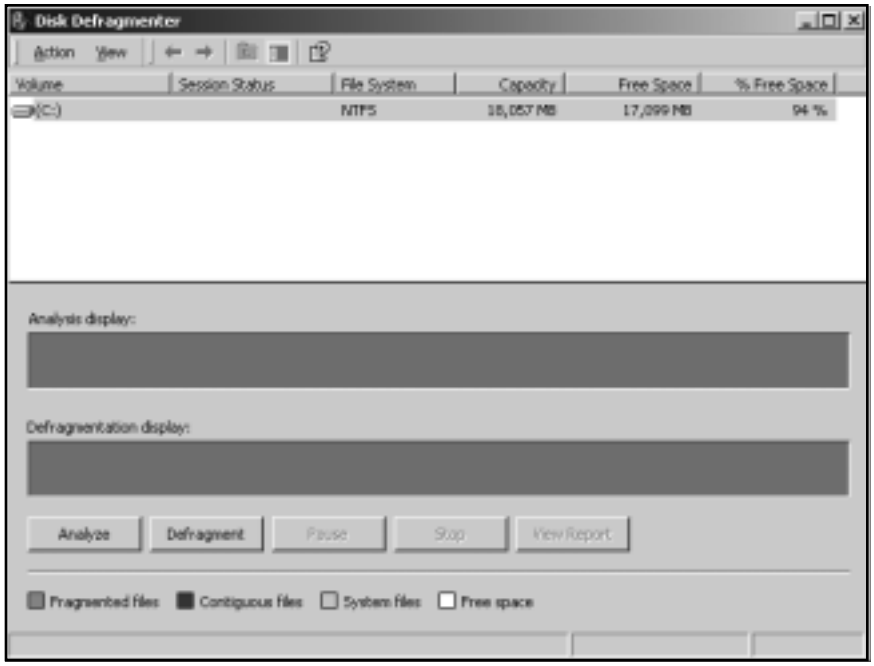


Figure 1
Disk Defragmenter window.

5. Click on the *View Report* button. An Analysis Report dialog box similar to the one shown in Figure 2 will appear. The top portion of the dialog box provides you with some information about your hard drive, including file fragmentation. The lower portion lists the files which are the most fragmented, and how many fragments there are for each file.

6. Click the *Defragment* button to begin the defragmentation process. While the process runs, you may see some movement in the Analysis and Defragmentation areas of the Disk Defragmenter window. This may take awhile, or it may run quickly, depending upon how fragmented the drive is. When the process completes, a Defragmentation Complete dialog box will appear.

7. When the Defragmentation Complete box appears, click *View Report*. This report will look similar to the report you saw earlier. Note that there are less fragmented files now than there were earlier. Also note that there are still some fragmented files.

   The Windows 2000 Disk Defragmenter is a limited version of the commercial program Diskeeper. As such, it does not do a very thorough job of defragmenting a drive.

8. When you are finished looking at the report, click *Close*. Your Disk Defragmenter screen should now look similar to Figure 3. The colored areas in the Analysis and Defragmentation displays provide you with details about how the files are arranged on the drive. Also note that

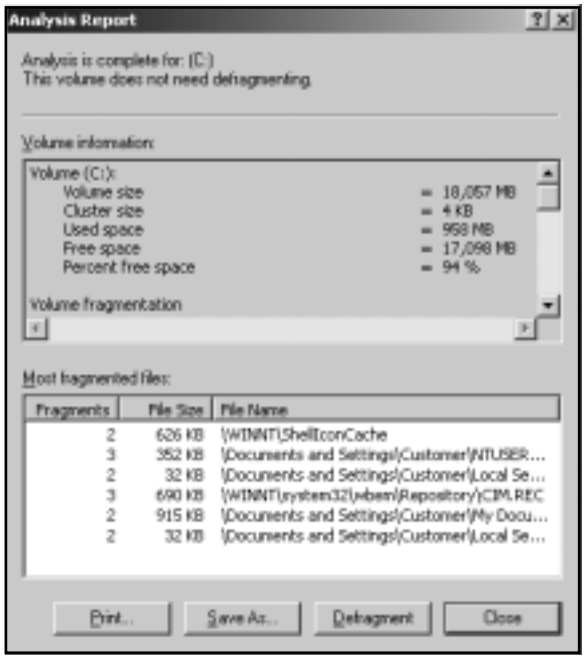


Figure 2
Analysis Report dialog box.

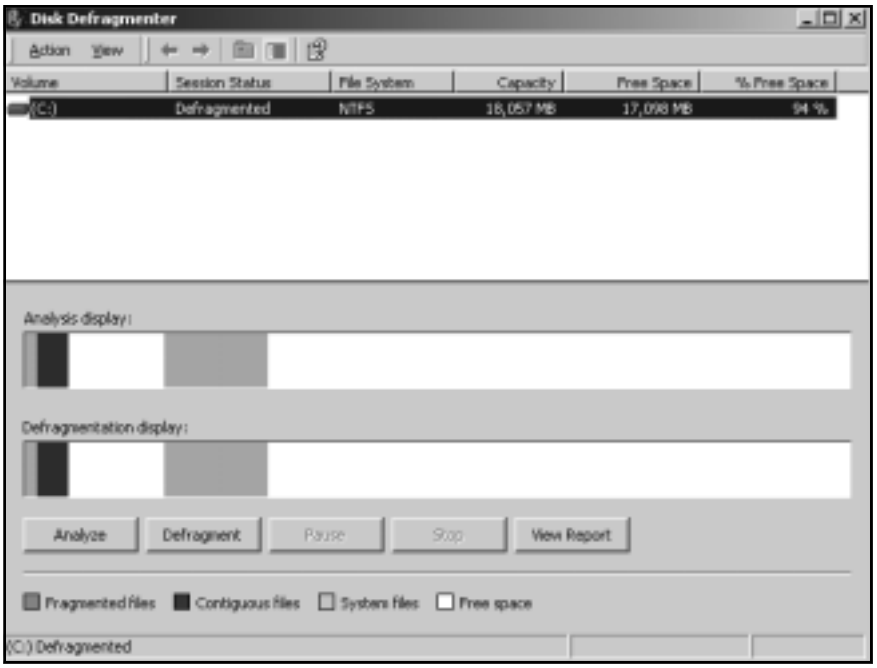


Figure 3
Disk Defragmenter window after defragmenting.

the bottom of the Disk Defragmenter screen indicates that the C: drive has been defragmented (this was missing from the screen when you looked at it earlier).

9. Close the Disk Defragmenter screen when you are finished looking at it.

Discussion

In the first part of this lab, you learned about defragging your hard disk drive. When a hard drive becomes fragmented, bits an pieces of data can become scattered over the disk surface. When you access this data, the system may slow down as it finds all the pieces. On older computers, a complete defrag should be performed once a month, waiting any longer will make the process even slower. With newer, much faster computers, defragmenting a hard drive is not as important as it used to be. These computers are generally fast enough that you don't notice any degradation is system performance. Perhaps that is why Microsoft included only a limited defragmentation program with Windows 2000.

As you found out, the defragmenter program supplied with Windows 2000 does not do a complete job of defragmenting a drive. All it really does is try to put all the related pieces of data back together and store it on the disk in one contiguous chunk; it does nothing with the "holes" left where the pieces were. If you need a more complete version of a defragmentation program, you should purchase one from a retail outlet.

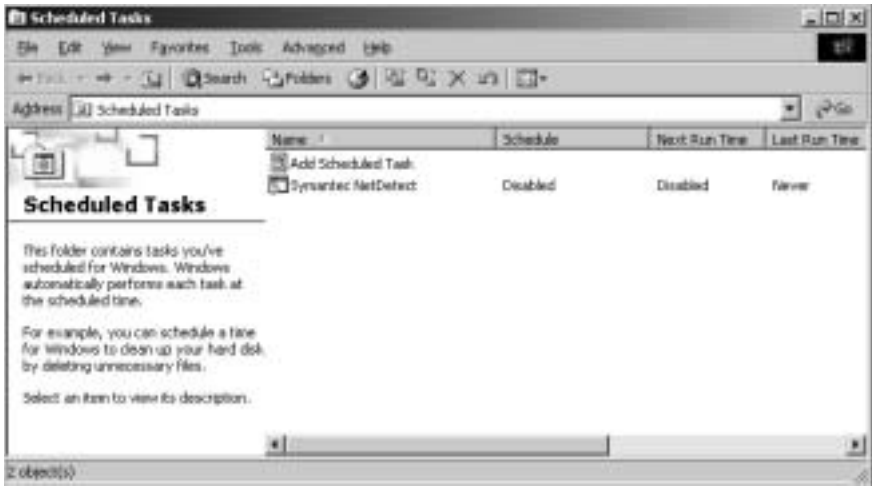
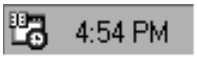


Figure 4
The Scheduled Tasks window.

One additional note that is very important. **You should never use a defragmentation utility that was not built specifically for Windows 2000.** For example, if you use the MS-DOS 6.22 defrag program on the Windows 2000 drive, you will have to reinstall Windows. A 16-bit program, such as the one from DOS 6.22 cannot handle the long file names present in recent Windows versions, and much of the data will be destroyed.

Procedure (continued)

10. There is another program in Windows 2000 which allows you to setup a task to run automatically, without any action on your part. There may or may not be a Task Scheduler icon in the system tray. The tray and the icon are shown here: 

11. If the Task Scheduler icon is present in your system tray, double-click it to open the Scheduled Tasks folder. If the icon is not present in your system tray, click *Start*, *Programs*, *Accessories*, *System Tools*, and *Scheduled Tasks*. You should now see a Scheduled Tasks window similar to the one shown in Figure 4.

12. Double-click the Symantec NetDetail icon to view the details about this task. If a Task Schedule dialog box appears which indicates an error, click *OK*. The first tab, Task, provides details about what program is to be run.

13. Click on the *Schedule* tab. Most of the information about scheduling the task is self-explanatory. Take a moment to browse through all the drop-down menus for the available options.

14. Click on the *Settings* tab. This tab provides you with even more control over when the scheduled task occurs. After you have seen enough, click the *Cancel* button.

15. Now that you have seen the settings for *which* program to schedule, *when* to schedule it, and *how* it will run, let's schedule a task. Double-click the *Add Scheduled Task* icon.

16. This action opens the Scheduled Task Wizard, which will take you through the entire process. Click *Next*. The next windows allows you to choose which application will be scheduled. You can schedule any application on the system. For the purpose of this lab, scroll down through the list of programs and choose *Calculator*. Then click the *Next* button.

17. On the next screen, choose *One time only* and click *Next*.

18. This part is a bit tricky. Look at the clock in the System Tray on the desktop. Pick a time that is approximately four minutes from now. Single-click on the minutes and then click the up arrow to set the time you picked.

19. Make sure today's date is specified in the Start date box, and click *Next*.

20. When the Wizard prompts you for a user name and password, just click *Next*. We do use user names and passwords in your computer trainer.

21. Windows provides a summary of the scheduled task. Check the box that opens the advanced properties for the task, and click *Finish*.

22. The resulting dialog window provides you with some information about the program you have scheduled. Makes sure the *Enabled* box near the bottom of the window is selected to indicate that the scheduled program runs at a specified time. Then click *OK*.

23. If the assigned time for the task you just scheduled has not arrived yet, wait until it runs. Does the task run at the scheduled time? _____ What now appears on the screen that wasn't there a few minutes ago? _____ If nothing seems to have happened, go back and double-check the time settings you chose.

24. Look closely at the Scheduled Tasks window. When will the task you just scheduled run again? _____ Why? _____
_____

25. Delete your scheduled task from the window, but be careful not to delete any additional tasks that might not be scheduled. Finally, close the Scheduled Tasks window.

26. Empty the Recycle Bin. Then shut down the computer and turn off the power to the computer and monitor.

Discussion

In the second part of this lab, you learned how to setup your computer to automatically perform a given task at a particular time. Although automatically starting up the Calculator is not very useful, it did demonstrate how the Scheduled Task utility works. It would be much more useful to program the computer to run the defragmentation program or perform a hard disk backup overnight while the computer is not being used. We could not have your computer automatically defragment the drive at a specific time, because the limited version of Diskeeper included with Windows 2000 does not allow you to schedule it without writing a script—something that is beyond the scope of this course. In addition, we could not backup your hard drive because it would require something larger than a floppy disk to hold the backup.

Lab 9-2

Display Adapters and Resolution

You have already explored the basics of adjusting the display resolution, refresh rate, and color levels on the monitor. Adjusting these settings is simple once you see how, and you get to explore a bit. This lab will focus on the video display subsystem in more detail.

In addition to repairing computers, your knowledge will allow you help others purchase appropriate computer systems. For instance, a computer to be used mainly for email, letters and spreadsheets does not need 32-bit high color 3D graphics with 8MB of video memory. A computer used for developing web pages or desktop publishing just might need these more powerful features.

Objectives

When you complete this lab, you will be able to:

- Remove and install an AGP video adapter.
- Demonstrate the display differences between 8-bit, 16-bit, and 32-bit color display settings.
- Use different adapter settings to control the dot resolution and the number of colors in a display.
- Demonstrate the best (highest) resolution levels that should be used for a monitor of a given screen area size.

Materials Required

You will need your computer booting to Windows 2000, the antistatic wrist strap, and an anti-static bag.

Procedure

1. Make certain that the computer and monitor are turned off.

2. Remove the left side panel from the computer.

3. Slip the antistatic wrist strap onto your wrist.

4. Attach the alligator clip at the end of the wrist strap firmly onto the computer chassis.

5. Disconnect the monitor cable from the VGA connector on the video card.

6. Remove the screw that secures the video card to the back panel of the computer. Place the screw in a safe location. A good place might be in the bottom of the computer chassis.

7. Carefully pull the video card free from the motherboard.

8. Set the card onto the antistatic bag on the table in front of you. Refer to the card and to Figure 1 when you perform the following steps. Your video card may not look exactly like this one, but it should have several things in common.

9. First, notice the bus connector. What type of bus does your card use?

   _____

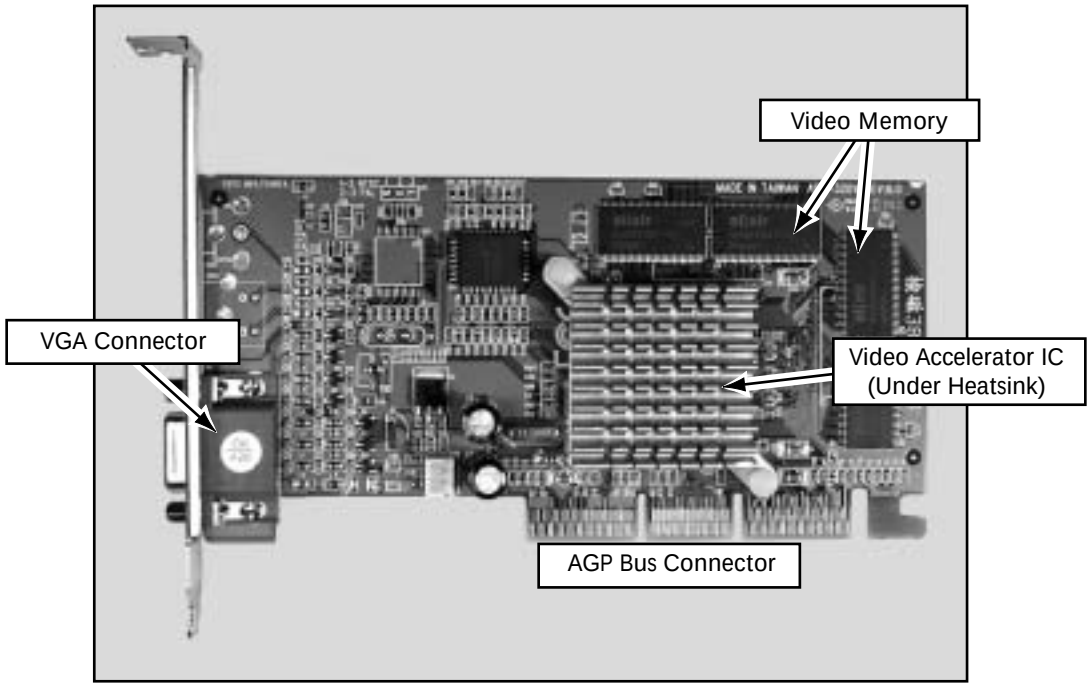


Figure 1
A typical AGP video card.

10. Find the connector on the video card that accepts the monitor cable. Is this a male or a female connector? _____ How many pins in this connector? _____ How are the pins arranged? _____

11. Find the large square IC on the board. It is covered by a large heatsink. This single IC controls every detail of the video display. It combines the video accelerator and the digital-to-analog converters in a single chip. **Do not remove the heatsink** to get a better look at the IC, we have provided you with a closeup of the IC in Figure 2. What is the name of the company that makes the video IC? _____ _____ What is the model number of the video IC? _____ _____ What is the name of the company that manufactured the video card? _____

    It is important to note that the company that makes the IC is often not the company that makes the card. If you are searching for replacement drivers for the video card, you should always try the manufacturer of the board first.

    The video processor IC on the card runs at a very high clock rate and requires a heatsink (or heatsink and fan) to keep it cool. Without a heatsink to remove the excess, high temperatures would likely destroy the IC in a few hours.

12. Notice the four identical ICs which make up 32 MB video memory. Your card may have a different arrangement of ICs, or may have more memory.

13. Notice the empty locations for extra components. The circuit board used for your video card may also be used for another type of video card, one that includes a composite video, or TV output. Your card may, in fact have these components. Figures 3 and 4 on the next page show other typical video cards you might encounter.

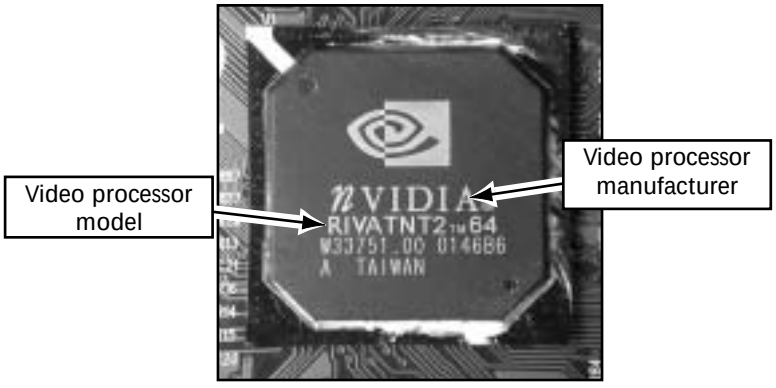


Figure 2
The video processor, with the large heatsink removed.

