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Computer Hardware Basics

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Digital computers have been around for over 50 years in many different sizes and configurations. When the first mainframe computes were designed, it was thought that all the computing needs could be accomplished with as few as 5 machines. Given the cost and complexity of the first systems, it's understandable why people felt that way. As far reaching an effect as the large mainframe had on the industry, it would soon be eclipsed by the inexpensive home computer.

You would be hard pressed to think of a business that has not been affected by computers. Large corporations that once relied totally on expensive mainframes began to put computers onto everyone's desk. Decentralizing computers made people more productive and with the addition of local area networks allow people to share data and communicate in ways that were once unheard of. E-mail has almost eliminated our use of the fax machine and allows instant communication worldwide.

The cost of computers has dropped so dramatically in the past few years that they are almost considered disposable. With home system prices as low as $300.00, you might ask why anyone would even bother repairing old systems. Wouldn't it be cheaper to buy a replacement rather than pay to have the system fixed? Especially when you consider that the new systems have twice as many new features as last year's model! So why would anyone want to take the time to learn about computers?

To answer that question, you need to define the user. Computer users can be basically broken into two segments, the home user and business user. Home users usually have enough knowledge to set up a new system, they simply plug color coded plugs into color coded ports and everything usually works. Most home users lack the knowledge to do much more than that; after all, they purchased the computer to connect to the internet, send e-mail, play games, and help their children with their homework. When it comes to knowing about

upgrading memory, replacing or defragmenting hard drive most would rather have someone else do it.

Businesses view computers differently; they see it as a tool used to increase productivity. They know computers will improve the bottom line of the company, but they also know there is a cost involved. Users must be trained to use new equipment that is constantly evolving. Preventative maintenance, networking, and printing is a daily issue with even small companies. It doesn't matter to a small company that the system they use only cost $500.00 when it crashes and has their accounts receivable information or payroll stored on it. Also consider the cost to the company in terms of the security of the data stored on a system.

According to the **U.S Bureau of Labor Statistics** the job market for Network & Computer Systems Administrators is expected to grow **much faster than the average** with and increase over 23% by the year 2018.

Job Outlook

Employment is expected to grow much faster than the average, and job prospects should be excellent.

Employment change. Overall employment of computer network, systems, and database administrators is projected to increase by 30 percent from 2008 to 2018, much faster than the average for all occupations. In addition, this occupation will add 286,600 new jobs over that period. Growth, however, will vary by specialty.

Employment of network and computer systems administrators is expected to increase by 23 percent from 2008 to 2018, much faster than the average for all occupations. Computer networks are an integral part of business, and demand for these workers will increase as firms continue to invest in new technologies

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Source: http://www.bls.gov/oco/ocos305.htm#outlook

Getting started, **opening up the system case**

Safety

The first thing you should notice on the back of any computer is that there are no warning labels telling you that there are "*hazardous voltages inside*", or that the unit contains "*no user serviceable components*" and maintenance should be done only by a "*qualified service technician*". On the back of every other electrical appliance, there is a warning label telling the end user not to open the case. Most appliances were never designed for the end user to remove the back since the inside of the appliances might have exposed power that could be lethal if accidentally touched. Then why isn't there a warning label on the back of a computer? Unlike other electrical appliances computers have an internal power supply that is completely enclosed inside the case. This **power supply** is completely sealed and any hazardous voltages are safely contained inside it. An end user who opened the computer located, the power supply, and attempted to open it would see a warning label. So it's important to remember that there are no hazardous voltages exposed inside a computer, unless you also open the power supply which is not a good idea. Monitors are also devices that should only be left to technicians certified to work on them due to the dangers of hazardous voltages. The manufacturers of computers realized that non-technical users would be required to open computers to install add-on devices, so every effort was made to make the inside of the computer safe to work on.

Hazards inside the computer

Knowing that you cannot be electrocuted if you put your hands inside a computer should be reassuring, but there are many other hazards you need to be aware of once you remove the cover.

- **Static Electricity** is something we have all experienced at one time or another, usually in the winter when the furnace is running and the humidity inside you home is very low. If you walk across a carpet and touch a

doorknob, you can feel the effects of static electricity. Depending on the conditions, you might not only feel it, but you might hear the discharge or even see a spark. Static electricity will not harm you unless you get struck by lightning which has much more voltage than you could build up by walking across a carpet. Static electricity can be devastating to a computer even at voltages lower than the average person could detect. When you consider that the average person cannot feel the effects of static electricity unless they manage to build up about 3,000 volts before they touch the doorknob, a component inside you computer could be damaged with as little as 30-50 volts. You could damage a component and never realize it. The worst part about this sort of damage is that the effects may take time before the component fails. It's similar to taking a piece of metal and bending it back and forth, eventually the metal will weaken and break. If you don't take proper precautions when handling components, you could be damaging them when you install them.

- **Static electricity facts / Figures**
    - It takes approximately **3,000** volts of static electricity before an average person can feel the effects
    - Walking across a carpet in a room with low humidity can generate as much as **35,000** volts of static electricity
    - Walking across a vinyl floor can generate **12,000** volts of static electricity
    - Styrofoam cups can generate **14,500** volts of static electricity
    - Electronic components can be ruined by as little as **30–50** volts of static electricity
    - Loose components like the CPU and Memory are more prone to static damage than entire circuit boards like a plug-in modem or a motherboard
    - When holding a circuit board always hold it by the edges, similar to the way you would hold a photograph, try not to touch anything metal

  o New devices are shipped in specially designed anti-static bags; these bags should be used to store components when not in use or when carrying components

- **Sharp Edges** Some computer cases are stamped out of sheet metal and the insides can have sharp edges. If you are working inside a computer check to see if the case has any sharp edges and protect yourself and electrical wires from them.

- **Heat**   One of the major causes of premature failures of computers is heat. All computers have fans built into the power supply, and all CPUs since the 80486 have had fans connected to them as well. The air circulation inside a computer is designed to allow cool air to be pulled in by the fans and maintain a proper temperature inside the computer. Pay close attention to the fans, keep them free of dust and if they start making noise they should be replaced. It much easier to replace a power supply fan rather than a motherboard. Try to keep wires inside pushed out of the way so air can flow through the system evenly, and be sure to replace any open slots in the back of the system that may have been removed; open slots can disrupt the airflow and cause overheating. Never run a computer for too long with the cover removed; without the cover, the airflow is disrupted and can cause the system to overheat. Another concern would be the build up of dust that accumulates on the components. Excessive dust should be removed by blowing the dust off with compressed air that is available in aerosol cans. Avoid using a vacuum cleaner to remove dust from the inside of a computer since most vacuum cleaners tend to generate a lot of static electricity.

Preventative Maintenance

- **Static Electricity** The best way to deal with static electricity is to eliminate it before you touch anything inside the system, or a loose system component. Do this by touching a metal piece of the computer <u>while the computer is plugged into the wall socket;</u> the system does not have to be

turned on, but it should be plugged in. When the system in plugged in its

metal frame will be connected to ground through the power cable. By

touching a piece of metal on the computer you give the static electricity on

your body an easy path to earth ground where static is dissipated. Be

certain to touch a metal piece on the unit, not the plastic front panel.

Remember, in order for this to work, the computer must be plugged into a

properly grounded electrical outlet.

Ground

If you use an extension cord to connect your computer to the electrical outlet, make sure the cord has the 3rd connector that provides the ground to the system case. The round connector on your power plug is what provides the earth ground that will effectively dissipate any static electricity that might be built up.
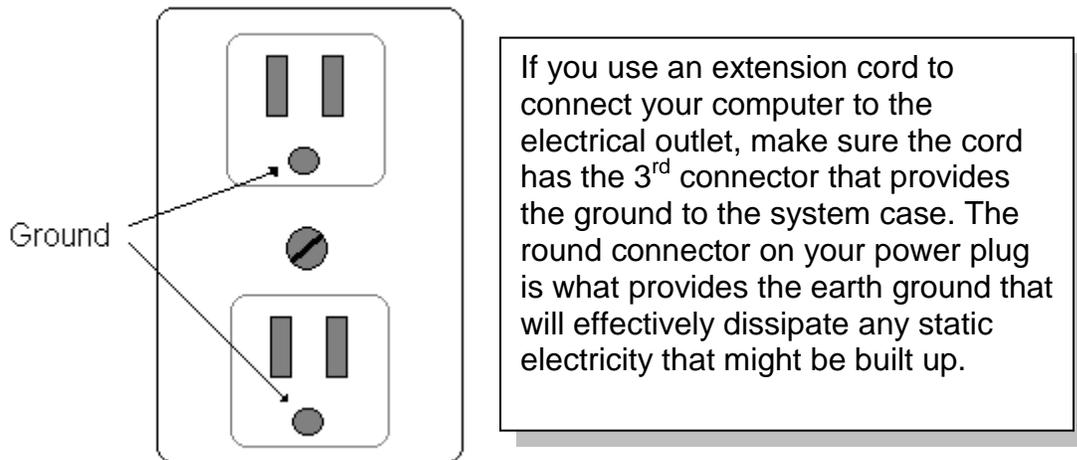
Other methods that will help reduce static electricity:

- Avoid carpeting whenever possible
- Maintain humidity at 50%
- Avoid synthetic materials
- Plants will help add humidity to a room and can lower static

- **Ground Straps** provide an effective method to eliminate any static that

  might be built up on you. The ground strap is a bracelet that has a clip

  attached which should be connected to the metal system case and worn

  whenever you work inside the system.

- **Heat build up** Be certain the system is not placed in a corner where there

  is inadequate ventilation. Do not place the unit in front of a heat register or

  any source of heat. Keep dust build up to a minimum by cleaning the

  system occasionally with canned compressed air; there are also special

anti-static vacuum cleaners available. If a fan starts making noise it should be replaced as soon as possible.

System Cases

A computer's case comes in two basic designs, a desktop, or a tower. They can be broken down into subsets. For example, there are towers, mini towers, and laptops. To keep it simple we will focus on desktop and tower designs.
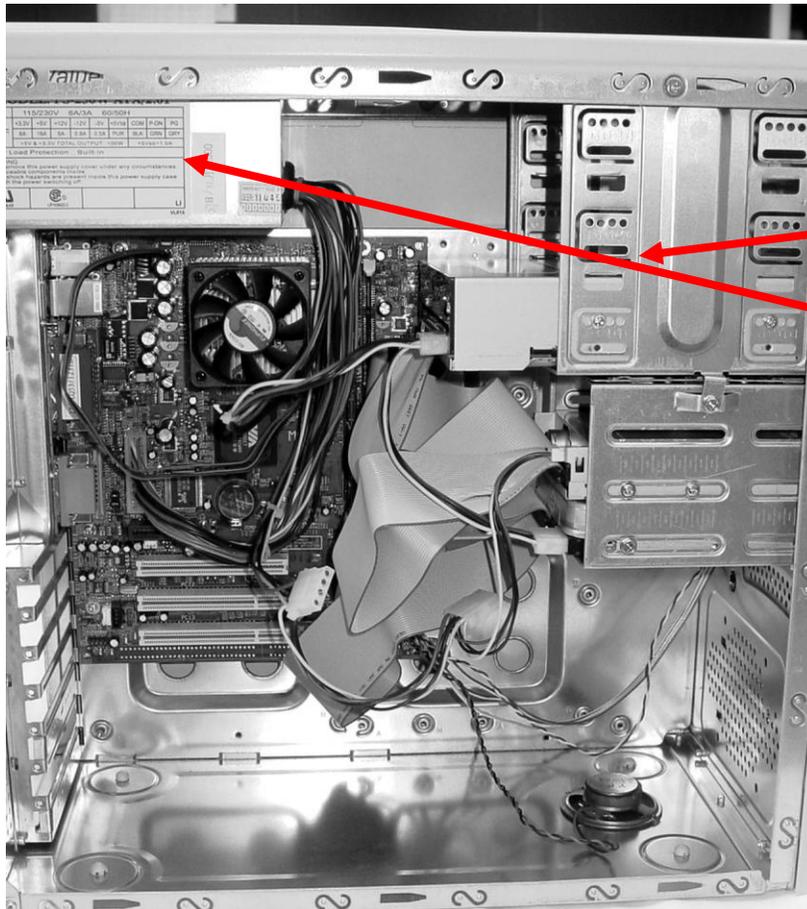
Typical Tower computer case, **Drive bays** shown on right. **Power Supply,** upper left corner.

Often the only difference between a Tower and a Desktop is the way the case is oriented.

If you are building your own system, there are some general rules you should follow when purchasing a system case:

- Avoid proprietary components whenever possible
- Will it accommodate your motherboard* (system board)
- Does it have an adequate power supply for the application you're designing the system for? A gaming machine requires much more power than an average computer

- Is the case built solidly?

- Are there sharp edges inside?

- Is there adequate space for add-on components such as:

    o Hard Drive bays

    o Expansion cards

    o Front Panel devices

    o Front mounted ports

- Is there adequate ventilation?

*Note the motherboard should be selected before considering the system case.

Form Factors

Computer cases support two standard-sized components: 3 ½" and 5 ¼". Floppy drives, some tape drives, and Zip drives typically fit into a 3 ½" opening. Larger devices like CD ROMs, DVDs, and some tape drives fit into a 5 ¼" opening. Depending on the style and size of the case you might get (2) of the 3 ½" external openings and (3) of the 5 ¼" openings; these are also referred to as drive bays. Computer cases have plastic plates that cover unused openings that can easily be removed to install new external devices. You should save these plastic knock-out plates; if you ever want to remove an external device, you can cover the opening with the original plate. Most cases also have a metal plate immediately behind the plastic front panel that needs to be removed as well. To remove the metal plate, take a pair of pliers and twist it off; the plates are made to be removed, but cannot be replaced after removal.

There are also **internal devices** that are installed behind the front panel. Hard drives are internal devices, meaning the end user doesn't have to be able to physically access it unlike an external device like a CD-ROM drive. Hard drives are usually 3 ½" form factor devices and fit into the same bay that a floppy drive might use, except that when you install the hard drive, you don't need to remove a front plate. Remember that you only have so many 3 ½" bays available. If you have a system needing a floppy drive, a Zip drive and (2) hard drives, and your system has (3) 3 ½" bays, you won't have enough bays to hold them all.

Chapter 1 Review questions –

1. T/F It is necessary to remove dust from the inside of the system because dust can conduct electricity and cause the system to short out.

2. It takes _____ volts of static electricity for the average person to feel the effects.

3. It takes _____ volts of static electricity to damage some components inside the system.

4. Floppy drives used in systems today have a _____ inch form factor.

5. CD ROM Drives used in systems today have a _____ inch form factor.

6. A computer used for _____ generally requires more power than system used to browse the internet, or send e-mail.

7. Electrical outlets used to power a computer should be _____ to dissipate static electricity.

8. Computer cases come in 2 basic designs, a desktop unit, and a _____.

9. When working inside a computer, wear a grounding strap that is connected to _____.

10. Name two devices a user should never open for safety reasons. _____ _____

DEFINITIONS Chapter 1

- **Drive Bay** – Is an area that is used to install drives

- **Mainframe** – Large expensive computers that could fill an entire room. The term has become obsolete over the years and is now referred to as **Enterprise Server.**

- **Power Supply –** A device housed inside the computer that is responsible for converting the electricity that you home uses (Alternating Current) to a form of electricity that your computer can use (Direct Current). Contrary to its name a Power Supply does not supply power it modifies it to a form that's usable by the system. Power supplies should not be opened since it would expose hazardous voltages to the user.

Useful Internet Sites:

- **http://computer.howstuffworks.com/** Information on computers and other interesting topics

- **http://www.bls.gov/opub/mlr/2004/02/art1full.pdf** Complete report from the Bureau of Labor Statistics on jobs

- **http://www.pcguide.com/** Comprehensive outline of the PC

- **http://www.tomshardware.com/** Up to date articles on what's new in the industry

- **http://www.pcwebopedia.com/** online dictionary and search engine for computer and Internet technology definitions

- **http://www.bls.gov/oco/ocos305.htm#outlook** U.S Bureau of Labor Statistics, **Occupational Outlook Handbook, 2010-11 Edition**, outlining significant points relating to:

  - Nature of work
  - Training, Other Qualifications, and advancement
  - Employment
  - Job Outlook
  - Projection
  - Wages
  - Related occupations

Computers

A computer is simply a device used to process data. The data being processed are words if you are running a word processor, pictures if you are running a photo editor, or numbers if you are running a spread sheet. The advantage a computer provides is its ability to quickly process information into a more meaningful form. Computers have existed for hundreds of years in mechanical forms. Gears, pulleys, and mechanical devices could be manipulated in such a way as to accurately accomplish mathematical computations. It wasn't until the beginning of the 20th century that the idea of an electronic computer was discussed, and it took a world war to make it happen.

The best way to understand the workings of a modern computer system is to study the evolution of computers. Even though you will probably never work on a vintage IBM PC, it's much easier to understand today's complex systems if you start from the beginning.

The evolution of the computer:

- The first known device used to assist with mathematical calculation was the Abacus developed around 3000 BC
- In 1617, John Napier created a mechanical calculator; referred to as Napier 's bones it was a crude slide rule
- In 1672, Blaise Pascal developed the first mechanical adding machine, capable of addition only
- In 1822, Charles Babbage created the Difference Engine which is touted to be the first general purpose computing machine
- In 1906, Lee De Forest developed the first vacuum tube
- During WWII, the concept of storing information using Binary code was devised; computing systems prior to that were based on analog voltage levels used to represent numbers

- In 1946, the ENIAC was developed which was the first electronic computing machine

- In 1947, AT&T Bell Labs developed the transistor

- In 1952, the Univac was used to develop the U.S. census

- In 1953, IBM delivered their first electronic computer

- In1955, AT&T developed the first all transistor computer

- in 1958, the first integrated circuit was developed by Texas Instruments

- In 1965, Gordon Moore co-founder of Intel, devised Moore's law which predicts that the number of transistors per square inch on integrated circuit doubles every year

- In 1969, the Department of Defense developed the first four nodes of the ARPA-net, which ultimately became the Internet

- In 1971, the first floppy disk was created; it was 8" and stored 160K

- In 1971, Intel developed the first microprocessor "**4004**"

- In 1971, the first personal computer Kenbak-1 sold for $750.00

- In 1972, Intel released the "**8008**"

- In 1974, the mouse was developed by Xerox

- In 1976, Steve Wozniak designed the Apple I

- In 1981, IBM released its first PC (Model 5051), based on the Intel 8088

This list is not a complete outline, but it does highlight some of the important milestones in the development of the modern computer. In 1906, Lee De Forest invented the vacuum tube, a simple device capable of amplifying electrical signals. Prior to that, devices used to perform calculations were mechanical, but with the vacuum tube, computing could be done electrically. The big breakthrough came in the 1940s when engineers decided to use **Binary** numbers as the method to communicate with computers rather than Decimal numbers. Binary uses only a single character that can represent two digits, a **Zero** and a **One**, rather than the ten digits required for **Decimal**. Using only one character makes it simple for a machine to understand; either it's ON, or it's OFF (1 or 0, black or white, true or false, yes or no). Then in 1947, AT&T's Bell Labs

developed the transistor; without it a lap top computer would be the size of a truck and use as much power as a small city. In 1971, Intel developed the first **microprocessor,** the 4004.This accomplishment took all the components required to create a CPU (Central Processing Unit), and integrated them into a single circuit (chip). This ultimately led to the 8088 used in the first IBM PC, and where we will begin our studies.

Basic Definitions:

To understand computers, you need to understand the terminology used to describe them. Many people find the hardest part of understanding computers is not the technology, but the terminology. These terms will be discussed in more detail throughout the course.

- **CPU**, the **C**entral **P**rocessing **U**nit is the device that is responsible for:
    - **Input** – User input from the keyboard, mouse, etc.
    - **Processing** – Adding, subtracting, sorting, and manipulating data
    - **Storage** – Storing data
    - **Output** – Delivering usable information to the user

As powerful as the CPU is, it is not a computer. A computer is made up of many other devices that work with and are controlled by the CPU, which we will discuss in other chapters.

The 4004 was the first CPU created as a single integrated circuit.

The 8008 soon followed the 4004 and was Intel's first 8-Bit CPU.
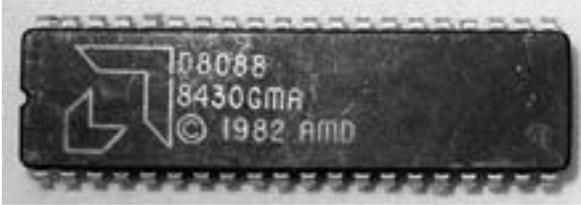
The Intel 8088 was the CPU IBM based the first PC (Model 5150) on in 1981

- **Bit –** Smallest piece of data a computer can work on, a 1 or a 0

- **Bus** – A bus is a term used in electrical work to define an electrical connection. Simply stated a BUS is a piece of wire used to carry a signal, or voltage between two points.

- **Byte –** 8 Bits

- **Clock -** Since computers work with Binary (on/off) there is a clock used to time exactly when events should happen.

- **Firmware –** A special type of hardware that has software written in it. Instructions are permanently stored inside hardware. Think of **firmware** as a book of instructions; the book is the hardware and the written instructions are the software. Firmware is also referred to as **R**ead **O**nly **M**emory (**ROM**).

- **Hardware –** A physical thing; you can touch hardware. Examples of hardware include a keyboard, a mouse, a monitor, an integrated circuit.

- **Operating System –** The instructions that coordinate the actions of hardware, software and the user.

- **Port –** A port is a connection used to connect an external device, either providing input (keyboard), or output (printer). Since there are a variety of external devices, there are many different types of ports.

- **Software –** Instructions that tell hardware what to do, hardware needs software to operate.

Computers communicate using Binary

The technology necessary to create a computer existed at the turn of the century with the creation of the vacuum tube. However, scientists never were able to resolve the issues of electrically representing, manipulating, and storing alphabetic or numeric characters. In order to manipulate data, there must be a

technique where it can be represented and stored electrically. Attempts were made using different voltage levels to represent numbers, but voltages tended to vary too much, and they were never successful. Then during World War II scientists solved the problem using the **Binary** numbering system.

Numbering Systems -

People are very familiar with **Decimal** numbering, probably because we have ten fingers; in the **Binary** system, you can only count using a single finger.

Binary digits = 0 1 ← one character can be either on or off.

Decimal Digits = 0 1 2 3 4 5 6 7 8 9 ← too many things for a stupid piece of hardware to keep track of.

When you count in Decimal, you start at 0 and continue until you reach 9 using only a single digit. To represent the number 10, you need to add a second digit, a 1 to indicate the number of "tens"; then go back to 0 again for the first digit to indicate the number of "ones". So when you see the Decimal number 23 you know there are 2 "Tens" and 3 "ones" that make up the number.

Like Decimal, Binary starts with 0, then 1 to indicate the first item. To count any further, you need to add a second digit since there are only 2 characters.

Counting in Decimal vs. counting in Binary –

Decimal   Binary

0   0   ← they both start the same
1   1   ← 1st item
2   10 ← add a 2nd digit
3   11
4   100 ← add a 3rd digit
5   101
6   110
7   111
8   1000 ← add a 4th digit
9   1001
10 ← add a 2nd digit   1010
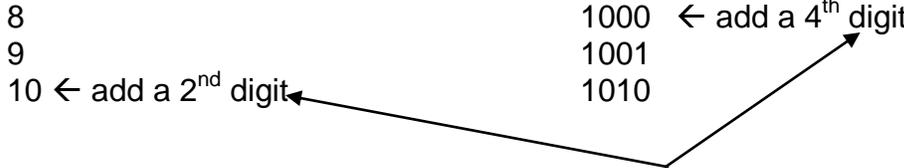
As in all counting systems when you add a new digit, all the digits to the right return to zero.

Decimal   99,999 + 1 = 1,000,000 ← when you add one more, 99,999 becomes 1,000,000; you add 1 in the "Millions" place, and everything else goes to zero.
Binary 11111 + 1 = 100000, when you add one more 11111 becomes 100000; all the ones to the right go to zero.

The character used to represent a numeric count of 8 would require 4 digits in binary, but only 1 using decimal.

- **Binary** representation of 8   →   1000
- **Decimal** representation of 8   →   8

Even though a Decimal representations uses up less space than binary, a single character rather than 4 as in digital, machines work with binary much better.

ASCII Character set

Since our alphabet contains 26 characters (A-Z) and we use both upper case and lower case, we would need 52 unique symbols to represent our alphabet. We also need to be able to represent the counting numbers as decimal, so we need ten decimal numbers 0-9 (remember the **output** is in Decimal so people can read it, the **input** is Binary so the computer can read it). So far, we have identified 62 unique characters. There are also unique characters for all the punctuation used in the English language, as well as quite a few characters for special purposes (like carriage return for the printer). When you add up all the characters needed by your computer, it comes up to 256. To uniquely represent 256 characters using Binary numbers, you would need 8 digits (think of digits as BITS, 8 BITS = 1 BYTE). So every character used by the computer can be represented by Binary numbers. Each character is represented by a binary number starting with 00000000 and going all the way up to 11111111. These characters are referred to as the **ASCII Character set**.

ASCII CHARACTER SET (Abbreviated set)

Character Name	Keyboard		Decimal	Binary	Hex
Question Mark	?	Shift /	63	00111111	3F
At Sign	@	Shift 2	64	01000000	40
Capital A	A	Shift A	65	01000001	41
Capital B	B	Shift B	66	01000010	42
Capital C	C	Shift C	67	01000011	43
Capital D	D	Shift D	68	01000100	44
Capital E	E	Shift E	69	01000101	45
Capital F	F	Shift F	70	01000110	46
Capital G	G	Shift G	71	01000111	47
Capital H	H	Shift H	72	01001000	48
Capital I	I	Shift I	73	01001001	49
Capital J	J	Shift J	74	01001010	4A
Capital K	K	Shift K	75	01001011	4B
Capital L	L	Shift L	76	01001100	4C
Capital M	M	Shift M	77	01001101	4D
Capital N	N	Shift N	78	01001110	4E

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Capital O	O	Shift O	79	01001111	4F
Capital P	P	Shift P	80	01010000	50
Capital Q	Q	Shift Q	81	01010001	51
Capital R	R	Shift R	82	01010010	52
Capital S	S	Shift S	83	01010011	53
Capital T	T	Shift T	84	01010100	54
Capital U	U	Shift U	85	01010101	55
Capital V	V	Shift V	86	01010110	56
Capital W	W	Shift W	87	01010111	57
Capital X	X	Shift X	88	01011000	58
Capital Y	Y	Shift Y	89	01011001	59
Capital Z	Z	Shift Z	90	01011010	5A

A complete list of the ASCII character set is available from the following web site:

http://www.pcguide.com/res/tablesASCII-c.html

The Data Bus

Since we can represent every character needed by a computer using only 8 bits we could communicate to the CPU using 8 wires to form a **BUS**, 1 wire for each.

This simple drawing shows 8 light bulbs connected to 8 on/off switches. By manipulating the switches, you can create any of the 256 ASCII Characters.

OFF **ON** OFF OFF OFF **ON** OFF OFF
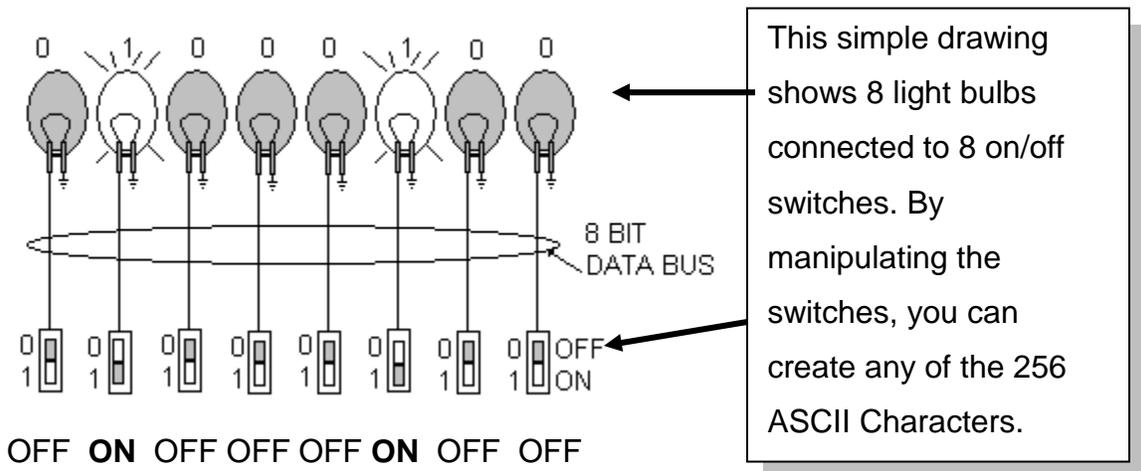
In the above example, **Bit #2** and **Bit #6** are **SET** (turned on), the others are **UNSET** (turned off). We sometimes use the term **SET** to indicate 1 and **UNSET** to indicate 0. The ACSII representation for the upper case "H" is **01000100**, represented by the light bulbs OFF **ON** OFF OFF OFF **ON** OFF OFF.

The **data bus** used in the first IBM PC was 8 bits wide (1 Byte).

8 Bit Data Bus
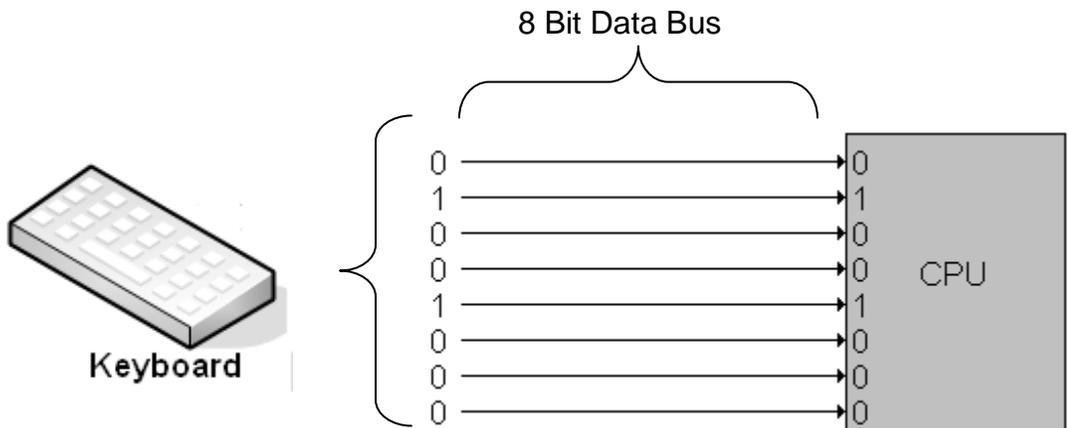
The data bus is conceptually 8 small wires that run from an input device (keyboard) to the CPU. The upper case letter "**H"** represented in ASCII with **01001000** is placed on the bus by the keyboard when the user enters "**Shift h**". To make a Binary **1,** the keyboard places a voltage on the wire; to make a Binary

0, the keyboard puts no voltage on the line. After the information from the keyboard is placed onto the data bus, the system clock pulses, signaling the CPU to read the input.

In the case of the **Intel 8088** the CPU can theoretically receive (or send) 1 Byte every time the clock pulses. The 8088 had a 16 bit internal bus, but the external bus (connections to the motherboard) was only 8 bits. Since the external bus was half the size of the internal bus the 8088 would have to take in 2 inputs to fill the internal bus. As CPUs progressed, the data bus became wider allowing it to work on more than one byte at a time (a clock pulse) which improved the speed of the processor. Processors will be covered in more detail later.

The total number of bits a processor can process at one time is referred to as **Word Size**. The Word Size of very early processors was16 bits, or 2 Bytes. The system's clock speed has also dramatically increased over time which also increased system speed.

The System Clock
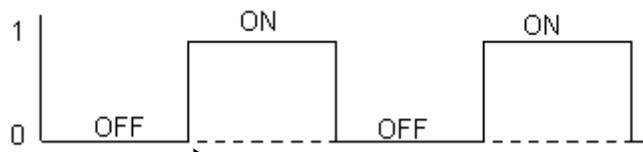
The system clock runs constantly, keeping everything running in step. During **INPUT,** the Clock goes from **0** (off) to **1** (on), it signals the CPU to read in whatever is placed on its **Data Bus**. The frequency of the clock (how many "ticks" per second) determines how fast a system would run. Some people will turn up the speed of the system clock to make the system run faster. This "**over-clocking**" can improve the system performance, but it also increases the heat generated by the processor and can possibly damage the system.
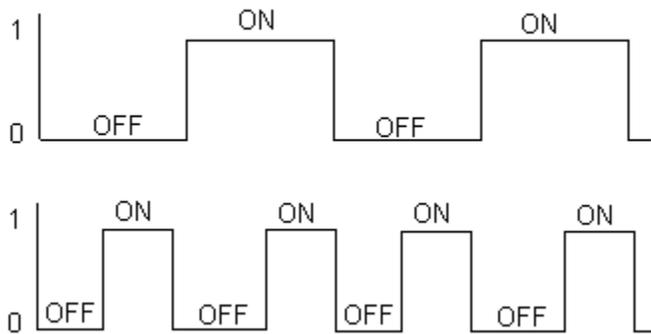
The clock on top runs slower than the one on the bottom. For each ON (1) pulse, the CPU can perform a single task. The faster the clock runs the faster the CPU will run.

