

# COMPUTER & INFORMATION LITERACY

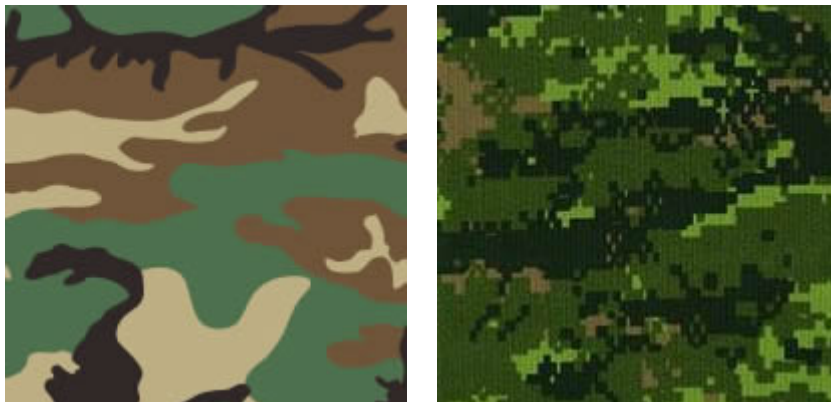
## COMPUTER SYSTEMS TUTORIAL – CIL.USU.EDU

### Bits, Bytes, Speed & Size

At their most basic level, computers communicate in binary language. Binary can be thought of as a series of switches that can either be "on" or "off", representing the presence or absence of electricity. Everything done with computers is converted into binary since they run on electricity. These two positions are represented by the computer as 1s and 0s. Practically all electronic equipment uses 1s and 0s on their power switches, so this convention should be familiar. 1 is ON and 0 is OFF.



Digital information is made up of discrete countable units, so it can be subdivided exactly, as opposed to analog information, which continuously varies over a range of values. The following pictures are camouflage in analog and digital patterns. The colors on the first picture look smooth, whereas the colors on the second picture are small squares. If the blocks are small enough or if you stand far enough back, the digital pattern looks continuous, even if it is not. Computers store and process information in a digital format, but humans process and store analog information.



Computers are found in many electronic devices and machinery, such as cars, DVD players, traffic lights, etc. These are called embedded computers, since they are embedded in another device to add specific functionality. They are usually less powerful than the desktop PC you usually use, since they are designed for a more limited purpose.

#### Size

Whatever the type of computer, the smallest unit of storage is a binary digit or bit. A bit can only store a single 0 or 1 and does not convey much information by itself. A string of 8 bits is called a byte, and with its 256 possible numeric values ( $2^8=256$ ); it is the unit of data that we use to store one character. Binary is a Base 2 counting system, meaning there are two possible values, 0 or 1, as opposed to how we normally count with a Base 10 counting system, 0 through 9.

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The following numbers show a byte (or set of 8 bits) converted to a number, along with the corresponding ASCII text character:

01000001 = "A"

01000010 = "B"

01000011 = "C"

Using the number of bytes to describe storage capacity would be similar to using the number of pennies to describe thousands of dollars... rather cumbersome, to say the least. The following Latin prefixes help specify the size of the large numbers we use when we talk about computer data file size.

Kilo means thousand.

Mega means million.

Giga means billion.

Tera means trillion.

*mnemonic to help you remember the order: Kings Make Great Tyrants*

8 Bits ~ 1 Byte

Bytes	Kilobytes	Megabytes	Gigabytes	Terabytes
1,000 Bytes	1 KB			
1,000,000 Bytes	1,000 KB	1 MB		
1,000,000,000 Bytes	1,000,000 KB	1,000 MB	1 GB	
1,000,000,000,000 Bytes	1,000,000,000 KB	1,000,000 MB	1,000 GB	1 TB

*Most modern hard drives and flash drives will hold many gigabytes of data. A small text file might be just few kilobytes, whereas a picture taken on a 10+ megapixel digital camera might be several megabytes. A word processing document that has many pages of text and pictures could easily be a couple of megabytes or more. It is important to remember the differences in these terms so that an informative decision can be made, for example, when choosing between a computer with 1 gig of memory and one with 512 megs of memory. Maybe you need to decide whether to buy the 8 GB USB drive to transport your data files with or if the 1 GB model will do. If more is better, which is more?*

### Speed

The speed of the Central Processing Unit (CPU) is very important. The faster the CPU, the faster the computer actually runs, since it acts like the brain of the computer. When the speed of a computer is mentioned in an advertisement, that speed references the speed of the CPU.