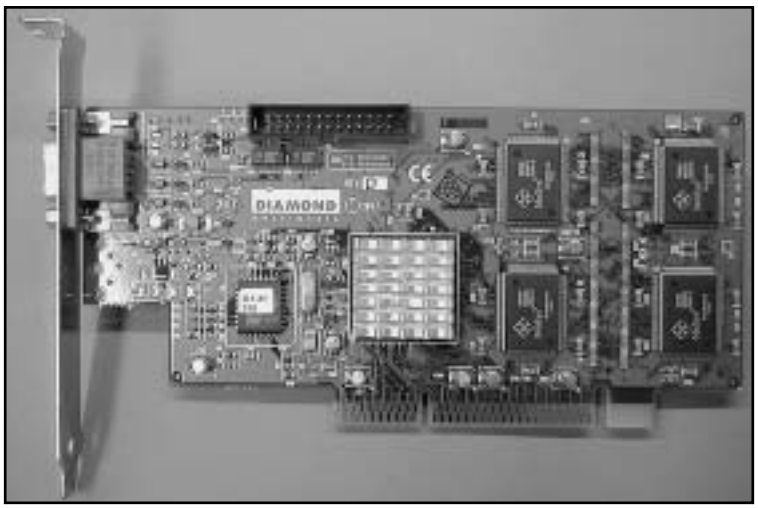


Figure 3
An older high-end video card.

14. Reinstall the video card in the same slot from which you removed it. Make sure the card is inserted all the way into the AGP slot. Reattach the retaining screw.

15. Plug in the monitor's VGA cable. Reinstall the left side panel onto the computer. Then turn the computer and monitor on.

16. Do you know how to change your display settings? Right-click on the desktop and select *Properties*. When the Display Properties window appears, select *Spectrum* from the wallpaper list. Change the display to any method you prefer, Center, Tile, or Stretch.

17. Click on the *Settings* tab. Change the Colors to *High Color (16-bit*) and the Screen Area to *640×480*. Then click *OK*.

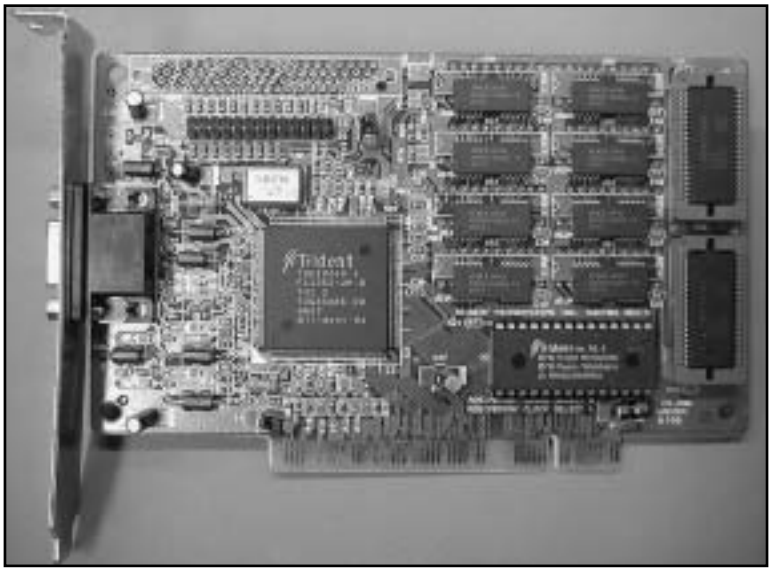


Figure 4
A typical PCI video card.

18. When the dialog box appears which indicates that Windows will now apply your settings, click *OK*. The screen will blank for a second, or maybe just blink. If you wait too long to click OK, the changes you made will be aborted.

19. When the Monitor Settings box appears which asks if you want to keep these settings, click *Yes*. Again, if you wait too long to click OK, the changes you made will be aborted.

20. You should now see a rectangle and a circle containing several thousand different colors. Is the transition between the colors smooth, or can you plainly see where the colors change? _____
_____

    A representation of the Spectrum desktop is shown in Figure 5. Obviously this book cannot reproduce the color that is on your screen. In addition, all monochrome printing methods allow for limited levels of gray to represent colors.

21. Open the Display Properties sheet if you closed it earlier. Click on the *Settings* tab. Change the Colors setting to *256 Colors*, and click the *Apply* button. If the Display Properties window is still open, click *OK* to close it.

22. Assuming the display was set to show more colors before this change, what happened to the display? _____
_____
_____

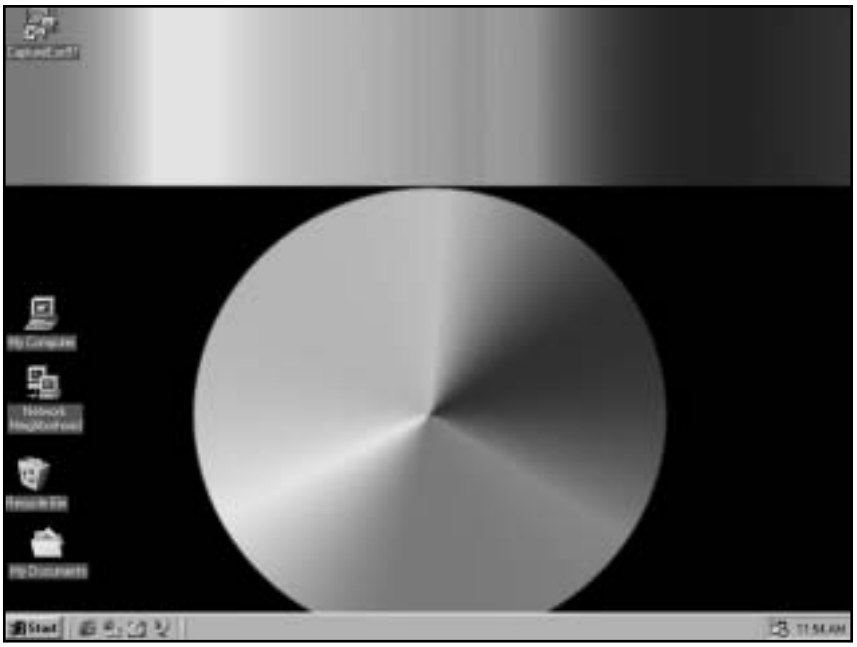


Figure 5
The Spectrum desktop, with 16-bit color depth.

Figure 6 shows a monochrome, or gray scale, representation of what you should see on the screen. The transitions between different shades of the same color are clear and distinct. In many cases a video card's performance, or ability to draw screens and windows, is very good at this setting. This is particularly true for low-end video cards. Many high-end cards actually perform better at higher color depth settings.

256 colors is typically the minimum number of colors necessary to view photos with any measure of realistic color. Most current games and other graphical software products require 256 colors at a minimum.

23. Open the Display Properties sheet again and adjust the color display to True Color (32-bit). Close the Display Properties dialog when you have done this. Notice that the transitions are gone on the circle, and difficult to see on the rectangle, particularly in the blue-green and red-yellow areas.

    Although this is called *32-bit* color, your video card is not reproducing 32-bits worth of colors. The processor is running in a 32-bit mode but only generating 24-bits worth, or 16.8 million colors. Table 1 shows the number of colors compared to the resolution and minimum amount of video memory required for each setting.

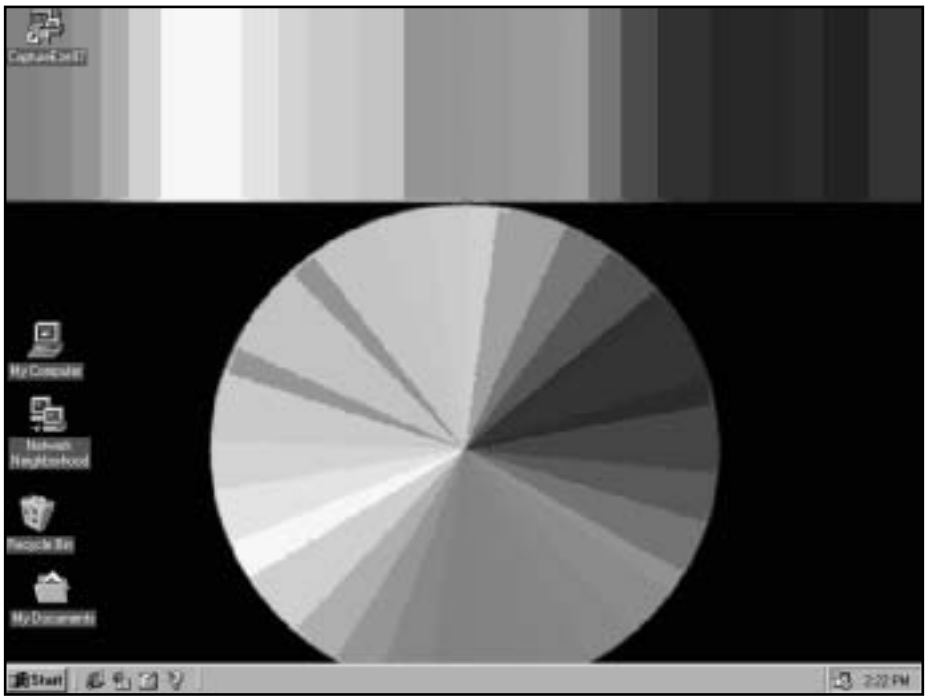


Figure 6
The 256-color mode, represented by shades of gray.

24. Adjust the color depth one last time, to High Color (16-bit). Then close the Display Properties window. This is a good trade between smooth color and adequate performance.

    With the proper drivers loaded, Windows will not allow you to use resolutions and color depths that your hardware cannot handle. That is, if the drivers are written properly, and you have the correct drivers loaded. If you are using a PnP monitor, and it is listed in the Windows monitor database, the settings will not exceed the monitor's capabilities, either. Don't bank on that last fact, however. We have seen several cases where the available settings are more than the monitor can handle, even though the specific monitor model is listed.

Resolution	*Number of Colors*	*Memory Required*
640×480	256 (8-bit)	512 KB (300 KB)
640×480	65,000 (16-bit)	1 MB (600 KB)
640×480	16,800,000 (24-bit)	1 MB (900 KB)
800×600	256 (8-bit)	512 KB
800×600	65,000 (16-bit)	1 MB
800×600	16,800,000 (24-bit)	2 MB (1.4 MB)
1024×768	256 (8-bit)	1 MB (800 KB)
1024×768	65,000 (16-bit)	2 MB (1.6 MB)
1024×768	16,800,000 (24-bit)	4 MB (2.4 MB)

Table 1
Memory requirements for various resolutions and color depths. The number in parentheses is the actual amount of memory required.

Discussion

Computer monitors can display virtually unlimited numbers of colors. The actual number of colors that is displayed is controlled by the video driver.

When you changed the palette of colors to 256, the number of colors appearing in the circle and rectangle changed. It was easy to distinguish between individual colors because the color choices are limited.

Switching to 65,000 colors produced images that were nearly free of distinctive bands of colors. You had to look closely to see the missing colors. You can see that in most instances, displaying more than 65,000 colors will not improve the quality of the display.

However, there are times when your work demands the greatest number of possible colors. That usually occurs when you are working with high-resolution photo art. For those times, you must use the video driver that has a color palette of 16.8 million colors. When you selected that setting, the circle and rectangle showed almost no color banding.

Often, you will hear the terms *true color* and *24-bit color* associated with the 16.8 million colors display—true color because it looks so true to life, and 24-bit color because 2^{24} equals 16,777,216. By the same token, people often associate the terms *real color* and *16-bit color* with the 65,000 colors display—real color because it looks almost real, and 16-bit color because 2^{16} equals 65,536.

Just because your computer and monitor can display millions of different colors doesn't mean you can actually see or use them. That will depend upon your software. If the software supports only 16 or 256 colors, that's all you will see. Those programs usually have some method for selecting color combinations within their limited color palette, other than the default values.

Having examined the same image using three different video drivers, with increasingly larger color palettes, you learned that what you see is not necessarily what you get. The circle and rectangle never changed, even though they appeared to change. It was the video driver attempting to fit all the image colors into its palette of colors that changed.

The number of colors that you can see is of little consequence for most computer activities. The size and quality of the image affects everything you do on a computer. So far you have limited the display image to standard VGA (640×480 or 800×600) resolution.

Procedure—Video Resolution Levels

1. Open the Display Properties window and change the screen resolution to 640×480 pixels, if it is not already set this way. Then close the Display Properties window.

2. Open the WordPad word processor and maximize the window to fill the display.

3. Open the View pull-down menu and select Ruler, if it is not already checked. How wide is the page (use the ruler as a reference)? _____

4. Type the numbers 1 through 0 down the left side of the "page" until you have a number on each visible line. How many lines are on the visible page? _____ Figure 7 shows what the WordPad window should look like.

5. Minimize the WordPad window.

6. Change the display setting to 800×600.

7. Maximize the WordPad window. How wide is the page (again use the ruler as your reference)? _____ (Make a guess at that unmeasured section on the right.)

8. Notice that you have room for a few more numbers down the left side of the page. Fill in the remaining free space until you have a number on each visible line. How many lines are on the visible page with this display setting? _____ Figure 8 on the next page shows what the WordPad window should look like.

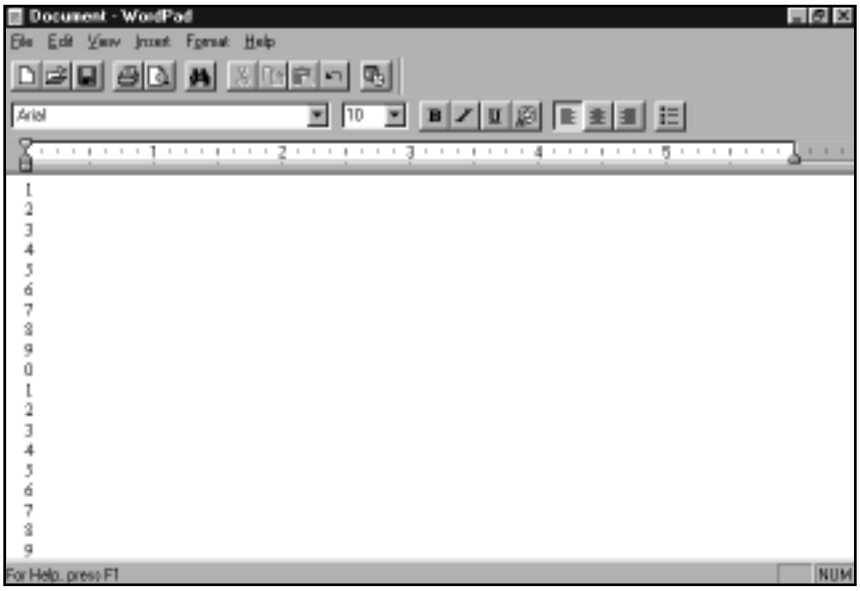


Figure 7
WordPad window using a 640×480 display.

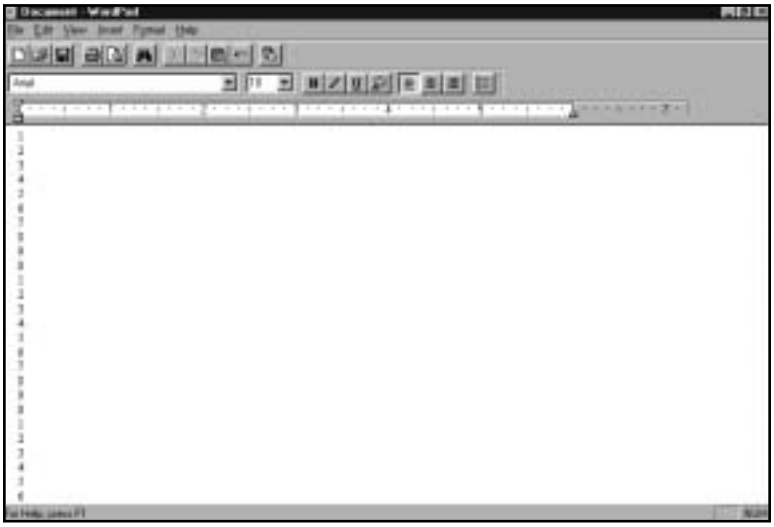


Figure 8
The WordPad window using the 800×600 display setting.

9. Let's do this one more time. Minimize the WordPad window and change the display setting to 1024×768. Then maximize the WordPad window.

10. How wide is the page (again use the ruler as your reference)? _____ _____ (Make a guess at that unmeasured section on the right.)

11. Notice that you have room for yet a few more numbers down the left side of the page. Fill in the remaining free space until you have a number on each visible line. How many lines are on the visible page with this display setting? _____ Figure 9 shows what the WordPad window should look like.

12. You could probably use this setting if you have good eyes, but if you did, your eyes wouldn't be good for long. Let's adjust the settings just a bit more. Minimize the WordPad window.

13. Open the Display Properties dialog box, and click the *Appearance* tab. In the Scheme drop down menu, select *Windows Standard (extra large)*.

14. Watch the Display Properties title bar as you click *Apply*. What happens? _____
_____
Close the Display Properties window.

15. Maximize the WordPad window one last time. Do you see any changes? _____ You might notice that the WordPad application area, the area where you would create a document, has not changed much at all. The only difference is that the last number you typed is now below the bottom of the display. Otherwise, the Appearance setting did not change the application.

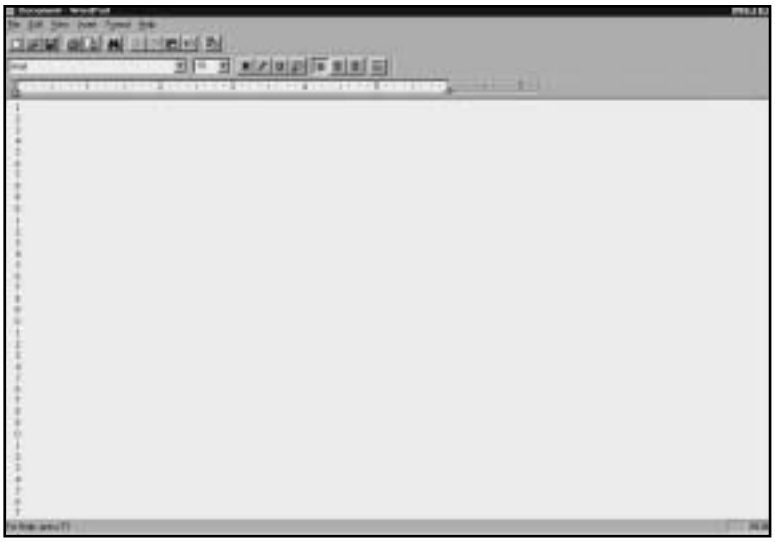


Figure 9
The WordPad window using the 1024×768 display setting.