Beyond the 8088

- **80286** has a 16 bit internal data bus (2 Bytes), twice the size of the **8088**, and a clock that runs at 10 MHz (beats 10 million times per second)

- **80386** has a 32 bit data bus (4 bytes) and a clock that runs at about 20 MHz

- **Pentiums** have a 64 bit data bus, and clocks that run up to 3.9 GHz (Billions). So for every clock pulse an 8088 receives 1 byte but a Pentium can receive up to 8 bytes, and its clock is running over 700 times faster.

Software

If our simple CPU was running a program that took upper case letters as **input** from the keyboard then converted each one to a lower case letter to be displayed as **output** by the monitor it might look like this.

Notice that the same 8 wires used for **input** are also used to send the **output** to the monitor from the CPU.
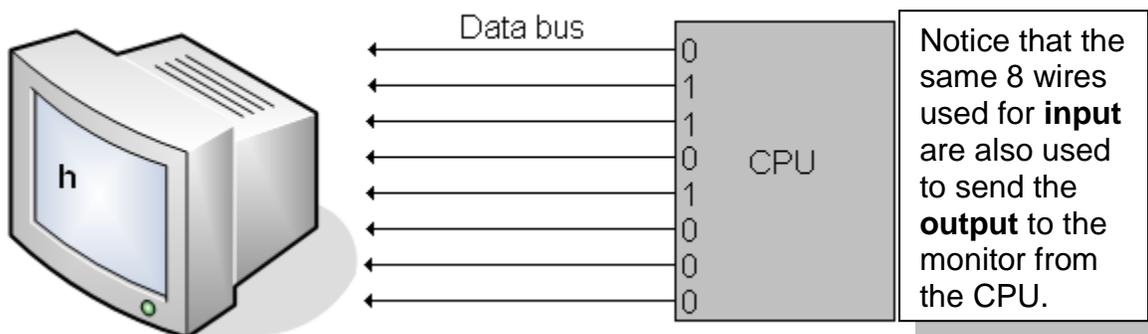
Software instructs the CPU to take any upper case character sent from the keyboard, convert it to lower case, and send it to the monitor to be displayed.

The examples used are overly simplified to clarify the interaction between devices over a bus. The actual steps involved would require many pages of explanation, but the results would be basically the same:

- The CPU receives **INPUT** from the Keyboard
- The **Software** (Program) instructs the CPU to convert any upper case character it receives to the lower case equivalent
- The CPU sends the **OUTPUT** to the system monitor
- The bus carrying the data into and out of the CPU, is often referred to as the I/O bus

Moore's Law: The observation made in 1965 by Gordon Moore, co-founder of Intel that the number of transistors per square inch on an integrated circuit had doubled every year since the integrated circuit was invented. Moore predicted that this trend would continue for the foreseeable future.

Chapter 2 Review questions –

1. The data bus for an Intel 8088 was _____ bits wide; the data bus for an Intel 80386 was _____ bits wide.
2. A _____ is used to carry signals and/or voltages.
3. What are the 4 main tasks of a CPU?
4. Hardware requires _____ to give it instructions that tell it what to do.
5. _____ is something physical that you can touch.
6. A Byte is _____ Bits.
7. ASCII Characters are _____ Bits in length.
8. The ASCII representation in bits for the Upper Case letter J is _____
9. The _____ runs constantly to keep the system running in step.
10. The _____ carries both input signals to the CPU as well as output characters from the CPU.

DEFINITIONS Chapter 2

*   **ASCII -** American Standard Code for Information Interchange
*   **Binary -** A numbering system using only (2) characters to represent numbers.
*   **Bus -** Wire(s) used to send signals or voltage from one point to another.
*   **Data Bus –** The bus that is used to move information into and out of the CPU.
*   **Decimal** – A numbering system using (10) characters to represent numbers.
*   **Firmware**- A device (hardware) that has software stored in it.
*   **Hardware** - A physical thing, you can touch hardware.
*   **Intel 4004** – The first CPU to be integrated into a single chip. By integrating the CPU, its cost would decrease tremendously.
*   **Intel 8088** – The first CPU used by IBM when they entered the home computer market. The 8088 had an 8-bit data bus.

- **Software** –The instructions that tell the hardware what to do.

Useful Internet Sites:

http://computer.howstuffworks.com/bytes1.htm Information on Number Systems.

http://www.pcguide.com/res/tablesASCII-c.html Information on the ASCII Character set.

http://www.cpu-world.com/links/ Information on the history of the CPU.

Computers come in many sizes and at one time we designated the functionality of the system by referring to its size. There was a Super Computer, a Mainframe, the Mini Computer, the Micro Computer, the Engineering Workstation and the Personal Computer. Each system was designed to serve a specific purpose, but over the years with CPUs becoming so powerful and inexpensive the various designations have become blurred. One thing they all have in common is the **Central Processing Unit**, but it wasn't until Intel created the 4004 that an entire CPU could be incorporated into a single integrated circuit. Once the CPU became an integrated circuit (Chip), the cost and size dropped to the point where home computers became a reality. Today's high powered Pentiums trace their beginning back to the **4004**.
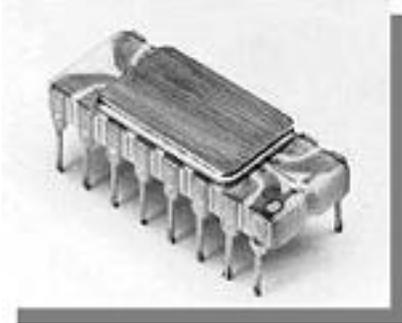
The 4004 was the first CPU created as a single integrated circuit. Created by Intel in 1972 to be used primarily in hand held calculators.

Central Processing Unit

The **CPU** handles **Input**, **Output**, **Processing**, and **Storage,** but is useless without instructions (**Software**), as well as other components that when added create a computer.

INPUT

The input to a CPU can come from various different sources. The keyboard is one easy to visualize component; the user types and the information is acted on by the CPU. Another area where Input can be provided is from the hard drive, a network connection, etc. We will cover storage at a later time, but for now just think of stored data as a place to save data until it's needed by the CPU.

OUTPUT

The CPU needs a way to send information to the user, which would be to the

monitor or possibly a printer. The CPU can also send information to memory where it can be stored for use at a later time. This stored data can later be read back into the CPU as input when needed.

STORAGE

As you can see from the first two examples, storage is a major function of the CPU. Data can be saved in many different ways to be used at a later time. Some storage is intended to be long term storage; some is short term storage and must be retrieved very quickly to keep the CPU running.

PROCESSING

CPUs must also be able to process data according to instructions provided by the software. Some of the things a processor does are actually rather basic. Add two numbers then store the result, compare two numbers and select the smallest, compare two numbers and select the largest, make decisions based on the outcome of an earlier computation.

TIME

One of the things that is the hardest to comprehend when studying computers is the concept of time. Consider this simple scenario:

- A person is running a word processing program writing a letter to her mother; she is typing at a rate of 100 words per minute. If the average word is 5 characters, then the user is typing 500 characters per minute, or about 8 characters per second. That means there is a new character being typed as input every 125 milliseconds.
- Now picture the CPU that's processing this input; assume it's a very old 8088. The 8088 had a clock rate of 4.77 MHz, which means it was theoretically possible of doing 4,770,000 tasks in 1 second. In our scenario the CPU would receive the first character sent by the keyboard, and then while waiting for the second character to be typed, it would keep itself busy by doing over 50,000 other processes! That's using an 8088;

imagine what a Pentium could do with all that spare time waiting for the next character to be sent!

BUSES

We already discussed the **DATA BUS,** which on an 8088 was 8 separate wires each carrying one bit of the 8-bit character; the other bus you need to understand is the Address Bus.

ADDRESS BUS

If you recall the example we used in an earlier chapter, we had a simple program that accepted an upper case character from the keyboard, converted it into a lower case character, and then sent it to the monitor to be displayed. We used the **data bus** to move the characters from the keyboard to the CPU (**Input**), and the same data bus to send data to the monitor (**Output**). This dual usage of the data bus, both providing input to the CPU and output from the CPU, greatly simplifies the main system board. Another thing to remember about the data bus is that every device that either sends data to, or receives data from the CPU is connected to the same bus. It would be like all the phones in a large city being connected to a single telephone line. If we had separate buses, one for input and a second for output for every device, our main system board would become huge, complex and very expensive. So how do we control all this traffic on a single bus?

All I/O Devices Connect to the DATA BUS, the ADDRESS BUS specifies which one is in use

The **Address Bus** has 20 bits (20 wires) that connect to every device that needs to either provide input or receive output from the CPU.

The Address Bus uses the I/O address of the device to allow the CPU to talk to it.
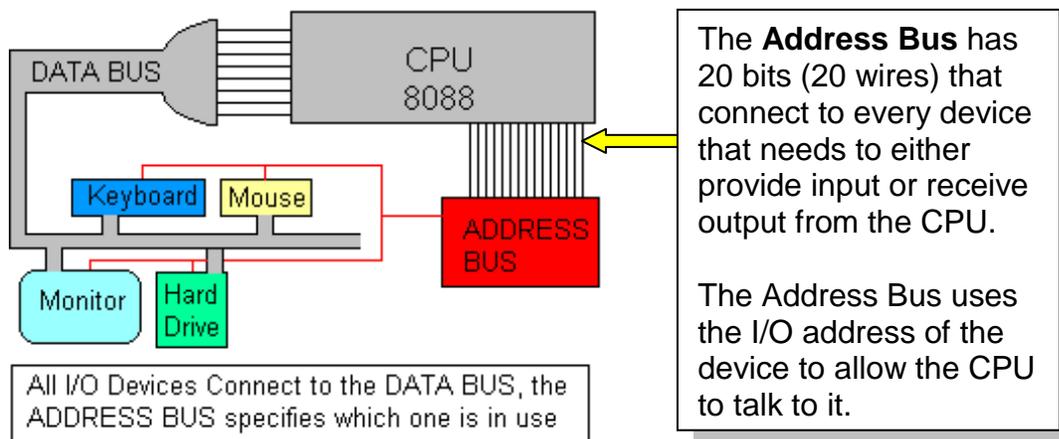
All devices that need to provide input, or receive output from the CPU (any device connected to the Data Bus) are assigned a unique I/O Address that the CPU uses to activate that specific device. In our simple drawing above, the Keyboard, Mouse, Monitor, and Hard Drive all have unique I/O Addresses that the CPU uses to point to (Address) the specific device. Only the devices being addressed by the CPU will respond. Think of the I/O Address as the phone number of the device.

8088 ADDRESS BUS

The **ADDRESS BUS** on an Intel 8088 is **20 bits** wide, used to uniquely identify the device the CPU wants to communicate with.

A simple Address bus

To simplify the explanation, assume we only have two devices connected to our extremely small 8-bit data bus, a keyboard at address 0 and a monitor at 1.

In our hypothetical system the Address Bus coming from the CPU is only 1 Bit wide.

With 1 bit we can only address 2 devices:
 0 →Keyboard
 1 → Monitor
 So we can only address the Keyboard and the Monitor.
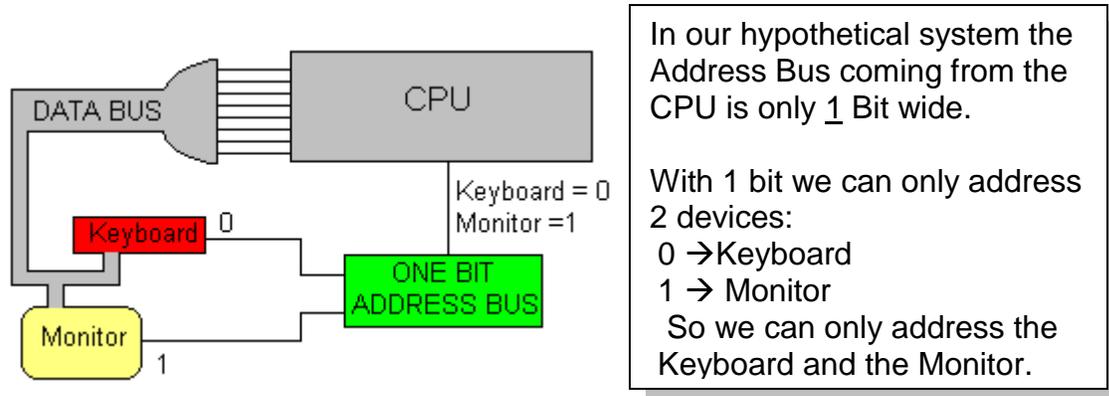
To enable the monitor, the address bus is set to 1; to address the keyboard the bus would be set to 0. So with a one-line address bus we can address two devices, one device with an address of 1 and one device with an address of 0. Now lets see what happens if we double the number of wires used in the Address Bus.

With **2** Address Lines, the CPU can now address **4** unique devices:
- 00 → Mouse
- 01 → Keyboard
- 10 → Hard drive
- 11 → Monitor

For every additional address line we add to the bus we double the number of addressable endpoints.
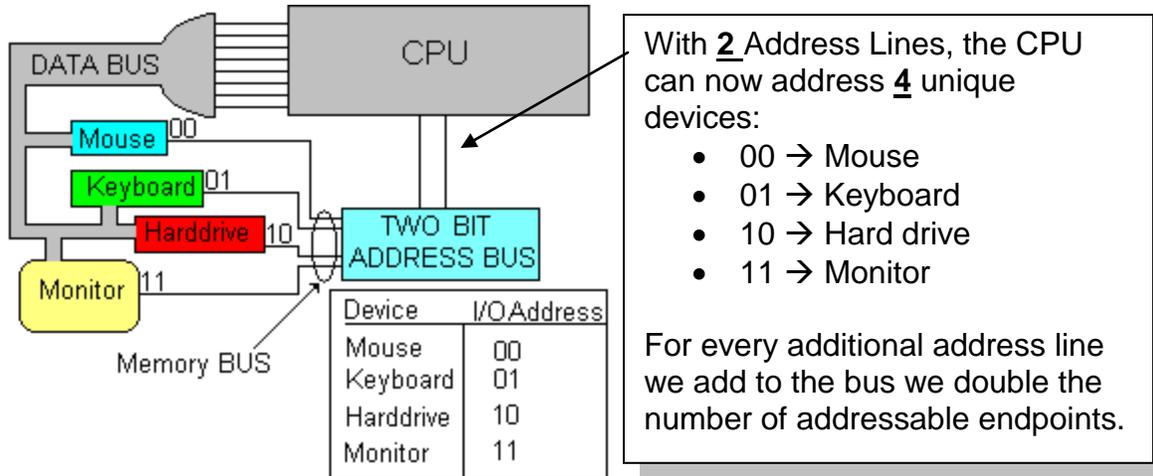
Since we are working with Binary (Base 2), for every line we add to the bus, we double the number of addressable endpoints (the devices we need to access).

Binary

With Binary, the total number of addressable endpoints is given by the formula:

2^n *where n = number of lines that make up the bus.*

1 line in the bus → $2^1 = 2$ **2** lines in the bus → $2^2 = 4$

3 lines in the bus → $2^3 = 8$ **20** lines in the bus → $2^{20} = 1$ Million+

Since an 8088 has 20 lines in its address bus it could address over 1 million endpoints. That might sound like a large amount, but in addition to addressing every I/O device, each storage location in memory also needs its own unique address, and systems today can easily use more than 526 million bytes of storage. When the 8088 was replaced by the 80286, an additional (4) lines added to the Address Bus. This 24-bit Address Bus allowed the 80286 to address 2^{24} or 16 Million locations. When the 80286 was replaced with the 80386, (8) additional lines were added to the Address Bus bringing the total to 32, allowing 2^{32} or 4,294,967,296 addressable memory locations.

The progression of the Intel CPU

The first CPU developed by Intel was the 4004 that had a 4-bi t data bus, was eventually replaced by a faster 8008 which led to the 8086.

8086

The **8086** was a full **16-bit processor** (it had a Data Bus of 16-bits), meaning for every clock pulse, the CPU could take in (or put out) 2 Bytes (2 ASCII Characters) at a time. The 8086 replaced the 8008 which was an 8-bit processor
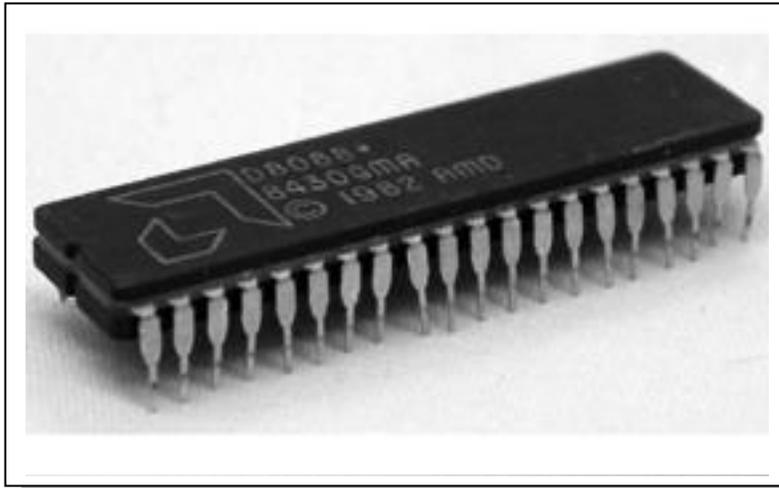
capable of only 1 byte per clock pulse. The 8008 had been in production for a few years before the 8086, and there were many companies manufacturing components designed to work on an 8-bit bus. These 8-bit components were vital to the overall operation of the computer and also added considerable cost. When the 8086 was announced, these 8-bit components had to be replaced by newer 16-bit components since the 8086 was a 16-bit processor. This created a huge surplus of the obsolete (cheap) 8-bit components since everyone was migrating to the new 16-bit architecture. Then (1981) IBM decided to get into the market manufacturing home computers. They weren't called PC (Personal Computers) yet, that name would be created by IBM once they released their first system. IBM realized that since there was an abundance of available 8-bit components left over from the 8008, and competitors were standing in line waiting for the new more expensive 16-bit components that were in very short supply; they could create a huge market for a new system. They approached Intel and requested a new processor called the 8088. The 8088 would be built similar to the 8086 except that the 8088 would only have an 8-bit external data bus. IBM knew that to re-engineer the 8086 to accept only 8-bits rather than 16-bits was relatively simple, and they could use the plentiful and cheap 8-bit

components since their system would be using an 8-bit data bus. Intel agreed and the 8088 was created. The 8088 maintained the 16-bit internal bus like the 8086, but used only an 8-bit external bus. This means that you would need 2 clock pulses to bring in enough data to fill up the internal data bus, but you could still use 8-bit components outside the processor.

The 8088 has an 8-Bit External Data Bus and a 16-Bit Internal Data Bus.
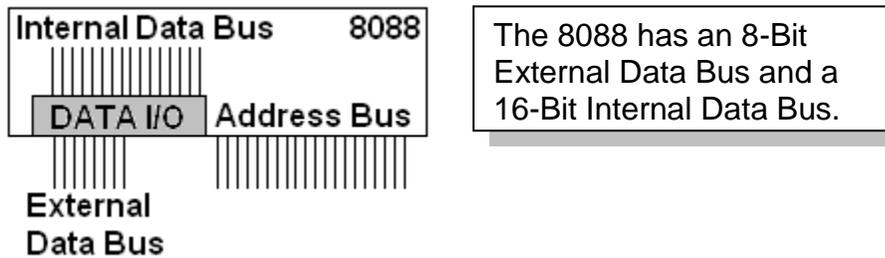
Not only could IBM produce a system using less expensive and readily available 8-bit components, they charged as much, and often more than systems using the full 16-bit 8086.

Beyond the 8088

Intel, wanting to sell more processors needed to come up with a new more powerful CPU that would make the 8088/8086 obsolete and create demand for the new processor. At the time, the market was ready for a new processor because the 8088/8086 was only capable of addressing 1 MB of memory with its small 20-bit address bus. Many of the applications that were being developed required more memory than the **8088/8086** could address.

Device	Data Bus	Address Bus	Clock Rate
8088	8-bit	20-bit (1MB)	4.77 MHZ
8086	16-bit	20-bit (1MB)	4.77 MHz

Intel 80286 – Released 1982

Intel released the **80286** with a number of improvements over the 8088/8086. The first improvement was a full 16-bit data bus, nothing new for the 8086. They also added (4) additional lines to the address bus; with a total of 24 they could now address up to 16 MB of RAM. They also increased the clock rate to 10 MHz.

So the new 80286 had a clock that was more than twice as fast as the 8088/8086 and could read in twice as much data per clock pulse as the 8088.

Device	Data Bus	Address Bus	Clock Rate
80286	16-bit	24-bit (16 MB)	10 MHZ

Bottom View of the 80286
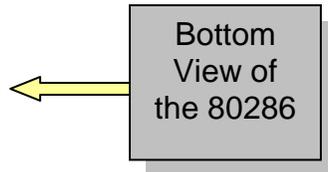
80386 – Released 1985

The 80386 doubled the Data Bus to 32-bits (4 Bytes), increased the Address Bus to 32-Bits and had a clock rate of 20 MHZ.

Device	Data Bus	Address Bus	Clock Rate
80386	32-bit	32-bit (4 GB)	20 MHZ

Surface Mounted 80386
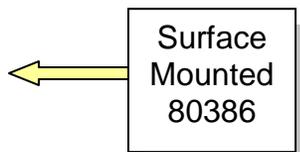
80486 – Released 1989

By this time, it was beginning to get harder to increase the throughput (speed) of the processor. A larger data bus would have been very expensive, since the mother board would have to be completely redesigned to add the extra wires, and the same holds true of the address bus. So they took an 80386, increased the clock speed to 40 MHz, and made the Math Co-Processor part of the CPU. Systems prior to the "486" did not incorporate a Mathematical Co-Processor. A math co-processor was a separate chip you would plug into the system board if you were doing math intensive computations. Without a math co-processor, any

math intensive calculations were performed using software, which was rather slow. Anytime you can replace software with hardware, you will improve the system performance, but sometimes at a cost. Hardware can be more expensive than a software program.

Device	Data Bus	Address Bus	Clock Rate
80486	32-bit	32-bit (4Gb)	40 MHZ

Surface Mounted 80486
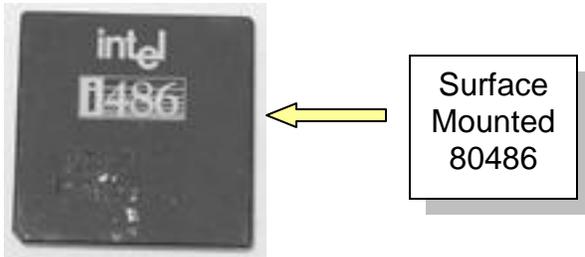
The Pentiums

By now, Intel was starting to feel the crunch of their competitors, many of whom were using the same numbering scheme as Intel 8086/80286/80386/80486; so Intel decided to stop using numbers to designate processors and start using names that could be copy written to prevent competitors from using the same name.

There are numerous versions of the Pentium starting with the "Pentium" all the way up to the "Pentium IV". The Pentium is actually made up of (2) 80486s ALUs. The ALU is the Arithmetic Logic Unit, which is the main calculation part of the CPU. The major change made with the Pentium was a 64-bit data bus, which is actually (2) 32-bit data buses, the Address bus stays at 32 bits. There were some Pentium class processors that went up to a 36-bit address bus, but that was primarily for servers. With a 32-bit address bus, you can address more memory than a system board can normally hold.

Beyond the Pentiums

Processor evolution up to the Pentium IV relied on increasing the size of the data bus as well as increasing the clock rate (The introduction of high speed cache memory also enhanced performance was introduced with the 486 memory will be covered in later

chapters) Up through the 386 increasing speed was accomplished by increasing the clock speed as well as increasing the size of the data bus. When the Pentium line was introduced, the size of the data bus reached 64 bits which was actually 2 separate 32-bit data buses each connecting to a separate ALU. To increase the bus size beyond 64 bits would require extremely complex and expensive motherboards so with the Pentium line Intel focused on increasing the system clock speed. In 2001 it was felt that CPU clock speeds would never exceed 1Ghz. Manufacturers were able to break the 1GHz clock speed, and the Pentium IV finally hit the limits of silicon at about 3.9 GHz.

The biggest problem with increasing clock speed is the heat generated by the processor as well as the tendency to create system noise. The solution to the problems with the high speed clocks was to create a 64-bit processor and run it at lower speed. The latest Intel and AMD processors run with multiple core 64-bit processors. The first Pentiums used two ALUs from the 486, new processors now run two or more 64-bit ALUs. In order to achieve maximum performance with new multi-core processors, applications must be rewritten to take full advantage of the processors capabilities.

Chapter 3 Review questions –

1. The 8088 was designed to use the 8-bit chips that were used in the earlier _____.

2. The 8086 has a _____ bit data bus and a _____ bit address bus.

3. The 80286 has _____ more address lines than the 8088.

4. The clock speed of the 80286 was _____.

5. An address bus with only 5 wires is capable of addressing _____ unique endpoints.

6. What improvement was made to the 80486 that the 80386 did not have?

7. Pentiums have ____ ALUs.

8. What is the size of the address bus for the 80386, and the 80486?

9. When was the 80286 released?

10. What was the first Intel processor that had a copy written name?

DEFINITIONS Chapter 3

- **Address Bus** – The bus used by the processor to address specific devices. Devices and Memory locations are assigned an address that the CPU uses to indicate which device is being accessed. Think of an address as a phone number used by the CPU to connect to memory locations as well as devices.

- **ALU** – Arithmetic Logic Unit is the part of the CPU that actually does the calculations. The Pentium is made up of (2) 80486 ALUs.

- **Co-Processor** – A co-processor is a specialized CPU that works with the main CPU to improve system performance

- **CPU** - Central Processing Unit is the device responsible for
    i. Input
    ii. Output
    iii. Processing
    iv. Storage

- **Math Co**-Processor - A math co-processor was intended to be added to an 8088, 80286, or 80386 to assist the CPU with math

intensive processing. The math co-processor for an 8088 was the 8087, the math co-processor for an 80286 was the 80287, and the math co-processor for an 80386 was the 80387.

Most people have an understanding of what makes up a computer since millions of people own one. All the various brands of computers all have a few things in common; they require software and hardware to perform even the simplest tasks. In this chapter, you will be introduced to hardware and how it contributes to the main functions of a computer: Input, Output, Processing and Storage.

Hardware is the term that is used to describe a computer's physical components. It is something that you can hold, a physical thing. The concept is rather simple; if it can be touched it's probably hardware, so why make such a big deal about defining hardware? Once you understand what hardware is, then it's a little easier to explain some of the other things that make up a computer, like software. Software is not something you can hold in your hand; you can not actually see software; it's virtual, not physical. You might say that when you hold a floppy disk in your hands you are "holding" software, but in truth you can't tell if that floppy disk is storing software or if it's blank; it certainly doesn't weigh more. The only way you know for sure is to load it into a computer and "look" at it there.

Input

Hardware used to interact with a computer would be categorized as an input device. To the end user a keyboard could be thought of as simply a small typewriter; a mouse is a device that moves a pointer on the screen. The ingenious thing about input devices is they're usually so simple to use they don't require any training, and they convert information from way humans see things (Analog) into information the computer can process (Digital). You can think of input devices as a very simple to use analog to digital converters that translate our human language into the special characters the computer uses; when a user enters the letter B, the computer sees it as series of on/off bits (01000010.)

Keyboards

The device used for input from the user, most have 104 or 105 keys. Some have enhanced functions that can be programmed allowing you to connect to your

home page or get your e-mail with a single keystroke. Some keyboards connect to the system wirelessly, but currently one of the most common method is to connect using a PS/2 connector, also called a 6-pin mini-DIN. Older keyboards (AT style) used a slightly larger 5-pin mini-DIN connector.

PS/2 connector used for keyboards and mouse connections, also referred to as a 6-pin mini-DIN

Older systems utilized a 5-pin mini-DIN connector for keyboard.
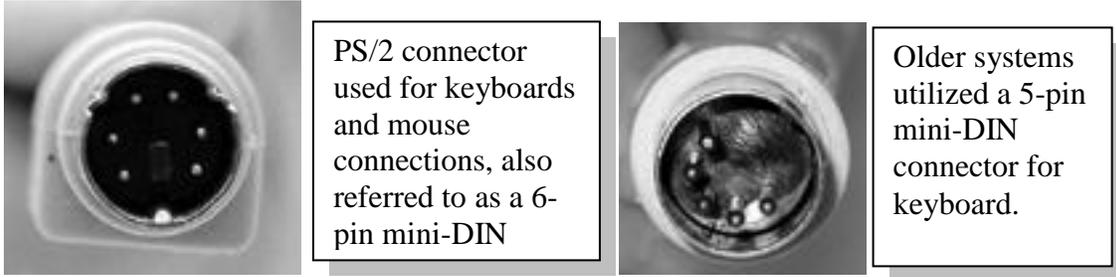
Obsolete

Pointing Devices

With the introduction of the Graphical User Interface (GUI), the mouse has become a normal part of every day use. It allows you to move a pointer across the screen and perform many tasks. The most common mouse is the track ball mouse that uses a rotating ball to track the movement on the screen. The optical mouse uses no moving internal parts; rather it tracks the movement using a light beam. One of the major benefits of an optical mouse is that since it does not use a ball, it requires no maintenance. A track ball mouse requires periodic cleaning of the ball to keep it tracking correctly.

There are numerous methods used to physically connect a mouse to the computer depending on the port used. The serial mouse connects using a 9-pin serial connection, the USB mouse connects using a USB port, but the most common method is through the PS/2 connection. On most systems the mouse and keyboard both connect to a PS/2 connector, which can cause a problem if the user plugs the mouse into the keyboard connector and the keyboard into the mouse connector. In an attempt to resolve the issue, manufacturers tried color coding the connectors. However, there was never a standard color. Some used green connectors for the mouse others used purple connectors for the mouse. One way to be relatively certain you plug the device in properly is to plug the

mouse in on top of the keyboard. Usually the keyboard is closest to the motherboard and the mouse is on top of the keyboard connector.
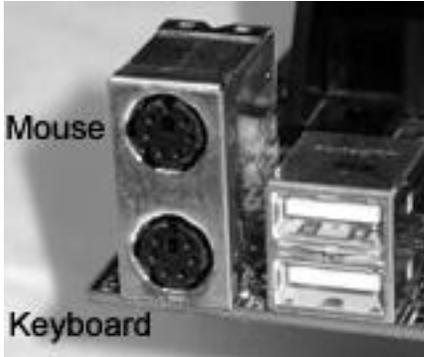

3 button Mouse

Ports

A **Port** is the physical connector used to connect an external device to the system; they are usually found in the back of the system.

The physical connection from the keyboard to the CPU is made through a port that connects the keyboard to the system board, then eventually to the CPU by way of the **DATA BUS**.

Ports found on a typical COMPUTER:
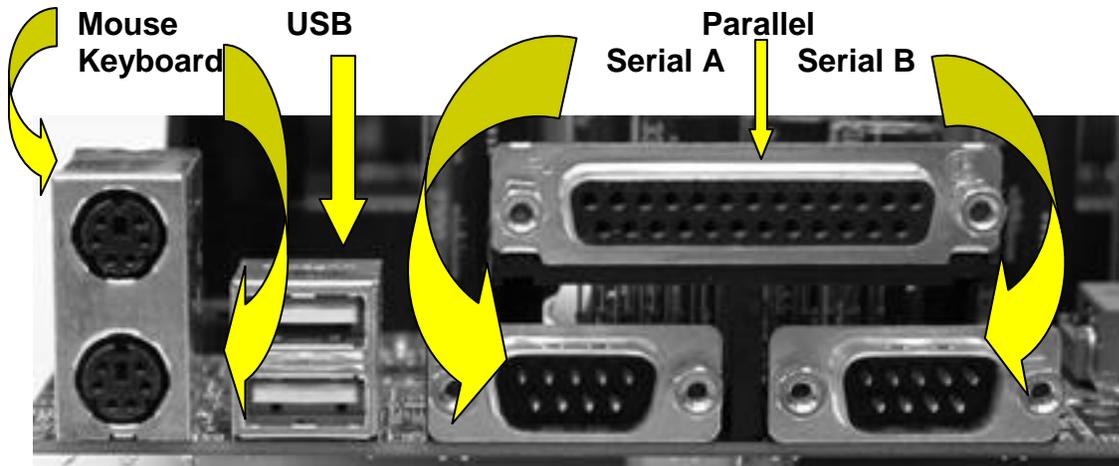
Universal Serial Bus (USB)

Over the years as computers have evolved, there have been numerous new ports added. In an effort to simplify systems, a new port is becoming a universal port (**USB U**niversal **S**erial **B**us) which in time will replace most of the others.

USB Ports are used to connect many varied devices:
- Keyboard
- Mouse
- Printer
- Scanner
- Camera
- Drives

Initially USB version 1.1 supported (2) speeds 1.5 Mb/s and 12 Mb/s. The newest version, ver 2.0 supports up to 480 Mb/s. Up to 127 USB devices can be connected using hubs.

An added feature of USB devices is that they can be daisy chained (linked) together to simplify wiring. For example, a USB keyboard connects with a single cable to the computer and the mouse daisy chains off the keyboard through a USB connection on the keyboard. Hubs are also available to expand the number of connections available to a USB port.