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When we talk about size, we use bytes. When we specify processing speed, we use units called hertz. The number of "hertz" describes the number of electric pulses per second, and the same prefixes are used with hertz as is used in bytes to specify larger values.

Currently, the speed of CPU's are measured in megahertz or gigahertz; most new computers will run anywhere from 1.5 to about 3.8GHz. A computer that runs at 800 megahertz has a CPU that can issue 800 million pulses per second, whereas a CPU that runs at 3.2 GHz can issue 3.2 billion pulses per second. 3.2 GHz is about 4 times faster than 800 MHz. Many new computers now come with two or even more processors, which greatly improves performance by allowing the computer to process more information at the same time.

Smaller devices such as phones and PDAs will run at slower processor speeds, because they don't have the power to run that fast or the cooling system to handle the extra heat. That is the same reason a laptop will generally not be as fast as a regular desktop computer. A server or mainframe will be physically larger than a desktop computer because it will have more processors and a stronger power and cooling system. They are often put in special server rooms with backup power and cooling to keep the system running. A supercomputer is generally a set of servers that are hooked together to run even faster in order to calculate large scale problems like predicting the weather, breaking encryption, mapping genomes and other biology or physics projects, and tracking the contents of the Internet for search engines.

## Storage Devices

Permanent storage in a computer can take one of two forms, internal or removable. The hard drive is considered internal storage. Removable storage includes things like floppy disks, backup tapes, USB drives, and CDs. Using the recording protection tabs can protect media (disks) from being deleted or written on accidentally, just the same as on VHS and cassette tapes. Unlike RAM, which stores data using electricity, permanent storage devices and media store data electromagnetically, so the data remains when the power goes off.

ROM is another type of permanent storage. It stands for Read Only Memory and can never be rewritten. All modern computers include ROM that contain start-up information and other critical information. The only way to change ROM is to replace the ROM chip. Most users never have to do something like this. CDs are sometimes referred to as a CD-ROMs, because you can only read it, not write to it.

There are and have been many different types of disks for many different uses. The first disks that were used were 8" floppy disks, which soon shrunk to the more commonly known 5¼" floppy disks. Later, the 3½" disk was invented. This disk is stored in a hard, plastic case. Many novice students



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called it a hard disk because it was enclosed in a hard case; however, the disk inside is still a floppy disk.

Improper handling can damage floppy disks. Never bend them, expose them to heat or cold, touch the read/write slot, place heavy objects on them, or remove them from the drive while the drive is reading them. Floppies are very prone to failure because they are not made of high quality material. Most errors come from being ejected while the drive is still writing to the disk, but they often have physical failures as well.

Backup tapes can often hold large quantities of data, but require special hardware that is not installed on most computers. Although they can hold large amounts of data, accessing that data can be very slow, since the drive has to fast forward through the tape to find the data it needs. They are normally used for backing up servers with large amounts of data, not personal PCs.

Hard disks are similar to floppy disks, but are made out of metal and usually are rarely removed by the user. Most of the time hard disks are actually several disks stacked on top of each other contained in a case. This case is called a hard drive and is installed inside the computer. Information can be saved to and retrieved from a hard disk much faster than on a floppy disk so they are used to store large files and programs. The main hard drive on most computers is usually referenced as the C: drive. It is not entirely uncommon to find personal computers with multiple hard drives. Servers almost always have multiple hard drives. Data can often be recovered off a hard drive if it is deleted or if the hardware is damaged because of the way the data is stored, but you'll probably need to contact a professional with special tools. They can be damaged by power surges, magnets, vibration, and heat.



A standard 3.5-inch floppy disk can hold up to 1.44 MB of data, which really isn't very much. An average size hard drive can hold 40-140 GB. Some hard drives will hold several hundred GB.