On the other hand, the taskbar and all the menu text is now larger, and more readable. Because this text is larger, there is slightly less space available to WordPad, but your eyes won't go bad quite as fast.

16. Close WordPad, and do not save this document.

17. On the Background tab in the Display Properties window, change the Wallpaper setting to *(None)*.

18. Under the Appearance tab reset the Scheme to *Windows Standard*.

19. And finally, under the Settings tab reset the Screen Area to 800×600 and click *Apply*.

20. Close any open windows.

21. Shut down Windows, and turn the computer and monitor off.

Description

When you switched color levels to 640×480 VGA mode, nothing in Windows 2000 changed. The only way you could tell the change actually took place was to examine the rectangle and circle of many colors in the wallpaper.

Switching from the 640×480 VGA mode to the 800×600 super VGA mode brought about some changes. The first thing you should have noticed was the size of the desktop. At 800×600, it is about 79% of the size of the desktop in the 640×480 display. When you compared the two WordPad displays, you should have seen a similar relationship. This time, the 800×600

display showed more lines and column inches than the 640×680 display. That's because the 800×600 display is squeezing more display information into the same area.

Switching to the 1024×768 mode brought about further changes. The initial change from 800×600 dots to 1024×768 dots was just as dramatic as between 640×480 dots and 800×600 dots. However, at this resolution and on a 15" monitor, the characters are a little small for word processing, spreadsheets, or data handling, but you do get a larger image for graphic arts purposes.

Unit 10

Networks

This Unit concentrates on networks, how they are constructed, and how they work. Computers unattached to a network are rare these days, but the "mystery" surrounding networks persists. Some networks are simple affairs, but many of them are large or complicated. This course won't get you to the point where you can construct a LAN, that will have to come from additional studies.

First, we are going to look at fundamental networking concepts, then discuss the components that are interconnected to form networks. Last, we will briefly discuss how computers communicate across networks.

Networking Concepts

The classic definition of a network is: *two or more computers linked together to communicate and share information.* Most networks are based around a cable that links the computers through a connection. That connection permits the computers to talk (and listen) through the wire.

Objectives

- Define the three essential components of a network; connections, protocols, and services.
- Explain the different types of networks, and where they are commonly used.
- Describe the three primary network topologies.

Basic Requirements of a Network

Before a network can become a network, you must have a way to connect, a shared language, and an idea of what you wish to do once you have the first two. Let's look at each of the elements that make up the most basic network.

Connections

Connections include the hardware (physical components) required to hook up a computer on the network. Two terms are important to network connections:

- The network *media*: The entire network hardware that physically connects one computer to another. This is the cable between the computers, and all the other hardware between the two computers.

- The network interface: The hardware that attaches a computer to the network media and acts as an interpreter between the computer and the network. Attaching a computer to a network requires an add-in board known as a *Network Interface Card* or *NIC* (also called a Network Adapter Card).

Protocols

Protocols establish the rules on how computers talk to and understand each other. Because one computer may run different software than another computer, this requirement means that computers must speak a "shared language." Without shared languages, or protocols, computers cannot exchange information and they will remain isolated. An example of this is a phone conversation where you speak English and the other person speaks Latin. Unless one of you speaks the other's language, or there is a third language you share, there will be no communication during this phone call.

Protocols also include the timing of communication. Again using our phone analogy, when you answer the phone the first words are when you say "Hello?" and the caller replies appropriately. Part of the protocol of a phone call is the language, another part is the answerer saying hello. You work through the conversation, and the last piece of the protocol is when both of you say "Bye." You are using a protocol every time you use the phone.

Services

A service defines what a computer shares with the rest of the network. For example, a computer may share a printer or specific directories or files. Sometimes they share nothing but an email or other interface. Unless computers on the network are capable of sharing a resource, they remain isolated even though they may be physically connected.

Networking

Now that you know the three basic requirements of a network, let's see how connections, protocols and services work together to make networks work properly:

- The connections must operate so that the computer can send or receive electrical signals across the physical media that link computers.
- Protocols must function so that when one computer sends a message, the others can listen and understand the message.
- The computers must be capable of working together, where one provides a service and the other computer delivers a service, and vice versa.

The Local Area Network

A *LAN* (*Local Area Network*) is a network that covers a limited distance, usually a single site or facility, and allows information and resource sharing. A LAN can be as simple as two computers hooked together or as complicated as a large corporation with hundreds of interconnected PCs. LANs are popular as they allow the workstation (stand-alone computer) to provide the processing power and utilize its own memory, while programs and data can be stored on any other computer.

Another type of LAN is the mini/mainframe that relies on the power of the mini/mainframe server to do all the work. The workstations are usually just a monitor and keyboard, sometimes called "dumb" terminals. With the power of today's personal computer, these types of networks are less common. However, they are still used in many places, but usually the PC fills the role of a dumb terminal through the use of terminal emulation software.

Sharing

One of the primary benefits of a LAN is its ability to share resources. There are many resources that can be shared on a LAN, but let's look at the most common shared resources.

Data

Sharing of data locations makes for easy access easy for multipleany users. Large customer databases and accounting data systems are ideal data-sharing situations for a LAN system.

Peripherals

The Sharing of printers, for example, allows multiple users to send jobs to the same printer. (This would beis useful if there wherewas only the entire office must use one high-quality printer in an office and the entire office needed to use this printer). Also, the same individual user can access multiple other shared printers. This allows for cost savings in hardware and redundant resources in case of a failure of one device. Other low usage peripherals such as scanners and plotters can also be sharedwill get better utilization.

Software

Sharing a single copy of an application can be cost effective, as well as allowing for easier maintenance and upgradingability.

Storage

Larger, faster disk systems can be used cost effectively, alsoto provideing centralized data backups for data storage.

Other Benefits

In addition to the ability to share resources, LANs offer many other benefits that include:

Resilience

With regular backups of the entire system, there is a greatly reduced the chance possibility of data loss. Well managed LANs have regular backup plans, and can easily restore data after a major event. This ability to restore lost data quickly is defined as *resilience*.

Copying

Replication of data to back up servers allows network operations to continue in the event of a failure. Making back-ups is the first step on the road to resilience.

Communication Gateways

In addition to sharing, another major benefit a network provides is communication. This includes many tools, including low-cost access to fax and Internet programs and email.

Wide Area Networks

A *wide area network* (*WAN*) spans a relatively large geographical area. Connection for these sites requires the use of ordinary telephone lines, T1 lines, ISDN lines, radio waves, or satellite links. (T1 and ISDN are special connections, usually provided by phone companies.) WANs are accessed through dial-up connections with a modem, or leased lines through a direct digital connection. The leased line method is more expensive, but can be cost-effective for large organizations.

Types of Networks

There are two basic types of networks, Client-Server Networks and Peer-to-Peer networks.

In a *Peer-to-Peer* network, each computer acts as either a server (sharing data or services with other computers) or a client (using data or services on another computer) depending on the users' needs. Each user, or workstation, establishes its own security and determines what resources are available to other users. Typically, these networks are limited in size to a maximum of 15-20 workstations. Microsoft Windows for Workgroups, Windows 95/98/Me, Windows NT Workstation and Windows 2000 Professional are typical operating systems used for Peer-to-Peer networking.

Peer-to-Peer networks can be easy to install and configure, and also easy to use. They are inexpensive, but they are not secure. When security is no issue, and the number of computers is limited to just a few, peer-to-peer can be a good design choice.

A *Client-Server* network requires a central server, or dedicated computer, to manage access to all shared resources (files and peripherals). This is a secure environment suitable for most organizations. The *server* is a computer that

runs the network operating system, manages security, and administers access to resources. The *client* is a computer that connects to the network and uses the available resources. The most common server operating systems are Microsoft's NT Server and Novell's NetWare.

Client-Server networks are widely used in large organizations where security must be managed and many users will be connected to the network. Because a server is required, client-server networks are more expensive and more difficult to administer than a peer-to-peer network.

Networking Topologies

The physical design of a LAN is called its *topology*. Topology describes the appearance or layout of a network and how data flows through the network. There are three basic types of topologies: star, bus, and ring. In the real world, you may encounter some hybrid versions of these topologies, but we will only focus on these three. *The following figures should not be used as exact wiring diagrams but as sample network designs.*

In a *star* network, as shown in Figure 1, all devices are connected to a central point called a *hub*. The hub collects and distributes data within the network. All network traffic flows through the hub. In large networks, several hubs are connected using many different arrangements. A star network is easy to troubleshoot as all information goes through a central point, making problem isolation easier. This also means that if the hub fails, the entire network fails.

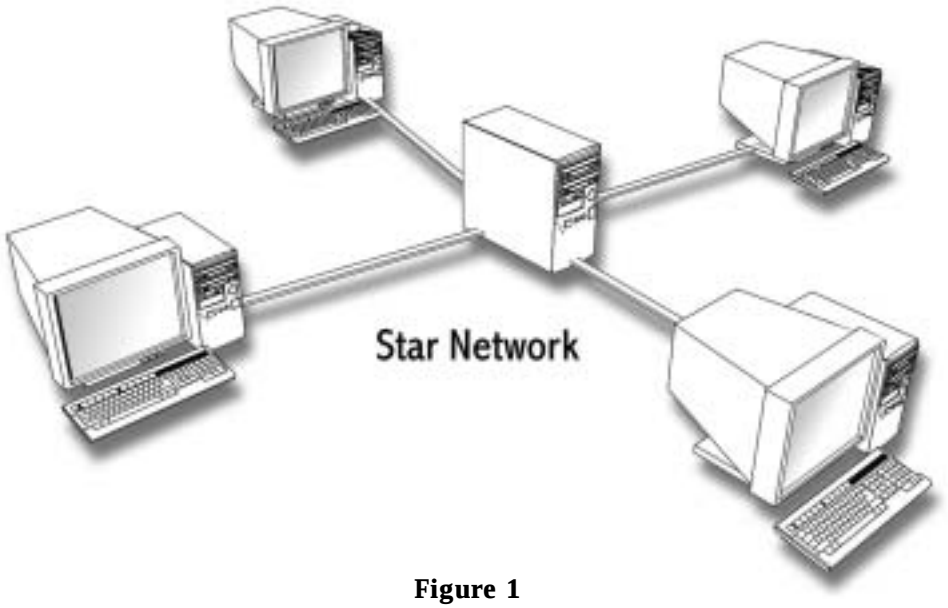


Figure 1
A network arranged in a star topology.

In a *bus* network, as shown in Figure 2, all devices are connected to a single linear cable. This single cable is often called a *backbone* or *trunk*. Both ends of the cable must be terminated (like a SCSI bus). Since the bus network does not have a central point, it is often more difficult to troubleshoot than the star network.

Figure 2
A network arranged in a bus topology.

In a *ring* network, as shown in Figure 3, all workstations and servers are connected in a closed loop. Each computer in the network will act like a repeater and boost the signal before sending it to the next station in the loop. This type of network transmits data by passing a "token" around the network. If the token is free of data, a computer waiting to send data will grab it, attach the data and the addressing information, and send it on its way. When the token reaches its destination computer, the data will be removed and the token sent on. If one computer fails, the circle is broken and the entire network will go down.

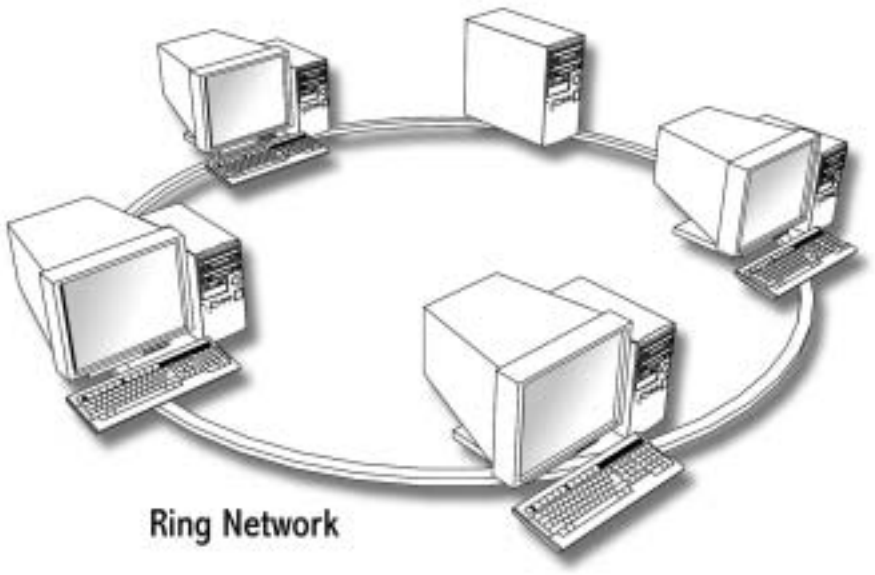


Figure 3
A network arranged in a ring topology.

Networking Components

In order to build a network, several network-specific components are needed. These include a special operating system, interface cards, and cables. Large networks may require dozens of different components, but for now we will just stick to the basics.

Objectives

- Explain the role of the main parts of a small network; the NIC and NOS.
- Describe how to install a network interface card.
- Describe the three types of network cabling, and their main features and benefits.

Network Operating System (NOS)

The Network Operating System (NOS) consists of a family of programs that run in networked computers. Some programs provide the ability to share files, printers and other devices across the network.

You'll recall that Computers that only share their resources are servers, while computers that use those shared resources are clients. It is common to have client and server software running in the same computer, so you can use the resources on other computers while co-workers make use of resources on your computer.

Network Interface Cards

Network Interface Cards (*NICs*) link the computer to the network cable system. They provide the connection between the computer expansion bus and the network cabling. The low-power digital signals inside a computer cannot travel long distances. A NIC boosts signals and changes them into a form that can be transmitted over the network cables.

The NIC, also called a *LAN adapter*, functions as an interface between the computer and the network cabling. Therefore it must serve two masters. Inside the computer, it moves data to and from RAM. Outside the computer, it controls the flow of data in and out of the network cable system. In between the computer and the cable, the NIC must change the form of the data from a parallel stream coming in 8 bits at a time to a serial stream moving 1 bit at a time in and out of the network port.

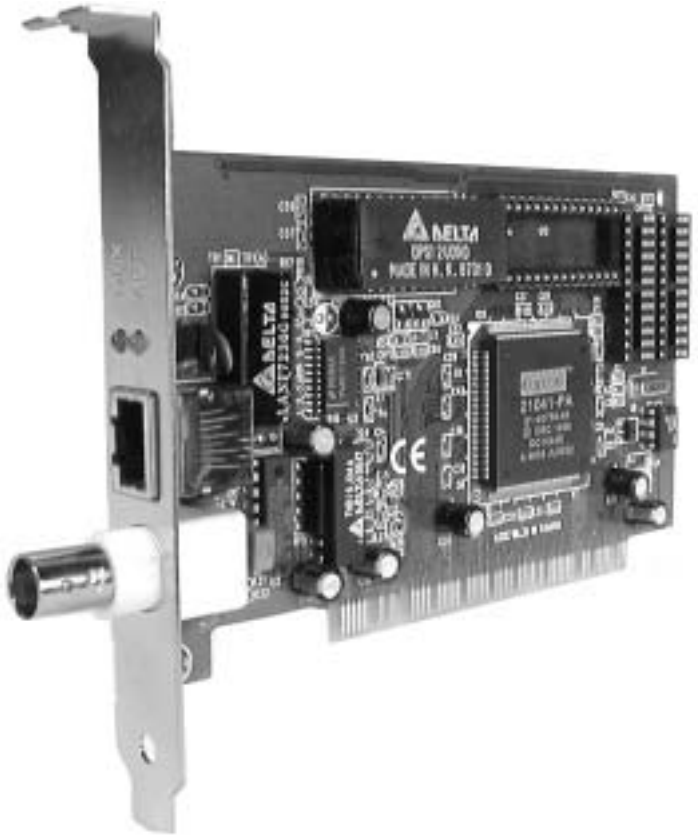


Figure 4
A typical Network Interface Card, featuring a PCI interface, and both RJ-45 (twisted-pair) and BNC (thinnet) cable connections.

Installing a NIC

Installing a NIC is the same as installing any other expansion card. Many NICs allow connection for both Thinnet (coaxial cable) and UTP (unshielded twisted pair) cabling. Thinnet uses a round BNC connector and UTP uses a RJ-45 connector, which is similar to a telephone jack, only wider.

If you are installing a PnP NIC into a Windows machine, you simply install the card and boot the computer. The card will be detected and install itself – you may have to answer a few questions along the way. NICs generally have long lives, and someday you will install an old non-PnP NIC into a new computer someday. It requires a little more work to install a non-PnP NIC. Here are some guidelines for installing a network card:

- Be sure to document any changes that you make. This will eliminate any confusion during the installation process and provide future reference in case of problems.
- Determine whether the card needs IRQ, DMA or address settings. Remember that you may have to configure these manually, so be sure to check the card's documentation for default settings and how to make any needed changes.
- Turn off the machine and remove the cover. Don't forget ESD protection.

- Set jumpers or DIP switches as necessary and insert the card.
- Turn on the machine and run the setup utility provided by the manufacturer. If you are using Windows 9*x* and this is not a PnP card, you can use the Add New Hardware wizard in the Control Panel to install the drivers and set up the card. Remember to document all the settings.

If you are replacing or upgrading an existing network interface card, use the same steps as described, with one addition. Before removing the card, document all of its resource settings.

One final word of advice: If you plan to install a NIC for the first time, we recommend that you do it on a machine that is not connected to a large LAN. The reason for this suggestion is that an improperly configured NIC, or one that is not working properly, can broadcast junk and noise across the entire LAN. This may cause other users to lose their LAN connection, or the entire LAN to slow to a crawl. Even worse, it can cause your LAN administrator to temporarily lose sanity. And you won't be the most popular person in the office that day!

Network Cabling

Most networks need some type of cabling. Wireless LANs are becoming more common all the time, but they are still uncommon. In the meantime, cables still rule. The three main types are twisted pair cable (TP), coaxial cable (coax), and Fiber Optic Cable (FDDI – Fiber Distributed Data Interface). A newer network technology uses wireless connections, either infrared signals or radio signals.