The **Parallel Port** is a 25-pin D-Shell female connector. This is usually the largest connector on the back of the system, which has been causing a problem for some laptop designers who are striving to make laptops as small as possible. Since this connector was generally used to connect a printer, new printers are coming configured with USB connectors in an effort to eliminate the large parallel port. Think of this as the Parallel port, rather than the Printer Port. Parallel ports send data to the device 8 bits at a time and are somewhat faster than standard serial ports that send a single bit at a time. Devices that connect to a parallel port are limited by the distance a parallel cable can run. Most parallel cables are less than 3 meters long (approx 10'); USB has a maximum distance of approximately 15 feet.

Underneath the Parallel port in the diagram are (2) **Serial Ports**, which are 9-pin D-Shell male connectors. Serial ports send data one bit at a time and are

somewhat slower than Parallel ports, but allow distances of up to 100'. Notice that the **D-Shell** connectors are shaped like the letter "D", this is to prevent you from accidentally inserting the cable backwards. Any cable that can only be plugged in one way is referred to as being a "**Keyed**" connector. All the ports shown in the above diagram are keyed.

Some systems provide (2) serial ports, a 25-pin and a 9-pin. A 25-pin port only needs 9 pins so in the interest of size most manufacturers only provide 9-pin connectors. Serial ports are male and parallel ports are female. In the next few years, manufactures will be phasing out the D-shell connectors in favor of USB.
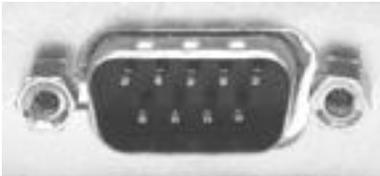
9-Pin D-shell serial port
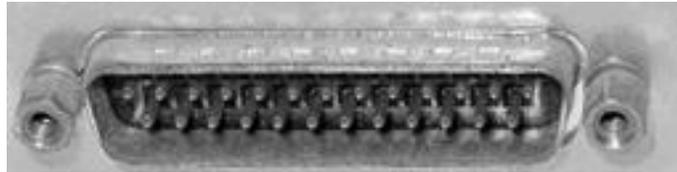

25-Pin D-shell serial port

Video Output Port

The connection to your monitor is made through a 15-pin D-shell female connector. The location of the connector varies depending on how the video card is connected onto the motherboard. On some systems, the video components are built right onto the motherboard. This method, referred to as *integration,* reduces the overall cost of the system. Many different devices can be integrated onto the motherboard like the sound card and the network interface card. Some systems do not integrate components which gives the end user more flexibility in selecting components. If the video card is plugged into an expansion slot look for the video port in the area of the expansion cards.

15 Pin Female, D-Shell connector is the only connector with three rows of pins.

Networking connections

Systems that are connected to a network (often referred to as a LAN) will incorporate an RJ45 connector. The RJ45 connector looks very much like the RJ11 connector that is used to connect the telephone line to the modem. The RJ45 connector has 8 pins and the RJ11 has 4 pins. Since the RJ45 connector is physically larger than the RJ11, it cannot accidentally be plugged into an RJ11 port, but an RJ11 connector will connect into an RJ45 port which could damage the Network Interface Card.

Top connector is an RJ45 8 pin connector used to connect to a Network Interface card shown above.

Bottom left is an RJ11 used to connect to a smaller telephone connector on a modem
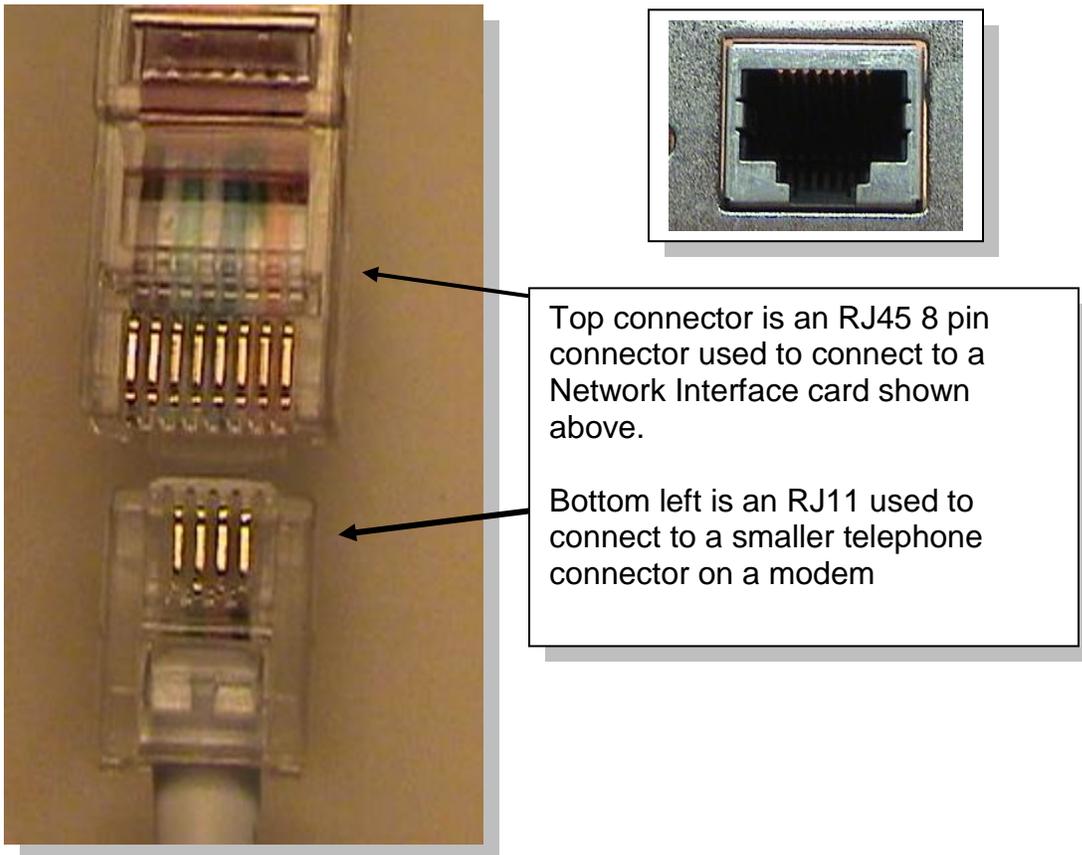
Expansion Slots

The first PC manufactured by IBM had expansion slots that allowed users to add devices like modems, sound cards, etc. These add-on devices plugged into slots on the motherboard to enhance the performance of the system. Since the 8088 had an 8-bit data bus and a 20-bit address bus, the expansion slot connected these buses onto the plug in cards, as well as signaling and power that the card required to operate. When the 80286 was introduced, the expansion slots would

have to be modified to accommodate the new connections for the data bus and address bus.

8-bit Expansion card & slot
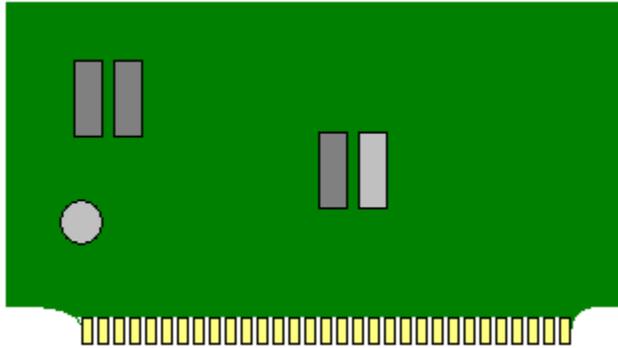
The original 8-bit expansion card had an 8-bit data bus and a 20-bit address bus

Obsolete
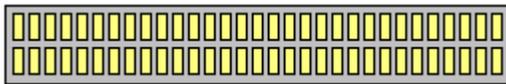
16-bit Expansion card & slot
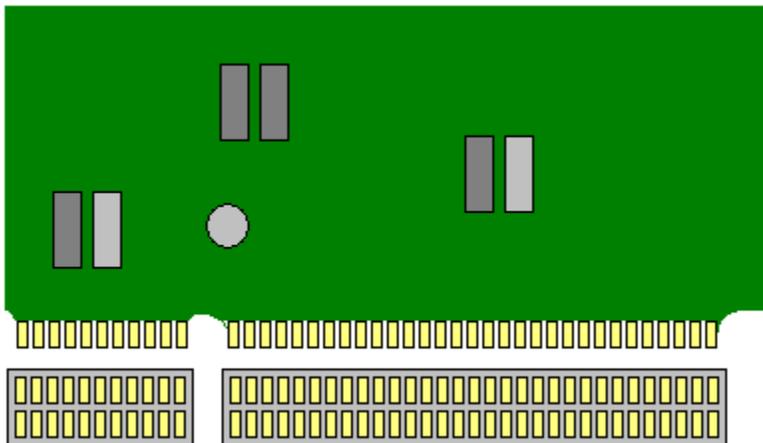
To accommodate the additional 4 memory lines and the additional 8 data lines of the 80286, the 16-bit expansion card added a second connection in the rear of the socket.

Obsolete

The 8 and 16-bit slot were referred to as an ISA slot, all are now obsolete. New motherboards do not incorporate ISA slots in their design, they had been replaced by a faster expansion bus, PCI which is now being replaced by the PCIe slot.
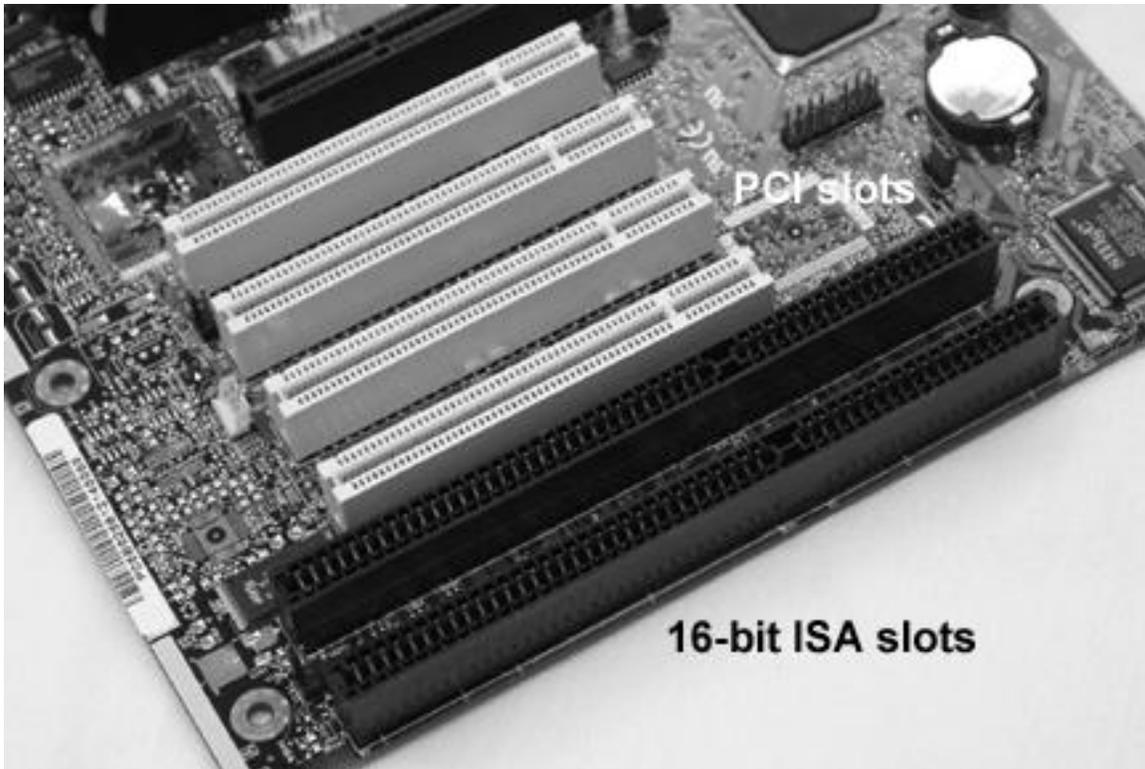
Now obsolete a motherboard with 2 16 bit ISA slots and 4 PCI slots

The PCI Expansion slots (**P**eripheral **C**omponent **I**nterconnect)

The standard for systems manufactured in the early 1990s was the PCI bus. The PCI bus is considered a **LOCAL** bus meaning that it runs in sync with the CPU. By being in sync, it makes transferring data much faster. The PCI bus uses a 32-bit data bus, that runs at either 33 Mhz. or 66 Mhz.

Plug and Play –

On all the newer systems since the introduction of PCI, support a feature called Plug and Play. This feature simplifies the installation of the device by allowing the BIOS and the Operating System to assign system resources needed for the device. Prior to Plug and Play devices had to be configured before installation. Parameters like IRQ, DMA channel, I/O addresses had to be unique for each device. Early systems did not utilize integrated devices so users often had to plugged in as many as (5) expansion cards. This made it extremely difficult to

keep track of which system resources were used by which device. Prior to Plug and Play resources could not be shared.

The PCI slots on the motherboard were usually white, are shorter than an 8-bit ISA slot and are set back farther from the rear of the system. In a system that once incorporated both PCI and ISA the PCI cards were closer to the CPU, with the ISA cards being positioned to the furthest edge.

PCI-e Expansion Card

All the abovementioned expansion cards have been replaced by the newest expansion card standard, PCIe (**P**eripheral **C**omponent **I**nterconnect **E**xpress), which was designed in 2004 by Intel, Dell, IBM and HP.The PCIe card changes the way expansion cards transfer data on the motherboard. Up to this point, all data transfer on the motherboard was done using parallel transfer. This means that for a 32 bit bus there were 32 wires that made up the bus on the motherboard, and 32 bits would be sent concurrently.

In Parallel Transfer all 8 bits move at once
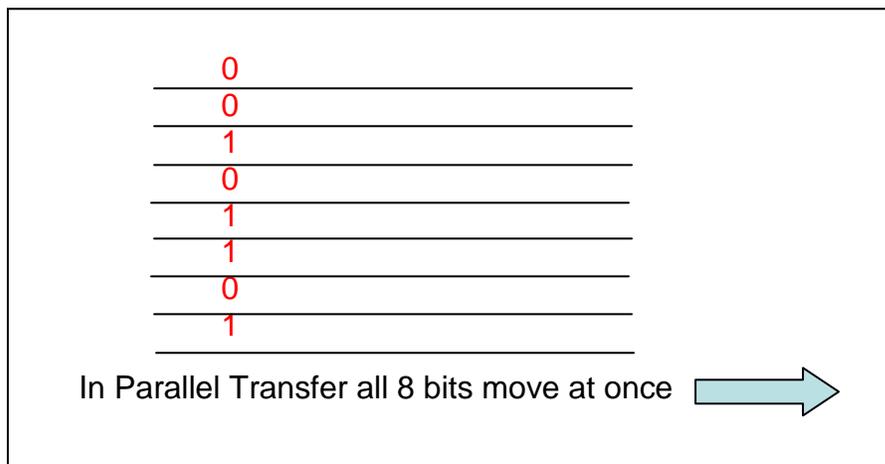
This transfer method worked well at slower speeds, but with new devices running at clock speeds in the GB range the 32 wires that made up the bus, would act like small radio transmitter and introduce noise that would interfere with normal operation. To alleviate the problem parallel transfer is being replaced by serial transfer. With serial transfer, data is sent down a single wire one bit immediately

after the other bit; rather than all at once. Serial transfer is does not have the same limits as parallel when it comes to introducing noise to the system.

1 0 1 1 0 1 0 ⟹

In Serial Transfer buts are encapsulated and sent one after the next
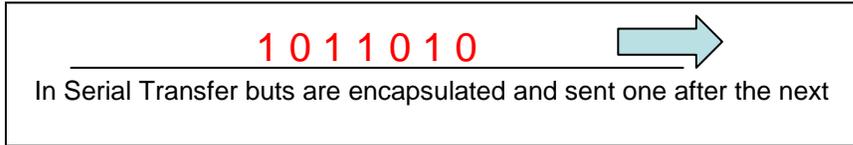
 The newest devices in systems are changing from parallel to serial data transfer including: USB, SATA Hard drives, as well as PCIe.

Lanes -

PCIe uses the concepts of lanes when transferring data. A Lane is made up of four wires two for transmit and two for receive, making PCIe full duplex. Full duplex is the capability of transmitting and receiving data at the same time. To increase speed (throughput) multiple lanes are added. The smallest (slowest) PCIe slot is the PCIe x1 (pronounced PCIe by one) which has one lane. The next larger is the PCIe x4 which is four times as fast as the PCIe x1. There are four defined PCIe slots designed:

Type	Rate v.1	Rate v.2	Rate v.3	Lanes
• PCIe X1	250MB/s	500MB/s	1 GB/s	One
• PCIe X4	1GB/s	2Gb/s	4Gb/s	Four
• PCIe X8	2GB/s	4GB/s	8GB/s	Eight
• PCIe X16	4Gb/s	8Gb/s	16GB/s	Sixteen

Since they have been introduced there have been 3 revisions. Each subsequent release is twice as fast as the previous.
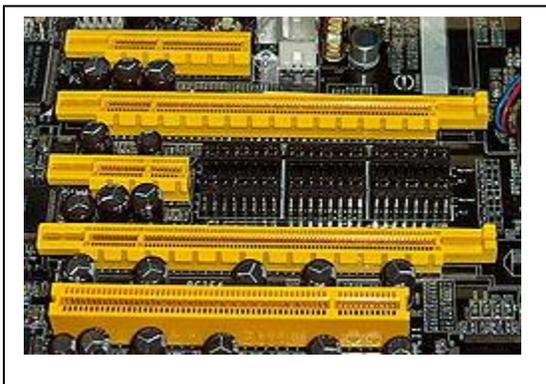
PCIe (top to bottom)
PCIe X4
PCIe X16
PCIe X1
PCIe X16
Standard PCI

Chapter 4 Review questions-

1. _____ is the term used to describe a computer's physical

    components.

2. What are the four main functions of a computer?

    a. _____

    b. _____

    c. _____

    d. _____

3. A 6-pin Mini-DIN connector is used to connect which device?

    _____

4. _____ is a physical connector used to connect an external device to the

    system.

5. The _____ port sends and receives data 8 bits at a time.

6. The _____ port sends and received data 1 bit at a time.

7. A network interface card connects to the network using a(n) _____

    connector.

8. The first ISA cards had a(n) _____ bit data bus, and a(n) _____ bit

    address bus.

9. An ISA Card that has a 16-bit data bus will have a(n) _____ bit

    address bus.

10. PCI cards have a _____ data bus and a(n) _____ bit address

    bus.

Drivers / BIOS

All hardware requires software to make it perform a specific task. This software, referred to as a **DRIVER** or **BIOS,** is the interface between the operating system and hardware. Since there are hundreds of manufacturers using hundreds of different components to manufacture a PC, it should be easy to see that no two PCs are exactly alike. With the countless variations in designs, how could a single operating system be expected to run on every system? The answer is it couldn't without the System BIOS. Think of the System BIOS (or Driver) as an interpreter that understands the requests made by the operating system and also knows how to make the hardware perform the operation.

USER
OPERATING SYSTEM
BIOS - DRIVERS
HARDWARE

On a computer the **user** interfaces with the **operating system;** the operating system interfaces with hardware through either **BIOS or DRIVERS.**
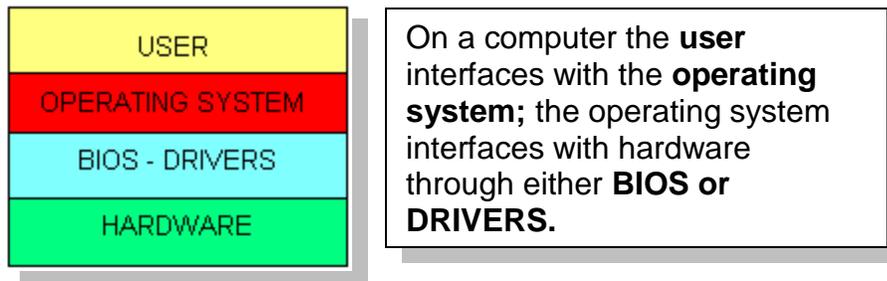
This arrangement makes it very easy for manufacturers to create new hardware to sell to the computer market. After creating a device, the manufacture writes the Driver or BIOS that interfaces their hardware with the operating system. The Driver or BIOS knows how to communicate with the operating system and how to communicate with the device.

Driver vs. BIOS?

So what is the difference between a **Driver** and **BIOS**? They both perform the exact same function; the difference is mainly how the software is loaded and where it's stored.

A **Driver** is usually provided by the manufacturer either on a floppy disk or a CD, when you purchase the device. When the device is plugged in for the first time, part of the installation procedure is to load the driver so the operating system can

interact with the new hardware. The driver is copied onto the hard drive during the initial installation then loaded whenever the system starts up. BIOS on the other hand does not load from the hard drive, its instructions are stored as firmware that is part of the device. This is the main difference between a Driver and BIOS.

BIOS is firmware that's actually part of the device you plug into the system.
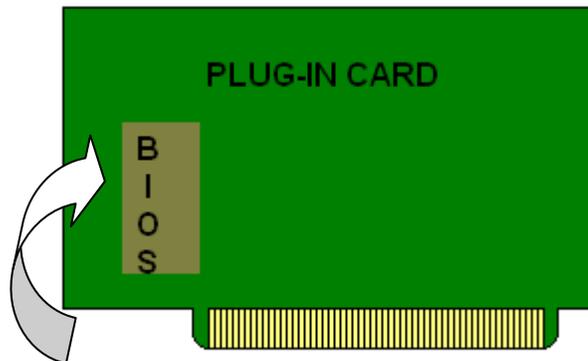
The instructions are stored in a small integrated circuit mounted on the device and load whenever the system boots up. The difference is BIOS loads into memory before the operating system, often before the hard drive is activated. If the instructions for a device were stored on the hard drive how could you get to those instructions if the hard drive hadn't been activated yet? There are many devices that must operate before the hard drive is available (during system boot) so those devices have their instructions loaded from **BIOS**. A good example of the need for BIOS is the hard drive. The instructions needed by the CPU to interface with the hard drive are stored on BIOS chips mounted on it. Imagine what would happen if the instructions needed to initiate the hard drive were only stored on the hard drive! The hard drive must be activated before the operating system is loaded, and the operating system is needed to load anything that's stored on the hard drive.

DRIVERS vs. BIOS

Apart from how the instructions load there are other features that differentiate Drivers and BIOS.

- **BIOS** is stored on Firmware which is Read-Only Memory (**ROM**). For a number of years if you needed to update a BIOS chip you purchased a new chip, unplugged the old chip and replace it with a new one. New developments have been made in Firmware chips that allow them to be re-written which simplifies updating. The process of re-writing a Read-Only Memory chip is referred to as **Flashing** the BIOS.

- **BIOS** is generally operating system independent so a BIOS chip on a plug in card from a system running an old version of DOS should work with a newer version of Windows 98, or Linux, but might not with newer operating systems like Windows 2000 and Windows XP.

- **BIOS** is written using older 16-bit code, which means it's slower than Drivers which are most likely written using faster 32-bit code.

- On newer operating systems (Windows 2000, XP, WIN 7) the **BIOS** used to start the system is automatically replaced with drivers once the operating system is up and running and the hard drive is accessible where the drivers are stored. This replaces the slower 16-bit BIOS with faster 32-bit Drivers

- **Drivers** are operating system dependent so if you are using an old driver that was written for DOS you might have to replace it when you upgrade to Windows 98, and you will definitely need to replace if you upgrade to Windows 2000, or XP.

- **Drivers** are very easy to update, when improvements to the software are made, or new functionality added, drivers can be updated by downloading the new driver from the Internet.

- Newer operating systems like Windows 2000 and XP have been written to include drivers for almost all devices and have almost completely eliminated the need for most **BIOS**.

System BIOS

Even the newest operating systems will never completely eliminate the need for **BIOS**. All motherboards have a **System BIOS** chip that serves a number of very important tasks.

System BIOS Chip serves (**4**) different functions:
1. POST
2. Load the operating system
3. Motherboard driver
4. Set-up, configure
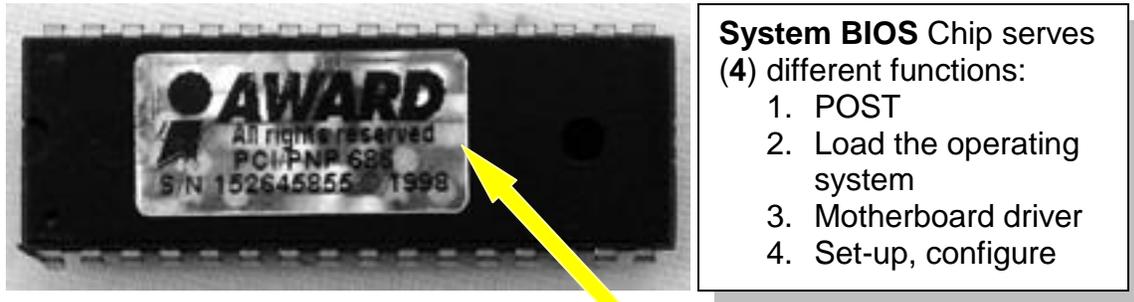
The System BIOS chip is often labeled with a metallic tag that identifies the manufacturer.

POST (Power **O**n **S**elf **T**est)

All electronic devices that are processor based (your cell phone, your car, etc), must go through an initialization when they're first powered up. The processor when it first receives power might still have some of the data in it from the last time it was used so it must be initialized to clear out its internal buffers.

When you first power-on a PC the power supply runs a self test, if good it sends a "Power Good" signal to the processor. Once the processor receives this signal it flushes out its buffers of any instructions or data and only knows one address to go to get instructions. This address points to a memory location inside the **System BIOS** chip. (Think of an address like a phone number the processor calls to get the first instruction) The **System BIOS** responds by sending instructions to the processor telling it what to do. The instructions sent to the processor make up what is referred to as the **POST** (**P**ower **O**n **S**elf **T**est). POST verifies that the components needed to start the system are functioning properly. It does not test every component, only the ones absolutely necessary to successfully "**Boot**" the system. Once every test has been run (10 to 20 seconds)

BIOS tells the processor to send a "beep" to the system speaker. This single beep indicates that the system successfully passed POST. If a system fails POST the user is notified in one of two ways:

1. If the failed device is discovered <u>before</u> BIOS gets to the point where it tests the video card then there is no video and the only means of communicating with the user is with "**Beep Codes**". Depending on the BIOS manufacture there is a list of Beep Codes that correspond to certain devices. The codes are different for each BIOS manufacturer, so you need to refer to the owner's manual, or better yet check the manufacturer's web site.

2. If the failed device is discovered <u>after</u> BIOS tests the video, then the error can be displayed on the screen. The error is often rather cryptic and given a number as a reference. The best way to resolve this is to look the number up in the owner's manual, or the manufacturer's web site.

Loading the Operating System

Once the system has completed the **POST** it's ready to load the operating system. *Notice that everything done up to this point has been accomplished without the use of drivers, only BIOS*. BIOS instructs the CPU exactly where to go to begin loading the operating system. Depending on how the system was configured the operating system might be found at a number of different locations:

- The "A" drive (floppy)
- The "C" drive (Hard drive)
- The CD ROM drive
- Network connected drive
- Other

This order can be changed in **System Configuration**.

When the CPU locates the operating system, it's loaded into memory and the system starts.

In addition to the **System BIOS** chip that runs POST, other devices that also have their own **BIOS** chips incorporated onto the plug-in card.

- Network Interface Cards

- Video Cards

- Sound Cards

- Hard Drives

When **System BIOS** runs the POST it also looks for any other **BIOS**, if found the new BIOS is also loaded which makes that device available. If the Video card did not have its own BIOS chip you wouldn't be able to see anything on your monitor until after the operating system loads and loads the video driver from the hard drive. This would be unfortunate since some of the errors you might encounter while booting the system are displayed on the monitor before the operating system is loaded.

Basic **I**nput **O**utput **S**ystem **BIOS**

Once the system has booted and the operating system has taken control, BIOS still serves a function on older systems (Prior to Windows 2000). BIOS allows the operating system to interact with some of the low level hardware devices on the system board such as the keyboard or the floppy drive. On the newer operating systems like Windows 2000 and XP this low level BIOS has been replaced with Drivers written using 32-bit code, that are stored on the hard drive.

SYSTEM SETUP

One last function that the **System BIOS** performs is for configuring the system.

Before we jump into what **System Setup** does we should go back to the 8088 and talk about configuring the system board (another name for the system board that is more commonly used is **motherboard**).

When you purchased an 8088 based system it usually came with 128K of memory installed, a floppy drive (maybe dual floppies, "A" drive and "B" Drive), a keyboard and a monitor. With that configuration you could run just about any software package that was available for a home computer, there weren't many at

the time. As you progressed you might decide to add more memory to your system, so you purchased an additional 128K of memory for about $100.00 and plug it into the system to bring it up to 256K of RAM. Assuming you didn't bend any of the pins on the memory chips, you plug them in correctly (not backwards), you properly configured the motherboard by setting the tiny little dip switches using the documentation that you didn't throw away, the system worked perfectly. If anything went wrong nothing worked and you would probably be on the phone with the manufacture trying to figure out why.

Manufacturers knew they had to find a better way to configure the motherboard

when changes were made to the system. The tiny switched mounted directly onto the motherboard were hard to find underneath all the wires, and the documentation was cryptic.
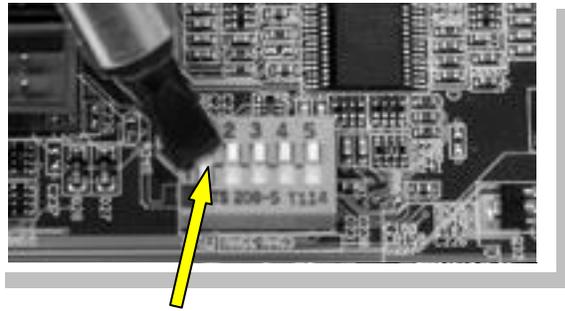
Manufacturers realized that changes made using DIP switches could just as easily be made using software. This is one of those areas where software is better than hardware. They did this by creating software that is also part of the **System BIOS**. Users could then configure the motherboard by running this software during boot up by hitting some special keystroke. This loads the **System BIOS Screen** (also referred to as **System Setup, or CMOS setup**) which displayed all the options the user could change.
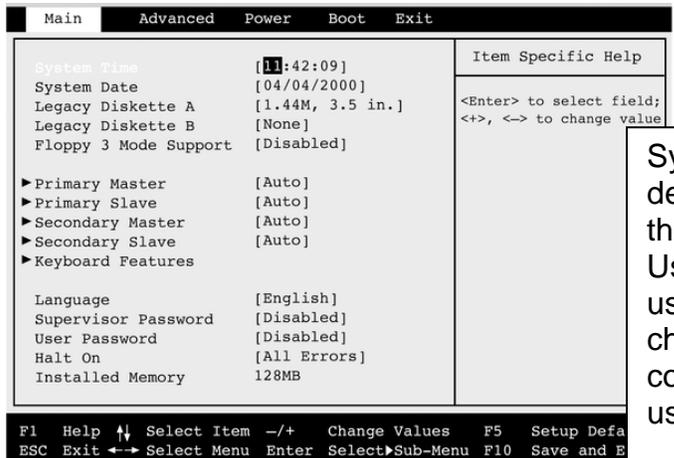
System setup screens vary depending on the company that wrote the program. Using the set-up screen users can easily make changes to their system configuration, rather than using small switches.

Users navigate through the setup screen using the arrow keys and making changes, (there was no such thing as a mouse back then, on newer systems the driver for the mouse would not have been installed yet). So for example if you add more memory you could make the necessary changes from the setup screen. (Newer systems will auto-detect most changes and make the necessary updates for you). These changes had to be saved somewhere, and since BIOS is read-only the changes are stored in another device called the **CMOS** (see-moss) chip. The CMOS chip is a special device that stores whatever you put in it as long as there is voltage applied to it, if you remove the voltage all the settings are lost. To prevent you from loosing the set-up data stored on the CMOS chip a small
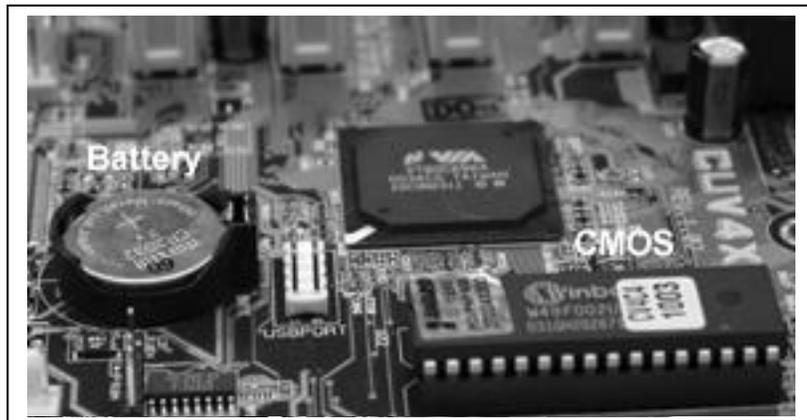
battery is installed that maintains the voltage required to save the data even if the system is unplugged. These batteries are typically good for about 4-5 years. The battery serves two purposes, the first is to maintain the system configuration stored in CMOS, and the second is to power the real time clock. The real time clock is a small integrated circuit that keeps track of the actual date and time. The clock must run even when the system in tuned off, so it is connected to the same battery as the CMOS chip. One advantage of this dual use of the battery is since the real time clock draws more power than CMOS, the clock will start acting up long before the battery goes completely dead. If the systems clock continually displays something like 12:00, 1/1/00, every time you turn on the system, then you know the battery is getting weak and should be changed. When you change the CMOS battery if you do it quickly you can avoid loosing any of your CMOS settings. There is a small capacitor in the circuit that will charge up to

the voltage of the battery to keep CMOS active for about 30 seconds or longer. If you loose your CMOS settings you will have to reset everything which is only a minor nuisance now days, but in the older systems it could take quite a while.