USB drives (thumbdrives, memory sticks) can be attached to a key chain or clipped to a shirt pocket. The storage capacity on these disks varies. Popular sizes range from 512 MB to 2 GB, although they go higher than that. They are much more durable and easy to use than floppies, which is why they have become so popular, but they are also prone to errors if you pull the drive out while the computer is writing to it.



Another way of storing data is on a CD or DVD. A CD can hold 700 MB, and a DVD can hold 4.7 GB or more. A special drive is needed to read these discs and write to them. A drive that can write to a CD or DVD is



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often called a burner because the data is burned into the disc with a laser. A laser is also used to read the data on the disc.

The following are various types of discs that can be used:

CD-R - CD recordable, disc can be recorded one time.

CD-RW - CD rewritable, disc can be written and over-written repeatedly.

DVDs - There are also different formats of recordable DVD discs. DVD-R and DVD+R are the most common, but there are several other types. They can only be used in drives that support that format, but most new drives support both. Just make sure when you buy DVDs for your burner that they are compatible, especially if your DVD drive is more than a couple years old. A CD drive won't read a DVD, but DVD drives will read CDs.

## Disk Formats

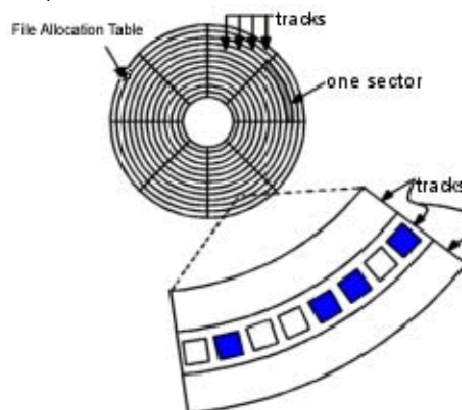
Before any disks are able to be used, they must be formatted, although many users never have to do so, because they usually come from the store pre-formatted. Formatting wipes out any existing data, creates a file system to manage the new data, and divides the disk into tracks and sectors like a circular grid system. FAT32 is a common format that is compatible with most operating systems to organize the contents of disks into files and folders. Most Windows computers use the NTFS (New Technology File System), which provides additional security features. The latest versions of Mac OS X use the HFS+ (Hierarchical File System Plus).

The formatting process also includes an error checking procedure that examines each sector of the disk and ensures that it is physically sound. It also deletes all the data on the drive, so before you format a disk, you should make sure you have backup copies of anything on it that is important.

*To format a disk in Windows, open My Computer, right-click on the appropriate drive, and select format from the available options.*

*To check a disk for errors in Windows, right-click the drive icon, click properties in that menu, click the Tools tab in the properties dialog box, and select the button Check Now.*

On the disk there is a File Allocation Table (FAT) or index, which identifies the specific sectors and tracks where files are stored. When a disk is close to full capacity it may be forced to save a single file anywhere there is extra space, even if it has to break it up so that it is not continuous. When the computer has to search and find these individual parts of a file to place them back together it can take a long time to open the file.



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That is one reason why larger hard drives are, in general, faster. This is also why older, smaller hard drives used to require frequent defragmenting, a process which reorganizes data on the drive so data files are no longer broken up and scattered around the disk, thus helping the disk run more efficiently.

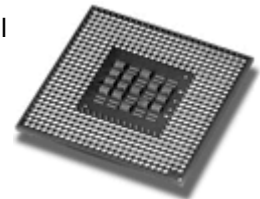
*The difference between a music CD and a data CD is in the formatting. You can fit about 5 times as many mp3 music files on a data CD as songs on a music CD, but the data CD probably can't be used in your car CD player, only on your computer.*

## Hardware

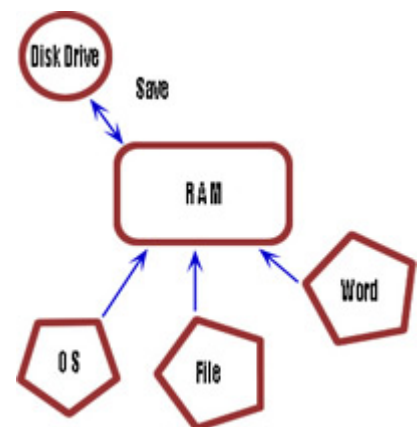
If you have ever looked inside a computer you may have seen what looked like a scene from a science fiction movie; wires and chips and little flashing lights. What you are looking at is usually called the motherboard or main board, and all the hardware or physical parts of the computer communicate with each other through the motherboard. Information traveling to and from the CPU and other computer components travels along groups of wires in the motherboard called buses.