Twisted-pair

Twisted-pair cable, as shown in Figure 5, consists of two insulated strands of wire twisted around each other to form a pair. Normally several twisted pairs are combined within an additional insulation jacket to form a complete twisted-pair cable. The purpose of twisting the wires is to eliminate electrical interference from other wires and outside sources such as motors and fluorescent lights. By twisting the wires, any electrical noise from the adjacent pair is canceled. The more twists per foot of cable, the greater the effect and cost of the cable.

Figure 5
A twisted-pair. A network cable has four of these pairs.

Twisted pair wiring comes in two types: shielded (STP) and unshielded (UTP). STP has a foil and wire braid wrapped around the individual wires that are twisted around each other in pairs, whereas UTP does not.

UTP is the most common network cabling used today and the least expensive. UTP cables are divided into five categories. Newer categories are being invented by networking companies, but these new cables are not widely accepted yet.

Twisted-pair cabling is already be installed in many buildings and new homes. It is easy to install and relatively inexpensive. On the other hand, twisted-pair is sensitive to electromagnetic interference (EMI) and eavesdropping, it does not support long distances (100m maximum) and it requires a hub to connect more than two computers.

Coaxial Cable

Coaxial cable (*coax*), as shown in Figure 6, is made of two conductors that share the same axis. The center is a copper wire insulated by a plastic coating. The material surrounding the center conductor is called the dielectric, which is made of plastic or foam. The center conductor and dielectric are then wrapped with an outer conductor, usually a wire braid formed into a tube.

The wire mesh tube around the insulation serves as shielding, sometimes this shielding is made of a thin foil. When electrical interference is a problem, both a braid and foil are used. Generally, cables with wire braid are stronger. The outside is a tough insulating plastic or vinyl tube. At one time coax was the most popular network cabling. With the improvements and lower cost of twisted-pair cables it has lost its popularity.

Figure 6
Coaxial cable.

Coax is available in two types: thin (thinnet) and thick (thicknet). Of the two, thinnet is the easiest to use. It is about ¼-inch in diameter, making it flexible and easy to work with. Thinnet cable looks just like standard TV cables, but its electrical characteristics are quite different, and you cannot substitute the two types. Thinnet can carry a signal about 600 feet (185 meters) before the signal strength begins to suffer.

Thicknet, on the other hand, is about ½-inch in diameter. This makes it a better conductor—it can carry a signal about 1,640 feet (500 meters) before signal strength begins to suffer. The disadvantage of thicknet is that it is more difficult to work with, and much more expensive than thinnet.

Use coax if you need:

- a cable that will transmit voice, video, and data.
- to transmit data long distances.
- a familiar technology that offers reasonable data security.

Fiber Cable

Fiber optic cable, sometimes just called *fiber*, is made of light-conductive glass. It can carry data signals as pulses of light. Multiple fiber cores can be bundled in the center of the protective tubing.

Although more expensive to use than twisted-pair or coax, fiber has several advantages. It is immune to electrical interference and eavesdropping. Fiber provides a reliable and secure transmission media. It supports very high bandwidths (the amount of information the cable can carry) and can handle thousands of times more data than twisted-pair or coax.

Cable lengths can run from ¼-mile to 20 miles, depending on the cable and network. If you need to connect multiple buildings, this should be the cable of choice. Fiber systems require the use of fiber-compatible hardware, including NICs.

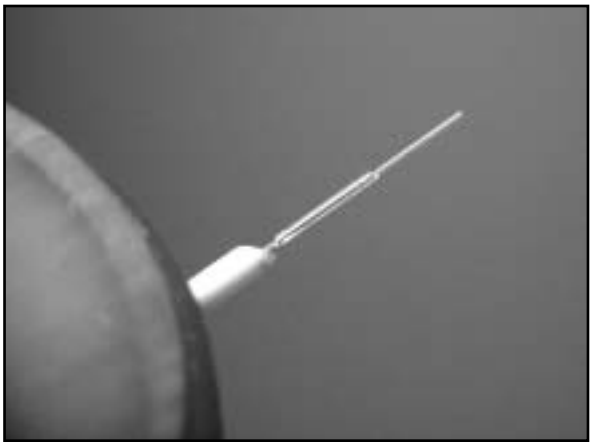


Figure 7
Fiber optic cable.

Specifying the Right Cable

To ensure trouble-free operation, network cabling must match the system requirements. This means balancing the system's speed, security, reliability, and cost. Cable specifications are based on three factors: speed, bandwidth, and length.

Cables will have a name like "10Base5." Speed is the first number in the identification. It represents the maximum transmission speed (bandwidth) in megabits per second (Mbps). This will be 1, 5, 10, or 100. Bandwidth is the second part of the identification, either baseband or broadband. These terms refer to the highest frequency that the cable can accommodate.

The last part of the identification refers to the cable length or cable type. If the unit is a number, it is the maximum length of the cable segments in hundreds of meters (one meter is approximately 3.3 feet). In some cases, it may refer to 50-meter increments (1Base5 is five 50-meter increments or 250 meters). In other cases, it represents cable type: T (twisted-pair) or F (fiber optic). The following table shows the common types of cables and their specifications.

While this table covers the basic cables, there are many other forms of network connections. For example, microwave links, radio (RF), infrared, and for small offices and homes, power line networks and phone line networks. These have relatively short ranges (generally limited to one office or floor).

Name	*Description*	*Type*	*Segment*	*Speed*
10BaseT	Common	UTP	.5 to 100m	10 Mbps
10Base2	Ethernet ThinNet	Coaxial	185m	10 Mbps
10Base5	Thick Ethernet	Coaxial	500m	10 Mbps
100BaseT	Becoming common	Twisted Pair	.5 to 100m	100 Mbps

LAN Communication

A LAN is similar to a telephone system with a one party simplex line—only one user can talk at a time. The difference is that with a LAN, the speed is so fast that it gives the perception that many transactions are going on at the same time. But just like a one-lane road, the more traffic, the slower things get.

Objectives

- Describe the main features of the two main network communication standards; Ethernet and Token Ring.
- Describe the most popular network protocols, and their function in a network.

Ethernet

There are several types of network communication standards currently in use in most LANs. Of these, two are used in the wide majority of networks. And of the two, Ethernet, is by far the most popular.

Ethernet uses a system known as *Carrier Sense Multiple Access with Collision Detection* (*CSMA/CD*). That's a huge name, but it's a simple concept. *Carrier Sense* means the network card listens to the cable to find a quiet period during which it can send messages. *Multiple Access* means that more than one computer can be connected to the same cable. *Collision Detection* is the ability to detect whether messages have collided in transit (neither message will arrive at their destination and both will be retransmitted).

Fast Ethernet was developed to meet increasing demands on networks to transmit more data. Fast Ethernet works on the same principle as Ethernet, but operates at 10 times the speed of the original. Ethernet transmits at 10 Mbps and Fast Ethernet transmits at 100 Mbps. Newer technologies allow speeds at 500 Mbps.

Token Ring

A token ring network uses a "token" as the basis for deciding who can communicate on the network. Token rings transmit at 4 or 16 Mbps. Token Ring is a proprietary technology used exclusively in IBM networks. It was once widely used, and it technically faster than comparable Ethernet networks.

However, Token Ring is more expensive than standard Ethernet, and more complicated to build and administer. As a result, this technology is rarely used in new installations.

Network Protocols

A *protocol* is a set of rules governing communication over a network. We discussed protocols briefly before, now it's time to look at some specific network protocols.

Network protocols are grouped according to their function, such as sending and receiving messages from the network interface or talking to the hardware and making it possible for applications to function in a network. Early computer networks had proprietary hardware and strict protocols. If you bought a server from a company, you had to buy their NICs, and use their client software and their protocols.

The networking world has completely shifted from that approach. Today's protocols are designed to be *open*, which means they are not vendor, hardware, or software specific. Protocols are generically referred to as protocol families or protocol suites because they tend to come in groups.

The following is a list of common network protocols:

- **IPX/SPX** (Internetwork Packet Exchange/Sequenced Packet Exchange): The NetWare core protocol developed by Novell in the early 1980s. Still widely used.
- **NetBIOS/NetBEUI** (Networked Basic Input-Output System/NetBIOS Enhanced User Interface): A protocol developed by IBM and refined by Microsoft; originally, the native protocol for Windows NT. IBM developed NetBIOS as a way to permit small groups of computers to share files and printers efficiently. NetBIOS is the original edition; NetBEUI is an enhanced version for more powerful networks in the 32-bit operating system. Widely used in Windows peer-to-peer networks.
- **TCP/IP** (Transmission Control Protocol/Internet Protocol): A huge set of standard protocols and services. TCP/IP is the result of Department of Defense funding for networks that began in the early 1970s, in an attempt to tie together government computers. This project led to the development of the Internet. Because TCP/IP is the foundation of the Internet, as well as the most widely used networking protocol, it is a good choice for many networks.
- **AppleTalk***:* The networking protocol utilized by Macintosh computers for communications with other Macs.

Depending upon the operating systems and the function of the network, you might use more than one protocol on a computer. It is important to use LAN drivers that can switch between one protocol and another as needed.

This protocol information will provide you with a rudimentary understanding of basic network techniques and terminology; however, networking is a complicated subject. Additional training resources should be obtained before installing a network on your own.

Extending a LAN

The previous lesson on network cables mentioned some limits to the length of cables. The requirements of today's LANs will often exceed the capability of these cables. The following section describes several devices that extend a LAN beyond its normal limits.

Repeaters

The main purpose of a repeater is to extend the length of a network beyond its normal allowable cable lengths. A repeater works like an amplifier to increase or boost the signal, allowing transmission over longer distances. Repeaters connect network segments, which are groups of computers on the same network. They also connect segments composed of different media, for instance, a Thinnet segment to a UTP segment.

Bridges

Bridges work like repeaters, but offer some additional advantages. A bridge separates a network into segments. Data will not be sent to the entire network unless its destination is in another segment. Bridges isolate data traffic within segments, reducing the load on the network as a whole. Should any problems occur within a segment, the bridge will isolate its segment and the problem will not affect the rest of the network. Bridges can also link unlike segments (Ethernet and Token Ring).

Routers

Routers provide interconnectivity between like and unlike devices on the LAN or WAN. Routers work like bridges, but can connect networks using different protocols. They are able to select the best route from network to network based on traffic load. Routers determine the flow of data based on such factors as least-cost, minimum delay, minimum distance, and least congestion. Routers are generally used to create a wide area network and connect dissimilar networks. Routers are the backbone of the Internet.

Gateways

Gateways provide all the connectivity and even greater functionality than routers and bridges. A gateway usually resides on a dedicated computer that acts as a translator between two completely dissimilar systems or applications. Since gateways are both translators and routers, they tend to be slower than bridges or routers. Gateways also provide access to special services such as email or fax functions.

Unit Summary

The world of computer networks is vast and far-reaching. Networking hardware is continually being improved and new devices are released every day, networking software is typically on a quick upgrade schedule. Keeping current on the technology is a part-time job, even for professionals working within this group of technologies. This unit presented a quick overview of basic PC networks. Hopefully the information presented here will provide a foundation for further study in networking, or a deeper understanding if your studies take you elsewhere.

Lab 10-1

Memory

Most experts agree that, on average, the most cost-effective upgrade that you can make to a personal computer is to increase its memory. More memory allows you to have more applications open at the same time. In addition, it speeds up many computer operations. Upgrading memory involves installing memory modules on the motherboard. In some cases, you simply plug in a new module next to the one (or more) that is already there. In other cases, you unplug and discard old memory modules to make way for newer modules that have more memory.

In this lab, you will learn how to upgrade memory. You will also demonstrate a computer memory malfunction. Finally, you will learn about beep codes. These are audio tones produced by the BIOS that indicate normal and abnormal conditions.

There are three basic types of synchronous dynamic memory (SDRAM) modules used in computers these days: single in-line memory modules (SIMMs), dual in-line memory modules (DIMMs), and Rambus in-line memory modules (RIMMs). SIMMs are virtually obsolete, like the 386, 486, and Pentium computers that used them. DIMMs have been around for several years, and are currently the memory module of choice. RIMMs are relatively new, but seem destined to play a much larger role in the future.

Originally, DIMMs supported a 66 MHz CPU bus. Faster Pentium II CPUs required a change to a 100 MHz bus. These DIMMs became known as PC100 memory modules. Further speed enhancements in the Pentium III demanded an even faster memory module. This resulted in the PC133—the 133 MHz bus DIMM. Both are single data rate (SDR) SDRAM because they read or write one word of data every CPU clock cycle.

To increase memory speed further, double data rate (DDR) SDRAM was developed. As the name implies, this DIMM is able to operate at twice the speed of the CPU bus. For example; if the CPU speed is 133 MHz, then the data transfer rate to and from memory is twice that, or 266 MHz.

Yet another type of memory device is called the Direct Rambus SDRAM, abbreviated RDRAM. Its memory module is called a Rambus in-line memory module, or RIMM. Unlike your typical DIMM, where only one device is needed to support system memory, at least two RIMMs must be installed. At the time of this writing, Rambus is the fastest of the three memory technologies discussed here, but it is also the most expensive.

Objectives

When you complete this exercise, you will be able to:

- Identify a memory module as a SIMM, SDR DIMM, or DDR DIMM.
- Demonstrate the proper method of uninstalling and reinstalling a Dual In-line Memory Module (DIMM).
- Explain the purpose of, and give an example of, a normal and an abnormal beep code.

Material Required

The computer and monitor

Antistatic wrist strap

Small antistatic bag

Procedure

Determining the Type of Installed Memory

Let's begin by determining the type of memory (SIMM, SDR DIMM, or DDR DIMM) installed in your computer.

1. Make sure the computer and monitor are switched off. If it is not already off, remove the computer's side cover as you did in earlier labs so that you can see the motherboard. Position the computer as shown in Figure 1.

2. Find the power switch on the rear panel of the computer. Flip the switch off. Make sure it is off by watching the LED at the bottom of the motherboard. After a few seconds the light should go out.

3. Slip the antistatic wrist strap around your wrist and connect the other end to ground on the computer, just as you did in earlier labs.

4. Look closely at Figures 1, 2 and 3 so that you know what you are looking for. Now, look under the tangle of cables and find the memory module sockets on your motherboard. They are just to the right of the fan on the CPU. How many memory sockets are there? _____ How many of the sockets have a memory module installed? _____

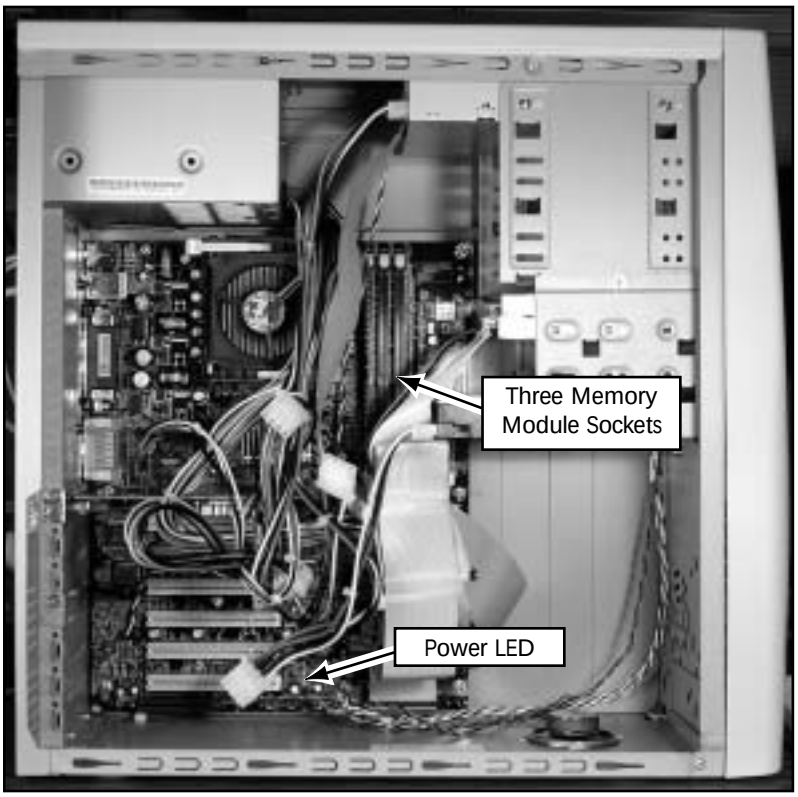


Figure 1
Position the computer as shown.

5. Refer to Figure 2. It shows three types of memory modules: the SIMM, the SDR DIMM, and the DDR DIMM. SIMMs are shorter than DIMMs and have a unique pattern of notches and holes. Notice that the DDR and SDR DIMMs are the same length—both are 5.375" long—about one finger width shorter than a dollar bill. Where they differ is in the way they mount to, and interface with the computer.

6. Once again, look at Figure 2. The SDR DIMMs have 168 connector pads—84 on the front and another 84 on the back. The DDR DIMMs have 184 connector pads—92 on each side. Finally SIMMS have only 72, all on one side.

7. A system of ridges and notches are used to make sure you don't plug a DIMM into the wrong type of socket. Each socket has either one or two ridges that fit into mating notches in the bottom of the DIMM. The positioning of the notches also ensures that you install the module in the correct direction.