One change that is often made in System Setup is the **boot sequence**, which tell the CPU where to look for the operating system when the system boots. Usually during boot up the system looks at the A drive (floppy) first, if it doesn't find the operating system on the A drive it will then look at the C drive. To speed up system boot time users will enter the system setup screen and change the boot sequence to have the system look at the C drive first rather than the A drive, which is where the operating system is usually found.

Chapter 5 Review questions –

1. When the system boots where is the first place BIOS, by default, looks for

   the operating system? _____

2. How can you tell if the CMOS battery is getting weak?

   _____

3. How long do CMOS batteries generally last? _____

4. What are the 4 tasks System BIOS is responsible for?

   a. _____

   b. _____

   c. _____

   d. _____

5. BIOS is written using old _____ code.

6. Drivers are written using newer _____ code.

7. Where are drivers stored while the system is powered down?

   _____

8. Where is BIOS information stored while the system is powered down?

   _____

9. What was the method use to configure very old system boards?

   _____

10. T/F   Beep codes used to inform you that there are problems

    encountered during POST are all the same.

Chapter 5 In-Class Lab Assignment –

*This lab uses a shareware copy of a program called **CMOS.com**. This program allows you to make a copy of your System CMOS onto a floppy disk. By making a copy of your System CMOS setup you can experiment with the System CMOS settings. Afterwards you can restore the original configuration from the backup copy of your System CMOS from the floppy.*

Note: The lab refers to CMOS (Bold) and System CMOS (underlined). When references are made to CMOS (Bold) it means the program CMOS. When references are made to System CMOS it means the System Setup

You will need a blank bootable floppy disk for this lab.

Systems today can be reconfigured in many different ways. Changes you make to system configuration such as selecting which drive the system looks at to locate the operating system when booting, are stored in System CMOS. Normally you boot from the hard drive C:\, but in certain cases you may want to boot from the A drive, or possibly the CD ROM Drive. One reason you may want to boot from the A drive rather than the C drive is to troubleshoot problems you are experiencing with the C drive.

This lab covers System CMOS, a device that is used to store any changes you make to the system. You will be using a program called **CMOS** to make a backup copy of all the Systems CMOS settings and store them onto a floppy disk in the A drive. Then you will make changes to the system settings and note the

effect on Windows. You will then use the **Restore** option in the **CMOS** program

to restore the system to its original configuration.

1. Obtain a copy of the shareware program "**CMOS**" from instructor.

2. The **CMOS** program must be run from a ***bootable*** floppy disk. To Create a

   bootable disk from inside **Windows 98**:

   a. **Start → Run → Command**

   b. Insert your floppy into the drive

   c. From inside the command prompt window enter → "**format a: /S**"

   d. When prompted for a **volume** label enter your name

   e. Type **exit** to return to Windows

3. Copy the program **CMOS** to your bootable A: drive. The **CMOS** command

   needs to run under DOS not Windows, so reboot your system using the

   DOS disk you just created which will start the system in DOS. BE

   CERTAIN TO SET YOUR SYSTEM CONFIGURATION TO BOOT FROM

   THE A DRIVE.

4. Enter the command **CMOS** and view the options available. You should

   see something similar to the following:

   CMOS.COM   v0.93   10-12-1996   C. Dye   raster@highfiber.com
   Freeware. Okay to distribute by any means. No warranty.

   Syntax:
   CMOS /SAVE filename   Save CMOS RAM to file
   CMOS /LOAD filename   Restore CMOS from file
   CMOS /VER filename   Compare CMOS against file
   CMOS /DUMP   Hex dump of current CMOS data

   If no filename is specified, CMOS.SAV will be used.
   Switches may be abbreviated to the first letter.

5. Make a copy of your current <u>System CMOS</u> settings onto a file called

   "CMOSlab".

   → **CMOS /s CMOSlab**   *the /s option used with* **CMOS** *is for save*

6. Using the **verify** command check that the CMOSlab file was created:

   → **CMOS /v CMOSlab**   (this will compare your current <u>System CMOS</u>

   settings against the CMOSlab file you created in step 5). It should

   indicate they're both the same, since you haven't made any changes yet.

   To see an output of your current <u>System CMOS</u> use the dump command,

   → **CMOS /d**.

The output from the **dump** command (**CMOS /D**) will be a series of HEX

numbers similar to the following:

> Standard CMOS (0Eh-3Fh)
> Extended CMOS (40h-7Fh)
>
> Checksum: 195C   Hashtotal: 492B
>
> Dump of current CMOS configuration: [01FC]
>
> 10: 40 00 F0 00 03 80 02 00 7C 7F 00 00 00 46 F1 00
> 20: 02 10 C9 01 11 00 34 00 BB 77 77 00 00 01 06 B2
> 30: 00 7C 20 00 00 00 00 01 00 00 00 00 00 00 00 00
> 40: AE 88 00 01 00 03 00 04 00 0B F0 40 00 FF FF FF
> 50: 00 06 50 04 0C 00 F0 04 0C 00 F0 1E 14 00 FF FF
> 60: FF 00 47 01 00 D2 18 02 96 80 31 06 FF F0 00 00
> 70: 00 00 00 00 00 00 00 02 08 0E 02 82 49 53 B2 00

This indicates the memory address starts at HEX location 0E and runs
through 7F.

7. Determine the procedure for entering the <u>System CMOS</u> setup sequence

   for the system you're working on. (Probably <delete>)

8. Reboot the system and enter the <u>System CMOS</u> Setup screen, make a

note of:

 a. Sequence used to enter setup _____

 b. The name of the company that wrote the BIOS _____

 c. Determine the boot sequence (what device does the system look to

  first for booting information-

   Usually **Floppy/Hard Disk/CD ROM/other device**)

  Note the default sequence below-

  _____/_____/_____/_____

  Change the setting of the first two boot devices, and note the new

setting.

  New Boot sequence (only change first 2)

_____/_____/ _____

 d. Note the default settings then change the following 3 device

  settings. (Note the changes for the following are usually found in an

  advanced screen, look for "**I/O Device Settings**"

Device	Default Setting	New Setting
COM1	_____	_____
COM2	_____	_____
LPT1	_____	_____

 e. Exit <u>System CMOS</u> setup screen and **save** the changes (Usually

  F10), allow the system to reboot to Windows 98 by removing the

  disk in the A drive.

9. Open the **Device Manager, Start→ Settings→ Control Panel→**

   System → Device Manager highlight **Computer** Click on **Properties,**

   then select **I/O**, view the following resources:

   i. COM1 _____

   ii. COM2 _____

   iii. LPT1 _____

   > Note that when you change the I/O addresses of your serial ports the designations will change from "Com1" to possibly "Com3".

   NOTE: These are the settings you setup in 8D above.

10. Shut down the system and reboot using your DOS disk.

11. Using your **CMOS** program use the verify command to check your current

    System CMOS configuration to the CMOSlab file saved earlier:

    → CMOS /v CMOSlab Notice this does show a difference between

    your current System CMOS and the earlier copy.

12. Use the **CMOS** command to restore your System CMOS to the settings

    you saved earlier in CMOSlab. After you use the restore command the

    system will automatically reboot, while the system is rebooting remove the

    disk from you're a drive so that you boot into Windows.

13. Repeat step 8 and check to see that you have restored your system.

14. Name a few of the System parameters that can be changed in System

    CMOS:

    _____   _____

    _____   _____

Memory comes in many different forms in a computer. Each has a different characteristic depending on the requirements of the system. Memory is divided into two main categories; it's either Volatile, or Non-Volatile. **Volatile memory** is used for short term storage and will loose whatever is stored on it when power is removed. **Non-Volatile** memory does not loose what is stored on it when power is removed, and is generally used for long term storage. Read-Only Memory (ROM), Floppy Disks, and Hard Drives are all considered Non-Volatile memory.

Accessing Memory

Data that's been stored in memory must be accessible by the CPU in order to be useful. The quicker it can be accessed the better since the processor requires a steady stream of data in order to run efficiently.

When data was stored on a tape drive, it was considered **Sequential Access**, since you have to run through the entire tape to locate data if it happens to be close to the other end of the tape. This works fine for data that's not time sensitive like a system backup, but for responsiveness that's fast enough for the CPU, Sequential Access Memory will not work.

Random Access Memory (RAM) stores data and instructions electronically in integrated circuits, each byte of data stored is assigned a unique address. Unlike sequential access memory, RAM is accessed extremely fast.

When the CPU wants to **Read** in data from RAM, it puts the address that points to the data on the Address Bus. The **Memory Controller** converts this address into (2) coordinates, Row & Column, where they cross determines the location where the data is stored (10101011). This is placed on the data bus and read into the CPU.
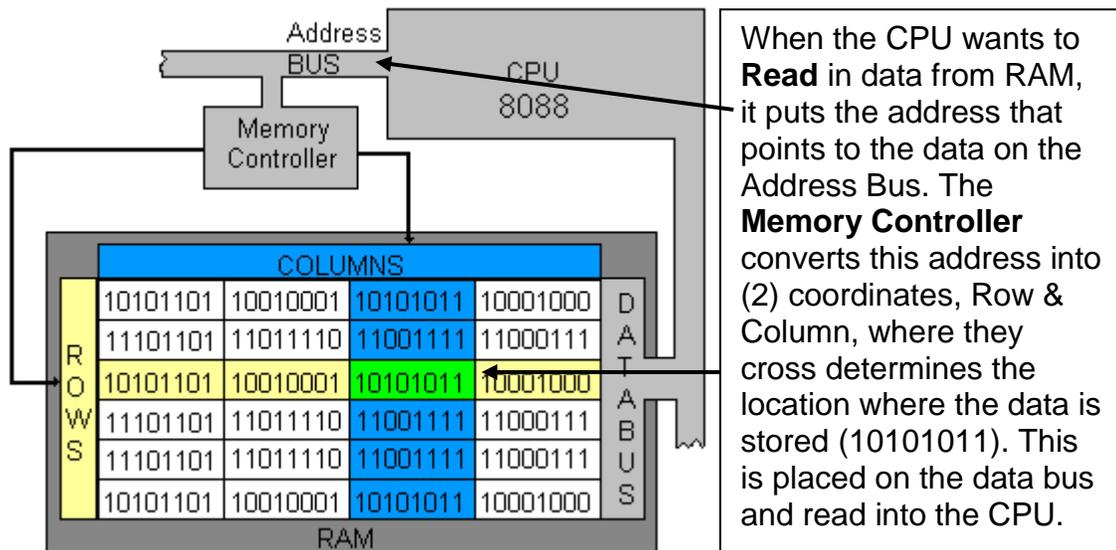
When the CPU wants to **write** data into RAM the process is the same. It places the address onto the address bus, the memory controller converts it into Row/Column coordinates that point to the storage location, then the CPU places the data on the data bus and it is saved in RAM.

The interaction between the CPU and RAM

In order for programs to be executed they must first be copied from the hard drive or other non-volatile storage device into RAM. When you "run" a program, the operating system locates it in storage, and then loads it into memory. When computers do even simple calculations there is a constant exchange between the CPU and RAM. The CPU might be instructed to add the number stored in one memory location to a second number stored in another memory location, then store the result in a third location. The data flow between the CPU and RAM is constant, so access to memory must be as fast as possible. When the PC was first introduced, the processor ran close enough to the same speed as RAM, so there wasn't a problem. As processors evolved, they soon required memory access much faster than RAM could deliver. This mismatch in speed between the processor and memory had to be addressed or increases in processor speed would be limited to the slower speed of RAM.

CACHE MEMORY

The problem with the mismatch of CPU speed and memory speed was resolved by using a special type of memory that is placed between RAM and the CPU. **CACHE MEMORY** runs considerably faster than RAM and is placed physically closer to the processor. Cache was first added to the 80486; a small amount was built into the CPU. Shortly after the addition of cache, motherboard manufacturers made provisions to add more by adding a special motherboard socket so users could add additional cache to the system. When cache is added to the motherboard, it is referred to as **layer 2 cache**; layer 1 cache was always

built into the processor. As processors evolved, manufacturers decided to move layer 2 cache onto the CPU just like later 1 cache.

CACHE CONTROLLER

The Cache Controller improves performance by predicting what data or instructions will be needed next by the CPU then moving it from slower memory and placing it in cache where it can be accessed faster. One way to think of the interaction between the CPU and the Cache Controller is to think of the CPU as being a chef following a recipe to make a cake, and the cache controller as his assistant. The recipe is the software telling the chef what to do, and the assistant is reading the same recipe but is about 10 steps ahead of the chef. The assistant sees the recipe calls for 3 eggs which he goes to the refrigerator to get and puts them within easy reach of the chef. (Cache controller retrieves data from RAM and puts in into cache) When the chef gets to the point where he needs the eggs, he doesn't have to go to the refrigerator (memory) he can simply grab the eggs and move on to the next step. The assistant continues to retrieve the contents, staying ahead of the chef until he reaches a statement in the recipe that says something like "if the customer is cheap use margarine, if not use butter". At this point, the assistant must make a decision; he knows that the last 500 times the cake used margarine, so he puts margarine in line for the chef. Later when the chef gets to the point where he reads the recipe, he knows the customer wants butter, but the assistant supplied margarine. Now the chef must get rid of all the ingredients that had been put there by the assistant and go to the refrigerator (memory) to get the next ingredient. The assistant must resupply the ingredients and start the process over at that point. This extra step will slow the process down if it happens too often. The ability of the Cache Controller to predict what data will be needed next is referred to as the Cache Hit Ratio. If the controller brings the correct data into cache more than 90% of the time, the system's response will improve. If it guesses incorrectly, then the cache and the system's response will be adversely affected. Most systems today have a Cache Hit

Ration greater than 95%; this is due in part to improved methods used when writing software.

RAM

Random Access Memory also referred to as primary storage; it's also volatile meaning that whatever is being stored in RAM is lost when power is removed. Hard drives on the other hand are considered secondary storage, and are non-volatile so when power is removed the data will remain. Primary storage is considerably faster than secondary more than 1 million times faster in most cases. It has to be faster to keep up with the processor, but even as fast as it is it can't keep up.

DRAM

Dynamic Random Access Memory (DRAM) is the term used to refer to the technology used in manufacturing memory and also a fancy name for RAM. Dynamic means constantly changing which is what happens inside DRAM. The technology used to store data is rather simple, a small capacitor charges up to a voltage level to store a binary one, each cell (data storage location) is actually a very small capacitor and a transistor. Unfortunately capacitors do not hold a charge for very long, and the voltage would dissipate in a few microseconds. So the capacitor must be constantly refreshed by the memory controller. With DRAM this refresh happens approximately every 15 microseconds. This constant refreshing slows the system down since memory cannot be accessed while it's being refreshed.

Another explanation for DRAM would be to think of the storage cells (memory locations) as buckets that are being filled with water. To store a "1" the memory controller fills the bucket, to store a "0" the bucket is left empty. When the processor accesses the bucket and it is filled with water it's a "one", if it's empty it's "zero". There is only one problem - the buckets have holes and must be

constantly "refilled" by the memory controller, if the bucket is not refilled the water empties out and rather than storing a "1" it appears as a "0".

SRAM - Cache

Static RAM works differently; rather than using a capacitor to store voltages, it uses a solid state switch. Once the switch turns on to store a "1", it stays on until power is removed from the system. Think of the bucket analogy, except now the bucket has no holes. The main advantage of SRAM is since it requires no refreshing, it's very fast. **Cache** memory uses this technology. SRAM is considerably faster than DRAM, but also considerably more expensive. Adding additional cache to a system can improve the overall performance, but there is a limit; too much adds cost and past a certain point does not noticeably improve performance.

Types of Memory

Memory has evolved over the years to make it easier to install and to increase the speeds required as processors improved.

DIP Chips

In the first PC manufactured by IBM, memory was made up of individual integrated circuits referred to as DIP chips, dual inline package.

> DIPs had 16 pins that would plug into a small socket located on the motherboard. Each individual chip stored a single bit; since the 8088 had an 8-bit data bus you would need to plug in 8 individual chips. If each chip was capable of 256K bytes by adding 8 you could increase your memory by 256k bytes.

Before   After
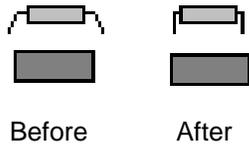
In the manufacturing process, the 16 pins that made up the chip were not lined up properly to plug into the socket, so the user had to bend all 16 legs to line up with the socket. If they were bent too much the legs folded under.

The problem with DIP memory was they could be inserted backwards, or if the user did not bend the legs properly they would not plug into the socket.
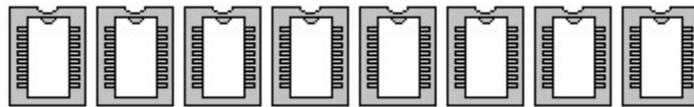
When all the tiny legs lined up correctly and they didn't bend it took 8 individual integrated circuits (chips) to populate one bank of memory.
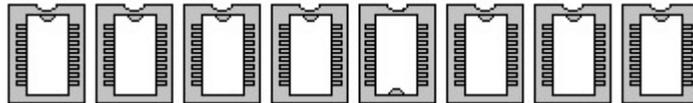
If one chip was inserted backwards the entire system would fail. This would usually result in a phone call to technical support where the user listened to music on hold for hours.

SIMM Chips   <u>S</u>ingle <u>I</u>n-Line <u>M</u>emory <u>M</u>odule

To resolve some of the problems users were having with the DIP package, SIMM chips were created making it much simpler to add memory.

30-Pin SIMM Chips were designed when the 80286 system was released. The 30-pin SIMM had the individual DIP package chips soldered onto a small board that would insert into a special socket on the motherboard. This design prevented the user from accidentally plugging the memory in backwards, and did not require the user to bend the legs of the individual DIPs to insert them into a socket.
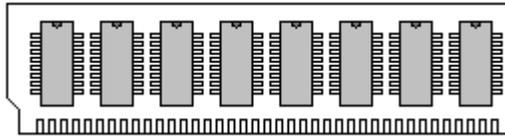
The 30-pin SIMM chip was an 8-bit memory module, but since the 80286 had a 16-bit data bus, it required the user to plug in (2) SIMM chips. On an 80286 it required (2) 30-pin SIMM chips to populate 1 bank of memory.
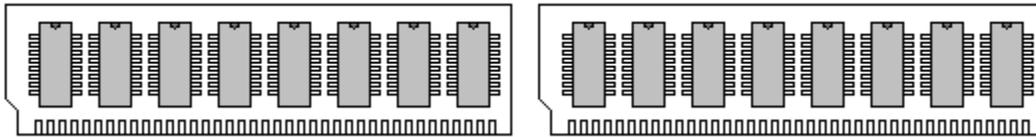
← One Bank of memory on an 80286 requires (2) 30-Pin SIMM chips →

72-Pin SIMM Chips were introduced when the 32-bit data bus became available. The 72-pin SIMM was a 32–bit memory module. So when a 72-pin SIMM was added to an 80486, it required only a single stick of memory. The same system would require (4) of the 30-pin SIMMs.
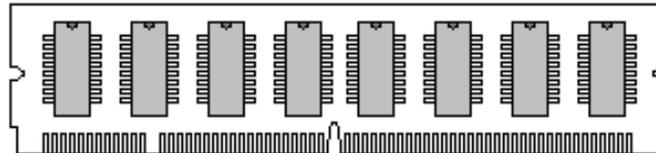
← One Bank of memory on an 80486 →

When the 72-pin SIMM chip is used with a Pentium, it requires (2) SIMM chips since Pentiums have a 64-bit data bus and 72 pin SIMMs are only 32-bits.

DIMM Chips   Dual In-Line Memory Modules
DIMM Chips are full 64-bit memory modules. To allow for the increased density the back side connectors are used to connect the additional memory devices, unlike a 72-pin SIMM where the back side and front side of the connectors are each connected together. Some earlier Pentium based systems allowed users to

use either SIMM modules or DIMM modules on a motherboard that had both types of sockets. When using SIMMs modules, users had to plug in two SIMMS to populate a complete bank of memory, or a single DIMM module.
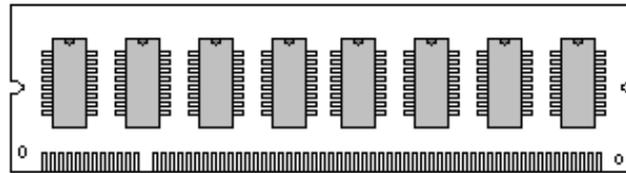
←   A single DIMM chip is 64 bits wide   →

Summary

- **RAM** is made up of electronic components that store data, and instructions inside the computer as ones and zeros

- **Non-Volatile** memory does not loose what it is saving when power is removed; examples:
    - Floppy drives
    - Hard drives
    - BIOS
    - ROM

- **Volatile** memory requires power to maintain what it's storing; examples:
    - RAM
    - Cache

- **DRAM** (RAM) requires constant refreshing

- **SRAM** (Cache) does not require refreshing

- The **physical memory address** is put on the address bus by the CPU; when the memory controller receives the address, it converts it into row/column coordinates which "point" to the memory location

- **DIP** (Obsolete) Dual In-line Package individual integrated circuits that plugged into the motherboard in special sockets

- **SIMM** (Obsolete) Single In-Line Memory Module, two versions were available, a 30-pin SIMM that provided an 8-bit memory module, and a 72 pin SIMM that provided a 32-bit memory module. SIMM chips have 72-pins on either side; both sides are identical.

- **DIMM** Dual In-Line Memory Module; provides a 64-bit memory module, unlike SIMM chips, DIMM chips use both sides of pins separately to double the number of connections to accommodate the higher density

DEFINITIONS

- **Cache** – High speed memory that is placed between RAM and the CPU to improve system throughput

- **DRAM** – Dynamic RAM, also known as RAM

- **Layer 1 Cache** – Cache that is integrated onto the CPU

- **Layer 2 Cache** – Cache that is either added to the motherboard on older systems, or integrated onto the motherboard in newer systems.

- **Layer 3 Cache** – Some of the newer CPUs incorporate a 3rd level of cache memory to improve system performance.

- **Non-Volatile Memory** – Memory that retains what it's storing when power is removed.

- **RAM** – Random Access Memory; each memory location can be immediately accessed using its address.

- **SRAM** – Static RAM, also Cache

- **Volatile memory** – Memory that will loose whatever it's storing when power is removed

Chapter 6 review questions –

1. _____ memory does not lose what is stored when power is lost.

2. Since RAM cannot keep up with the demands made on it by the processor a small amount of _____ is placed between RAM and the CPU.

3. The _____ is responsible for determining what the processor needs before the processor actually needs the information.

4. _____ is a type of memory that does not need refreshing.

5. _____ is a type of memory that requires refreshing.

6. Primary storage is volatile and _____ than secondary storage.

7. Cache is _____ than RAM and also more expensive.

8. The Intel first processor to use cache memory was _____.

9. SRAM is another name for _____

10. DRAM is another name for _____

11. If DIP chips were used in a modern Pentium how many would be required for a single bank? _____

In the evolution of computing, one of the design issues that had to be resolved was a method to store information. Information is represented to a computer in its simplest form as Binary 1's and 0's; each 1 or 0 is referred to as a bit. If there is voltage on the wire, then the bit is a "one"; if there is no voltage on a wire, then the bit is a "zero". It's very easy for electricity to represent bits, but how do you store this information for later use? An analogy would be to think of sunlight, if the sun is shining it's a binary "one", if the sun is not shining it's a binary "zero", (day=1, night=2), but how do you "store" sun light?

Magnetism / Electricity

There is a very close relationship between **electricity** and **magnetism** that solved the storage problems. If you cause current to flow in a piece of wire, a few interesting things happen -
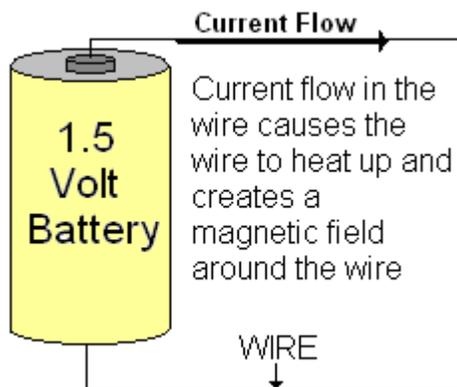
Current Flow

Current flow in the wire causes the wire to heat up and creates a magnetic field around the wire

WIRE

By connecting a wire to each end of a battery, you create a circuit which causes current to flow in the wire. You can't see current flow or the magnetic field around the wire, but you could easily detect the heat being generated.
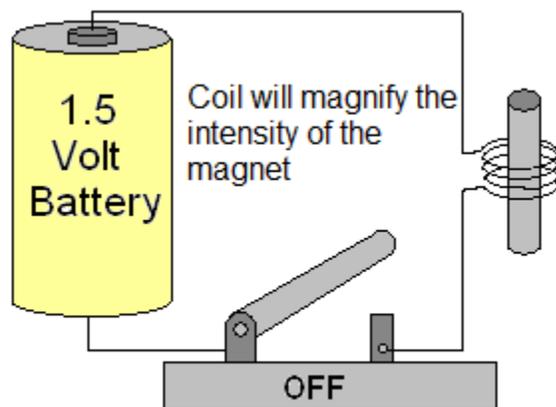
Coil will magnify the intensity of the magnet

OFF

If you wind the wire around a piece of iron, you can create a very powerful Electromagnetic that you can turn on and off by turning on and off the circuit.

Electricity / Magnetism

Not only can you create magnetism from electricity, but you can also create electricity from magnetism. Around every magnet there is an invisible magnetic field that extends from one end (pole) to the other end.

N   S

A wire that cuts the magnetic field will have voltage induced into it.

N   S
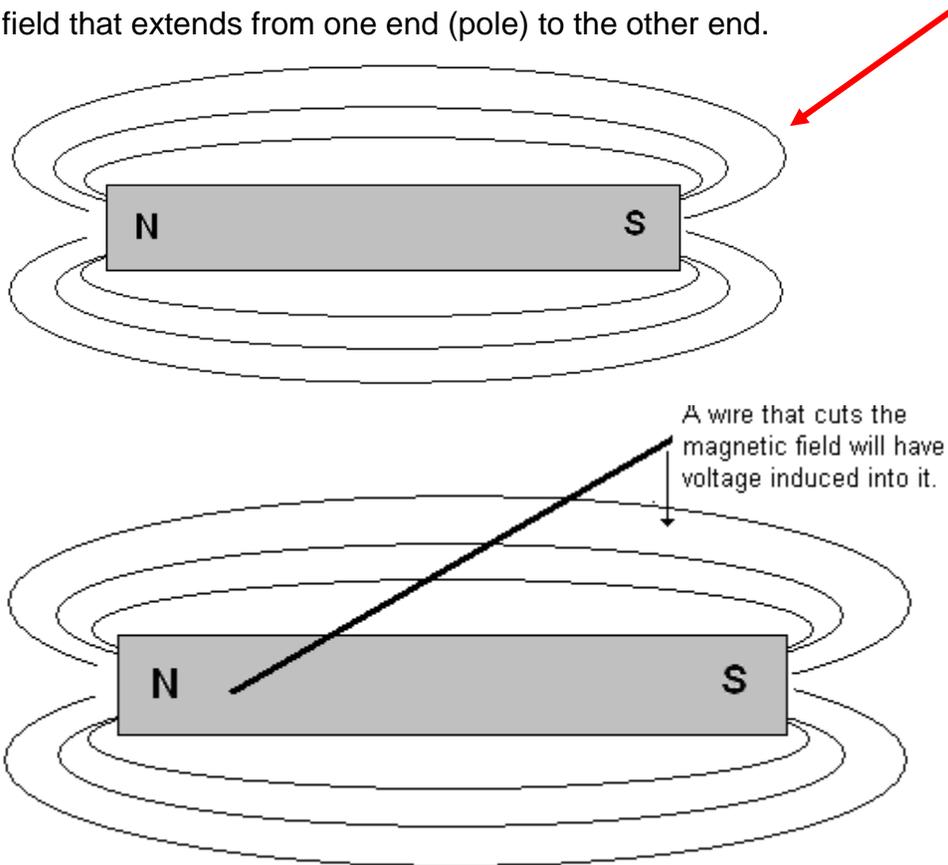
As a piece of wire moves toward the magnet causing it to cut through the invisible magnetic lines, a current is induced into the wire.

If this piece of wire is coiled up and the magnet is strong enough, a large amount of electrical energy can be created with our simple generator.

So if an electric current flows through a wire, you can create a magnet; and if a piece of wire moves through the magnetic field, you can create electricity.

Magnetic Core Memory

The first use of "magnetic" storage was Core Memory developed in 1949 by An Wang. Core Memory was built by hand using tiny donut shaped cores that wires would be passed through. When current flowed through the wires they would magnetize these tiny cores. The cores remained magnetized even after the current was removed. To retrieve the bit stored, the magnetic field was sensed by another wire used to read the information. Since core memory was built by hand, it was extremely expensive, large, and wouldn't store very much data.

This early example of core memory about the size of a postage stamp could store 2K of data.
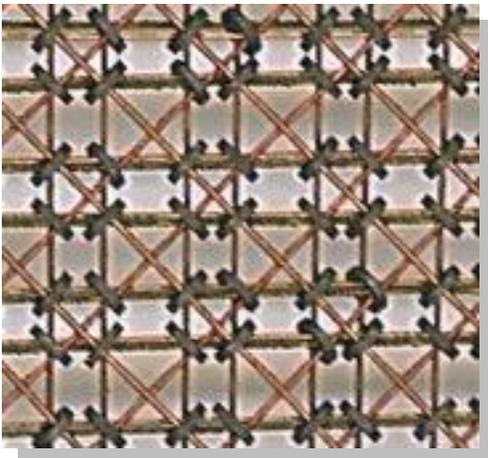
Magnified view shows tiny cores with sensing wires looped through each. Core memory was handmade.

Hard Drives

The next development in magnetic storage was the hard drive; created in 1950 , it was about 20" in diameter and was capable of storing only a few megabytes.

Hard drives are made on round platters of aluminum, ceramic, or even glass coated with iron oxide (rust) or similar coating. Each disk rotates under a small electromagnet (Read/Write head) that floats over the surface of the disk. The electromagnet when turned on will magnetize the iron oxide and leave a very small magnetized area to represent a bit. This magnetized area will remain magnetized even after the magnet has been removed. Later to read this information, the head will sense the magnetic field which will induces a small voltage into it allowing it to "Read" information.
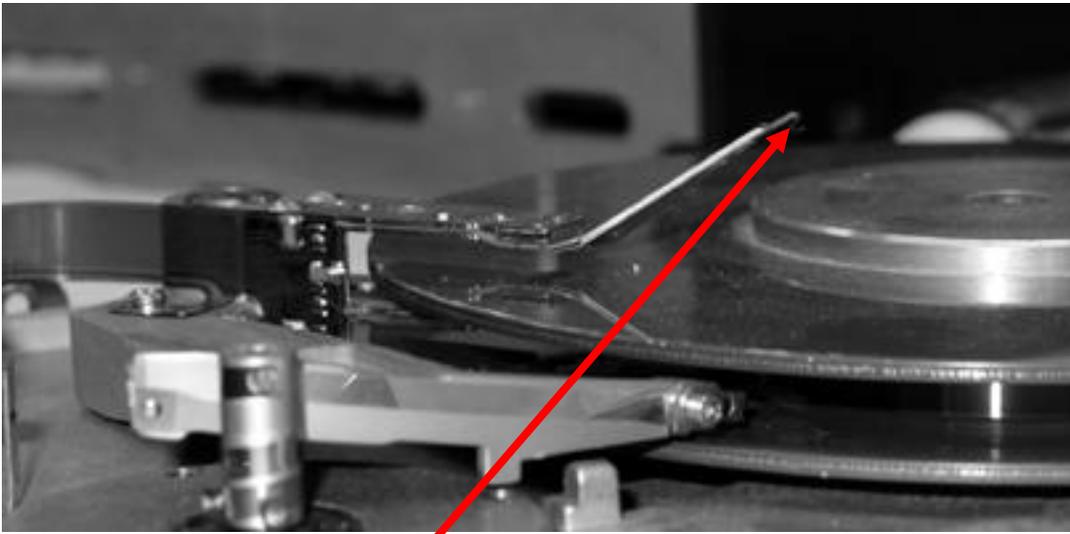

Diagram showing the Read/Write head (bent upward) above one of the hard drive platters. The drive shown above has 2 platters with (4) R/W heads, one for each side.

Tracks, Sectors –

The Read/Write head creates tracks (one complete circle), and each track is further divided into sectors.

Tracks are complete circles that are divided into sectors. A sector on a hard drive or floppy drive will store 512 bytes of data.

2 Platters
4 R/W Heads
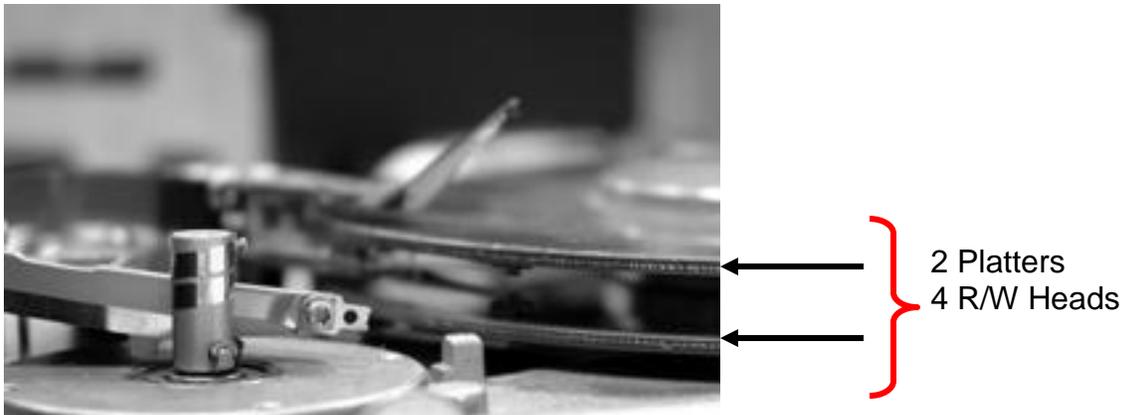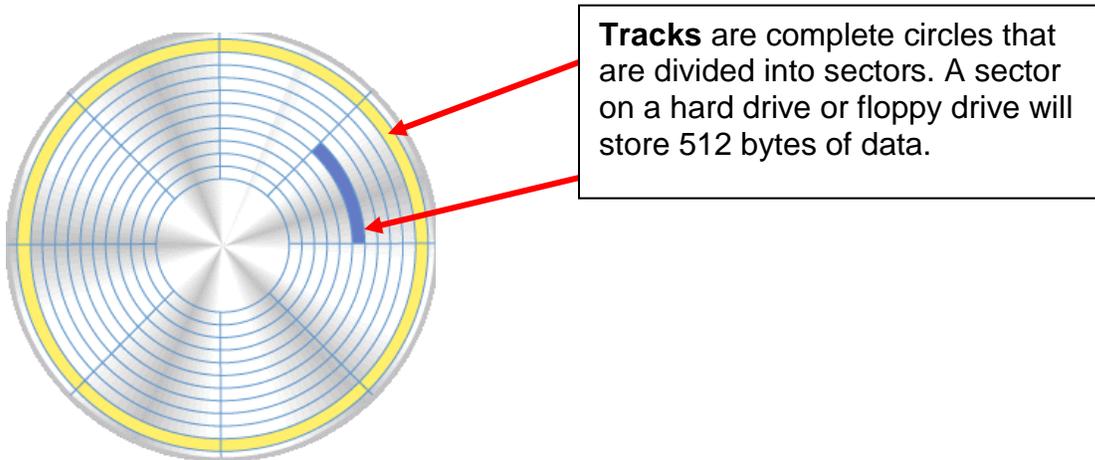
Photo showing the stack of (2) Disk with (4) R/W Heads.

IDE Drives

When hard drives were first introduced for home computers, they were large, slow, and very expensive. The approximate cost per megabyte was $150.00; today hard drives are less than .01 per megabyte. Originally hard drives required a separate plug-in controller to connect the drive to the rest of the system. This eventually led to a problem because as drive speeds increased, the amount of information that had to travel through the cable connecting the drive to the controller also had to increase. Since the cable was rather long, it introduced interference into the system that hadn't been a problem with slower drives. If a

user wanted to add a second hard drive to the controller (the controller had 2 drive connections), the new drive had to be the same size as the first.

Today's hard drives have the controller built onto the drive rather than using a separate controller. This shortens the distance between the controller and the hard drive and eliminates the interference problem inherent with older drives. These newer drives are referred to as **IDE I**ntegrated **D**rive **E**lectronics.
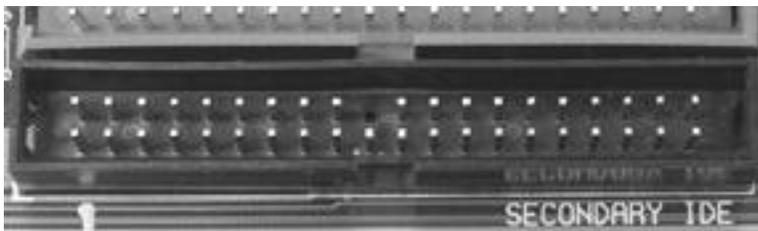

One of the IDE 40 pin connectors on a motherboard.

The Controller connects directly to the back of the hard drive.

Connecting an IDE drive

Motherboards all come with at least (2) connections for IDE devices, one marked **primary** and one marked **secondary**. Each cable supports (2) IDE drives that connect to a 40-pin cable.
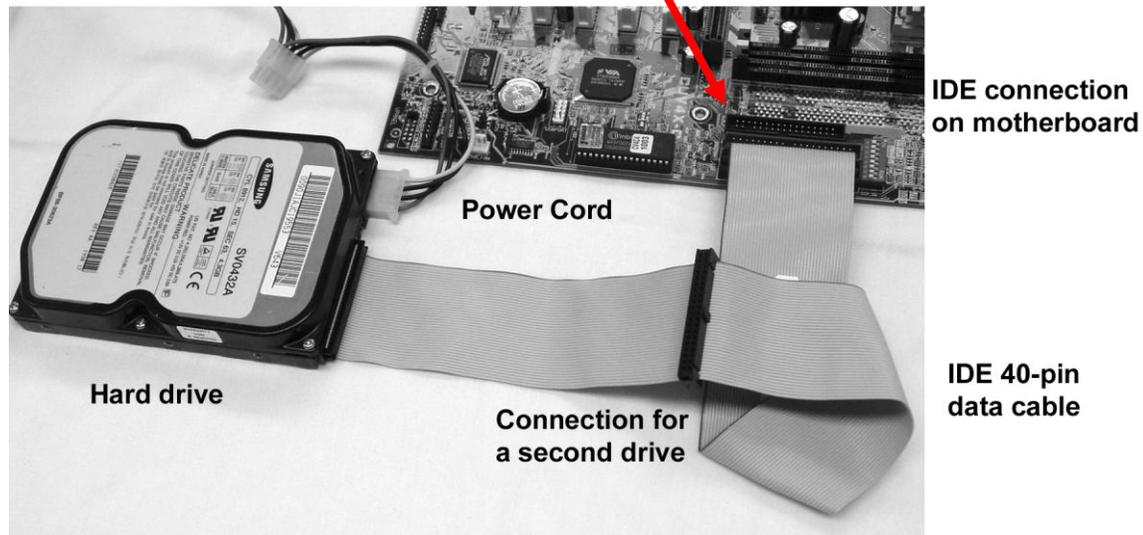
When 2 devices are connected to an IDE cable one must be set to **master** and the second is set to **slave**. These settings are made with small jumpers on the hard drives, depending on the manufacture if there is only a single drive on a cable it will be set to either "**master**", or "**single**". The jumpers are between the power connector and the ribbon cable on the back of the drive. A typical system can support up to 4 separate drives, 2 on each channel. Some systems support more than 2, but all will support at least 2.

ATAPI devices Shortly after the introduction of the IDE drive, CD-ROM drives were being added to the system to add multi-media capabilities. At the time, there would have to be a separate controller card that plugged into the motherboard, or possibly a sound card. It was decided that a new standard should be created to allow hard drives and other devices be connected using the 40-pin IDE cable. With the **ATAPI** (Advanced Technology Attachment Packet Interface) standard devices like CD-ROM drives, Tape Drives, Zip Drives, and DVD Drives could share the same IDE hard drive cable.

SATA Drives

All IDE Hard drives have a 16-bit data bus and at best can transfer data at a rate of 133 Mbytes/ second, and then only in bursts. In order to achieve spends faster than 133 Mbytes, hard drives have to change the way they transfer data. The 16-bit bus transfers 2 bytes in parallel and as is the problem with all parallel devices, once they reach a certain speed, the wires emit electromagnetic energy that interferes with the signals on adjacent wires. This problem has been resolved with the introduction of USB bus and the PCI Express bus by transferring data in packets serially. The data bus on an IDE drive is being replaced with a similar serial bus referred to as the Serial ATA bus, or SATA. The SATA Drive was initially introduced with a supported transfer rate of 150 Mbytes/second and a second version capable of 300 Mbytes is being released. IDE drives can connect 2 drives to a single cable; SATA devices allow only a single device per connection.

IDE Cabling optimization –

The newer IDE Hard drives are capable of transferring data much faster than devices like Zip drives, CD-ROM drives, and DVD drives. The controller of the fastest device is used to control both devices on the cable. To allow slower devices to operate properly, the IDE channel is set to the speed of the slowest device. So you should avoid putting a CD–ROM drive and a high speed IDE drive on the same ribbon cable.

- If there are 2 devices on a single cable – The fastest should be the master.

- For a single device on a cable – Should be Master (or single) and should use end connector, farthest from the motherboard.

- If there are 2 devices on two cables – HD / CD-ROM – HD should be Primary IDE set to master on farthest connector, CD-ROM should be on the secondary channel as the slave.

- Try not to connect ATAPI Devices on the same channel as the Hard Drive. The controller will set up both devices to operate at the speed of the slower device.

- If you have (2) CD-ROM drives, (CD-R/W, CD-ROM), and you plan to copy data from the CD-ROM to the CD-R/W, you should put each one on a separate cable.

- By default the drive used to boot the system should be on the primary channel and set to master device, but this is not a requirement.

- Maximum Cable length for IDE = 18"

Floppy Drives

Floppy drives function almost exactly like hard drives. The floppy was originally designed to allow information to be moved between different computers, and to provide storage on early computers since hard drives were prohibitively expensive. Floppy disks are made of Mylar, a clear plastic like material that is similar to scotch tape. The Mylar is coated with magnetic material and often with a coating of lubricant. Unlike the read/write heads of a hard drive that never come in contact with the surface of the platter, the read/write head of a floppy drive will touch the surface of the disk. Hard drives can spin at rates of up to 10000 rpm where the average floppy will spin at 360 rpm.

The earliest systems used two floppy drives, the A: drive and the B: drive. Both connect to a 34-pin cable with a twist at one end. The twist is used to designate the A: drive from the B: drive, the A: drive coming after the twist and at the end of the cable. Today systems have dropped the second drive in favor of other more efficient methods of storing and moving data, but the cable often comes with two connectors. Just remember that the A: drive is connected after the twist at the end connector.
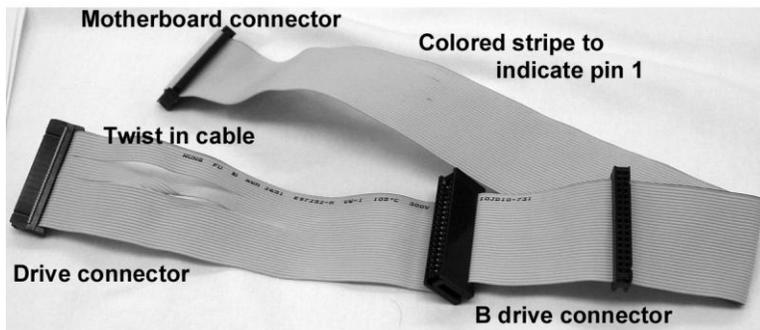
Ribbon cable used to connect floppy.

To indicate which end of the cable is pin 1 on a drive cable, a stripe is drawn on the edge of the cable.

With the introduction of newer storage devices like the USB thumb drive, the floppy drive has being eliminated on newer systems.

Chapter 7 Review questions –

1. When current flows through a piece of wire what are two of the side

    effects?

    _____ & _____

2. The _____ drive is the floppy drive that is connected *after* the twist in the

    cable.

3. Flat ribbon cable used to carry data designates which end of the wire is

    number one by _____.

4. The maximum suggested length for a hard drive cable is _____.

5. _____ is the standard that was written allowing CD ROM drives and

    other devices to share the same cable.

6. Hard drives use a _____ pin data connector.

7. Floppy drives use a _____ pin connector

8. Hard drives and floppy drives use a _____ pin power connector.

9. A sector holds _____ bytes of data.

10. A _____ is one complete circle around a disk.

11. The _____ drive transfers data serially in packets rather then in parallel

    like _____ drives.

The Power Supply

One of the most important and often overlooked components of a computer is the Power Supply. Depending on the intended use of the system, power supplies come in wide range of wattage outputs. A system used only for casual Internet browsing and light word processing could easily get by with a 200 watt power supply, but a system used for gaming with powerful video graphics and sound might easily require 400 watts or more. Users who update systems by adding additional memory, improved video, or more disk storage often fail to address the needs of system power and end up with a sub-standard system.

Electricity

Everyone has some experience with electricity. To most people, it's nothing more than a utility that powers their electrical devices by simply plugging them in. Most people give little thought to where it comes from and how we use it. If you have a basic understanding of electricity, it will give you a much better understanding of power supplies.

Voltage & Current

To understand electricity, you need a basic understanding of how it's measured, and what it does. One analogy that is often used to discuss electricity is to compare it to a liquid.

Water

The water in a water tower exerts pressure in the pipe. If the valve is closed, no water will flow and the water wheel will sit motionless.

The pressure exerted by the weight of the water is comparable to voltage in a circuit. Voltage is the pressure that causes current to flow through the circuit.
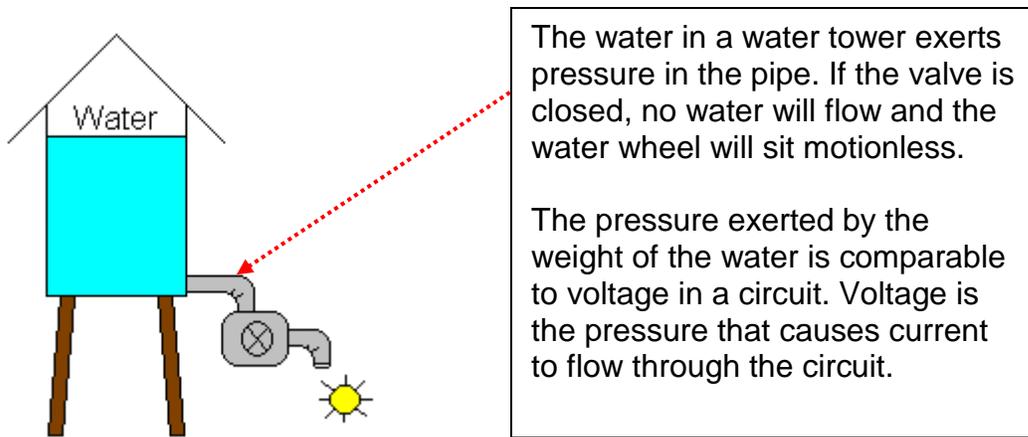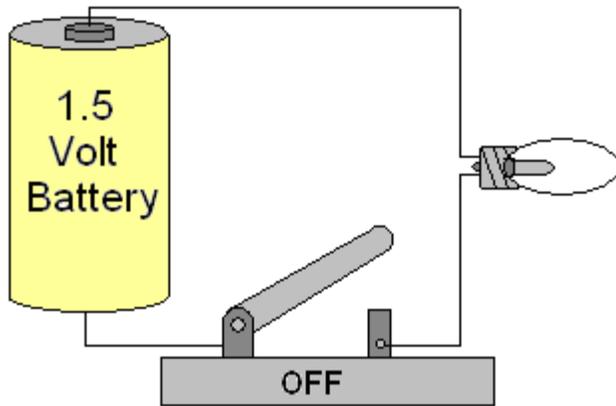
Just as in the example above, the circuit shown has a battery connected to a light bulb. In this case the switch is open (Off) which prevents current from flowing and turning on the light bulb.

Just like the valve in the water tower above that stops the water flow, the open switch stops the current flow.
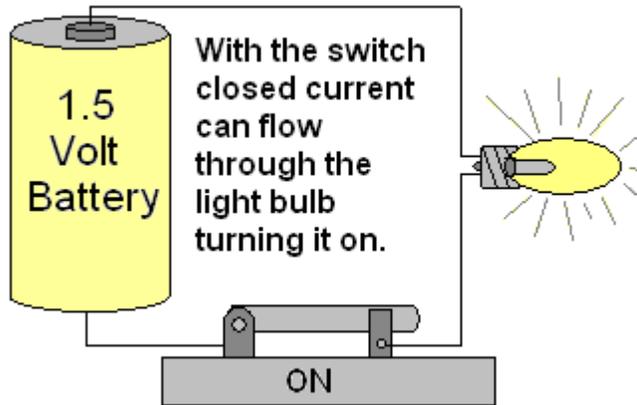
With the switch closed current can flow through the light bulb turning it on.

The voltage (from the battery) is the pressure that pushed the current (electrons) through the wire. As current flows through a wire there are a number of side effects:
1. The wire gets hot, and in the case of the light, the special wire gets hot enough to glow
2. There is a magnetic field around the wire

The ability to do mechanical work is measured in **Horsepower**; the ability to do work with electricity is measured in **Watts**. A 300 Watt power supply is capable of doing more "work" (deliver more power) than a 200 Watt power supply.

Measuring power supplies

Voltage is the pressure that pushes the electrons through the conductor (wire). Voltage is measured in **Volts**.

The electrons that flow through the wire is referred to as **Current**, measured in **AMPS**.

The power delivered by a power supply is measured in **Watts**.

A Power Supply does not supply power; electrical power comes from your local utility company. The Power Supply converts the power from alternating current to direct current at levels that the system requires.

Alternating current works fine for certain appliances and has the added advantage of being easy to distribute over long distances, but many devices will not work on AC.

Maximum Voltage **Reverses direction**

Zero volts

Alternating Current starts at zero voltage, continues to some maximum amount, drops back to zero, then reverses polarity. For some devices, this start-stop does not affect the way it functions. An electric light bulb, when connected to AC, flickers on and off each time the current reverses direction; but since it happens so fast the flicker is not noticeable.

Alternating current works fine for many appliances like light bulbs, toasters, refrigerators, and electric motors; but many electronic devices like computers cannot tolerate voltage that drops to zero or even varies a little bit. The Power Supply converts **Alternating Current** into **Direct Current** that is suitable for the electronic devices inside a computer.

Alternating Current

Volts

Direction of Current flow

Direct Current

Volts

Direction of Current flow
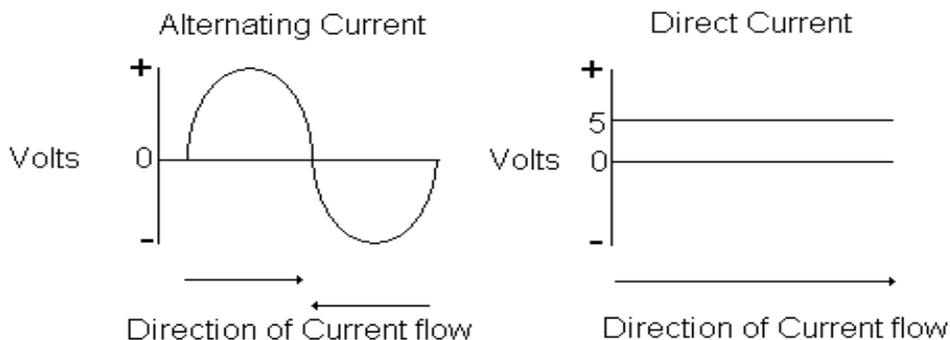
The Power Supply of a modern PC delivers voltages at different levels that are supplied to the motherboard and other components.
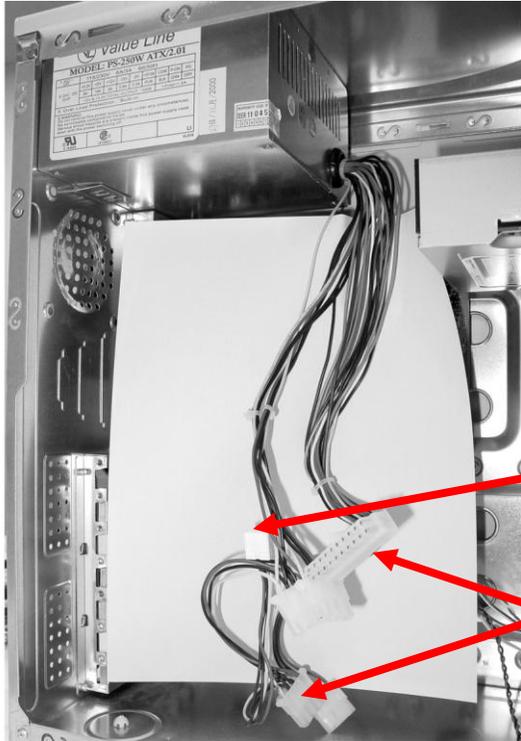
Cables from the power supply deliver voltage to the mother board as well as hard drives, CD-ROM drives, and floppy drives using different connectors.

Floppy Connector

Hard Drive connector

Mother board connector

3.5" floppy   All other drives
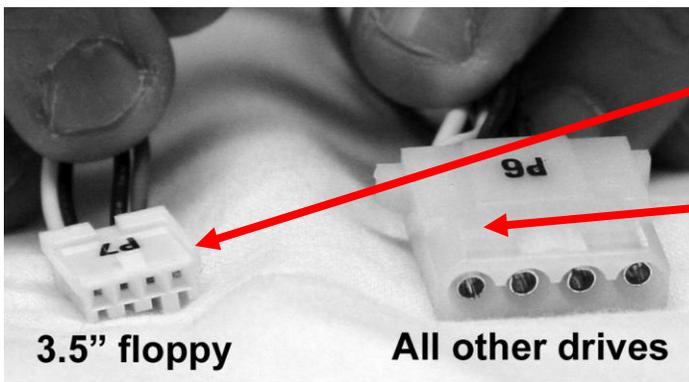
Close-up view of **Berg** connector used for connecting power to the floppy drive, and the **Molex** connector for connecting power to the hard drive and other devices.

20-Pin **ATX** style power connector used to connect Power to the mother board.

MAIN POWER CONNECTOR (PIN-SIDE VIEW)

+3.3VDC			+3.3VDC
+3.3VDC			-12VDC
COM			COM
+5VDC			PS_ON#
COM			COM
+5VDC			COM
COM			COM
PWR_OK			N/C
+5VSB			+5VDC
+12V1 DC			+5VDC
+12V1 DC			+5VDC
+3.3VDC			COM

+3.3VDC			+3.3VDC
+3.3VDC			-12VDC
COM			COM
+5VDC			PS_ON#
COM			COM
+5VDC			COM
COM			COM
PWR_OK			-5VDC
+5VSB			+5VDC
+12VDC			+5VDC
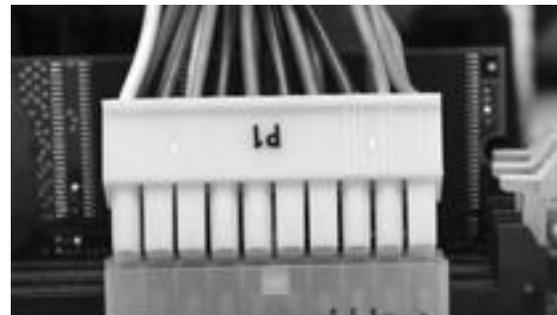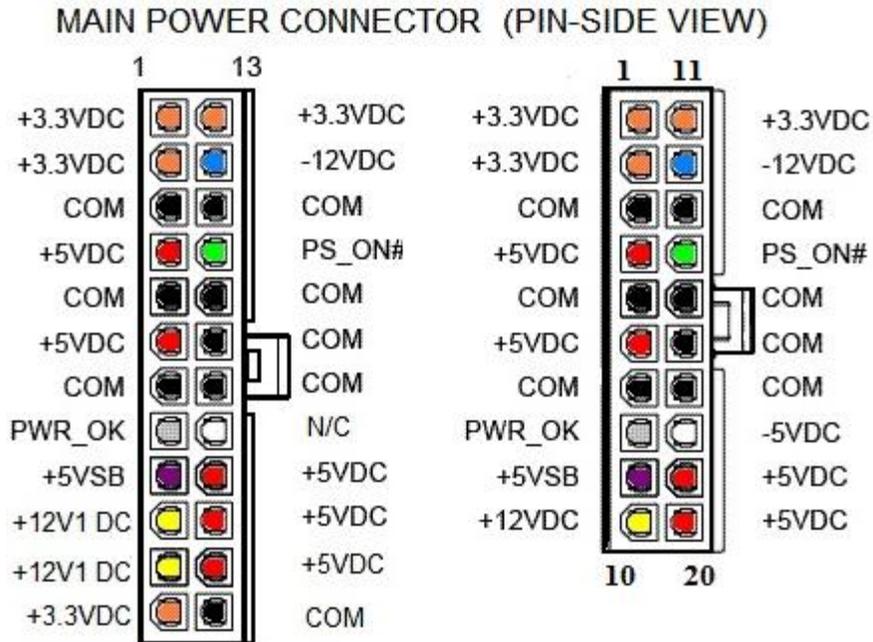
In order to support new systems increasing power requirements, the 20-pin connector has been replaced by a 24-pin connector.

ATX style motherboard connector detail:
- Orange wires ------------- 3.3 Volts
- Red wires ----------------- 5.0 Volts
- Yellow wires -------------12.0 Volts
- Black wires --------------- Ground

Current requirements-

Each pin on the power connector is capable of supplying a maximum of 6 Amps of current to the motherboard. This requires multiple wires supplying 3.3, 5, and 12 volts to the motherboard. For example, on some systems the current requirement of the 3.3 volt connection can be exceed 20 amps. If there weren't multiple (4) orange wires for supplying 3.3 volts, the current draw would have to be increased through the other orange wires causing them to overheat and possibly fail. So power is supplied through multiple cables to the motherboard to balance the load.

Control Lines –

Some connections made through the 24-pin connector are for purposed other than delivering power. The green wire, pin 16 on the 24-pin connector or pin 14 on the 20-pin connector; is used with the from panel power switch to turn on the system. Knowing that, you can test the on-off switch by shorting the green wire to a black wire to see if the system powers up.

Power Requirements for typical systems.

Item	Power requirement	Voltage used
OLDER CPUs	20-40 Watts	3.3 Volts
Athlon XP – Pentium IV	60-90 Watts	12 Volts
MOBO	20-60 Watts	3.3, 5.0, 12 Volts
RAM	20 Watts /256 MB	3.3 Volts
PCI Card	5–10 Watts	3.3 Volts
AGP Video	20–50 Watts and more	5, 12 Volts
CPU Case Fan	2 – 4 Watts	12 Volts
5400 RPM Hard Drive	5 – 10 Watts	5, 12 Volts
7200 RPM Hard Drive	5 – 15 Watts	5, 12 Volts
10000 RPM Hard Drive	5 – 20 Watts	5, 12 Volts
Floppy Drive	5 Watts	5, 12 Volts
CD / DVD	10 – 20 Watts	5, 12 Volts

Using the Power Requirements listed above, calculate the size of a power supply for the following system:

- Mother Board with a Pentium 4 processor, 256 MB RAM, a 7200 Rpm Hard Drive, a floppy drive, a CD and an AGP Card.
  - **Mother Board** ---------------------------- 50 Watts
  - **Pentium 4** -------------------------------- 90 Watts
  - **256 MB RAM** ---------------------------- 20 Watts
  - **Hard Drive** -------------------------------- 15 Watts
  - **Floppy Drive** ----------------------------- 5 Watts

- **CD** -- 20 Watts
- **AGP Video Card** ------------------------- <u>50 Watts</u>

Total System Power: **250 Watts**

To be on the safe side, you should choose a 350 Watt power supply to allow for future expansion.

Other issues when dealing with Power:

Electrical Noise should not to be confused with noise that people can hear; a better description might be interference. Electrical interference can be caused by many different sources but the effects are basically the same. It can cause a system to lock up, produce inconsistent results, damage data stored on drives, weird images on the screen, or scratchy noise in the systems sound output.

Electrical noise types:

- **EMI** Electromagnetic Interference can be created by other electric appliances, typically devices that have a motor or possibly a telephone that has a bell ringer (not a newer phone that has an electronic chirping ring). The best way to eliminate this type of noise is to physically move the source of noise away from the system.

- **RFI** Radio Frequency Interference is created sometimes from industrial equipment, certain medical equipment, or close proximity to a Radio transmitter. The best method would be to locate the system as far from the source of interference or be certain the computer is properly grounded.

- **Natural Interference** Would be electrical noise generated by a lightning storm. To prevent lightning from damaging electronic equipment, be certain to use a surge suppressor when plugging in the system.

Coping with electrical noise:
- Be certain to keep the computer case on and bolted in place. The cover provides shielding from some electrical interference.
- Be certain to close any opening on the back of the case; all filler plates should be in place.
- Use shielded cables whenever possible.
- Turn off cordless phones.
- Avoid high power electrical machinery.

Trouble caused by power line faults:

Brownouts are times when the amount of voltage from the power company drops to a low level. The voltage from power companies is generally between 115 and 120 Volts AC; during a brownout the power could drop to less than 110 volts. Brownouts can cause serious problems to electrical devices. If the lights dim, it's a good indication that you are in a brownout condition and systems should be powered off.

A blackout is when power is completely lost, often caused by a power line being knocked down. To prevent power loss, a battery power backup device is your best bet.

Transients can be created in many different ways. Lightning can induce a large amount of voltage into your power line; or if there is a large machine that switches on and off that is on the same line, you can get a surge from it. If the voltage increase is very short in duration (lightning) it's referred to as a **Spike**. Most power supplies can handle small spikes with a suppressor that is installed in the supply. The suppressor acts like a sponge and can dissipate small spikes. If the increase lasts longer, it is referred to as a **Surge**. A surge suppressor is an electrical outlet that has built in fuses that will open to protect attached equipment.

Battery Backup

A battery backup is a device that will provide 120 Volts AC in the event that you lose primary power. A battery backup plugs into an AC outlet and uses that to keep a battery charged as well as provide power to your PC. If the power is lost, the battery takes over and is used to power a special device that converts DC from the battery (typically 12 Volts) to 120 Volts AC to continue powering your system. Battery backup devices come in many sizes depending on how much power you want to provide and how long you want to be able to run your system without power. A five-minute battery backup device would be about the size of a shoebox and have a small battery in it. A one-hour battery backup could be the size of a small refrigerator with numerous batteries inside. Most people who use battery backups in the home use a small five-minute unit that gives them enough time to save their work and shut down the system. Larger battery backups are used to power servers and might include special software that will shut down the system if it is unattended before the battery goes dead.
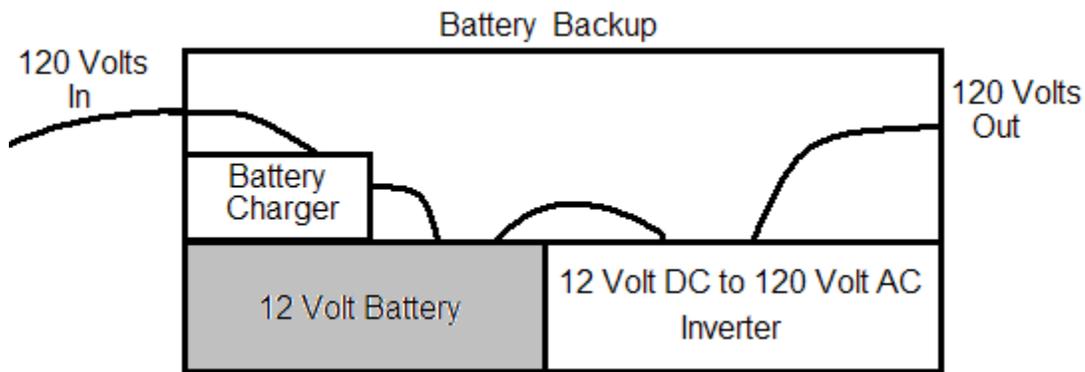
A typical batter back up unit plugs into 120V.A.C., converts that to 12V. D.C. to charge the battery. 12 volts from the battery is fed into an inverter which converts 12V.D.C. back into 120V.A.C.

Chapter 8 Review questions –

1. _____ is the measurement of a power supply's ability to do work.

2. Voltage is measured in _____.

3. Current is measured in _____.

4. A _____ is complete loss of power

5. A _____ is when power drops below a certain amount.

6. How much power is used by the floppy drive?

7. The _____ colored wire is used to carry 5 Volts.

8. The _____ colored wire is used to carry 12 Volts.

9. The _____ colored wire designated a ground connection.

10. The _____ colored wire is used to carry 3.3 volts.

11. How many watts would a power supply have to deliver for the following configuration?   _____

   - Athlox XP Motherboard

   - 512 MB RAM

   - A high end Video card

   - A 7200 RPM Hard Drive

   - A floppy Drive

   - A CD-ROM Drive

DEFINITIONS Chapter 8

   - **Alternating Current –** The type of power delivered by the electric company, where current flows in one direction then stops and reverses direction

   - **AMP -** The measure of current in an electrical circuit

   - **Blackout –** Total loss of power

   - **Brownout -** When the voltage delivered by the power company drops to a less than expected level

   - **Direct Current –** The type of power delivered by batteries; the voltage is constant

- **EMI –** Electromagnetic Interference is electrical interference caused by nearby devices that have electromagnets, like motors or transformers

- **RFI –** Radio Frequency Interference is electrical interference caused by other electronic devices operating nearby

- **Spike –** When the power increases for a very short period of time

- **Surge -** When the voltage increases to higher than normal for a duration of time

- **Surge Suppressor –** Device used to absorb voltage spikes

- **Volt -** The Measure for Voltage

- **Watt -** The measure of Power

What is an Operating System?