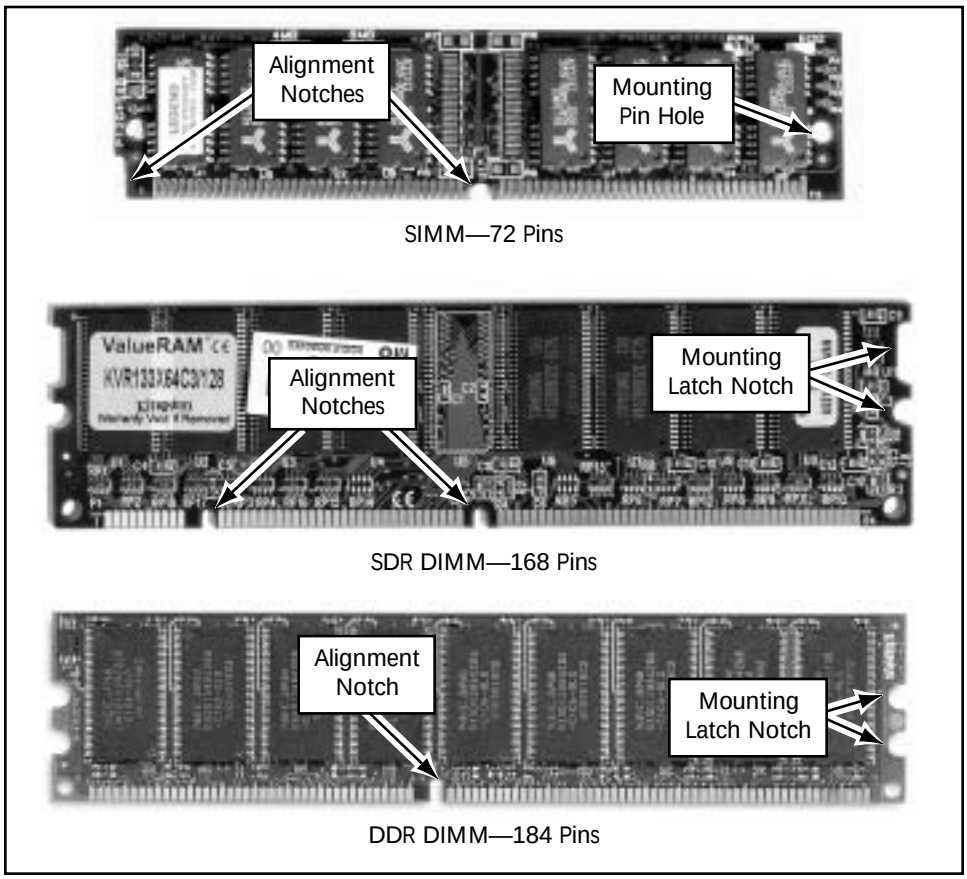


Figure 2
The three common types of SDRAM memory modules.

8. Look at the latches on the memory module sockets on the motherboard. The latch on the SDR DIMM socket is shaped differently from the latch on the DDR DIMM socket so that one will not work with the other. This further ensures you don't mix incompatible SDR and DDR DIMMs. The latches also serve as a signal that you have correctly installed the DIMM. If the latch doesn't close automatically when you push in the DIMM, then something is wrong. You either installed the DIMM backward, you haven't pushed the DIMM all the way down into the socket connectors, or you somehow put the wrong DIMM in the socket.

9. Using Figures 1, and 2 as references, examine the memory module and especially the empty sockets installed in your computer. What kind memory is installed? _____

   Figure 3 is a close-up of the memory sockets in your computer. You can tell the memory module shown in Figure 3 is a DDR DIMM because there is only one alignment ridge in the bottom of each socket, and the socket is too long to hold a SIMM.

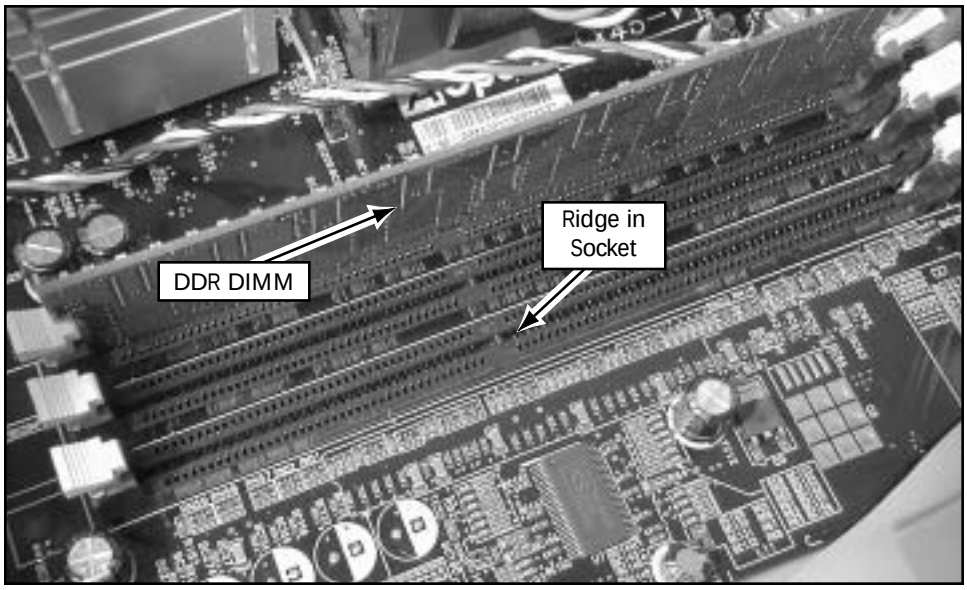


Figure 3
A single DDR DIMM installed in a motherboard..

Determining the Amount of Memory Installed

You have examined the memory in you computer and determined its type. Now let's determine the amount of memory installed. Most computers run a memory test as they boot up. If you watch closely, you can see the amount of memory found during this test. However, since the boot process goes so quickly, it is easy to miss. Let's see how we can slow things down. Read over the next four steps so that you know what to expect and what to do to view the results of the memory test.

10. Switch the rear panel power switch on the computer to power on.

11. Find the *Pause/Break* key on the keyboard. Hold your finger over the key as the computer boots up in the next step. However, do not press the key until the proper point in the boot up process as described in the next step.

12. Switch on your computer and monitor and watch the display screen closely at the start of the boot process. First you should see a few lines of text at the top of the screen. And unfortunately, one of these lines gives a wrong impression of the amount of memory installed. After about a second, the screen goes blank again and you hear a single, short beep. Then a second screen full of information appears. As soon as the second screen appears, depress the *Pause* key on the keyboard. This should stop the display so that you can see the results of the memory test. If you miss it the first time through, let the computer boot to the Windows 2000 Desktop, then shut down the computer and try again. Note that you must shut down the computer completely, not just restart it. How much memory does this test say is installed? _____

13. Press the F12 key and then the F1 key and allow the computer to boot to the Windows 2000 Desktop, then shut down the computer again.

Discussion

Your computer has a single 128 MB DDR DIMM installed. But why did the BIOS indicate it found 131,072 KBs of RAM? The answer lies in the definition of 1 kilobyte. A *kilobyte* (KB) is defined as 1024 bytes. A *megabyte* (MB) is 1000 kilobytes or 1,024,000 bytes. 128 times 1,024,000 equals 131,072,000 bytes. Normally you don't worry about a meg here or a meg there. You need to be concerned when you're off by some multiple of 16, which usually means the BIOS isn't seeing one of your DIMMS, or one of them is bad.

Procedure (continued)

Simulating a Failure in the DIMM

In the following steps you will simulate a total failure of the memory module by unplugging it from the motherboard. In the process you will learn the proper technique for removing a memory module. In a later step you will reinstall it.

14. Verify that the computer and monitor are turned off.

15. Switch off the power switch on the rear panel of the computer. The LED at the bottom of the motherboard should go out after a few seconds. Wait for it to go out before proceeding.

16. Connect the antistatic wrist strap to the computer ground and to your wrist.

17. Move the cables out of the way so that you have clear access to the DIMM. Place your thumb on the latch at one end of the DIMM and press the latch to its out position. Notice that this forces one end of the DIMM upward freeing it from the socket.

18. Hold on to the DIMM with one hand. Then, being very careful not to let the DIMM fall out of the computer, use the same technique to open the latch at the other end of the DIMM.

19. Carefully, remove the DIMM from the computer and place it in the antistatic bag until called for later.

20. Switch the rear panel power switch on the computer to power on. The LED power indicator at the bottom of the motherboard will light.

21. Switch on the computer and monitor and allow the computer to boot. Did the computer boot normally? _____ What symptoms did you observe to indicate that the memory has failed? _____
_____

22. Are you able to switch off power to the computer using the front panel power switch? _____

23. Switch off the monitor. Switch off power to the computer using the switch on the rear panel of the computer.

Discussion

In this part of the lab you simulated a complete failure of the DIMM by removing it from the motherboard. As you discovered, a total failure of main memory puts the PC out of business. Obviously, without memory the boot process doesn't get very far. This part of the lab also demonstrated how the BIOS can generate an "abnormal condition" beep code. Generally, anything other than the single, short beep while the computer is booting means that something is wrong.

Procedure (continued)

Installing a DIMM

Now, let's reinstall the DIMM and get the computer working once more.

24. Power should be turned off at this time. But just to be on the safe side, look at the LED at the bottom of the motherboard. If it is glowing, switch off power to the computer using the switch on the rear panel of the computer. Wait for the power LED on the motherboard to go out. And, make sure you still have the antistatic wrist strap attached to the computer ground and to your wrist.

25. Remove the DIMM from its antistatic bag.

26. Refer to Figure 2 and note the notch on the bottom of the DDR DIMM. Compare that notch to the socket ridge shown in Figure 3 and to the ridge on the empty computer motherboard socket. Make sure the latches on the empty DIMM socket are positioned to their unlatched, out positions.

27. You will install the DIMM in the same socket from which you removed it—the socket on the left, closest to the CPU. Position the DIMM so that its notch lines up with the ridge in the DIMM socket.

28. Slide the DIMM into the slot at each end of the socket.

29. With your thumb, push one end of the DIMM down into its socket. The latch should automatically close on the DIMM.

30. Then push the other end of the DIMM down into its socket. The latch on that end should automatically close on the DIMM.

31. Push down on each end of the DIMM once again to be sure it is fully seated in the socket.

32. Switch the rear panel power switch on the computer to power on. The LED power indicator at the bottom of the motherboard will light.

33. Switch on the computer and monitor and allow the computer to boot. Watch the memory test. How much memory is installed in the computer? _____

34. Allow the computer to boot to the Windows 2000 Desktop. If the computer booted properly, skip down to step 36. If the computer did not boot properly, turn off the computer and monitor. Switch the rear panel power switch to off. Wait for the motherboard LED to go out. Reseat the DIMM in its socket.

35. Switch on the computer and monitor and allow the computer to boot. If it does not boot properly this time call your instructor. Once the computer is booting properly, the DIMM is properly installed.

36. Remove the antistatic wrist strap. Turn off the computer and monitor. Reattach the cover. This completes the lab.

Discussion

In this part of the lab you reinstalled the DIMM. The memory test should have indicated that the 128 MB DIMM was once again recognized and the computer should boot normally to the Windows 2000 desktop. You should also have noticed a single short beep during the boot process.

Lab 10-2

The Peer-to-Peer Network

In this lab, you will connect four computers together in a simple peer-to-peer network so that their users can share resources and work together more conveniently. To facilitate the connections you will use a device called a hub. Hubs make it easy to setup a network. You simply plug the computers into unused connectors on the hub. If you run out of connectors, you can add another hub and interconnect the two. Hubs like the ones used here in the classroom have multiple RJ45 connectors which require Unshielded Twisted Pair (UTP) cable.

In this lab, you will team up with additional students and configure the four computers in preparation for connecting them together to form a simple peer-to-peer network.

Objectives

When you complete this lab, you will be able to:

- Use UTP cables and a hub to physically connect computers together in a peer-to-peer network.
- Configure a Windows 2000 computer to act as a member of a peer-to-peer network.
- Change the Client, Services, Protocol, and Name of a Windows 2000 computer.

Materials Required

To complete this lab, you will need four computers with Windows 2000 Pro installed, a hub with four or more RJ45 ports, and four UTP cables which are long enough to connect the hub to the four computers. Also you will need a piece of masking tape and a pen for identifying the four computers.

Procedure

Positioning and Labeling the Computers

1. Team up with the students from three other computers to form a four-computer workgroup.

2. Find the hub, the power cube for the hub, and four UTP cables that will be used to connect the computers to the hub.

3. Move the four computers and the hub as necessary so that the cables easily reach from each computer to the hub. You will connect the cables later.

4. Place a small piece of masking tape on each computer. Assign each of the four computers a unique name as follows: *Web*, *Rock*, *Time*, and *River*. Any four names could have been used. We chose these four because they are short and easy to remember. Write one of the names on the piece of masking tape you placed on each computer so that each computer has a different name.

Exploring the Network Adapter

Note: Perform the following steps on all four computers unless instructed to do otherwise.

5. In order to network the computers together each computer must have a network adapter installed and working. The network adapter is a piece of hardware that physically connects the computer to the network. In some computers it is a separate Network Interface Card (NIC). In others computers (like this one) the Network Adapter is built right into the motherboard. In the next few step, your team will verify that each of the computers has an installed and working Network Adapter.

6. Turn on the computer. You should now be looking at the Windows 2000 Desktop.

7. Right-click on *My Computer* and select *Manage*.

8. In the left pane of the *Computer Management* window, double-click on *Device Manager*. In the right pane of the window you should see a list of various components installed on the computer as shown in Figure 1.

9. Look down the list and find *Network adapters*. Click on the + sign just to the left of the *Network adapters* icon. This will show you all the Network adapters that are installed. How many adapters show up under *Network adapters*? _____

Figure 1
The *Device Manager* listing.

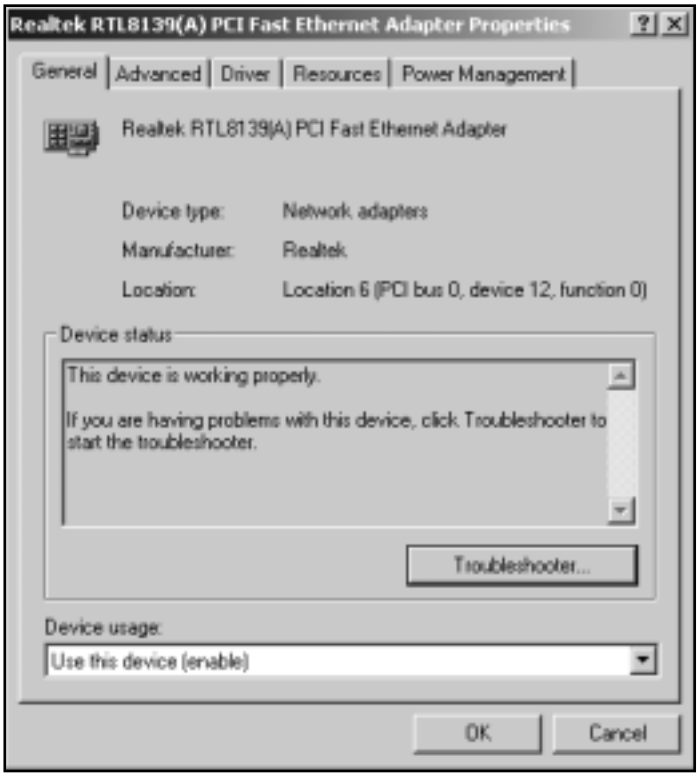


Figure 2
The *Network Adapter Properties* dialog box.

10. Right-click on the *RealTek PCI Fast Ethernet Adapter,* or whatever the first (or only) enter in the list happens to be. Select *Properties* from the menu. The *Properties* dialog box will open as shown in Figure 2.

11. At the General tab note the following information about the network adapter:

    Device Type: _____

    Manufacturer: _____

    Location: _____

12. Also at the General tab, note the *Device status* in the middle of the window. The message should say: *This device is working properly*. It goes on to say that if you are having trouble, the *Troubleshooter* button is available. Hopefully, you will not need the troubleshooter today.

13. Click on the *Driver* Tab. The Device Driver is a piece of software that allows the Network Adapter to talk to the Network Operating System. Note the Date and Version number of the Device Driver. This information is important because the Device Driver may be updated from time to time. Generally, it is advisable to have the latest device driver installed. Later versions of the device driver may be available at the website of the computer or Network Adapter manufacturer.

14. Click on the *Resources* tab. This tab lists the computer resources used by the Network Adapter. The key idea here is that the Network Adapter must not use the same resources as any other device in the computer. If it does attempt to use the same resource as another device, a device conflict occurs and, most probably, neither device will work properly. Any conflict should be detected by Windows 2000 and listed at the bottom of the window. What message is in your *Conflicting device list*?
    _____

15. While there are other tabs to explore, you have seen enough to indicate that the Network Adapter is working properly. Close the *Properties* dialog box by clicking *Cancel*. Close the *Computer Management* window.

Identifying the Computers

16. Each computer on the network must be uniquely identified. In the next few steps you will see how the computers are presently identified and you will change their names so that each one is uniquely identified.

17. On the computer labeled *Web,* Right-click on *My Computer* and select *Properties*. In the *Systems Properties* dialog box, select the *Network Identification* tab. The dialog box should now resemble that shown in Figure 3. Note the *Full computer name*.

18. Have the other team members look at the *Full computer name* on the other computers in the Workgroup. Does each computer have a unique name?

    _____

19. Clearly, this will not do. Fortunately it is easy to change the computer name. A lower line in the window tells you how. Click on the *Properties* button. On the computer labeled *Web*, change the *Computer name* to *Web*. Leave the *Member of* boxes set to Workgroup and make certain that the workgroup name is *WORKGROUP*.

20. Click on the *More* button and notice that the *NetBIOS computer name* is now *WEB*. NetBIOS is a simple protocol that allows networked computers to be identified as names. Without changing anything click on *Cancel* to dismiss the dialog box.

21. Back at the *Identification Changes* window click on *OK*. Read the message that tells you that you must reboot for the changes to take place. Click on *OK*.

22. Back at the Identification Tab verify that the *Full computer name* is now *Web* and that the *Workgroup* name is *WORKGROUP*. Also, note the yellow warning at the bottom of the window. Click on *OK*. When asked if you want to restart the computer, click on *Yes*. After a short delay, the computer will reboot to the desktop.

23. At the computer that you labeled *Rock*, use the above procedure to change the *Full computer name* to *Rock*.

24. At the computer that you labeled *Time*, use the above procedure to change the *Full computer name* to *Time*.

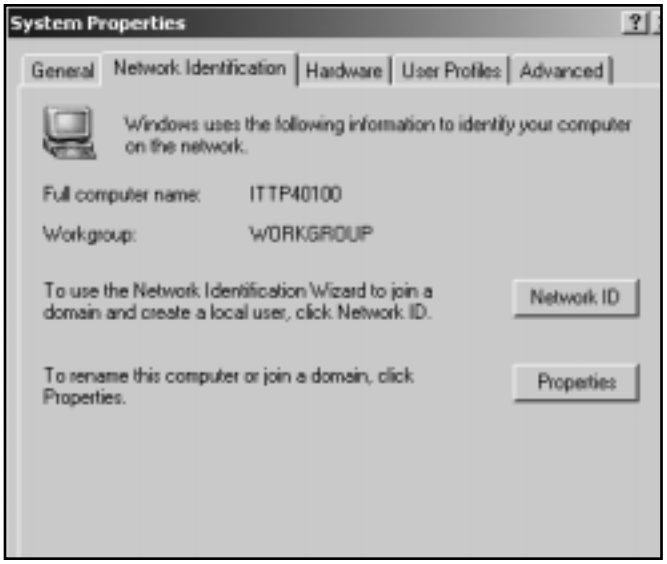


Figure 3
The *Network Identification* tab of the *Systems Properties* window.