An operating system is the program that acts as the interface between the user

(and/or application) and the hardware. It's basically the program that controls the

computer.

User	Application
Operating System	
Hardware	
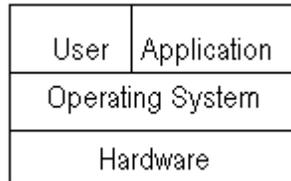
The operating system helps simplify the task of writing applications, since the

programmer does not have to be concerned with the complexities of interfacing

with the hardware. The interface to the Operating System (O/S) is made simpler

by providing Application Programming Interfaces (APIs) that programmers use

when accessing various devices. Once a program is written using an API, it is a

simple matter to move the program to a new hardware platform. Some very early

applications like Lotus 1-2-3 were originally written to directly interface with the

hardware. This had the benefit of allowing the application to execute very fast,

but meant that if the hardware level changed, the program would need to be

rewritten.

What is DOS?

DOS was written by Tim Patterson for Seattle Computer Products; at the time it

was called QDOS "Quick and Dirty Operating System". Even before that, the

term DOS was used by IBM for their Disk Operating System used on the IBM

360. Bill Gates purchased the rights for QDOS in 1981 and MS-DOS 1.0 was created. The first version of DOS 1.0 supported a whopping 16KBytes of RAM and a single-sided 5 ¼" floppy that stored 160K. From the original release, DOS evolved to its latest version 6.22; thereafter (1995) it was embedded into the Windows Operating system. Windows 95 is DOS 7.0.

Why bother learning DOS?
Even though DOS as a stand alone operating system has been completely replaced by Windows, the utilities that were available in DOS are still available under Windows. Most every utility that once used a *command line interface** has since been replaced by ICONS in a Graphical user Interface (GUI).

Over the years, computer users have forgotten how to use the basic DOS utilities or were never exposed to them in normal use. As a computer technician, you will be expected to have a good understanding of these utilities and how to use them to troubleshoot some system problems. One example would be a system that has a problem preventing it from booting properly, possibly a hard drive problem, or an incorrect system parameter setting. The best way to troubleshoot this sort of problem is to boot the system using the A: drive with a 3 ½" floppy. Since a floppy can only hold 1.44 MB you won't be able to use it to boot windows; instead you have to work in a command line environment. This command line environment uses the same DOS commands that were used before windows. There are numerous utility programs available that can be used to bypass your system hard drive and boot from a CD-ROM drive. The benefit to using a CD-ROM drive over a floppy is that you can store considerably more troubleshooting programs on a CD than you could on a floppy. One company, TuffTEST www.tufftest.com , has a suite of available programs that can be used for system maintenance and they allow you to download a sample version that can be used to troubleshoot many hardware related issues.

Types of user interfaces:

1. Command line interface → c:\format

2. Menu interface →users select from a menu of options

3. Graphical User Interface → (GUI "gooey") ICONS are clicked on

What does DOS look like?

DOS does not support a graphical interface, so there is little need for a mouse since you can't click on a system ICON from your desktop. To enter a command you need to remember the correct syntax for it and type it in.

Formatting a floppy disk using the DOS command line: → **format a:**
Command lines that required users to memorize many commands and options have been replaced by Graphical User Interfaces, **GUIs**.
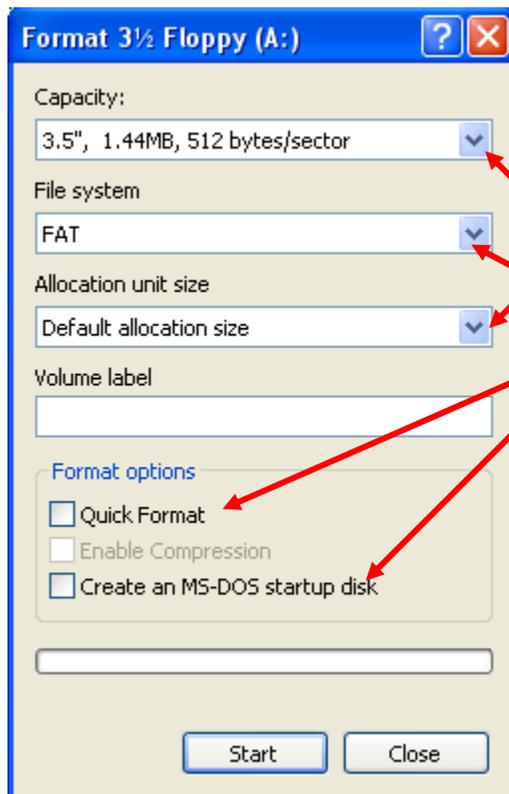
When working in a **GUI** environment, you can quickly see all the options available when formatting a disk.

Options can quickly be set using drop down menus, or radio style selection buttons.

These simplify the options that can be added to commands

Graphical Interface used when formatting a 3 ½" disk from Windows

Entering DOS from Windows -

You can enter a command line interface from Windows which will give you a feel for what DOS looks like:

Windows 9X	**Start → Programs → MS-DOS**
Windows 2000 / XP	**Start → Run → CMD**

*To exit "**DOS**" and re-enter Windows, enter "exit"*

The DOS Prompt C:\>

When you enter DOS or its command line equivalent, your screen will turn black; and your **PROMPT** will look something like → **C:\WINDOWS\COMMAND > __**
The underscore "__" shown above is usually blinking indicating where whatever you type would be displayed.

The Command Interpreter

Type a command followed by **<cr>** (<cr> also known as the "Enter" key.).   Try entering **CLS,** this is the "**Clear Screen"** command which will clear your screen. Anything entered is seen first by the **command interpreter**, which determines if it is a valid command. Try entering **abc;** the command interpreter will determine that abc is not a valid command and give you an error message.

The File System

Before you can understand the inner workings of an Operating System, you must first understand the File System associated with it. DOS uses a hierarchical file system. The easiest way to understand a file system is to think of the hard drive (where all your files are stored) as a very large file cabinet. In the old days, the file system was a flat file system, which was like having a huge file cabinet that stored every file one after the other with little thought given to grouping certain files together. Wouldn't it make more sense to divide your file cabinet into

drawers and in each drawer make a folder; one folder might contain memos, and another contains letters, and another that contains correspondence, etc. By creating separate folders for files, you are creating a hierarchical file system. Another way to visualize the file system would be to think of someone writing a book; they would create a folder for chapter one, another folder for chapter 2, etc. Then when looking for information, the user knows that if she needs a memo, she looks in the memo folder, and items for chapter one would be stored in the chapter one folder. The hierarchical file system used by DOS looks like an inverted tree with the root on top and the limbs underneath.
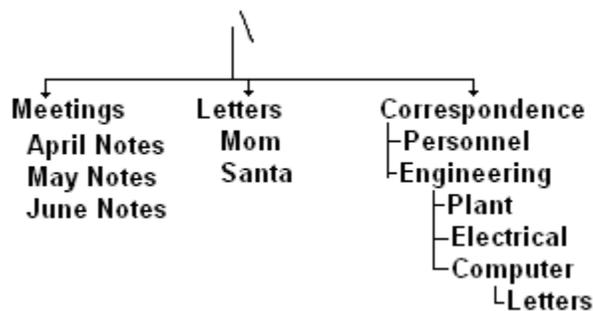
Figure 1.0

Figure 1.0 is an example of a typical file system. The highest level is referred to as ROOT \ Underneath the ROOT directory are other subdirectories:
- Meetings
- Letters
- Correspondence

Folders are also called Directories. Before Windows they were called Directories and after Windows they're called Folders. Either way they both do the same thing, namely store files and possibly other folders. When a Directory/Folder has another Director/Folder in it, it's referred to as a Sub-Directory, or a Sub-Folder. In Fig 1.0 as you follow from Root down through the sun directories, you see Meetings, Letters, and Correspondence as sub-directories. Under Meetings you see three files that store information about meeting notes from April, May, and June. Under Letters you see 2 files one letter to Mom and one to Santa. Under Correspondence you see 2 sub-directories' one called Personnel and one called Engineering. In the Personnel sub-directory you would expect to find personnel correspondence; under Engineering there are 3 more sub-directories: Plant, Electrical, and Computer; and finally under Computer there is another Sub-Directory called Letters. This is where you would find any Correspondence to the

Computer Engineering department in the form of a letter. There is a lot of information that can be easily located if the file system is set up properly. Unfortunately users often made the structure too detailed as shown in the above letter to the Engineering department. One more thing about directories, they all have names; luckily the names are easy to figure out. The Sub-directory that stores letters for the engineering department is called:

"**C:\Correspondence\Engineering\Computer\Letters**" ← *Notice that each sub-directory is separated from its parent directory with a "\", and the "\" is also the symbol for the root directory.* The root directory is always preceded by the drive letter, in this case **C:**\. All drives have root directories, so the A: drive's root directory is **A:**, the C: drive's root directory is **C:**, the D: drives root directory is **D:** all the way through the Z: drive if there is a Z drive. Whenever you refer to a directory starting from its root directory it's called a ***fully qualified path name***, with a fully qualified path name, you can find anything stored on a system. **C:\Correspondence\Engineering\Computer\Letters** is the fully qualified path name to the sub-directory "*Letters*".

Navigating through the File System

Users navigate (Move) through the file system using the **CD** command, CD stands for <u>C</u>hange <u>D</u>irectory; not all commands are that easy to figure out. So if you're in the **Correspondence Directory** and you want to move to the **Personnel Directory,** you would enter ***CD Personnel.*** (Note, commands in DOS ArE NoT CaSe sEnSiTiVe.)

In DOS it's very easy to tell what directory you're in because the Prompt will change to display the directory. So when you're in the Correspondence Directory, your prompt will be "**C:\Correspondence>**", which is its fully qualified path name. When you change to Personnel, the prompt will change to **"C:\Correspondence\Personnel "**.

The Path Variable

When you enter a command, the ***Command Interpreter*** must locate it before it can be executed. If it cannot locate the command it gives an error message exactly like the one you got when you entered "ABC", which was an erroneous command. If your file system was very large, it would take the command interpreter a long time to locate commands if it were allowed to look through the entire file system trying to locate it. DOS limits the locations where the command interpreter looks for commands to speed up the process. It would not make sense to look for executable commands in your Correspondence directory since it only contains files and not executable commands. It would be like looking for the lawn mower under the kitchen sink! To limit where the command interpreter looks for commands, DOS used the **PATH** variable. The PATH variable tells the command interpreter where to look for executable commands. The default (normal) way the command interpreter works is to first look in the directory you are in to see if the executable command is there; if it's not there, the PATH variable is used to tell it where to look next. The Path Variable lists every directory one after the other each separated by the ";" symbol.

Sample Path Variable set up in DOS

Path=C:\WINDOWS\System32**;** C:\WINDOWS**;** C:\WINDOWS\Command

Search order :   1st 2nd 3rd

The above Path Variable tells the command interpreter to look in the 3 following directories:
- C:\WINDOWS\System32
- C:\WINDOWS
- C:\WINDOW\Command

Try the following in a **DOS** environment –

- To see how your **PATH** variable is set in DOS
    - *echo %path%*
- To see **all** the system variables that have been set in DOS
    - *Set*
- To see how **any** single system variable is set, enter
    - *echo %system variable% Use the command **echo** and surround the system variable with **"%"***
- To set up a system variable
    - *set variable=value*
- Example of setting a system variable
    - *set Name="Mary"*
- To see the variable
    - *echo My name is %name%*

Variables are used by the Operating System to identify parameters that could vary between 2 different systems. For example, one system might create a new directory that has executable files it needs, while another system does not have the directory. Each system's Path variable will be changed to reflect the needs of that system.

Chapter 9 Review questions-

1. DOS uses a command line interface, Windows uses a _____ interface.

2. The _____ variable tells the command interpreter where to look for

   commands.

3. Commands used in DOS are case sensitive.   T/F

4. What command is used to clear the screen? _____

5. The _____ command will display all system variables.

6. The _____ determines if a command is valid.

7. DOS uses a(n) _____ file system.

8. Another name for a directory is _____.

9. What would be the result of the following?

   Set Name= "Bill"
   Set Last = "Smith"
   Echo My name is: %Last", %Name%

   _____

Disk Management

Whenever you purchase a new hard drive for a system there are a few steps that must be performed before it can be used. It doesn't matter if it's to be used in a Windows environment, Linux, or UNIX the drive needs to be partitioned and formatted before it can be used. Whenever partitioning a drive that might have important data, be certain to back it up first, after partitioning a drive any date will probably be lost. This chapter will cover 2 methods of preparing a hard drive, one using Windows XP utilities and one using a freeware program "Gparted".

Hard Drive Partitioning -

The cost of hard drive storage has dropped dramatically over the last few years so let's assume you are starting with a new 500 GB drive for your installation. Since the drive is brand new there are a few steps you need to take before you can begin the installation, but first you will need to consider how you want to configure your drive.

Think of your 500 GB hard drive as a very large home you're designing with 40,000 square feet. You most likely don't want an 40,000 square foot home with only one room so you divide your space into the various rooms deciding how many bedrooms you want and how large to make the kitchen, etc. You should also consider dividing your 500 GB hard drive into smaller more manageable storage spaces. The process of dividing a large hard drive into smaller units is referred to as **Partitioning**. When you partition a hard drive you make it appear to the operating system as multiple smaller hard drives, referred to as **Logical Drives**. Partitioning also informs the operating system certain details about the drive such as where it starts the size of the drives, etc. (Partitioning is covered in more detail in CIT 1112) You could make five 100 GB hard drives, four 125 GB hard drives, two 250 GB hard drives or any combination up to as many as 22 drives. The number of drives is usually limited by the letters in the alphabet A-Z, A & B is historically reserved for floppy drives use, a CD, or a DVD would probably be

seen as the D drive. It probably would be a good idea not to create too many drives since it becomes hard to keep track of them all.

The main reason people partition a drive is to make it easier to manage the data. You could create a 250 GB drive to load the operating system and the applications onto, then another 250 GB drive for data storage. How you divide your system depends on how you plan to use the system. If you are putting together a super gaming system you might only create a single partition. If you plan on doing video editing and storing large amounts of video you will need a data partition as large as you can make it. In fact you might even consider getting a second drive just for video storage.

Planning a Partition -

Since there is no way to know exactly how everyone would use their system, you need to make some general assumptions. To most people, the data created and stored on their drives is more important than applications, so you might want to start there. Unlike application software which can easily be reloaded from the original distribution disks, if data is lost it's is gone forever. To keep it simple we will create 2 partitions of 200 GB each. The first partition (Primary) will contain the operating system and applications, and the second partition will contain data. Storing data on its own logical drive makes it easier to back up, if everything was on a single drive you would have to back up the operating system, applications, as well as data.

Partitioning the hard drive using Windows XP setup disk -

After planning your partitioning scheme and physically installing the hard drive, set the system BIOS to boot from the CD as the first device. Insert the Windows XP startup disk into the CD and boot the system. Even though you have set up BIOS to boot from the CD, it will stop and prompt you asking if you want to boot from the CD or the Hard Drive. If you do not select CD, the system will bypass the CD and attempt to boot from the hard drive after a few seconds. The

following describes loading XP onto a new drive, if you are loading on a drive that had a previous version of XP or another Windows operating system the prompts will be slightly different. Typically if you're reloading XP you will overwrite the older installation.

1. After a few minutes of loading drivers and initializing the system, Windows XP will present you with the **E**nd **U**sers **L**icensing **A**greement (EULA). Press **Page Down** and push **F8** to accept the terms.

2. After you have accepted the End Users Licensing Agreement you will get a blue screen that displays the disks current partition scheme.

3. If your hard drive is new there will be no partitions displayed (go to step **5**), if there are other operating systems installed you can delete them from this screen. If you have loaded another operating system and left unpartitioned space on the drive you can load XP in that space if there is enough room (at least 2GB). This will allow you to create a dual boot.

4. To delete old partitions, highlight the partition using the arrow keys and press "**D**", you will be required to hit enter, then "**L"** to completely remove the partition.

5. To create a new partition highlight **Unpartitioned space**, enter "**C"**, on the next screen you can select the size of the partition.

6. After selecting the size for the new partition you are returned to the **Setup screen**, highlight the new partition created in step 5 and hit **enter** to go to the formatting screen. (Windows XP has a utility that allows you to create additional partitions after the system is setup. It's easier to setup any additional partitions using that utility, after XP is loaded.)

7. The next screen asks you to select the type of file system you want to use. Select **NTFS** and hit **enter**. The system will format the new partition.

8. To complete the remainder of the XP setup follow the system prompts.

To completely load XP takes approx. 25 minutes. Note that by default Windows XP would use the entire disk as a very large C drive. By creating a smaller

partition (step 5 above) you can use XP's **disk manager** to create new partitions as needed.

Creating partitions using XP Disk Manager -

After XP has completed the installation, right click on **My Computer** and select **Manage** to open the **Computer Manager**. Locate the icon in the left screen labeled **Disk Management** and click on it. You should get a graphical representation of your hard disk, showing the single partition (blue) and unpartitioned space (black) next to it. Right Click on the unpartitioned space and select **New Partition** to start the **New Partition Wizard** select **Primary** and click **Next** enter the partition size in MB (for 200GB enter 200,000) then **Next,** select the drive letter (Probably E) **Next,** Format using **NTFS Next, Finish.** After the partition is formatted you will still have unpartitioned space left over which can be used to create another partition at a later time. Right Click on the New Volume and select Properties in the Name box enter "Data"
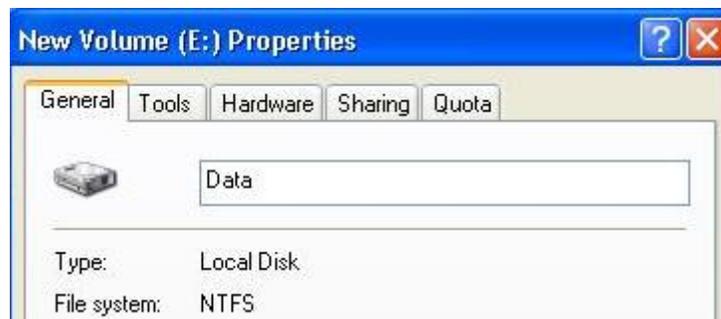
Click on **OK** to save the change, then exit out of the **Disk Manager.** Open MY Computer and you should see the new drive listed as **Data** (E:)
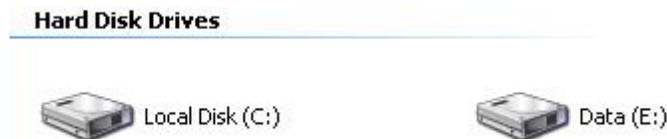
Naming hard drives helps you keep track of the function of the drive, in this case the E drive is where we will store the systems Data. After you have completed

the partitioning and formatting of your drives you should run check-disk to verify the drives integrity. The command is launched by right clicking on the drive (do it on both C and E) and selecting **Properties**. Click on the **Tools** Tab and select **Error-Checking** select Check Now. Select **Automatically fix file system errors** and **Scan for and attempt recovery of bad sectors**. (covered in more detail in CIT 1112)

Do this for C and E drives.

When you click on **Start** the application will fail since the system cannot run if there are any files are open on the drive. So it asks if you want to run disk check after the next system boot, select **YES** and reboot the system.

Data Backup

Your system by default will load all your applications on the same partition as the operating system, the C drive. This is what you want since you now have a separate drive where data will be stored. By separating the operating system and applications from your data if the operating system becomes corrupted you can reload it without loosing the data.

Backing up data can be done in a number of ways the most common method was to use a tape drive. The problem with tape drives are they require maintenance, numerous expensive tapes that had to be changed, and are rather expensive. Since hard drives are so inexpensive and generally more reliable than tape drives you might consider purchasing a second drive. Windows XP has a utility that will allow you to automatically backup from one drive to another based on a schedule you set, this will be demonstrated in the lab. Using a second hard

drive to backup data is not a good idea for data that is extremely vital, if the building burns down you would probably loose both drives. For that type of reliability consider an external drive that you can move to a safe location, or possibly a tape backup.

Using Gparted to Manage Disk Partitions

GParted is a program that allows you to change the partition scheme of a hard drive, while preserving the partition contents. **Gparted** is similar to *Partition Magic* a commercially available product. The program allows you to create new partitions, delete existing partitions, or resize partitions.

Gparted runs in **Linux**, and since you boot directly from the CD into Linux, you are bypassing the C drive which is very convenient if the C drive or Windows is corrupted preventing you from booting. You can use **Gparted** to set up a partitioning scheme for XP, Linux, or any operating system. The true value of **Gparted** however is not the ability to create partitions since all operating system have adequate programs for creating partitions, but it allows you to modify existing partitions. If for example you have a drive with 2 partitions one is almost completely full and the other is nearly empty, **Gparted** allows you to shrink one and enlarge the other. Or if you leave some unpartitioned space at the end of the drive you can use it to enlarge an existing partition using the unpartitioned space.

Gparted is an available application that is included with almost all Linux systems. In upcoming labs you will create a Linux live CD that includes Gparted and other programs that can be used to trouble shoot Windows systems.

CIT 1100
Chapter 10 Disk Partitioning and File management

Chapter 10 review questions-

1. Hard drives must be _____ and _____ before you can load an operating
   system.

2. How many physical drives can you install in a standard system? _____

3. Why would you name a hard drive?

4. What is the XP Utility that allows you to create partitions?

5. What is the benefit of loading the operating system on a separate partition?

6. If installed using Windows default settings, how big would the primary partition
   be set to?

7. When would a tape drive be a better backup method than a second installed
   hard drive?

Up until this point, you should have a good understanding of the major components that make up a computer system. Chapter 10 introduced you to the basics of disk partitioning and formatting, this chapter covers some areas that help you effectively design, maintain, and perform some of the more basic troubleshooting tasks to keep a system running properly.

Implementing Windows XP

Assume you have just completed building a system and are at the point where you are ready to load an operating system. Since the majority of problems encountered with a computer are related to operating system issues, there are steps you should take initially to protect your system. In this section we will decide how to partition your disk drive, create areas to store backups of the operating system and your data files.

Disk Partitioning for Windows XP

Partitioning schemes are determined by the overall size of the hard drive, in our example we will be using an 80GB drive, for larger drives adjust the partitions as you see fit. For an average system running Windows XP Professional, setting up a 20GB primary partition will easily allow enough for loading the operating system as well as allowing room for applications. When prompted in the initial, installation create a 20GB primary partition and format it using the **FAT32** file system (see Chapter 10). Windows XP also supports the **NTFS** file system which provides a higher level of security and other advanced features, but the overhead needed to run NTFS plus the fact that you cannot easily boot to NTFS using a floppy makes FAT32 a better choice for the primary partition. Later when you create a partition for data, NTFS will be used; this allows you to better secure your data and control access, as well as encrypt it if necessary. Follow the prompts and complete the initial installation, for any additional service packs and upgrades connect to the Microsoft web site

http://update.microsoft.com/windowsupdate/   to bring your system up to date. After the Windows XP is completely loaded, load any applications to complete the installation. If you plan on installing applications that might require extremely large disk space, adjust the size of the primary partition accordingly.

Create a Data Partition

The next step is to create a separate disk partition for storing your data. By default, Windows XP uses **C:\Documents and Settings**_USER_**\My Documents** directory to store all your data files; this places both your operating system files and your data files on the same partition. The problem with having your data and operating system files on the same partition is that if an operating system file becomes corrupted and forces you to reload the operating system, your data files could be lost. By moving the data files to another partition, or even better to another disk drive altogether, you can reformat and reload the operating system onto the C: drive without affecting the data. In the example we started with an 80GB drive using 20GB for operating system and application, leaving 60GB for creating a data partition.

To create a new data partition:

- **Right-Click** on "**MY COMPUTER**" and select **Manage**
- From the **Computer Management** menu, select **Disk Management**
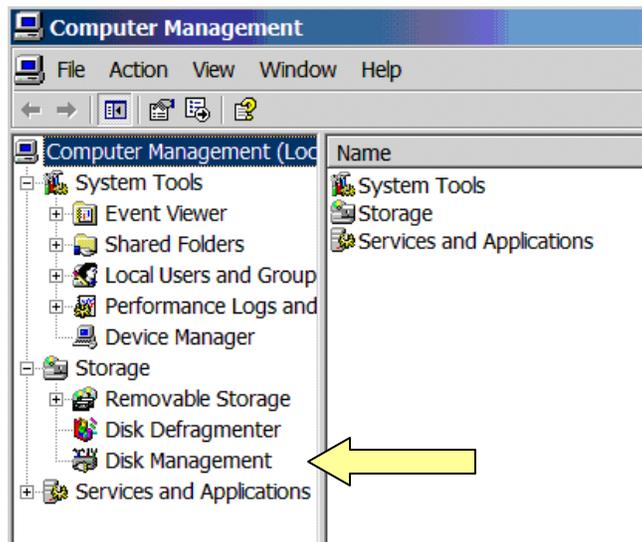
- Disk Management will graphically display the hard drive, right-click on the unpartitioned space (black) and select **New Partition**, create a primary partition

- Determine the amount of space you will require for data storage, in our example we decide to use 20GB*, (you can optionally change the drive letter) and format the new partition using **NTFS**. *Note some applications create very large files; adjust the size of the partition accordingly*.

- Once the format completes, the operating system will assign the drive letter to the new partition
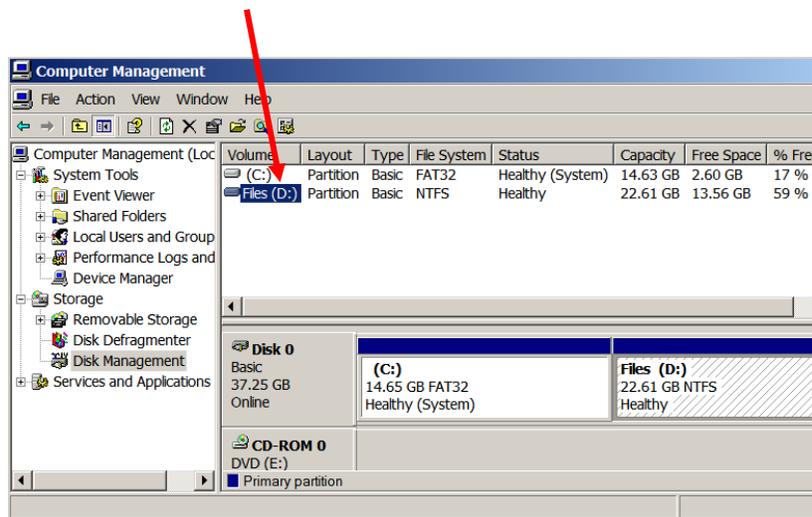
- Right-click on the **D:** drive icon and select **Properties**
- In the Text box, enter a name for the Drive "**Files**"
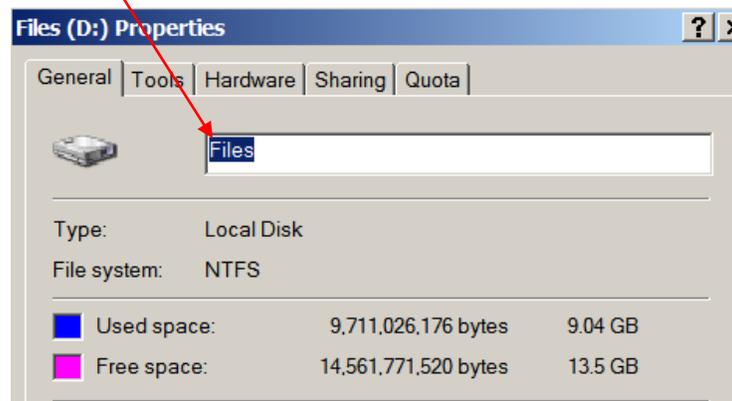
Fig 12.2 Naming your drive

- You now have a D: drive named **Files**.

By creating a name for the drive, it makes it easier to remember what is stored on the partition; use any name that makes sense to you.

To change the location Windows uses by default to store files from the system default of **C:\Documents and Settings\USER\My Documents** to the new **D:** drive:

- Click on **Start**, Right-Click "**My Documents**", select **Properties**

My Documents Properties   ? ×

Target | General | Sharing

The My Documents folder is a shortcut to the target folder location shown below.

Target folder location

Target: d:\Documents and Settings\Clyde\My Documents

[Restore Default]   [Move...]   [Find Target...]
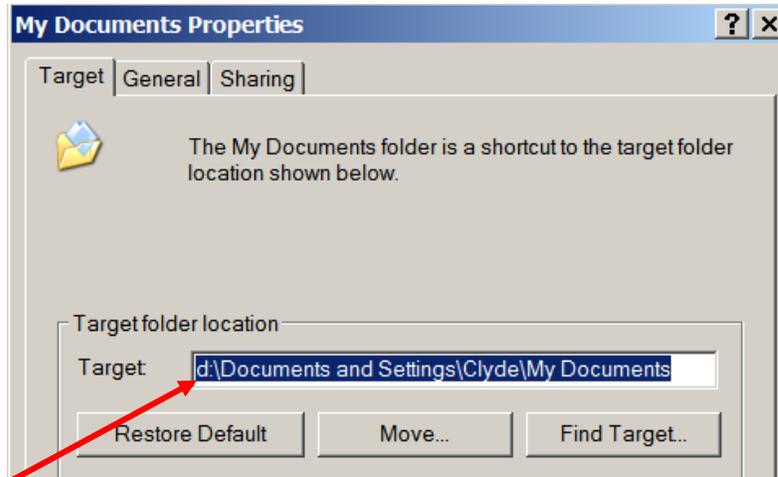
In the **Target,** change from **C**:\ Documents and Settings…
to **D**:\ Documents and Settings ...
(use the drive letter for the new drive you just created, probably D)

The operating system will create a new folder on the D: drive and move any files that were stored on the C: drive to the new folder. Now any new data file created will now be stored on the D: drive by default. Assuming you started with an 80GB hard drive, the operating system now sees it as a separate 20GB C: drive, a 20GB D: drive, and the remaining 40 GB is unpartitioned space.

C: Drive 20GB Windows XP Applications	D: Drive 20GB "Files" System stored data	Unpartitioned space
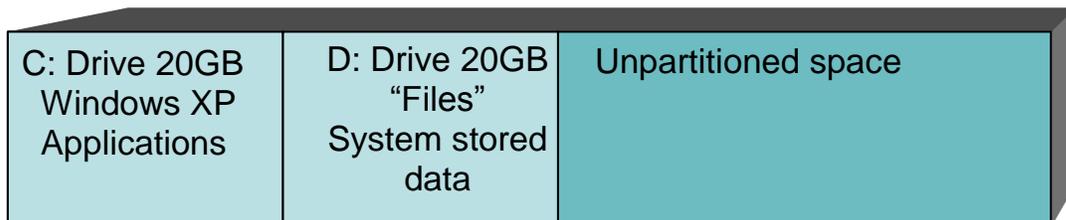
Fig 12.3 Hard Drive before setting up backup partitions

Backing up your Hard Drive

Once you have the hard drive configured the way you want it, you need to make a backup copy so that if it becomes corrupted you can easily restore it. In this example, we will be creating a third partition for backing up the C: drive and the D: drive. This will allow you to restore your system if it becomes corrupted, **but not if the drive itself should fail**. If you can afford a second hard drive, use it as the backup drive; that way if the drive fails, you can replace it and restore everything from the second drive. If you cannot afford a second drive or if you're using a laptop that only supports a single drive, you can use the unpartitioned space to create the backup.

| C: Drive 20GB Windows XP Applications | D: Drive 20GB "Files" System stored data | Z: Drive OS Backup Data Files Backup | |
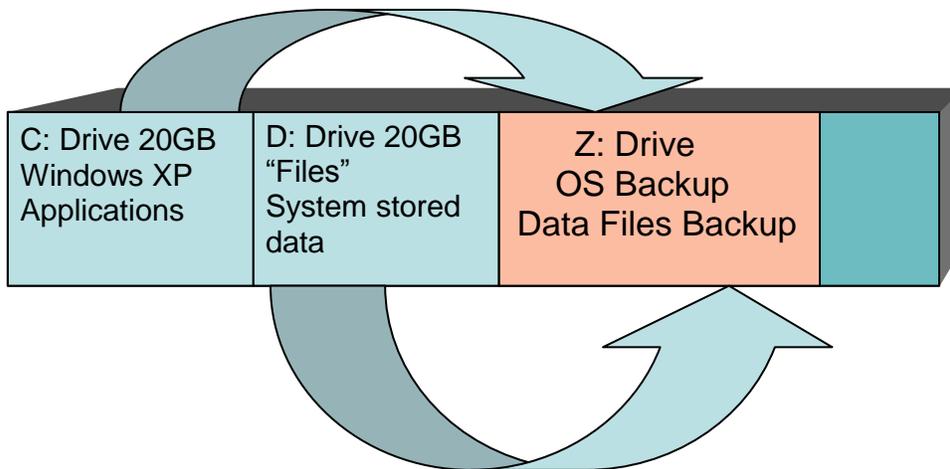
Fig 12.4 Using a single drive to backup the C: Partition and the D: partition

Obviously a second hard drive to back up your system would be a better solution for most systems. It would also allow you to create larger partitions since you're not going to store the back up on the same physical drive. With the cost of drives dropping it is faster, less expensive, and easier than using a tape drive for system backups. However, a tape drive does allow you to take the tapes with you at the end of the day to protect against data loss due to fire and other natural disasters. For home systems, it is usually sufficient to use a hard drive for backup rather than a tape drive.

Using the **Disk Manager** as before, create a new partition formatted with NTFS called "**Backup**" and set it to be the **Z:** drive; make the partition about 30 GB.

The Z: partition is where the operating system and the Data Files will be backed up.

You can set the drive letter to Z: in Disk Manager, or right click on the drive in **Computer Manager** and select **Change Drive Letter and Paths…**
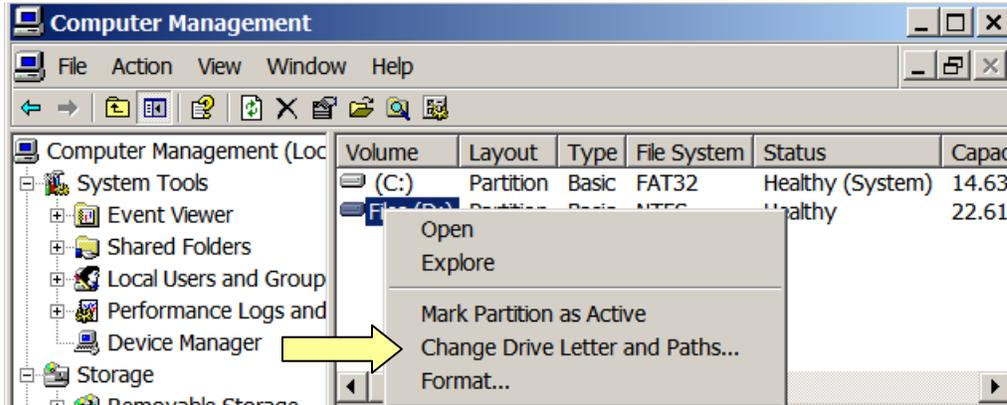

Fig 12.5 Assigning drive letters in Computer Manager

Now that the drive has been partitioned it appears to the operating system to be 3 separate drives. The C: drive contains the operating system and any applications that have been loaded. The D: drive is the default storage location for all data files you will create. The Z: drive will be used as backup drives for the C: and D: drives.

Create a Backup using ASR (Automated System Recovery)

Windows XP Professional includes a backup utility called **ASR** (Automated System Recovery) that allows you to restore your system to the exact configuration it was in when you last ran ASR. This is similar to what system manufacturers do when they pre-configure a new system and include a restore CD that puts the system back to the way it was originally configured. The problem with those system restores is that it not only restores the system back to the original configuration, but it also reloads all the useless applications that are normally loaded with a new system that you have spent hours removing!

Windows **ASR** creates a floppy disk that will be used to store some of the system files, so you will need a blank floppy disk to set up ASR.

To create an ASR:

- Start → All Programs → Accessories → System Tools → Backup
- From the **Backup Restore Wizard,** select **Advanced Mode**
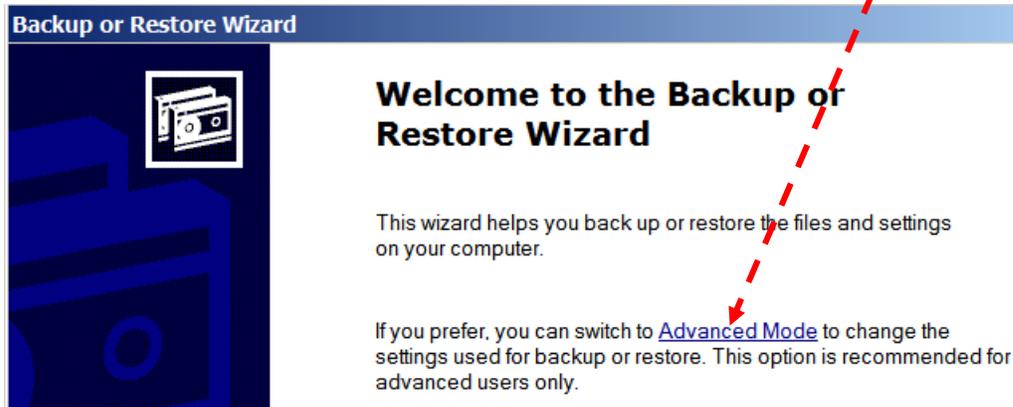
- Select **Automated System Recovery Wizard**
- Click **Next** to enter into the **Automated System Recovery Preparation Wizard. I**n the textbox that asks for the **Backup Media or File name** (the system tries to default to the A: drive), use the **Browse** button to locate the Z: drive, enter System Backup, click on **Save** and click **Next,** then **Finish**.
- The operating system and associated system files will be copied to your Z: drive
- The system will prompt you to enter the floppy drive and instructs you to label it. Store this in a safe place; it will be used to restore your system later if necessary.

Since Microsoft constantly updates Windows XP, it's a good idea to run the ASR about once a month; any updates made will not be recovered using ASR unless the update was made before the latest ASR was created.

Backing up the Data Partition

Now that the C: drive has been backed up to the Z: drive, the next step is to back up the data drive. Microsoft has a utility that simplifies backing up your system. It allows you to manually back up the system, or set up a schedule and allow the operating system to perform the backup on a set schedule.

*Note: The following example requires that the user be logged in using the administrator account, or have administrator privileges (this is the default for single user systems); also your login must have a password assigned to it. To assign a password to an existing user account: **Start → Control Panel → User Accounts**

To back up a specific drive/file:

- Enter the backup utility as outlined earlier; this time from the **Backup Restore Wizard,** select **Next**, rather than entering Advanced Mode

- Select "**Back up files and settings**", **Next**

- Select **"Let me choose what to back up", Next**

- In the left window "**Items to Backup**", click on the "**+**" next to **My Computer** and select **D: drive;** this is the data drive created earlier
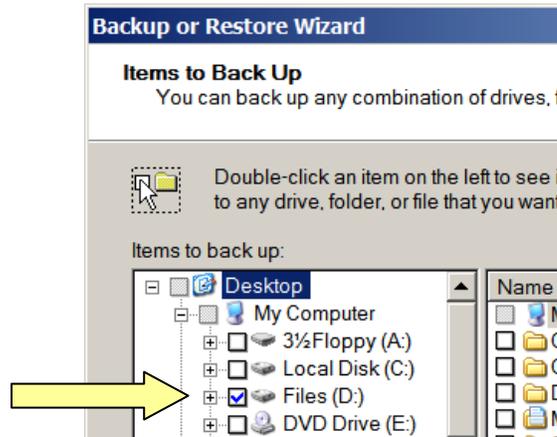
Fig 12.6 Selecting backup target

- After selecting what you want to back up click on **Next**

- In the text box "**Choose a place to save your backup**" select **Z:**, in the text box, "**Type a name for this backup**", enter **Data Backup**, click **Next**, then **Advanced**

- **For "Type of Backup",** Select **NORMAL, Next**

- Select **Verify Data after backup, Next**

- Select **Replace the existing backups**, **Next**

- For **When do you want to run the Backup,** select **Later**

- Once you have selected Later, the system asks you for a Job Name; enter **Data Backup,** select **Set Schedule** to open the **Schedule Job** menu.

In the **Schedule Job** menu you can decide how often the system will back up the data files, and at what time it will be done.
For most data backup you can run **weekly** backups, and select a **Start Time** for early in the morning when you're not using the system.
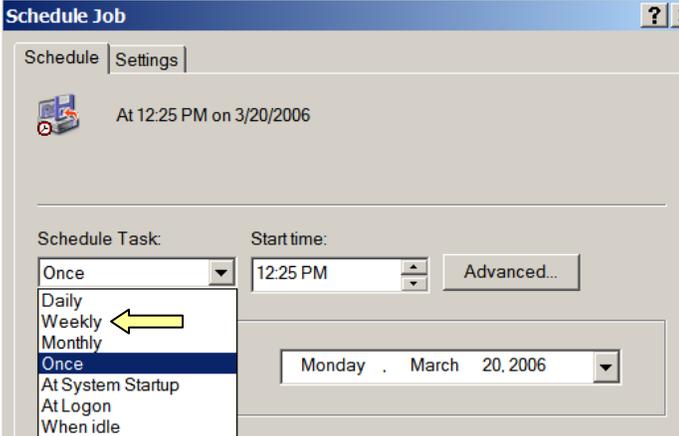
- When you select **Weekly,** the screen will prompt you for which day of the week it should be run. Select whatever day of the week you want the system to run the back up; select **OK**

- After you have setup the back up, you will have to enter the password for the system administrator. In most cases, the system has a single user and that user will be the administrator as well. Enter your password, or the administrator password if you are not the system administrator, click **OK,** then **Finish**

The system is now set to automatically run a system backup at whatever time and day you selected.

Verifying a Scheduled Task

To verify that a scheduled task ran properly Windows has a Scheduled Task screen that gives details on any scheduled tasks.

To view **Scheduled Tasks**:

Start → Control panel → Performance and Maintenance select Scheduled Tasks
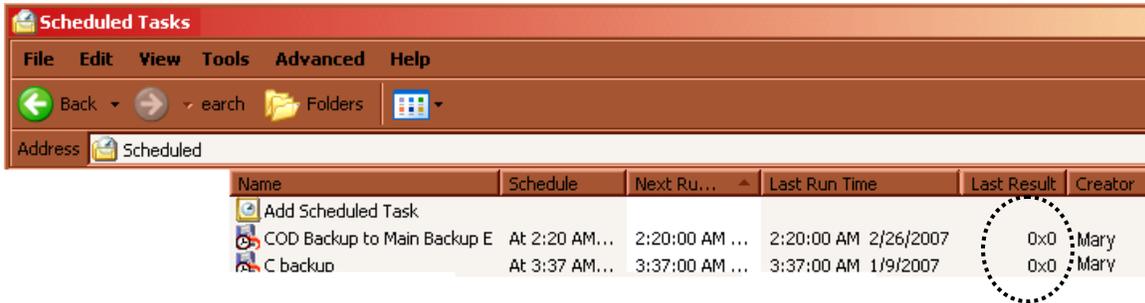
The **Scheduled Tasks** windows shows information about any scheduled tasks. Under the column **Last Result,** if it displays "**0X0"** for the task that indicates that the task ran without an error.

Restoring backed up files

Restoring using **ASR** is used in the event the C: drive becomes too corrupted to allow the system to reboot normally. To restore the operating system and the system files, you will need the original distribution CD and the ASR disk. Set the system up to boot from the CD, insert the Windows XP CD and reboot the system from the CD.

- Watch the bottom of the screen for the following prompt "**Press F2 to run Automated System Recovery (ASR)**", when prompted push **F2** and insert the ASR disk into the A: drive
- The system will reformat the drive using the same partitioning size as before
- During the process, you will be prompted to remove the floppy disk and reboot the system
- The system will prompt you for the location of the ASR recovery, the Z: drive will be selected by default, click **Next** and the system will begin restoring

- After restoring the system will reboot; since the CD is still in the drive it will prompt you to hit any key to boot from the CD; do not reboot from the CD or the system will start the reloading process over

Restoring Data Files

If data files need to be restored, the simplest method would be to open the drive containing the backed up files (Z: in our example), and locate the backed up image. By double clicking on the file, the restore process will start and prompt you through the restore procedures.

Additional System Protection

Systems that connect to the Internet are exposed to a wide variety of problems that can cause serious problems. You should never download free games, utilities, or screen savers unless you're certain they come from a reputable site.

Spyware is malicious software that can infect your system and can be used to track which Internet sites you visit or even passwords and account numbers. To eliminate spyware, there are many programs available that will scan your system and remove any spyware found; some of the most popular are also free.

Spyware Software:
- Ad-Aware   www.lavasoft.com
- Spybot   www.spybot.info
- Defender   http://www.microsoft.com/athome/security/spyware/software

Virus protection:

In addition to spyware, virus protection is also a necessity for systems connecting to the Internet. Viruses come from many various sources and can cause many

problems ranging from simple annoyances to serious system disrupting problems. There are many commercially available virus protection software available; just like spyware some of the more popular is free to download.

Virus protection software:

- AVGfree   http://freegrisoft.com
- Avast   www.avast.com
- Microsoft Security Essentials   www.microsoft.com/security_essentials

Chapter 11 Review Questions:

1. Large hard drives can be _____ to more effectively manage the drive space.
2. The Microsoft file system that supports a high level of security is _____
3. By default, Microsoft loads the operating system as well as _____ on the same partition.
4. Tape backup has the advantage that allows you to store data _____.
5. The utility that allows you to restore your system to an exact configuration is _____.
6. In order to schedule a task users must have _____ privileges.
7. In the "Last Result" field of scheduled tasks, what is meant if 0x0 is displayed? _____
8. _____ is malicious software that can track internet usage.
9. Windows XP by default stores data files in _____ .
10. http://update.microsoft.com/windowsupdate/ is used for what reason?

    _____

Chapter 11 In-Class Lab Assignment –

Using **Chapter 10** of your textbook to reload your system according to the following dual boot configuration:

- o **Setting up Windows 98 (Completed in Chapter 10)**
  - o Set up a **1 GB** Partition to install Windows 98
- o **Setting up Windows XP**
  - o Set up a **3 GB** Partition using Windows XP
  - o Set up a **Data** Partition

LAB

1. Load Windows XP on its own partition (about 3GB)

   Create a new partition (about 1GB) called **Data** on the drive using Windows XP Disk Manager

9/5/2010

The idea of connecting computers together to form a network has been around since the beginning of personal computers. Initially, peripherals and components were extremely expensive and the idea of connecting computers together to allow users to share devices made sense. Without a basic network, people who did not have their own printer would save their work onto a floppy drive and carry it to a computer that was equipped with a printer. The process of moving data around on a floppy disk was referred to as "**Sneaker Net**".

In order to simplify the process of creating networks, network operating systems have been developed that mask the complexity of the network by making it appear to the application that the printer is locally attached. By adding this layer between the application and the hardware, applications did not have to be modified in order to work on a network.

Network Media

As networks evolved, many methods were developed to physically connect the computer to the network cable. The cable is referred to as the network medium. As you can imagine, there were quite a few different schemes, each employing their own cabling scheme. Since most were proprietary, you could not take components from one network and move them to another. Eventually, open system standards were developed which helped the industry grow into what it is today.

The most common type of cable used today is referred to as twisted pair. Twisted pair cable is made up of eight wires twisted together in pairs of two resulting in four pairs. Twisting cables together is effective in reducing electrical noise that would otherwise be introduced into the cables. Twisted pair is inexpensive, easy to work with, and is capable of carrying large amounts of data. The ability of cable to carry signals is referred to as bandwidth. The original twisted pair cable was referred to as Category 3 (Cat-3) cable and could carry digital signals at a rate of 10 Mbits per second. Today with improvements in technology, category 5

(Cat-5) cable can carry signals at rates of up to 1 Gbit per second, one hundred times faster than the original Cat-3. For home and many small businesses, Cat-5 twisted pair cable can easily handle the demands. For larger installations requiring more bandwidth, fiber optic cables are usually run between floors of a multi-story building or between buildings in a campus environment. Fiber optic cable has many advantages over twisted pair cable in that it is immune to electrical noise, can carry signals much farther without requiring signal regeneration, and has a bandwidth of 10 Gbit per second. The cost involved with fiber optic cable usually limits its use in medium to large businesses environments.

Network Interface Cards

The hardware used to physically connect the computer to the medium is referred to as a Network Interface Card (NIC). One of the main functions is to physically connect one computer's data bus to another; it also contains an address that is used to uniquely identify the device on the network, referred to as a MAC address (think of this as its phone number). Some earlier NICs were designed to allow interfacing with more than one type of network medium. Over the years, the industry has standardized on network media making the selection of a suitable NIC relatively simple. Many of the new personal computers being manufactured have the NIC integrated directly into the motherboard using an RJ-45 type connector. RJ-45 connectors are similar to the small connectors phones used to connect to the telephone system except that RJ-45 connectors have 8 connections and telephone connectors RJ-11 use only 4 connections.
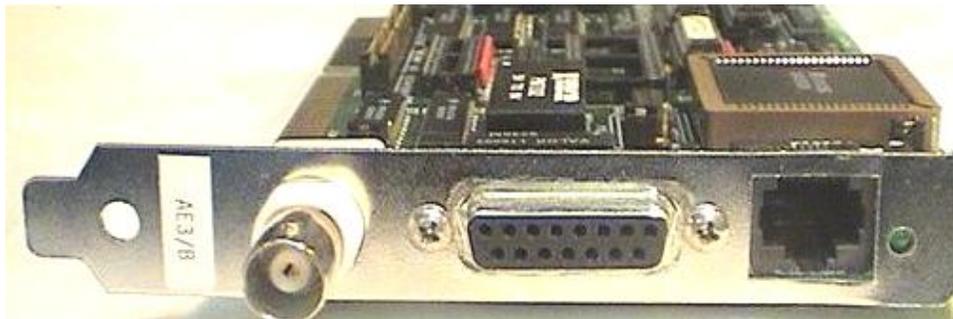

Combination NIC card showing 3 various physical connection types, only RJ-45 is currently used.

To accommodate inevitable changes in networking speeds and various types of media (Twisted Pair, Fiber Optic, Wireless), NICs are designed using a layered approach. Just as the network operating system acts as an interface between the application and the hardware, the NIC is the layer between the physical connection and the operating system. The NIC is developed so the physical connection can be modified without requiring changes to the rest of the system. NICs take the data being sent and format it into what is referred to as a frame. Frames are created by taking the outgoing data and adding the destination address (MAC Address) to it as well as its own address, the source address. NICs have circuitry that transmit and receive these frames onto the network. As these frames travel down the network media, other NICs constantly monitor the data traffic looking for frames that have their address. When a NIC detects a frame with its own address, it copies in the entire content of the frame and sends it up to the system to be further processed; if the address does not match it is ignored.

Network Setup

A very simple network can be setup with as few as 2 computers.

Cross-over Cable

PC One   PC Two
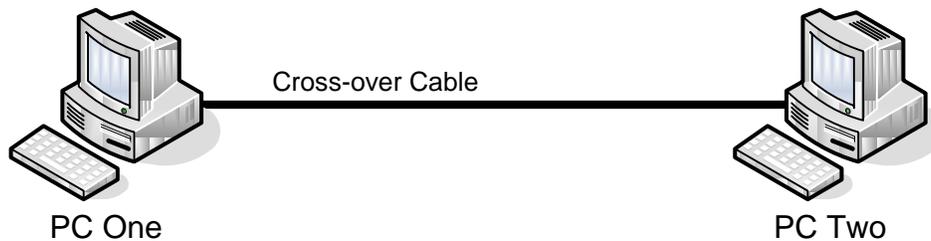
In the above example, **PC One** and **PC Two** are connected together through their NIC cards using a special cross-over cable.

A **cross-over** cable is needed when directly connecting 2 PCs together. A cross-over cable connects pin 1 & 2 to pins 3 & 6 on each end.

Pin out of an RJ-45 connector
- Pins 1&2 → for transmit
- Pins 3&6 → for receive
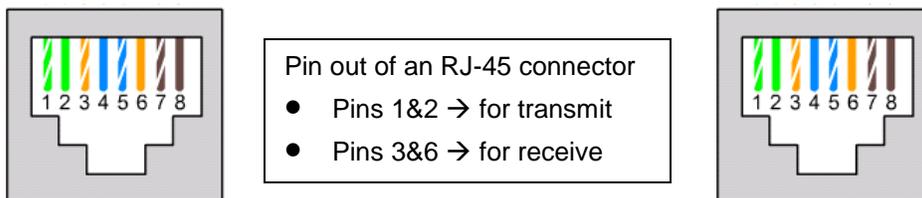
Each NIC transmits data out pins 1 & 2 and receives data on 3 & 6, the cross-over cable connects pin 1 & 2 to pins 3 & 6.

A cross-over cable connects the transmitter to the receiver between 2 systems
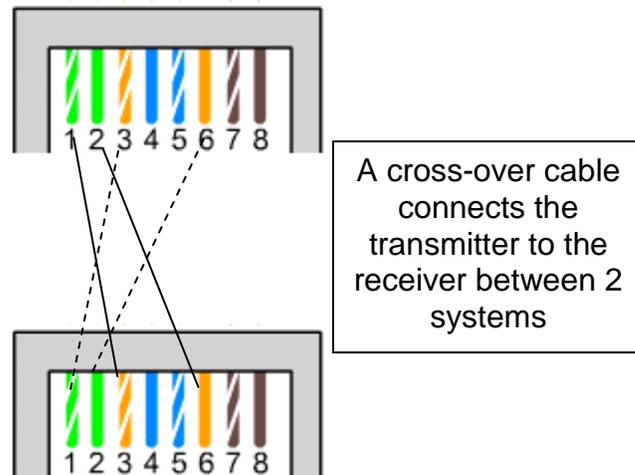
Using a cross-over cable between two systems is an easy way to set up a very small network, but there are no provisions to add any additional computers. A simple solution to this problem is to use a hub to connect computers.

Star Topology (Hubs)

When a hub is installed in a small network, the total number of connected devices is determined by the number of ports on the hub. As hosts are added to the physical network, they resemble a star with wires emanating from the central hub; this is referred to as a Star Topology. When connecting PCs to a hub, you must use straight through cables. As the name implies, a straight through cable connects pins directly from 1 to 1, 2 to 2, etc. The hub redirects the transmit to the receiver, so you do not need to use the special cross-over cable.

| Straight Through Cable	Cross-over Cable
Pin 1 → Pin 1	Pin 1 → Pin 3
Pin 2 → Pin 2	Pin 2 → Pin 6
Pin 3 → Pin 3	Pin 3 → Pin 1
Pin 4 → Pin 4	Pin 4 → Pin 4
Pin 5 → Pin 5	Pin 5 → Pin 5
Pin 6 → Pin 6	Pin 6 → Pin 2
Pin 7 → Pin 7	Pin 7 → Pin 7
Pin 8 → Pin 8	Pin 8 → Pin 8
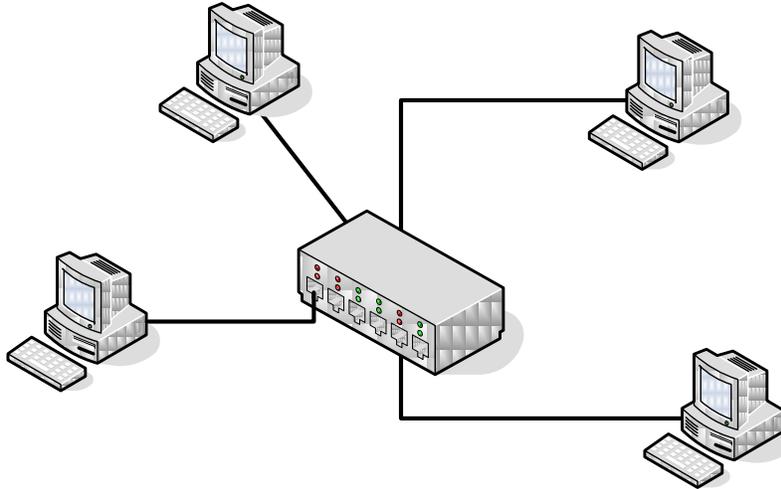
Four PCs connected to a hub using 4 straight through cables

One of the limitations of twisted pair cable is due to attenuation. As electrical signals travel through wire, some of their energy is lost to heat due to the resistance of the wire; if not compensated for, a signal would become too weak to be usable after it travels about 100 meters. Hubs are active devices that amplify (regenerate) the signals and also remove any noise that might have been added to the signal. By placing a hub between any 2 PCs, they can be a maximum of 200 meters apart. Data frames arriving at any single port are regenerated and sent out all the other ports to the receive wires of all the attached devices. If the frame is addressed to a connected PC, it receives the packet and sends it up to the system. If the packet is not addressed to the attached PC, it is ignored.
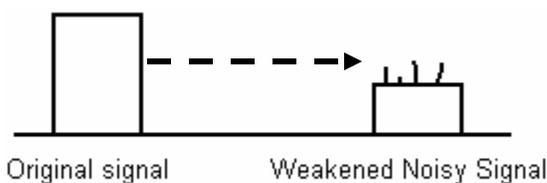
As signals travel they weaken and pick up electrical noise, eventually these signals become unusable
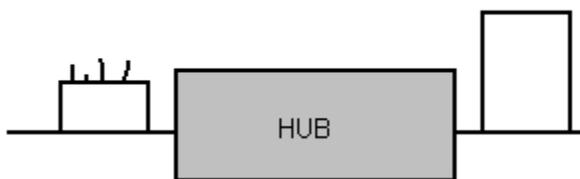
A hub will amplify (regenerate) the signal and remove electrical noise.

Local Area Networks (LANs) created using hubs can be increased in size to allow for more users by daisy chaining more hubs together. If you start with an 8-port hub and your LAN needs to allow for more users, a second 8-port hub can be attached; this is typically done using a cross-over cable to daisy chain the 2 hubs together. There is a limit to how many hubs can be daisy chained together, no more than four hubs are allowed in a daisy chained environment.

Hubs Daisy Chained together using a cross-over cable to expand the size of a LAN
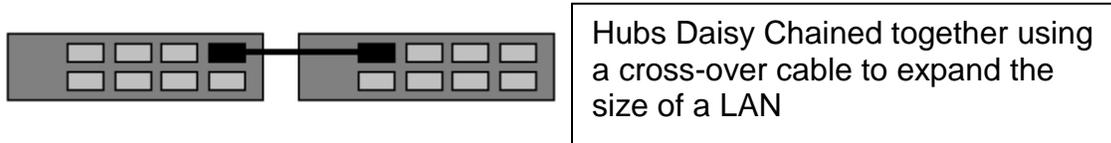
Ethernet

When a PC sends data on a network, the signal is sent to every attached PC; only one PC can send data at a time. All the PCs are sharing the available bandwidth provided; if more than one PC tries to send data at the same time their signals would collide and the data would be unusable. To allow multiple PCs equal access to the shared bandwidth, a method to control access was developed referred to as **C**arrier **S**ensed **M**ultiple **A**ccess with **C**ollision **D**etection (CSMA/CD). With CSMA/CD, before a NIC can put information onto the media, it first monitors it to see if it's being used. If there are no signals on the wire, the NIC transmits the data; if the media is being used the NIC stores the data until the media is freed up, then tries again. As networks became larger and more PCs were vying for connections it becomes inevitable that there could be an instance when 2 or more PCs are ready to send data at the exact same time. After monitoring the media and determining there is no traffic, they all transmit at the same time causing a collision. When a collision occurs, the NICs detect it and stop transmitting. Each NIC must then wait a random amount of time, then attempt to retransmit. Very large networks using hubs can spend more time recovering from collisions than actually sending data. When this happens, the responsiveness (throughput) of the network will decline to the point where it becomes almost useless. A typical network using hubs is usually limited to no more than 20 PCs; even though expanding a LAN with more hubs is relatively simple, there is a limit.

Switches

One way to effectively eliminate the negative effects of collisions is to replace hubs with switches. A switch works somewhat like a hub in that it will regenerate signals and remove noise from data signals, but unlike hubs, switches do not require the use of CSMA/CD and effectively eliminate collisions. A switch is an intelligent device that examines frames on the media and learns the address of an attached device by making note of its source MAC address. All transmitted frames have both the source address as well as the destination address added to the data by the NIC before being sent. A switch creates a table that stores the addresses of attached devices by reading their source addresses. When a switch receives a data packet, it examines the destination address to determine where to send the data. If the destination port is being used, the switch will store the data until the receiving device is free. Using switches not only improves performance by eliminating collisions, but the design of a switch allows it to run in full duplex. Full duplex means a NIC can send and receive data at the same time.

Switching Table

Port #	MAC Address
1	ABC234
2	ABC321
3	DCB234
4	DCB321

The switching table is automatically built by the switch. The switch monitors the source address of data frames arriving at the port to determine the MAC address of attached computers. *Note, Mac Addresses used have been shortened to simplify diagram.*

PC2
MAC ABC321

Port 2

Port 1

PC1
MAC ABC234

To: ABC321 From: ABC234
Data Being Sent

Port 3

Port 4

PC3
MAC DCB234

PC4
MAC DCB321

Every NIC card has a unique address that is used for identification on the network; referred to as the MAC address, it is made up of 12 Hexadecimal

numbers. The MAC address is sometimes referred to as the physical address and often written in a dashed format 00-11-22-AA-B1-1F. When PC1 has data to send to PC2, the NIC adds the Source MAC address ABC234 as well as the Destination MAC Address ABC321 to the data, creating a frame. When the data arrives at Port 1, the Destination Address ABC321 is compared to the switching table and the data is forwarded to Port 2. While this is happening, PC3 could be sending data to PC4 without a collision.

A **frame** is created when data that's been segmented (cut to a size determined by the network) has the destination MAC address added as well as the source MAC address added. The frame is converted into electrical signals in the NIC and transmitted onto the media. When the PC that has the NIC with the address ABC321 detects the frame, it will copy it in; the MAC addresses will be removed by the NIC. The remaining data will be sent to another process where it will be added to other pieces of data that have been received, until the entire signal is received.

Mac Destination Address ABC321	Mac Source Address ABC234	Data to be sent

Setting up the Network Operating System on a Small Network

There are 2 basic types of networks supported by Microsoft. Large enterprise networks would be configured as a **Client/Server** network using **Domain Controllers**; for home or small office use; a **Peer-to-peer** network is often used. In this chapter, we will be focusing on the smaller peer-to-peer network, referred to by Microsoft as a **Workgroup**. Unlike a Client Server network that uses Domain Controllers to control access to the system a smaller peer-to-peer network forgoes the expense of dedicated servers. The down side to eliminating Domain Controllers comes at the expense of security and ease of administration, but since home networks are typically small, it usually is not cause for concern.

Setting up a Workgroup –

Setting up a workgroup involves loading a group of machines with a common protocol (a Protocol is a set of rules used to manage communications). Each of these machines shares a common **workgroup** name but has a unique computer name.

To create a **Workgroup**:

- Log in as the **Administrator,** or assign yourself administrative privileges

- Click →**Start** button, right click the **My Computer** icon, → **Properties**

- Open the **Computer Name** Tab

- Select "To rename this computer or join a domain click **Change**"

Computer Description- An optional entry used to help identify PCs on a LAN

Full Computer Name - must be unique to your Workgroup

To change the **Full Computer Name** click on **Change,** enter name then enter workgroup name then → OK

You **must reboot** the system to set the name.
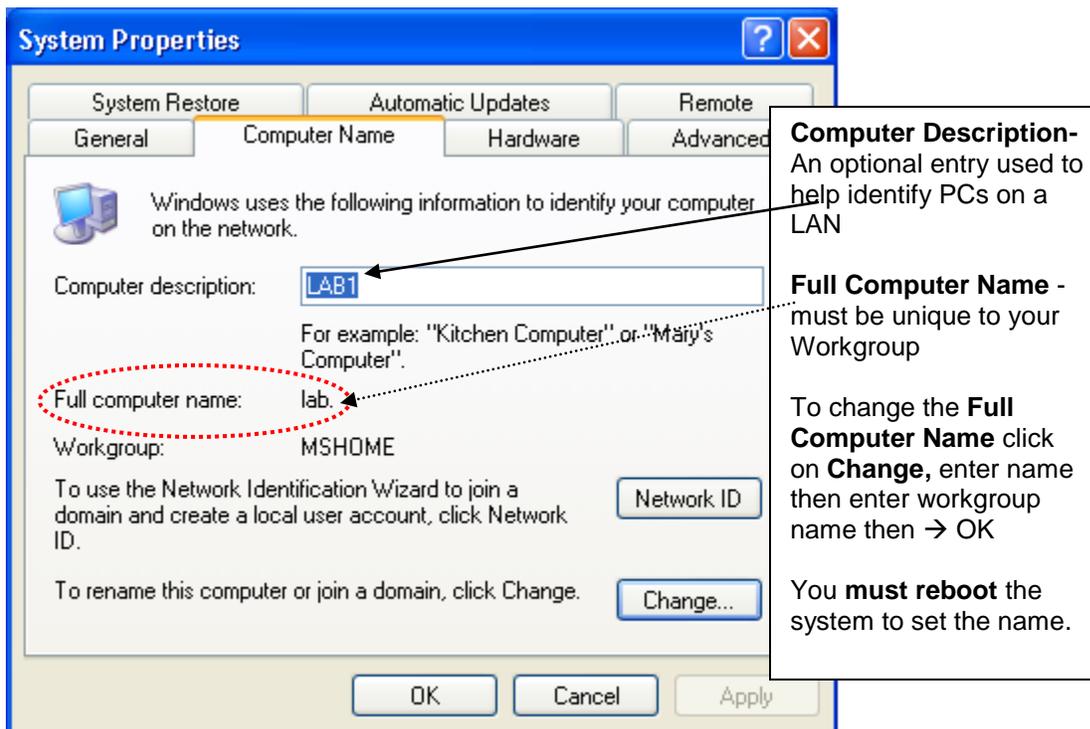
Windows XP Computer Properties Menu Computer Name

- After giving the computer a unique name, making a member of a workgroup, and rebooting the system, open the **System Properties** menu again to set up a small workgroup.