25. At the computer that you labeled *River,* use the above procedure to change the *Full computer name* to *River*.

26. At this time, all four computer names should have been changed and the computers should be rebooted to the Windows 2000 Desktop.

Physically connecting the four computers

27. Find the hub and its power cube. Connect the power cube to the power socket on the rear of the hub as shown in Figure 4. Then plug the power cube into a wall outlet. The Power indicator on the front of the hub should glow.

28. Find the four UTP cables. Connect one end of one of the UTP cables to the RJ45 connector nearest the edge of the hub as shown in Figure 4.

29. Connect the other end of the UTP cable to the RJ45 connector at the Network Adapter on the back of the computer that you labeled *Web*. See Figure 5. Back at the hub, Port Status indicator 1 should glow (or blink) green.

30. Refer to Figure 6 and connect a second UTP cable between the next RJ45 connector on the hub and the Network Adapter jack on the computer labeled *Rock*. Back at the hub, Port Status indicator 2 should glow (or blink) green.

31. Next, connect the third UTP cable between the next RJ45 connector on the hub and the Network Adapter jack on the computer labeled *Time*. Back at the hub, Port Status indicator 3 should glow (or blink) green.

32. Finally, connect the fourth UTP cable between the next RJ45 connector on the hub and the Network Adapter jack on the computer labeled *River*. Back at the hub, Port Status indicator 4 should glow (or blink) green. Your setup should now resemble Figure 6. Notice that Port 5 on the hub can be used for connecting to another hub but is not used in this lab.

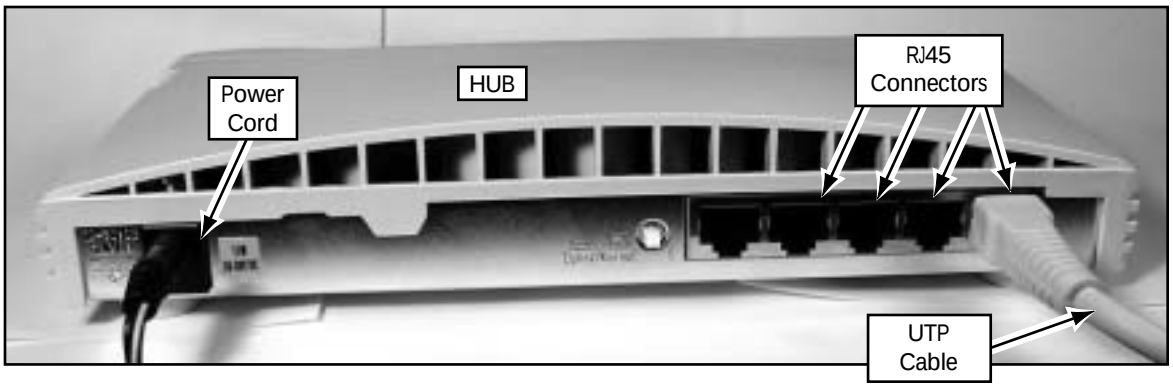


Figure 4
Connect the power cube and UTP cable to the hub.

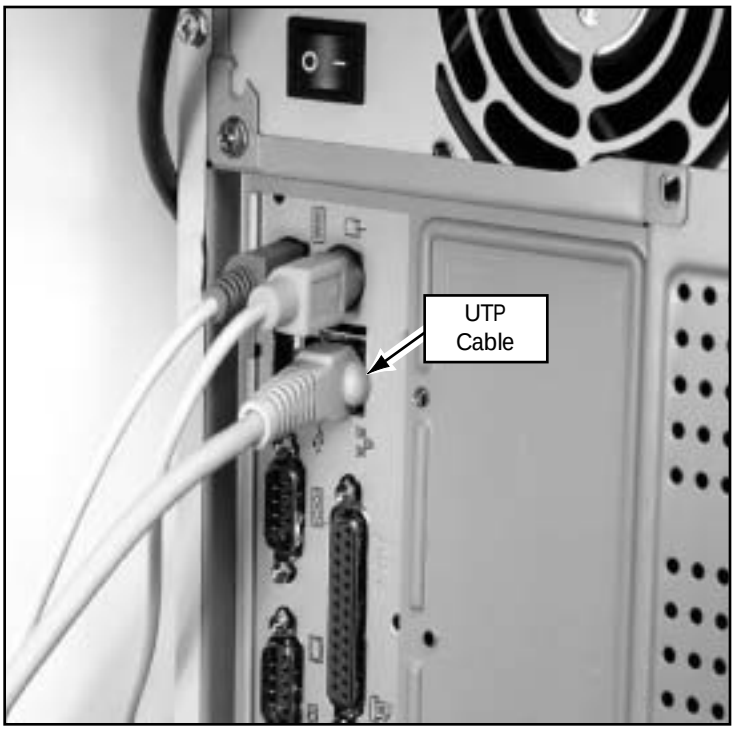


Figure 5
Connect the UTP cable to the computer.

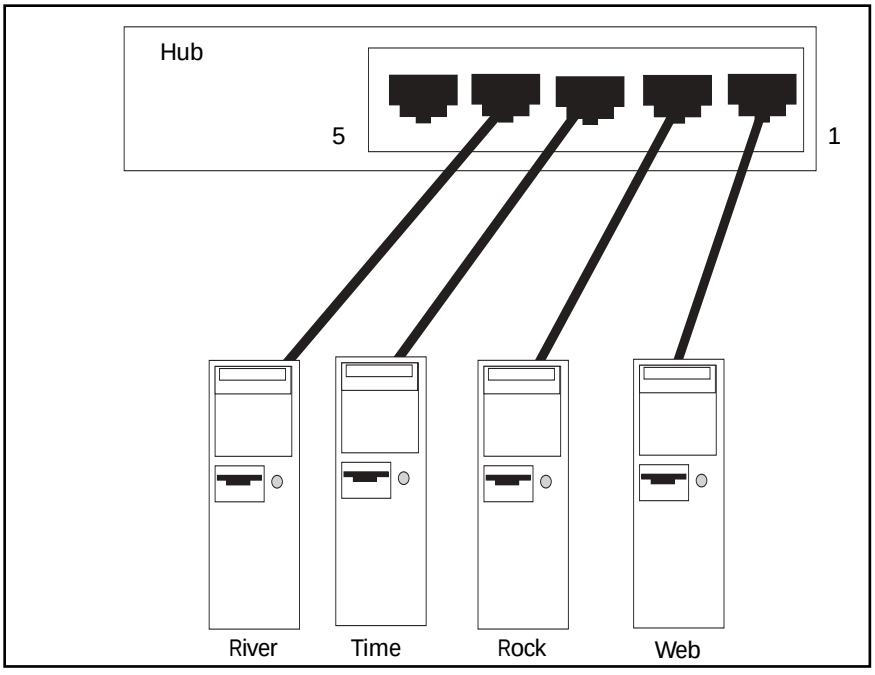


Figure 6
Four computers connected to the hub.

Configuring the Network

Note: The following steps are to be performed on all four computers.

33. Open the Control Panel and double-click on *Network and Dial-up Connections*. Right-click on the *Local Area Connection* icon and select *Properties* from the menu. The *Local Area Connection Properties* dialog box will open as shown in Figure 7. Notice that the *Connect Using* box contains the name of the Network Adapter that you explored earlier.

34. Find the box entitled *Components checked are used by this connection*. Three network components are already installed. Components are installed or uninstalled by using the appropriate button below the list. To see the type of components that can be installed click on the *Install* button. What three types of Network components can be installed? _____, _____, and _____. At least one of each of these types of components must be installed to complete the network connection.

35. *Client* should be highlighted. Read the *Description* at the bottom of the window.

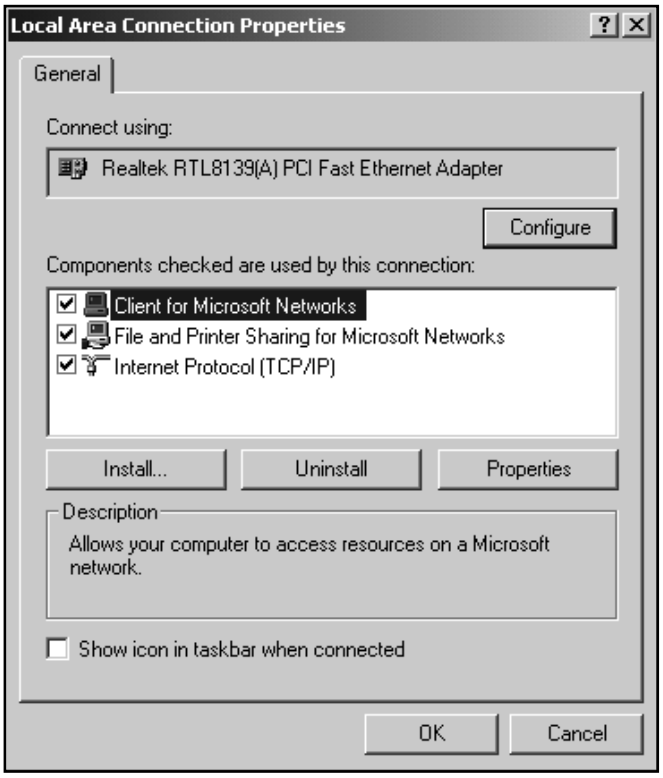


Figure 7
Local Area Connection Properies dialog box.

36. Highlight *Service* and read the *Description* at the bottom of the window.

37. Highlight *Protocol* and read the *Description* at the bottom of the window.

38. Now that you know what these components do, go back and look at those already installed once more. Click on *Cancel* to return to the prior window.

39. Highlight the *Client for Microsoft Networks* and read the *Description* near the bottom of the window. In this lab you will be connecting computers using Windows 2000, a Microsoft product. Thus, the proper client is the *Client for Microsoft Networks* which is already installed.

40. In order to share files and printers, the sharing service must be installed. Again, because this is a Microsoft Network, *File and Printer Sharing for Microsoft Networks* is required. So once again, the proper Service is already installed.

41. Finally, Internet Protocol (TCP/IP) is already installed. While this is the protocol that is most often used, it requires a great deal of configuration. In fact, we will devote a whole lab to this subject later. However, it is not the protocol that we will use today. So highlight *Internet Protocol (TCP/IP)* and click on the *Uninstall* button. Click *Yes* to verify that you wish to uninstall TCP/IP.

42. After a short delay, the protocol icon will disappear from the list and a message will ask if you want to restart the computer. Click on *No* because you are not yet done.

43. In this lab, you will use the NetBEUI protocol. Click on *Install*, select *Protocol*, and then click on the *Add* button. At the next window, select *NetBEUI Protocol* and click *OK*.

44. When asked if you want to restart the computer, click on *Yes*. After a short delay, the computer reboots to the Desktop. Clear any error messages that occur, if necessary.

45. You should now have NetBEUI installed on all four computer. All computers should be booted to the Windows 2000 Desktop.

Verifying the Network Connection

46. At the computer labeled *Web*, double click on the *My Network Places* icon. In the *My Network Places* window, double-click on the *Computers Near Me* icon. You should now see four computers, *Web*, *Rock*, *Time*, and *River* as shown in Figure 8. If all four computers do not show up, open the *View* menu and select *Refresh*. It may take a couple of minutes before all four computers show up.

47. At the computer labeled *Rock*, double click on *My Network Places* icon. In the *My Network Places* window, double-click on the *Computers Near Me* icon. Once again, you should now see all four computers. If not, try selecting *Refresh* from the *View* menu.

48. Repeat the process at the computers labeled *Time* and *River*.

49. At the computer labeled *Web*, double-click on the *Rock* icon. The display should resemble that shown in Figure 9. Notice that the name in the upper left corner of the window identifies this as coming from the computer called *Rock*.

50. One after another, double-click on each computer icon and make sure that each computer responds by showing a window labeled with its name. Repeat this process on all four computers.

Figure 8
The *Computers Near Me* window shows all four computers.

51. This verifies that you have successfully constructed and configured a simple peer-to-peer network having four nodes. This concludes this lab; however, leave the computers set up just as they are. In the next lab, you will begin using the network.

Discussion

In this part of the lab, you used a hub and four UTP cables to connect four computers together in a simple peer-to-peer network. You also configured the network by assigning unique names to each computer and changing the protocol. You saw that a properly working Network Adapter is required as well as three types of network components: the correct Client, the proper sharing Service, and a common Protocol. You removed the TCP/IP protocol and installed NetBEUI in its place. Finally, you verified that the network was constructed and configured properly—at least to the point that you can see all four computers from each node of the network.

We chose NetBEUI for this lab because a minimum of configuration is required. In a future lab, you will configure the TCP/IP protocol. But first let's see how you can use your new network to share files, folders and other resources with the various users.

Figure 9
The name in the upper left corner of the window tells you which computer you are looking at.

Lab 10-3

Sharing Resources

In the prior lab, you connected four computers together in a simple peer-to-peer network and confirmed that they were communicating. In this lab you will experiment with sharing resources on those computers, and assigning share permissions. Also, in the prior unit you saw how to install a networking software component called File and Printer Sharing—a must before resource sharing is possible. However, installing File and Printer Sharing does little more than give you the ability to turn sharing on or off for various resources. Share Permissions refers to the limitations placed on the ability of one computer to locate, read, and modify files on another computer. These are important networking concepts which should become clearer as you work through this lab.

Also, in a much earlier lab you learned about *Security permissions*. It is easy to confuse Security permissions with *Share permissions*. However, there is an important distinction between the two. Security permissions determine how a file or folder on the local computer is treated whether or not the computer is networked. Sharing permissions, on the other hand, only affect how a user on the network may access a file or folder over the network. In this lab, you will be concerned with Share permissions.

Objectives

At the end of this lab, you will be able to:

- Explain the difference between *Security permissions* and *Share permissions*.
- Explain the difference between Full Control access and Read-only access.
- Turn sharing *on* or *off* for a particular resource.
- Access and modify files on a host computer from a remote guest.

Materials Required

The four-computer, peer-to-peer network configured as it was at the end of the last lab.

Procedure

Creating Folders and Files to Share

Sharing resources is what networking is all about. A *resource* can be thought of as any useful service or object that can be shared. For example, a resource can be a printer, a file, a folder, or a disk drive. In the previous lab, you saw how to install *File and printer sharing for Microsoft networks*. However, this does not automatically mean that one computer can now access the resources of another. No resource is shared automatically. You must also turn on sharing on a resource-by-resource basis. You will do this later in this lab. But first, you will create a couple of specific resources that you can work with.

1. If the computers are not already on, turn them on and allow them to boot to the Windows 2000 Desktop.

2. On the computer labeled *Web*, open the *My Documents*. If there are folders named *Guest1* and *Guest2* inside, drag them to the Recycle Bin. These are left over from a previous class and must be discarded.

3. In *My Documents*, create a new folder and name it *Guest1*.

4. In the same way create an additional folder and name it *Guest2*.

5. You should now have two empty folders in the My Documents folder as shown in Figure 1. Notice the icons that are used to represent the folders.

6. Open WordPad.

Figure 1
My Documents with the new folders.

7. In WordPad type the following message:

   The quick brown fox jumped over the lazy dogs.

8. Name the file *Fox1* and save it in the *Guest1* folder that you just created.

9. Now, without leaving WordPad, save the file again as *Fox2* in the *Guest2* folder. Close WordPad.

Sharing Folders

At this time you have two folders named *Guest1* and *Guest2* in the My Documents folder of the computer called *Web*. Each folder contains a single file. They are called *Fox1* and *Fox2*, respectively. The two files are identical except for their names. Now, let's turn on different levels of Sharing in these resources. The first thing you need to realize is that you share files by sharing the folder that the files are in. That is, sharing occurs at the folder level, not the file level.

10. On the computer labeled *Web* highlight the *Guest1* folder. Open the File menu and select *Sharing*. The Guest1 Properties dialog box will open as shown in Figure 2. Select the Sharing tab if it is not already selected.

Figure 2
The *Guest1 Properties* dialog box.

11. As you can see, the *Guest1* folder is not yet shared. Click on the *Share this folder* button to activate the sharing options. Notice that several new options are now active.

    The *Share name* box allows you to change the name the share will have on the network. For now, leave the Share name as *Guest1*. Also, leave the comment box blank.

    The *User Limit* allows you to control how many users can access the folder. Leave it set to *Maximum allowed*.

12. Read the message to the left of the *Permissions* button. Click on the *Permissions* button and the *Permissions for Guest1* dialog box opens as shown in Figure 3. This is where you set who has access to the folder and what level of access they have.

13. Notice that by default *Everyone* is given full permission to access the folder. You may recall from an earlier lab that *Everyone* is a special group that includes everyone and anyone connected to the network. In a small network like this one, this level of openness may be appropriate. But in the real world, a more restrictive group is often selected. For now, make sure the dialog box is configured as shown in Figure 3 and then click on *OK*.

14. Back at the *Guest1 Properties* dialog box, click on *OK*.

Figure 3
The *Permissions for Guest1* dialog box.

15. Look at the *Guest1* folder icon in *My Documents*. Has the icon changed? _____ If so, describe how it has changed. _____
_____
This indicates that sharing has been turned on for this folder.

16. Highlight the *Guest2* folder. Open the *File* menu and select *Sharing*. Click on the *Share this folder* button to activate the sharing options. Click on the *Permissions* button. Leave the *Name* set to *Everyone* but in the *Permissions* box change *Full Control* from *Allow* to *Deny*. Notice that *Deny* is now automatically checked in all three boxes. After the word *Read*, check the *Allow* box. The Share Permissions should now be set as shown in Figure 4. As you will see, this places certain restrictions on *Everyone's* access to the folder and its contents. Click on *OK*, read the Security caution, and click on *Yes*. Click on *OK* again.

Discussion

Let's quickly review what you just did. You gave everyone on the network access to two folders on the computer named *Web*. However, the level of access is different for each folder. Everyone has:

- *Full Control* of the *Guest1* folder and its contents.
- *Read* access to the *Guest2* folder and its contents.

Figure 4
Set *Guest2 Permissions* as shown.

Procedure (continued)

Preparing the Computers

In the next part of the lab, we want to view the shared folders from the remote computers. At this point we cannot be certain how sharing is set up on the computers in the network. To insure that you see only the shared folders and not the entire hard drive, you will disable sharing on all hard drives.