- Click on **Network ID** button to launch the **Network Identification Wizard**, then click **Next**

- In the "**How do you use this computer?**" screen select **"This computer is part of a business network …",** then click **Next**

- Select use **Without a Domain**

- For the **Workgroup Name,** select a name for the workgroup then click **Next,** then **Finish**

- Reboot the computer for the changes to take effect

Configuring the Network Interface Card:

When your operating system was initially loaded, if it detects that there is a network interface card installed, it will automatically load all the necessary drivers and load a default network configuration. If you add a network interface card after loading the operating system, the operating system should automatically detect the new card, load the drivers, and set up a default network configuration; so either way once the network card is present there will be a default configuration available. Microsoft uses the following as a default configuration for networks:
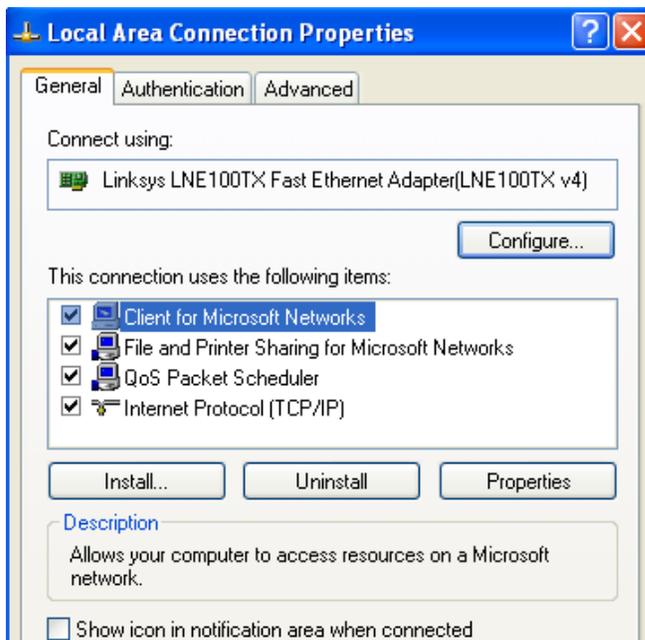

To access **Local Area Connection Properties**:

Open the **Control Panel,** select **Network and Internet Connections**, then **Network Connections**, Right Click on the network icon and select **Properties**

- The **Client software** is set to work with Microsoft networks

- **File and Printer Sharing** is enabled

- The **Quality of Service packet** scheduler is enabled

- **Internet Protocol** is selected as the default networking protocol

These settings are the most generic and do not require any modification when connecting a home PC to a Cable Modem, or DSL connection for Internet connectivity. We will modify this slightly to accommodate our small home network.
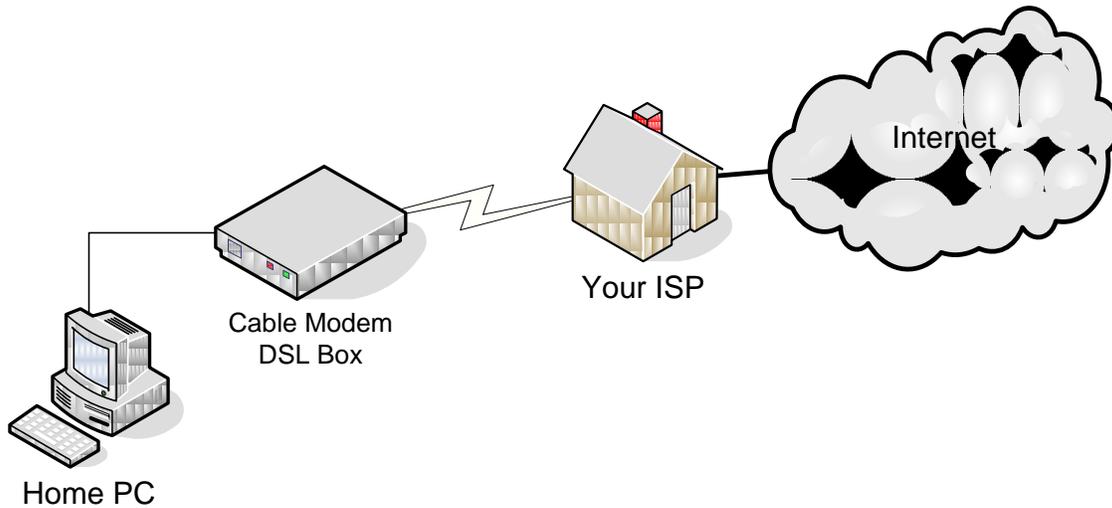
Typical home user Internet Connection using either Cable Modem, or DSL Box

The default settings used by Microsoft greatly simplify the setup for a home user. The connection from the PC to the Cable Modem/DSL Box is made using a single cable. To set up a small home LAN a simple device (Router) is added to allow multiple users to share internet connections, as well share files and printers.
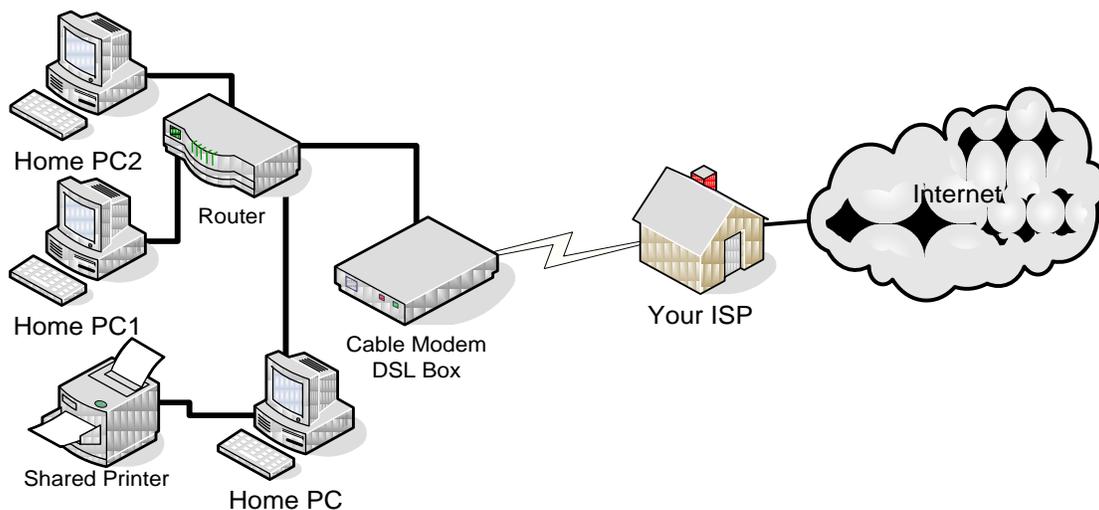

Home user Internet Connection using either Cable Modem, or DSL Box with Router setting up small LAN

Home routers also come configured as a wireless access point allowing you to wirelessly connect devices. Configuration of the router is not covered in this textbook; home routers come with instructions and are easily configured.

Once a router has been added as shown above, when your PC powers up, it will receive all the necessary configurations from the router which is acting as your **DHCP** server. A DHCP server is the device that will provide all the necessary configuration parameters for your PC when it boots each time.

Confirming Network Configuration –

Router

Cable Modem
DSL Box

Your ISP

Internet

Shared Printer   Home PC
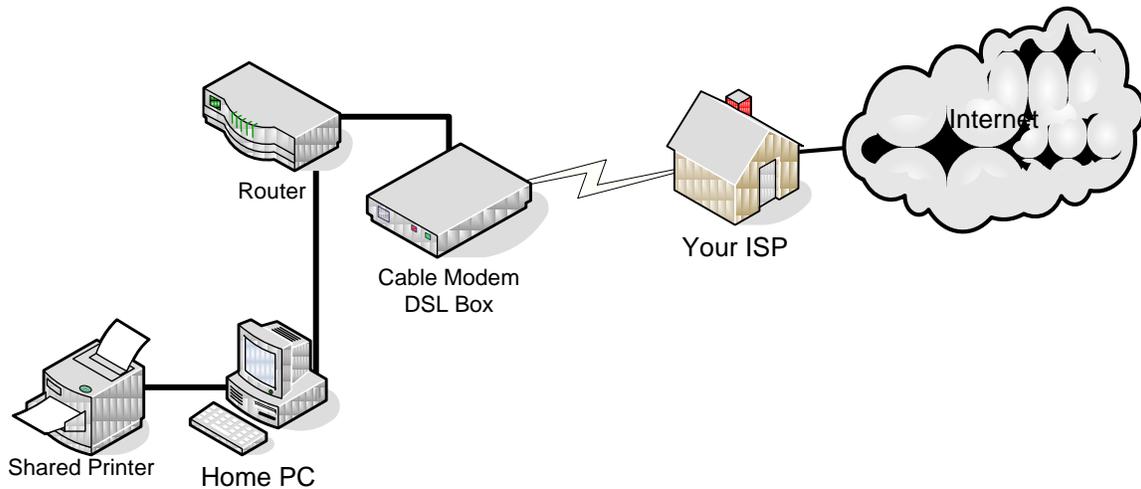
To verify the network configuration of Home PC above, from the system prompt, enter *IPCONFIG* .

C:\Documents and Settings\ >**ipconfig**

Windows IP Configuration

Ethernet adapter Local Area Connection:

      Connection-specific DNS Suffix. :
      IP Address. . . . . : 192.168.0.199
      Subnet Mask . . . . : 255.255.255.0
      Default Gateway . . . . : 192.168.0.1

The output from **IPCONFIG** command shows your system's IP address 192.168.0.199, as well as the default gateway 192.168.0.1 which is your router. The IP address is necessary for Internet connectivity; IP is one of the main

protocols used by the Internet. A more detailed report can be found using the command **IPCONFIG /ALL** form the command prompt. The necessary information required by your PC is provided automatically by the DHCP function built into your router.

C:\Documents and Settings\Clyde>IPCONFIG/ALL

Windows IP Configuration

     Host Name . . . . : basement-main   System Name

     Primary Dns Suffix . . . . :

     Node Type . . . . : Unknown

     IP Routing Enabled. . . . . : No

     WINS Proxy Enabled. . . . . : No

Ethernet adapter Local Area Connection:

     Connection-specific DNS Suffix . :

     Description . . . . : Broadcom NetXtreme Gigabit Ethernet

     Physical Address. . . . . : 00-E0-18-D3-72-44   MAC Address

     Dhcp Enabled. . . . . : Yes   DHCP is used

     Autoconfiguration Enabled . . . . : Yes

     IP Address. . . . . : 192.168.0.199   IP Address assigned by DHCP

     Subnet Mask . . . . : 255.255.255.0

     Default Gateway . . . . : 192.168.0.1

     DHCP Server . . . . : 192.168.0.1   Services provided by Router

     DNS Servers . . . . : 192.168.0.1

     Lease Obtained. . . . . : Sunday, March 11, 2007 4:09:04 PM

     Lease Expires . . . . : Sunday, March 11, 2007 5:09:04 PM

If you boot your system with no other connected devices, the output from the **IPCONFIG** command would display "**Media Disconnected**" and no configuration would be set on the NIC.

C:\Documents and Settings\Clyde>**IPCONFIG /ALL**

Windows IP Configuration

     Host Name . . . . : basement-main

     Primary Dns Suffix . . . . :

     Node Type . . . . : Unknown

     IP Routing Enabled. . . . . : No

     WINS Proxy Enabled. . . . . : No

Ethernet adapter Local Area Connection:

Media State . . . . : Media disconnected

Description . . . . : Broadcom NetXtreme Gigabit Ethernet

Physical Address. . . . . : 00-E0-18-D3-72-44

To view attached PCs in a Workgroup:

- **Control Panel → "Network and Internet Connections" → "My Network Places" → "View Workgroup Computers"**
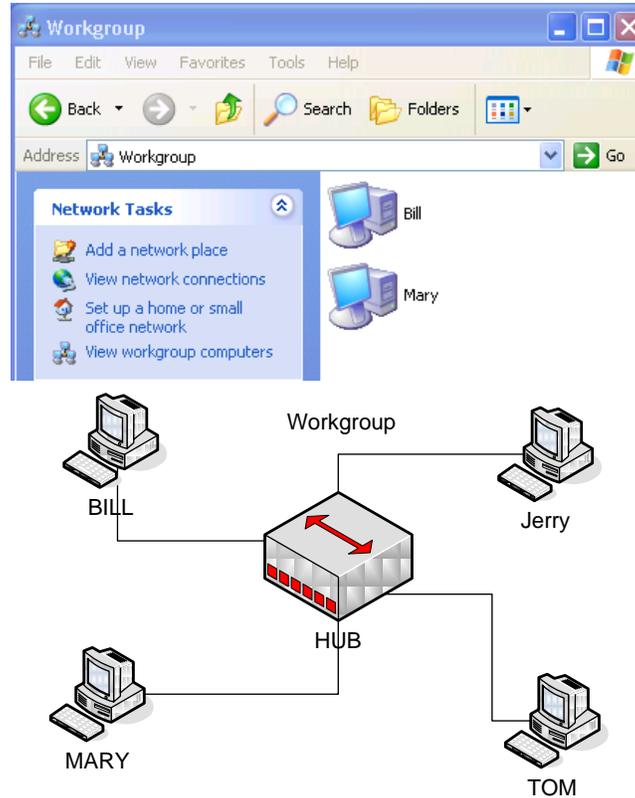
Four PCs Bill, Mary, Jerry, and Tom are all members of Workgroup, only Bill and Mary's systems are turned on in the above example.

File & Print Sharing –

Files and/or printers on a computer that are members of a workgroup can be shared with other computers. To share a file, create a shared folder and place the file in it.   Windows automatically creates a shared folder called **Shared Documents** that can be used to store files you want to share on the LAN. To create a new shared folder right click on the folder and select **Sharing and Security**. You can optionally set the
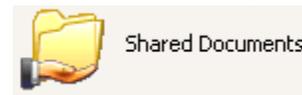
attributes of the shared folder so other users can only read files but are not allowed to write to files. **Read-only** permission prevents others from modifying a master file, but if they copy the file to their own PC they will be allowed to change the file.

Under the **Sharing** tab - click on "**Share this folder on the network**", you can optionally change the name to make it easier to locate. If you want to allow other users the ability to change the contents, select "**Allow network users to change my files**", by not selecting this, users will only be able to read files but not write to them.
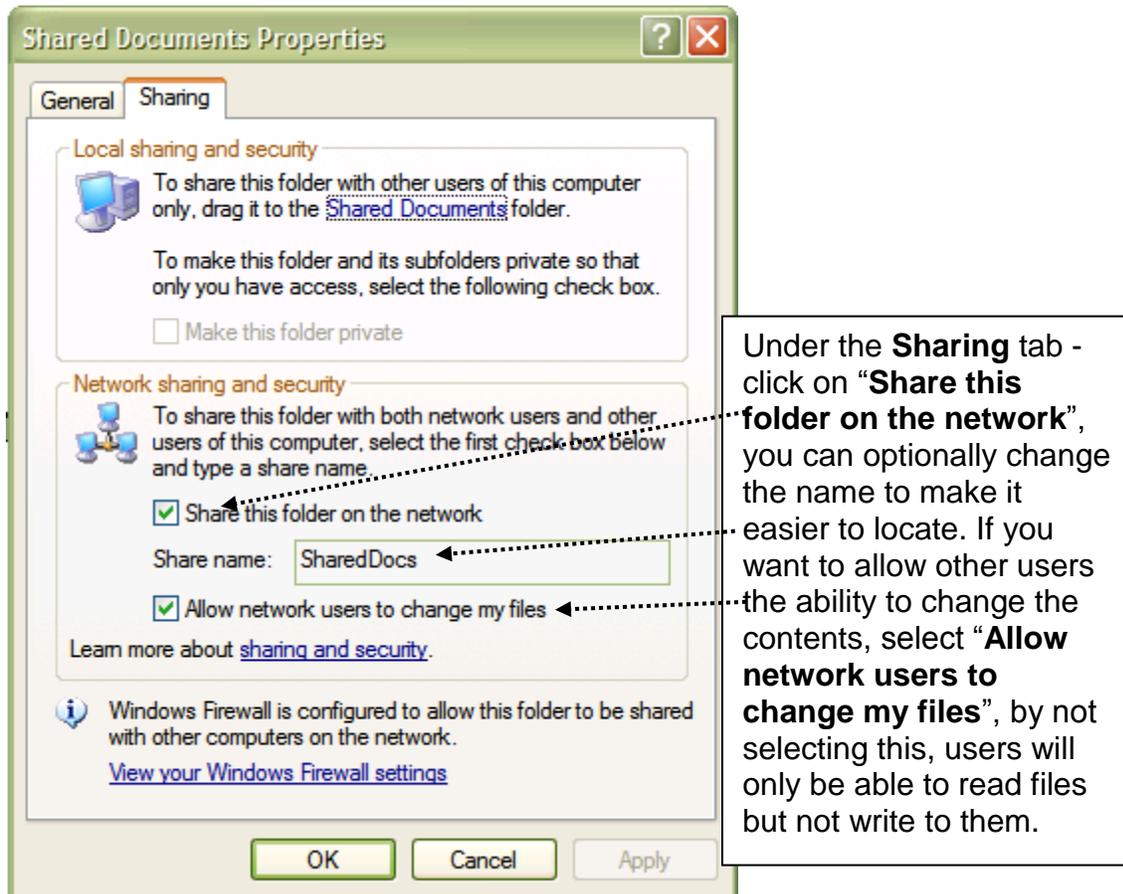
After a folder has been shared, the folder's icon will change indicating it is

shared.

Accessing Shared Folders –

To simplify working with networks, add the "**My Network Places**" selection to the **Start Menu:**

- Right click on the **Start Menu**, select **Properties**
- In the **Start Menu** tab, select **Customize,** select the **Advanced** tab

- Scroll down and select "**My Network Places**" to include "**Network Places**" in the "**Start Menu**"
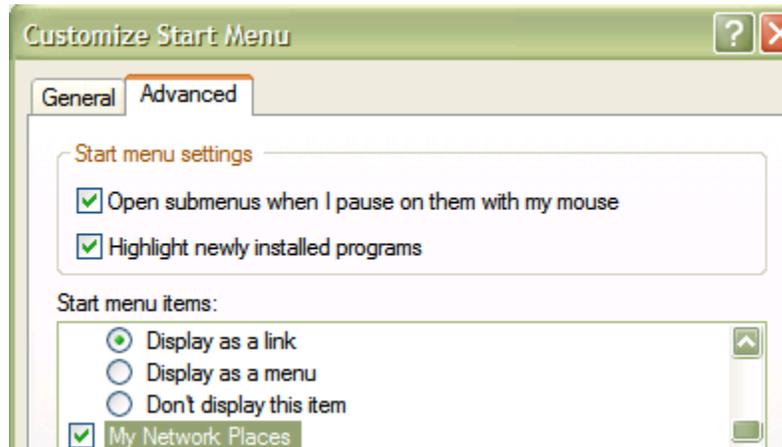
To access a shared folder, click on "**My Network Places**" →"**Entire Network**" → "**Microsoft Windows Network**" → **workgroup** and click on the computer that is sharing the file. At this point, you open the folder the same way you would on your own system. If the folder is one that you would be using often, you can map it as a network drive.

Mapping a Network Drive –

A shared folder can be mapped to appear as a network drive to simplify locating and accessing the folder. After locating the folder on the network, right click on it and select "**Map Network Drive …**", then select a letter to assign to the drive. After a drive has been mapped you can quickly locate it under "**My Computer**", it will be shown as a hard drive icon with a network attached.

 Shared Drive (H:)

To disconnect a shared drive right click on it and select **Disconnect.**

Printer Sharing –

Just as files can be shared on a LAN, locally connected printers can be shared for use by other users in your workgroup.
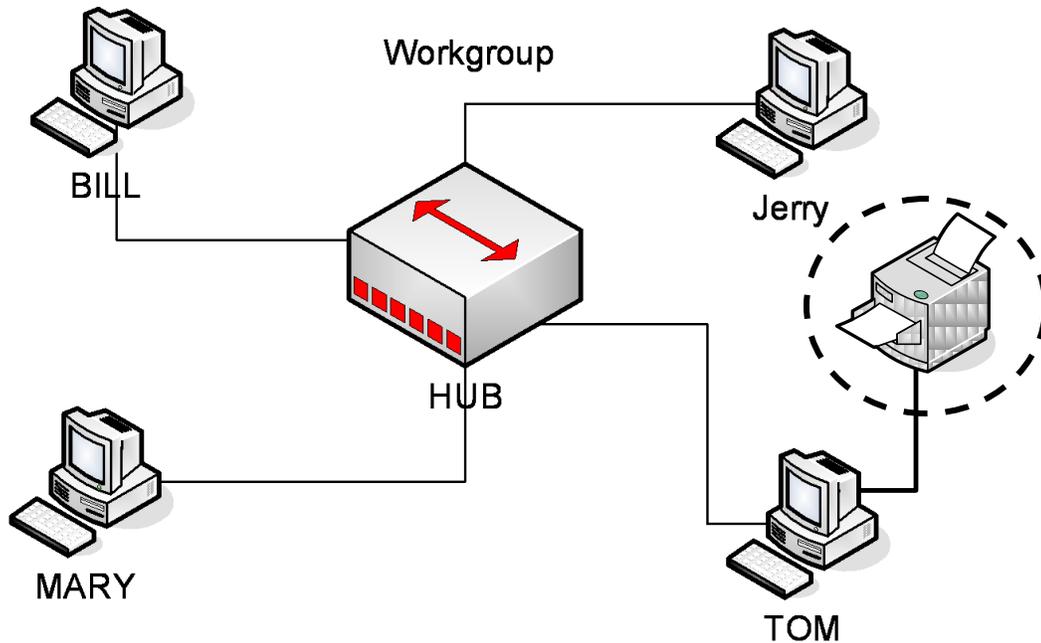
In our small workgroup example, TOM has an attached printer he wants to share on the network. To share an attached printer, open the "**Printers and Faxes**" in the "**Start Menu**", right click on the attached printer, click "**Sharing**" tab.

Select "**Share this printer**" you can optionally give the printer a name
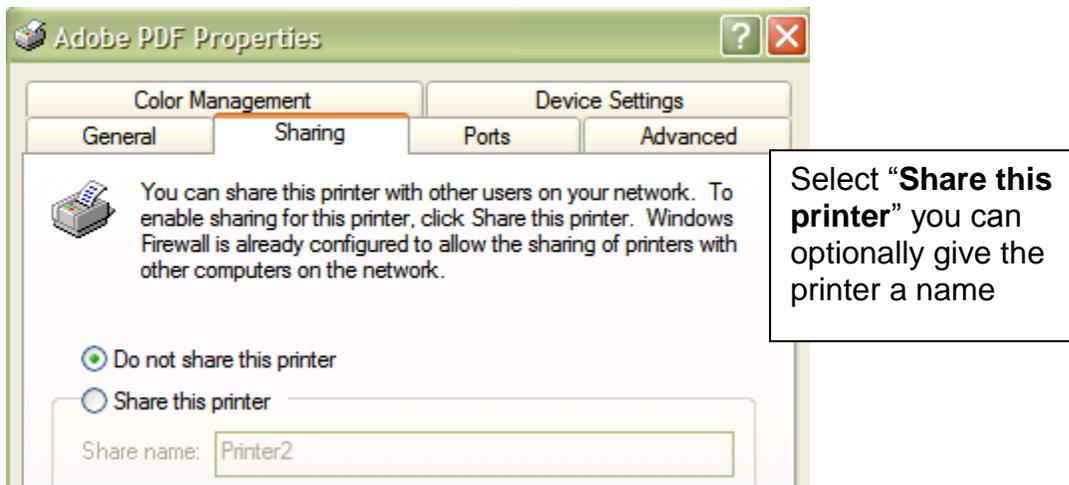
Connecting to a Shared Printer:

 To connect to a shared printer on a network, open the **Control Panel** → "**Printers and Faxes**" → "**Add Printer**" to start the "**Add Printer Wizard**". In the **Add Printer Wizard** click *Next* to start the wizard, → "**Add a network printer**", → "**Browse for a Printer**". All network printers will be displayed; select the printer and click *Next*. Once a printer has been mapped, it appears to the PC as though it were a locally attached device.

Chapter Review questions –

1. _____ is the most widely used type of cabling when creating a LAN.

2. Category 5 cable is made up of ____wires twisted together to form 4 pairs.

3. A _____ cable takes the output from pin 1 & 2 from one end and connects it to pins 3 & 6 at the other end.

4. Electrical signals traveling through cables must be regenerated every _____ meters or the signal will become useless as it weakens.

5. A switch uses the MAC _____ address to decide where to send a frame.

6. A switch uses the MAC _____ address to build the switching table it uses to determine where to send frames on the LAN.

7. A MAC Address is made up of _____ hexadecimal digits.

8. Which of the 2 Microsoft network operating system type is considered the least secure? _____

9. What 4 network configuration parameters are setup by Microsoft by default?

    1. _____
    2. _____
    3. _____
    4. _____

10. What command at the system prompt will display the parameters set on the NIC? _____

Building a System

There are many reasons why a person would elect to build a system rather than purchase a new one, but cost is usually not the deciding factor. New computers are selling for as little as $500.00 for a complete system which includes the monitor, the printer, the operating system, and software. So what are the benefits of building your own system?

Proprietary Hardware

One of the main reasons given by people who build their own systems is to avoid the hassle of trying to upgrade a system that uses proprietary parts. Like most people who understand computers, you will eventually want to update your system which can be a problem if it's using proprietary components.

Power Supplies are one item that many manufacturers will modify to fit their specific needs. On some systems, the power supply might be made as a plug in module which makes replacement simple for anyone, but since there is only one source for the power supply, a replacement is typically much more expensive than a standard ATX power supply.

Integrated components are often found on these systems. Manufacturers will build onto the motherboard components that are normally added as plug-in components. By integrating the functionality of a sound card, a network interface card, and the video display controller, the cost of the system board can be greatly reduced. Integration might force the buyer to accept a video display controller that limits the performance of the system. Systems that use a high degree of integration often limit the number of expansion slots that are available to reduce cost, which limits the ability to upgrade the system.

Systems include the operating system as well as bundled software when purchased as a packaged deal. Often the applications that are included are limited versions, or "shareware" that users probably would never purchase otherwise. The operating system and all the software is delivered as a single (or

multiple) CD-ROMS, and to reload the operating system, you usually are required to restore the system. On some systems, the restore will not work unless the system is configured the same way it was when first purchased. That means that if you have added any new devices or upgraded the memory, you would have to remove these devices then reinstall the operating system. Some system restore CDs will also reload all the "free" software that users will often end up deleting. Some restore disks are so particular about changes to the configuration that if you attempt to upgrade to a larger hard drive, you will not be able to use the restore disk.

Most people who decide to make their own system find that they my have already acquired some of the necessary components needed. Operating systems, hard drives, floppy drives, CD-ROM drives, plug-in cards, keyboards, monitors, and mice are often reused when new systems are built. So when making a decision based primarily on cost, this should be taken into consideration.

When Purchasing A Packaged System Makes "Sense".
Building a system does not necessarily make sense if the end user does not plan on upgrading the system. For parents purchasing a computer for their children to do homework, browse the Internet, and get e-mail, a packaged system would be the best decision. For businesses, schools, and organizations purchasing computers for individual use a prepackaged system is usually the choice.

There is niche market for companies that can build systems to the specifications of individuals and companies that want the flexibility of non-proprietary systems. In answer to this, some manufacturers have become more flexible by allowing customers the ability to configure their system and have it custom built by the manufacturer. This makes the systems more flexible for users, but does not address the issue of proprietary designs.

Selecting components

The first step would be to decide exactly what you want from a system. Keep in mind that if you want the absolute latest processor with the newest mother board, it might cost as much as 50% more than the system that was the hottest thing on the market just 6 months ago. Don't forget to factor in the cost of the operating system unless you already have a copy. The best advice for new builders is to try and purchase components from the same source. This can lower the cost for shipping and simplify warranty issues if that becomes an issue. Also, many locations have put together bundled systems that include many of the components necessary, like a system board with a CPU and fan. Be certain that if you are planning on using memory from an older system that it will work with your system. Many components can easily be reused like hard drives, floppy drives, monitors, PCI cards, CD ROM drives, DVD drives, keyboards, and mice.

The **Power supply** is a device that you might want to consider upgrading. Depending on what you plan to use the system for, a power supply might range anywhere from 350 to 500 watts or more; this is not an area you want to skimp on. (See the chapter on power supplies to help you determine the size of needed)

The **System Case** can usually be re-used, but you might consider replacing an old one if the case might not accommodate future expansion. System cases range in price anywhere from $10.00 to over $250.00. An all aluminum case with sound absorbing material, extra fans, and a slide out tray for mounting the motherboard is expensive, but if you plan on continually upgrading your system you might consider paying the price for a case that will last for years.

The **Motherboard** is the one component that you will always replace. If not, you're not building a new system; you're upgrading and old system. Often dealers will bundle the motherboard with the CPU, cooling fan, and system case.

This can often be a great way for a beginner to build their first system. When purchasing a motherboard, be certain that it comes with adequate documentation and that the system comes with a warranty that allows you to return it if necessary.

Assembly

The first step in the assembly process would be to install the CPU. Locate the
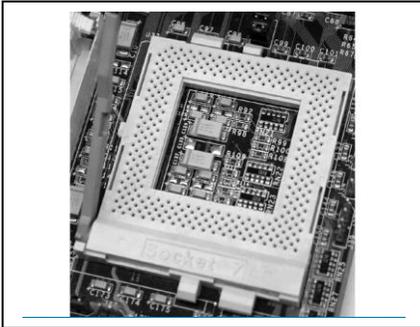
CPU socket and lift the ZIF level to open the socket. Refer to the documentation that came with the CPU to insure that you orient the pins of the CPU so they fit into the socket. Close the ZIF lever to lock the CPU into the socket. Attach the cooling fan to the CPU and follow the manufacturer's suggestion for the heat

transfer compound. Some use silicon grease; others come with a special material covered with clear plastic that needs to be removed prior to assembly. Plug the fan into the connector on the motherboard. Some cooling fans have metal clips that clip onto the socket to hold the fan in place. Be **EXTREMELY CAREFUL** when you install these types of cooling fans; often to get leverage, people will push down with a screwdriver. If the screwdriver slips off the clip you can easily gauge the motherboard which more often than not will ruin it.

The next step is to install the memory; be certain the DIMMs are inserted all the way and the clips snap in place.
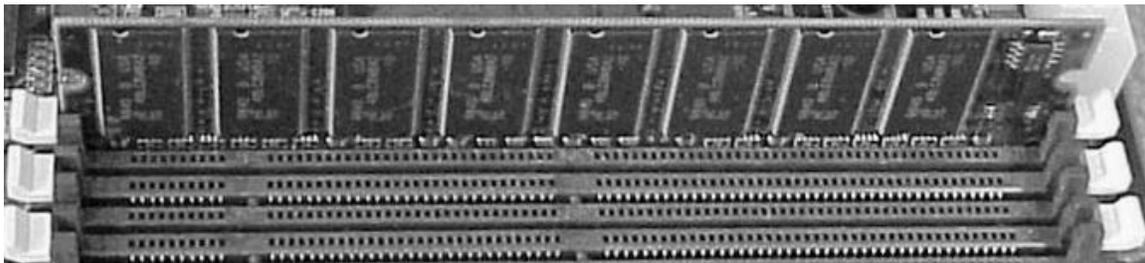
Install the I/O shield onto the system case. The I/O shield is designed to snap in place in the rear of the system covering the ports.

I/O shields come in various configurations to accommodate many different motherboard configurations. Shields are designed to snap into place in the rear of the system case.

Install the hard drive, CD/DVD, and floppy into the system case before installing the motherboard. Stand-off spacers need to be inserted into the system case to align with the holes on the motherboard; refer to the motherboard documentation for positioning. Install the motherboard into the case and secure with screws.

Connecting Cables

The system case has cables that connect to the front panel lights and various switches to the motherboard. These must be connected to the motherboard onto a series of connectors that are located in the corner of the board.
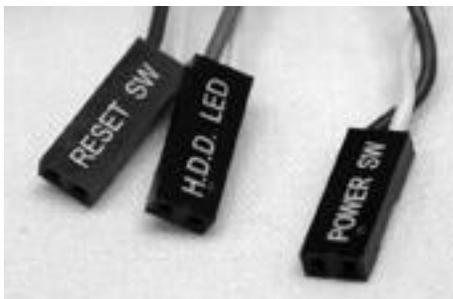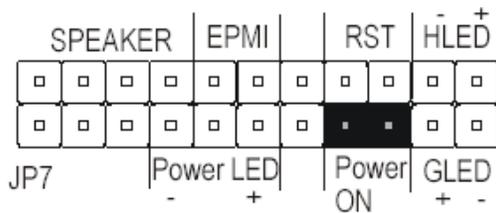
Cables from the front panel are labeled indicating where they plug into the motherboard.

Plug the power cable into the ATX connector. If your system does not have integrated video, insert the AGC card and complete the connections from the CD/DVD to the sound card. Make sure cables are dressed properly to allow proper airflow in the system.

Drivers

Your motherboard will include a CD that contains all the necessary drivers for the system. Follow the instructions to load these drivers.