17. On the computer that you labeled *Web*, open My Computer and highlight *Local Disk (C:)*. Open the File menu and select *Sharing*. At the resulting dialog box, click on the *Do Not Share this folder* button and then click on *OK*. This will turn off sharing for that resource.

18. Repeat the prior step for the computers that you labeled *Rock*, *Time*, and *River* and then return to this point.

Using My Network Places

19. On the computer that you labeled *Web*, close all open windows and double-click on the *My Network Places* icon.

20. Double-click on the *Computers Near Me* icon. Your display should now resemble that shown in Figure 5. *Computers Near Me* shows the workgroup to which you belong. Normally, this is a small part of a much larger network. But in your case, the workgroup is also the entire network.

21. Return to the prior display by clicking the *Back* icon or the *Up* icon in the toolbar. Double-click on the *Entire Network* icon.

22. At the *Entire Network* window, you are given three choices. You can Search for a particular computer; you can search for a particular file or folder; or you can view the *entire contents* of the network. The two search options are designed for complex networks in which a particular computer, file, or folder would be hard to find. Your network is relatively simple, so click on *entire contents*.

23. At the next screen, double-click on the *Microsoft Windows Network* icon. Next double-click on the *Workgroup* icon. And once again you see your four-computer workgroup.

24. On the computer that you labeled *Rock*, close any open windows and double-click on the *My Network Places* icon. Then double-click on the *Computers Near Me* icon. Your display should now resemble that shown in Figure 5.

25. On the computer that you labeled *Time*, double-click on the *My Network Places* icon. Then double-click on the *Computers Near Me* icon. Your display should now resemble that shown in Figure 5.

26. On the computer that you labeled *River*, double-click on the *My Network Places* icon. Then double-click on the *Computers Near Me* icon. Your display should now resemble that shown in Figure 5.

27. On the computer that you labeled *Rock*, double-click on the *Web* icon in *Computer Near Me*. After a short delay, the screen should resemble that shown in Figure 6. Additional shared folders may also be displayed.

28. Look at the Address box. Notice that it contains the address *Web*. The double backslash (\\) is part of the Universal Naming Convention (UNC). This is a convention that was created by Microsoft and IBM to identify resources on a network. The double backslash tells you and the computer that the resource is on the network. Notice also that the remote computer is identified by the name we gave it in the previous lab.

29. The screen shows a list of resources in the *Web* computer in which sharing has been turned on. Find these same resources using the computers named *Time* and *River*.

Full Control

Recall that we granted Full Control access to the *Guest1* folder.

30. From the computer labeled *Rock*, double click on the *Guest1* folder. Could you successfully open it? _____

Figure 5
The members of the workgroup are *Web*, *Rock*, *Time*, and *River*.

31. The *Guest1* folder should open revealing the *Fox1* file. Now look at the address box. What address is shown? _____

32. Attempt to open the *Fox1* file by double-clicking on it. Could you successfully open it? _____ If so, what application opened it for you? _____

33. Change the content of the file to read:

    I have changed your message to: The quick dog jumped over the lazy brown foxes.

34. Save the file and exit WordPad.

35. From the computer labeled *Time*, double click on the *Guest1* folder. Could you successfully open it? _____

36. The *Guest1* folder should open revealing the *Fox1* file.

37. Attempt to open the *Fox1* file by double-clicking on it. Could you successfully open it? _____ Does the change that *Rock* made appear in the message? _____

38. Change the content of the file to read:

    I have changed your message back to: The quick brown fox jumped over the lazy dogs.

    Save the file and exit WordPad.

Figure 6
The Shared Folders on the computer called *Web*.

39. From the computer labeled *River*, double-click on the *Guest1* folder. Could you successfully open it? _____ Drag and drop the Fox1 file into the Recycle Bin. Could you successfully delete the Fox1 file? _____ Open the Recycle Bin by double-clicking on it. Is the Fox1 file inside? _____ What happened to the Fox1 file on the other three computers? _____

Discussion

As you can see, with Full Control, a user can open, modify, or even delete a file that is inside a shared folder. In fact, a user out on the network can do just about anything to the folder and its contents that the creator and original owner of the folder can do. While this offers the greatest degree of flexibility, it may be a dangerous thing to do on a large network with many users.

Procedure (continued)

Read Permission

Recall that you granted *Read* permission to the *Guest2* folder.

40. From the computer labeled *River*, double-click on the *Guest2* folder. Could you successfully open it? _____ The *Guest2* folder should open revealing the *Fox2* file. Double-click on the Fox2 file. Were you able to open it? _____

41. Change the content of the file to read:

    I have changed your message to: The quick dog jumped over the lazy brown foxes.

42. Attempt to save the file. What happened? _____ _____ Why? _____

43. Click on *OK* and then exit WordPad. When asked if you want to save your changes click *Yes*. What happened? _____ _____

44. Click *OK* and then exit WordPad again. When asked if you want to save your changes click *No*. Close the *Guest2* folder.

Discussion

In this part of the lab, you attempted to change the wording of Fox2. However, recall that network users are restricted to read-only access to the *Guest2* folder and its contents. Therefore, you could not change the *Fox2* file from the network. You should be aware that network users can copy the *Fox2* file to their own machine and then make changes to the new *Fox2* file. But read-only access does not allow network users to make changes to the original *Fox2* file.

The above are examples of share-level access or share-oriented security. Access is granted on a resource-by-resource basis. You control which resources are shared by turning sharing on or off for each resource.

Procedure (continued)

Sharing Other Resources

Up to now, you have been concerned with sharing files and folders. But other resources can be shared as well. Let's look at a couple of examples.

45. At the computer called *Web* open My Computer. Your display should appear somewhat like that shown in Figure 7. Several of the devices shown here can be shared.

Figure 7
Several of the resources shown here can be shared.

46. Right click on the *Local Disk (C:)* icon. From the right-click menu select *Sharing...*. The *Local Disk (C:) Properties* dialog box appears. Notice that the selected tab is the familiar Sharing dialog box we looked at earlier.

47. Click on the *Shared this folder* button to turn on the share-access options. Change the *Share name* to: *Web's Hard Drive*. Set the share access permissions so that the remote computers have read-only access to Web's Local Disk (C:) drive.

48. Back at My Computer, right click on the *3½ Floppy (A:)* icon. From the right-click menu select *Sharing...*. The *3½ Floppy (A:) Properties* dialog box appears. Here again, the selected tab is the familiar Sharing dialog box. Enable sharing and name the share *Web's Floppy*. Set up share access so that guests have full-access to the floppy drive.

49. In the same way, set up share access so that the computers on the network have full-access to *Web's* CD-ROM drive.

50. Presumably, there are no printers connected to *Web*. But if there were, you could share them as well.

51. On the computer that you labeled *Rock*, open *Computers Near Me* and double-click on the *Web* icon. It should display the drives on which sharing has been turned on. See Figure 8.

Figure 8
Rock's view of the shared resources on *Web*.

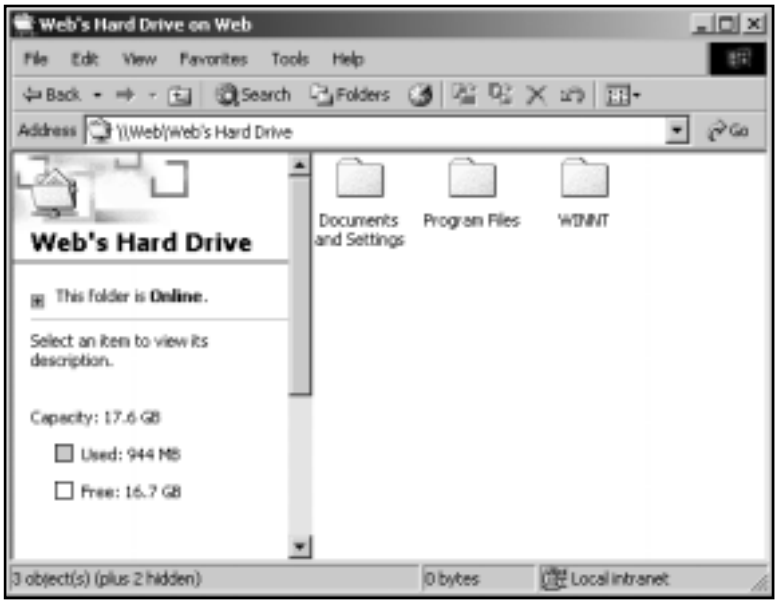


Figure 9
The contents of the C: drive on *Web* are available to the computers called *Rock*, *Time* and *River*.

52. Double click on the *Web's Hard Drive* folder, keeping in mind that this is the C: hard drive on the computer named Web. You should see a display similar to that shown in Figure 9. Notice that the window is labeled *Web's Hard Drive*.

53. This concludes the lab. However, you should leave the computers configured just as they are for the next lab. Using the proper technique, shut down the computers.

Discussion

In this part of the lab you learned that a wide variety of resources can be shared. Sharing a hard drive is an excellent way to give quick access to all the files contained there. How is it that you can click on an icon on *Rock*, *Time*, or *River* and have the *Web* computer respond? It is handled by a software device called a *redirector* that is enabled when networking is installed. The redirector determines if the command issued is intended for the local machine or for the remote machine. The redirector then directs the command to the proper computer for execution.

The need for sharing a hard drive or a printer is obvious. But why would you want to share a floppy drive or a CD-ROM drive? On some laptops, the user must choose between installing a floppy drive or a CD-ROM drive. In this case, most users choose the CD-ROM drive. Even so, they can still have access to programs and data on floppies via the network. In the same way, older computers that do not have CD-ROM drives can still access data on CDs through the network.

Lab 10-4

TCP / IP

In prior labs you configured a peer-to-peer network using a Microsoft protocol called NetBEUI. It is simple, easy to configure and relatively fast. However, it has some major shortcomings. For one thing it does allow routing. Routing is the act of passing information from one network to a totally different network. And because it is not routable, NetBEUI will not allow you to connect to the Internet. The Internet uses a protocol called TCP/IP. With the phenomenal rise in the popularity of the Internet, TCP/IP has become the most popular networking protocol in the world. It is also the networking protocol used on UNIX computers. But even if your LAN doesn't connect to the Internet or UNIX computers, it can still use TCP/IP.

In this lab, you will change the protocol of your network from NetBEUI to TCP/IP. While TCP/IP requires a more involved configuration, it makes up for this extra work in a number of ways. It allows you to connect your network to other TCP/IP networks, including the great-grand-daddy of all networks—the Internet. TCP/IP also provides a wide array of utilities that allow you to trouble-shoot connectivity problems. You will investigate two of these in this lab.

Objectives

When you complete this exercise, you will be able to:

- Configure the TCP/IP protocol.
- Use IPCONFIG to determine the TCP/IP configuration of computers on the network.
- Use PING to verify the connections to other computers on the network.
- Explain three ways that TCP/IP can be configured on a Windows 2000 based network.

Material Required

The four-computer, peer-to-peer network configured as it was at the end of the last lab.

Procedure

Changing the Protocol to TCP/IP

Note: Perform the following steps on each of the four computers.

1. If the computers are not already on, turn them on and allow them to boot to the Windows 2000 Desktop.

2. On each of the four computers, double-click on *My Network Places* and open *Computers Near Me*. The display should resemble that shown in Figure 1. Make sure all four computers (Web, Rock, Time and River) show up. One after another, double-click on each computer icon and make sure that each computer responds by showing a window labeled with its name. This shows that the network is still intact and working. Close the *Computers Near Me* window.

3. Right-click on the *My Network Places* icon and select *Properties* from the resulting menu.

4. Right-click on the *Local Area Connection* and select *Properties* from the resulting menu. The *Local Area Connection* dialog box will open as shown in Figure 2. The *NetBEUI Protocol* should still be installed from the prior lab. Highlight *NetBEUI Protocol* and read the *Description* at the bottom of the window. What does the Description say? _____
_____
_____

   Because NetBEUI is not routable, it is used only on small networks. Let's change the protocol to TCP/IP.

Figure 1
The four computers on the network.

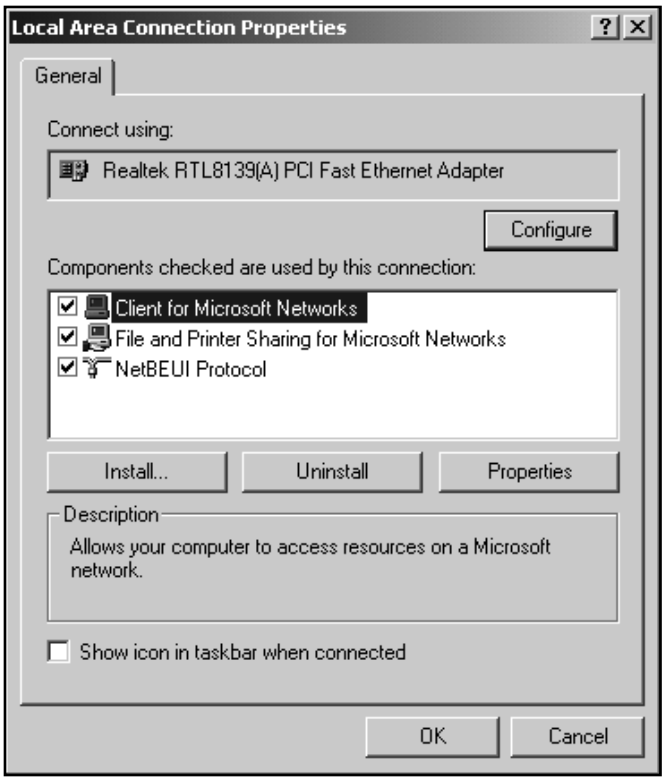


Figure 2
The Local Area Connection properties dialog box.

5. We could install TCP/IP in addition to NetBEUI. However, here in the classroom, there might be some confusion as to which protocol is in use. To avoid any doubt as to which protocol is in use, let's uninstall NetBEUI altogether. Highlight *NetBEUI Protocol* and click on the *Uninstall* button. Click *Yes* to verify that you wish to uninstall NetBEUI.

6. After a short delay, the protocol icon will disappear from the list and a message will ask if you want to restart the computer. Click on *No* because you are not yet done.

7. In this lab, you will use the TCP/IP protocol. Click on *Install*, select *Protocol*, and then click on the *Add* button. At the next window, select *Internet Protocol (TCP/IP)* and click *OK*.

8. When asked if you want to restart the computer, click on *Yes*. After a delay (possible several minutes), the computer reboots to the Desktop. Clear any error messages that occur, if necessary. If one or more of the computers should hang up during the process, restart the computer using the front panel power switch.

9. You should now have TCP/IP installed on all four computer. All computers should be booted to the Windows 2000 Desktop.

10. Right-click on *My Network Places* icon and select *Properties* from the resulting menu. Then right-click on the *Local Area Connection* and select *Properties* from the resulting menu. The *Local Area Connection* dialog box will open. Notice that the *Internet Protocol (TCP/IP)* is installed. Highlight *Internet Protocol* (TCP/IP) and read the *Description* at the bottom of the window. What do the initials TCP/IP stand for? _____
_____
The description explains why TCP/IP is preferred to NetBEUI.

11. With *Internet Protocol (TCP/IP)* still highlighted, click on the *Properties* button. The *Internet Protocol (TCP/IP) Properties* dialog box will open as shown in Figure 3.

12. Read the message at the top of the dialog box. It gives you two choices. You can get the IP settings automatically if your network supports this capability. Otherwise you must get the appropriate settings from your network administrator. We will explain this is more detail in the following Discussion. For now, make certain that the *Obtain an IP address automatically* radio button and the *Obtain DNS server address automatically* are checked as shown in Figure 3. Click on *OK* and at the next window click on *OK* again.

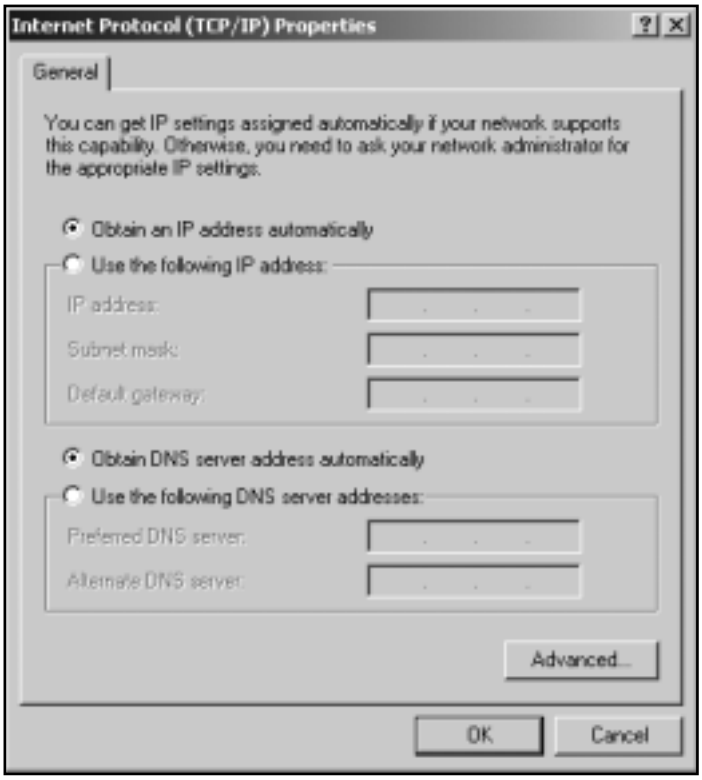


Figure 3
The *Internet Protocol (TCP/IP) Properties* dialog box.

Discussion

At this point you have changed the protocol from NetBEUI to TCP/IP. Because you did not make changes in the *Internet Protocol (TCP/IP) Properties* dialog box, TCP/IP is set to its default state which is to obtain its IP settings automatically. Normally, this means receiving its IP settings from a special server called a DHCP server. DHCP stands for Dynamic Host Configuration Protocol. The DHCP server is great when there are lots of computers on the network. It saves the network administrator (or someone) the laborious job of entering TCP/IP information manually. As you will see later in this lab, several pieces of information are required by each computer on the network. Unfortunately, no DHCP server is presently on the network. Nevertheless, Windows 2000 does a fair job of configuring the network anyway. Let's take a look.

Procedure (continued)

Exploring the TCP/IP Settings

Note: Perform the following steps on each of the four computers.

13. Close any open windows. On each of the four computers, double-click on *My Network Places* and open *Computers Near Me*. The display should resemble that shown earlier in Figure 1. Make sure all four computers (Web, Rock, Time and River) show up.

    One after another, double-click on each computer icon and make sure that each computer responds by showing a window labeled with its name. This shows that the network is still intact and working, even though you changed the protocol. Since you did not manually configure TCP/IP, the computer must have done it automatically. Close the *Computers Near Me* window.

14. TCP/IP has a group of wonderful utilities that help you to explore the network. We will examine two of them in this lab. The first is called IPCONFIG, which stands for Internet Protocol Configuration. Its purpose is to tell you the Internet Configuration of the computer on which it is executed. IPCONFIG is executed from the Command Prompt window.

    Earlier versions of windows use a command called WINIPCFG which does the same thing, but gives a more graphical display. Also, UNIX/Linux has a command called IFCONFIG that performs the same function. Whatever the command is called, it is instrumental in determining how TCP/IP is configured on your computer.

15. Click on the *Start* button. Select *Programs*. Then select *Accessories*. Finally select *Command Prompt*. The *Command Prompt* window will open as shown in Figure 4.

16. Type:

    ipconfig

    and press *Enter*.

17. Your display should now resemble that shown in Figure 5, although some of the numbers will be different. Look at the line entitled *Autoconfiguration IP Address* and complete the following:

    169.254.____._____

18. Consult with the other members of your Workgroup and complete the following table:

Computer Name	**Autoconfiguration IP Address**
Web	169.254._____._____
Rock	169.254._____._____
Time	169.254._____._____
River	169.254._____._____

19. Also, consult with the other members and see what the Subnet Mask is for each computer. Is it the same for all computers? _____ What is the Subnet Mask? _____

Figure 4
The *Command Prompt* window.

Figure 5
The results of the IPCONFIG command.

Discussion

In this part of the lab, you used the IPCONFIG command to determine the IP parameters used on the computers. Using IPCONFIG you saw that each computer had been configured with an IP address and a Subnet mask.

Where did these IP addresses and Subnet masks come from and what do they mean? Well, remember that we left TCP/IP configured for "automatic" even though there is no DHCP server in the network to provide the needed IP configuration information. When this happens, Windows 2000 does a special Autoconfiguration. Here is how it works.

When Windows 2000 boots, it sees that TCP/IP is configured for automatic setup from a DHCP server and it attempts to contact the DHCP server. In effect, it broadcasts a message saying: "Can someone give me my IP configuration parameters?" When it receives no reply, it takes matters into its own hands. It picks an IP address at random in a range between 169.254.000.001 and 169.254.255.254. and it uses a Subnet mask of 255.255.000.000. Since there are about 64,000 IP addresses in this range, chances are good that on a small network no two computers will pick the same IP address. Even so, to be on the safe side, the computer broadcasts a message asking if anyone else is already using that address. If so, it picks another address at random. But if it gets no reply, it keeps the selected address. This is how the four computers on your LAN got their IP configuration information.

The TCP/IP LAN can be autoconfigured as it was here. It can be configured by a DHCP server, assuming one has been set up. Or, it can be configured manually. If you want to know more about *the IP Address and the Subnet Mask*, read the next section. Otherwise, skip over to the next *Procedure* section, *Manually Configuring TCP/IP*.

The IP Address and the Subnet Mask

Notice that the IP address consists of four numbers separated by dots in the form: 169.254.123.111. Each of the four numbers can have a value between 0 and 255. If you do the multiplication you will see that there are about 4 billion possible IP addresses.

Every computer of the network must have a unique IP address. This holds true, even if the network is the Internet. Since there are tens of millions of computers using the Internet, who makes sure that everyone has a unique IP address? That job falls to the Internet Network Information Center (InterNIC). If a computer is going to connect to the Internet, its IP address must be registered with InterNIC. By assigning IP addresses, InterNIC ensures that no two computers on the Internet have the same IP address.

The IP address starts as a 32-bit binary number that uniquely identifies your computer on the Internet. Also, it uniquely identifies your computer within your own network when the TCP/IP protocol is used. While the IP address is a 32-bit binary number, it is most often expressed in a "dotted decimal" form. To convert from binary to dotted decimal, the 32-bit number is divided into four 8-bit groups, like this:

11001100 10000001 01110001 00000111

Then each 8-bit number is converted to its decimal equivalent. In this case:

204 129 113 7

Finally, the decimal numbers are separated by dots like this:

204. 129. 113. 7

Usually, you do not have to worry about converting the IP address from one form to the other.

The IP address consists of two parts: a network address and a node address. In the example shown here, the first three dotted decimal groups (204.129.113) form the network address. The final dotted decimal group forms the node address. Since this group can have any value between 1 and 254, up to 254 computers can be connected to this network.

The Subnet mask is another 32-bit binary number. It is usually expressed as a dotted decimal equivalent. Its purpose is to make the IP address more flexible. When converted from its dotted decimal form to binary, the Subnet address is always a string of 1's followed by a string of 0's. For example, the subnet mask in the above example is 255.255.255.0. Expressed in binary this is:

11111111 11111111 11111111 00000000.

The 1's tell the computer which part of the IP address is the network address; while the 0's indicate which bits are be used as the node address.

Procedure (continued)

Manually Configuring TCP/IP

Generally, you will not have to be concerned with the details of IP addresses and Subnet masks. These will be assigned either by a DHCP server or by your network administrator. However, once you are given the proper IP configuration information, you should know how to configure TCP/IP manually.

When configuring TCP/IP manually, you will normally be given the following information:

- A range of IP addresses to use, or a specific IP address for each computer.
- A Subnet Mask
- A Default Gateway IP address
- One or more DNS server addresses

For example, let's assume that your network administrator tells you to use the following IP parameters for your workgroup:

- IP addresses:

  Web: 192.168.254.001

  Rock: 192.168.254.002

  Time: 192.168.254.003

  River: 192.168.254.004

- Subnet mask: 255.255.255.000
- Default Gateway: 192.168.254.254
- DNS Server: 192.168.200.001

Now let's use this information to manually configure TCP/IP on the four computers.

Note: Perform the following steps on each of the four computers.

20. Close any open windows. Right-click on *My Network Places* icon and select *Properties* from the resulting menu. Right-click on the *Local Area Connection* and select *Properties* from the resulting menu. The *Local Area Connection* dialog box will open.

21. Highlight *Internet Protocol (TCP/IP)* and click on *Properties*. The *Internet Protocol (TCP/IP) Properties* dialog box opens.

22. Click on the *Use the following IP address* radio button. Notice that the five dialog boxes become active as shown in Figure 6.

23. Note the name of the computer that you are using. Refer to the IP configuration information given above. Find and enter the proper IP Address for your computer.

24. Enter the Subnet mask in the box provided. What happen when you placed the cursor in the Subnet Mask box? _____
_____

    The reason for this is that 255.255.255.0 is the default subnet mask for any IP address starting with the numbers 192 through 223.

25. Enter the Default Gateway address in the space provided.

    The *Default Gateway* address is usually the IP address of a device called a Router. The Router is a special purpose computer that connects multiple networks together and determines the optimal path to direct information from one network to another.

Figure 6
Manually configuring the Internet Protocol (TCP/IP) Properties dialog box.

Each network can be thought of as a separate world unto itself. And yet many different networks can be connected together by a system of routers. Each network can have a router that acts as a gateway to the world outside the local area network (LAN). The outside world is accessible only through the router. When used in this way the router is called a default gateway. Any information intended for a computer that is not in the LAN is sent to the default gateway.

A simple LAN like yours may not have a default gateway. If not, it cannot communicate with networks outside the LAN. You know that your LAN presently does not have a default gateway. But your network administrator has plans to add one, which explains the Default Gateway address you were given.

26. Enter the DNS server address given above in the *Preferred DNS server* address box. Leave the *Alternate DNS server* address box blank.

    DNS stands for Domain Name Service. Computers on the Internet (or any other TCP/IP network) are identified by IP addresses. But if you have used the Internet, you know that you do not refer to locations by IP addresses. You use Domain Names like *www.ford.com* and *www.nasa.gov*. Somewhere along the line something must convert these domain names used by humans into the IP addresses required by computers. The conversion is done by a Domain Name Server. This is simply a server that looks up the Domain Name and converts it to the proper IP address. In order to do this, the computers on your network must be given the IP address of the Domain Name Server that they are to use for this purpose. At present you network does not have a Domain Name Server. But again the network administrator has plans to connect your LAN to one, which is why the DNS address was given.

    Often a second, alternate DNS address is given in case the preferred one is off the air or busy. In this case you were not given an alternate DNS address.

27. Recheck all the information in the *Internet Protocol (TCP/IP) Properties* dialog box. When you are sure everything is correct, click on *OK*.

28. Back at the *Local Area Connection Properties* dialog box, click on *OK*.

29. It may take a while for the network to recognize all the new settings. While you are waiting, use the IPCONFIG command to verify that your computer has the new settings installed. Click on the *Start* button. Select *Programs*. Then select *Accessories*. Finally, select *Command Prompt*. The *Command Prompt* window opens.

30. Type:

    ```
    ipconfig
    ```

    and press *Enter*.

31. Verify that the *IP address*, *Subnet Mask* and *Default Gateway* address are correct.

32. While you are at the Command Prompt, let's examine another of the TCP/IP utilities called PING. Ping is a command that allows you to test the connectivity to another computer. More over, it tells you if the other computer can respond. It does this by transmitting a series of data packets to the selected computer. The selected computer responds by resending the data packets back to the original computer.

33. To see how it works, at the keyboard of the computer called *Web*, type:

    ```
    ping rock
    ```

    and press *Enter*. Watch the screen closely as the replies return from Rock. When all four packets are returned, the display should look similar to that shown in Figure 7.

34. Recall that Web's IP address is 192.168.254.1. At the keyboard of the computer labeled *Rock*, type:

    ```
    ping 192.168.254.1
    ```

    and press *Enter*.

35. If time allows, try pinging other machines both by name and IP address.

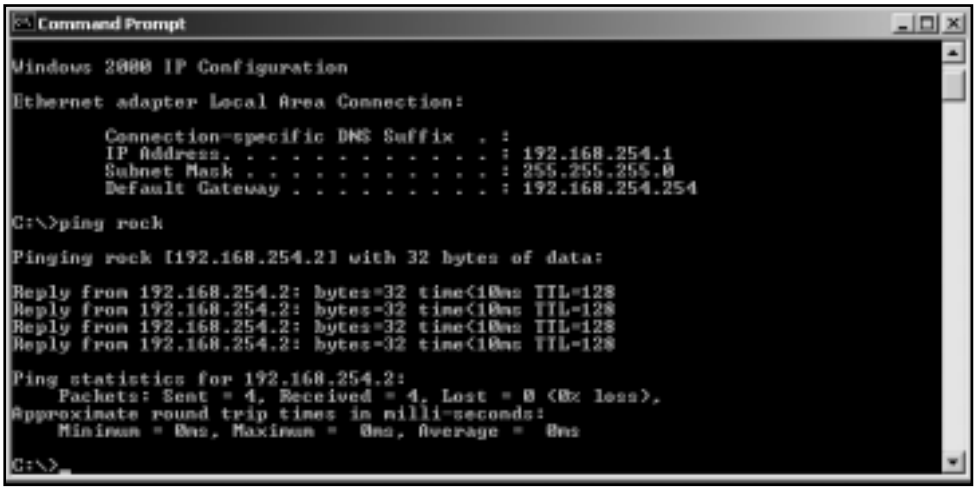


Figure 7
Replies from Rock show you that the connection is working.

36. When you have had enough pinging, double-click on *My Network Places* and open *Computers Near Me*. Make sure all four computers (Web, Rock, Time and River) show up. One after another, double-click on each computer icon and make sure that each computer responds by showing a window labeled with its name. This shows that the new TCP/IP setting work as they should.

37. Close all open windows and using the proper procedure shut down the computers.

Discussion

In this part of the lab, you configured TCP/IP by manually entering the proper IP address, Subnet mask, Default Gateway, and DNS server address. Because of the simply nature of your network, only the IP address and Subnet mask are absolutely required.

Next you verified that each computer could communicate with every other computer using the PING command. You saw that you could PING a computer by using either its name or its IP address. Finally, you verified that the network was working by opening folders on each of the other computers.

This has been a brief introduction to TCP/IP. You saw that Windows 2000 has the ability to establish a minimal configuration through a process called *autoconfiguration*. Normally though, TCP/IP is configured either through a DHCP server, or manually by a network administrator or a designated representative—like you.

This concludes your introduction to TCP/IP, your introduction to Networking, and perhaps even your Introduction to Personal Computers. The key to remembering what you have learned is to use the information. In this regard, a computer is a bit like a piano. You learn to use it effectively by practicing every day. Try to get in the habit of using your computer daily and always with an eye toward using it more effectively and for a wider range of activities. The personal computer is a magnificent tool that will serve you well if you master even a fraction of its capabilities.

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Lab Objective Checklist

Lab 1-1

_____Identify, disconnect, and reconnect the computer's external units.

_____Remove and replace the computer's cover, cables, and interface cards.

_____Identify the external connectors on the computer.

_____Identify the major internal units.

Lab 1-2

_____Identify the input and output voltages of the power supply.

_____Explain how power is distributed throughout the computer.

_____Demonstrate the proper way to remove and replace the power supply in the computer.

_____Compute the power consumption of the PC.

Lab 2-1

_____Explain how power is distributed throughout the motherboard.

_____Identify and explain the purpose of the main circuits on the motherboard.

_____Identify and explain the purpose of the CNR expansion bus, the PCI expansion bus, and the accelerated graphics port (AGP).

_____Identify and explain the purpose of the DIMMs.

Lab 2-2

_____Start the Setup Program.

_____Use Setup to change the configuration of your computer.

_____Restore the default configuration if the Setup information is lost or changed.

_____Customize your configuration by making changes in Setup.

Lab 3-1

_____Identify the elements on the Windows 2000 Desktop.

_____Resize and move a window.

_____Open and close a program.

_____Use the Start button features: Programs, Settings, and Shut Down.

_____Use several different methods to switch between open applications.

_____Customize the Taskbar.

Lab 3-2

_____Use the functions built into the Windows 2000 *Save As* and *Open* dialog windows.

_____Create, name and save files.

_____Create and name folders.

_____Move files to a folder.

_____Use the right mouse button to access common Windows functions.

Lab 4-1

_____Modify the contents of the Start menu.

_____Choose between several viewing options.

_____View Hidden files and display file extensions.

_____Display a file's properties, including version and attributes.

_____Locate files using the Search utility.

Lab 4-2

_____Create shortcut icons of applications, documents, folders and drives.

_____Place files, folders, and shortcuts on the desktop.

_____Copy, move, delete, restore, and organize files and folders.

_____Explore and adjust the properties of the Recycle Bin.

Lab 5-1

_____Select and Configure the available options in several Control Panel managers including: Regional Settings, Keyboard, Mouse, Sounds and Multimedia, and Accessibility.

_____Determine the version number of Device Drivers.

_____Determine the resources used by a particular device.

_____Access the Microsoft Troubleshooting procedure for a device.

Lab 5-2

_____Identify the purpose of the Check Disk and "Defrag" Utilities included with Windows 2000.

_____Identify the purpose of the Backup, Restore, and Emergency Repair Disk utilities of Windows 2000 and explain where each is located.

_____Describe two ways to access the Disk Manager in Windows 2000.

_____Use the Disk Manager to create and delete a disk partition, format a partition, and change the partition name, drive letter, or path.

Lab 6-1

_____Implement password protection.

_____Identify the properties of every local user on the computer.

_____Add a new local user to the operating system.

_____Identify where user information and resources are stored on the local computer.

_____Identify the current users and groups on the local computer.

Lab 6-2

_____Describe the purpose of the Security and Sharing tabs of the Windows 2000 Properties dialog box.

_____Explain why sharing is only useful on a network of computers.

_____Use a Properties dialog box to regulate how a user may access the contents of a file, folder, or computer.

_____Explain why different users and groups would have different permissions for the same file, folder, or computer.

Lab 7-1

_____Use the Backup and Restore Tools to build an ERD.

_____Describe the contents of the ERD.

_____Create a set of Windows 2000 floppy disk start-up disks.

_____Boot the Windows 2000 Setup program from floppy disks.

_____Install and use the Recovery Console.

_____Use the Advanced Startup Options to boot into Safe Mode.

Lab 7-2

_____Remove the floppy disk drive from a PC.

_____Identify the major components of a floppy disk drive.

_____Configure a floppy disk drive.

_____Install a floppy disk drive.

Lab 8-1

_____Safely remove a hard disk drive and a CD-ROM drive.

_____Use the BIOS Setup Utility to determine the configuration of hard drives and CD-ROM drives.

_____Replace a hard drive ribbon cable.

_____Properly configure hard disk drives and CD-ROM drives using the Cable Select method.

_____Install a hard disk drive.

Lab 8-2

_____Explain why the *Cable Select* method of configuring drives may not always be appropriate.

_____Configure hard disk drives and CD-ROM drives using the *Drive Select* method.

_____Properly install hard drives and CD-ROM drives.

Lab 9-1

_____Define the term fragmentation as it relates to computer data files.

_____Defragment the system hard drive.

_____Schedule a task to run automatically.

Lab 9-2

_____Remove and install an AGP video adapter.

_____Demonstrate the display differences between 8-bit, 16-bit, and 32-bit color display settings.

_____Use different adapter settings to control the dot resolution and the number of colors in a display.

_____Demonstrate the best (highest) resolution levels that should be used for a monitor of a given screen area size.

Lab 10-1

_____Identify a memory module as a SIMM, SDR DIMM, or DDR DIMM.

_____Demonstrate the proper method of uninstalling and reinstalling a Dual In-line Memory Module (DIMM).

_____Explain the purpose of, and give an example of, a normal and an abnormal beep code.

Lab 10-2

_____Use UTP cables and a hub to physically connect computers together in a peer-to-peer network.

_____Configure a Windows 2000 computer to act as a member of a peer-to-peer network.

_____Change the Client, Services, Protocol, and Name of a Windows 2000 computer.

Lab 10-3

_____Explain the difference between *Security permissions* and *Share permissions*.

_____Explain the difference between Full Control access and Read-only access.

_____Turn sharing *on* or *off* for a particular resource.

_____Access and modify files on a host computer from a remote guest.

Lab 10-4

_____Configure the TCP/IP protocol.

_____Use IPCONFIG to determine the TCP/IP configuration of computers on the network.

_____Use PING to verify the connections to other computers on the network.

_____Explain three ways that TCP/IP can be configured on a Windows 2000 based network.