One of the most important components in a computer is the CPU (Central Processing Unit) or processor. Intel Pentium 4 and AMD Athlon are examples of processor lines. The CPU controls all of the components within the computer and performs all necessary calculations, kind of like your brain does for you. When a user selects a file to be printed, for example, it controls everything inside the computer that is needed for the file to be printed, i.e., sending the document in a word processing program to the printer.



RAM stands for Random Access Memory and influences how fast the computer runs. RAM is often referred to as main memory, primary memory, or just memory. This is because the CPU uses this memory first to complete all its tasks. Secondary memory is a permanent storage device, usually a disk. RAM acts as a temporary storage location for files, programs and other electronic data that are currently being used. RAM is electronic memory so it is very fast. Opening several programs and files at one time can slow down a computer because it begins to run out of RAM. A computer with more RAM allows more files to be open without slowing it down. Most computers nowadays have from 512 Megs of RAM to 2 Gigs of RAM and can also be upgraded to have more RAM.





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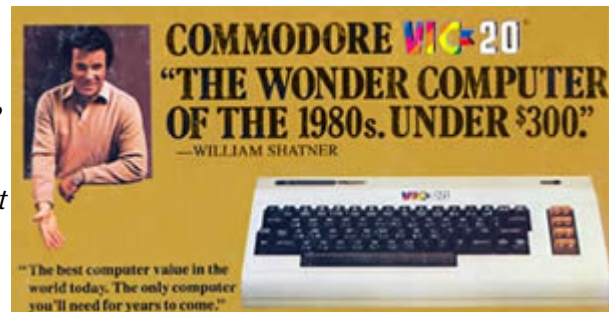
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Because accessing hard disks is very slow (usually measured in milliseconds), RAM (usually measured in nanoseconds) is used to hold data that is currently being worked on. When a Microsoft Word Document is opened and prepared to be edited, the application components needed to run Microsoft Word are first loaded into RAM by the Operating System. This means those components can be used immediately without being loaded from a disk each time they are used. Additionally, the data file to be edited or viewed is loaded into RAM. As the file is changed, the changes are saved in RAM so the user can see the changes as they are made. The original file still is on the disk. If each change was written to the disk as it was made, the computer would not be able to keep up with the changes. Disks are just too slow.

*Think about how long it takes when you hit the save button on your document; it is only a second or two, but think about how slow it would be to type if you had to wait a second or two each time you hit a key or moved your mouse.*

The only disadvantage of RAM is that when the power on the computer is stopped, RAM is lost because it is "volatile." It is powered by electricity, and when there is no more electricity, RAM is emptied or cleared. When a file is saved, the CPU takes what is in RAM and saves it to a disk which is a more permanent form of storage that can survive the power being turned off.

*When you see discount specials in the Sunday newspaper for a \$299 computer, chances are they're selling you only 256 MB of RAM and a 2 GHz processor. Don't be fooled into buying a low-end machine with a CRT monitor that won't do what you need. For basic computing tasks, such a machine will be adequate, but you should really look at what software you will be*



*running to determine whether it will be powerful enough. If you're working with large multimedia files or databases, the computer will need enough RAM to load the files into memory, otherwise the system will run slowly, because it has to keep reading from and writing to the hard drive. It doesn't make sense, however, to purchase a high-end machine for over \$2,000 that will only be used for surfing the web and occasionally composing a few text documents.*

## Software

Software is a set of instructions that tell the computer what to do. The greatest hardware in the world will not do you much good if you can't control it.

The operating system, or system software, is the first thing to load when the computer starts. It is different from application software like Word or Firefox in that it controls the entire computer system, including managing what data or programs are loaded into

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memory, what a user has permissions to do, communication with peripheral devices, and what applications run. Multiple operating systems can be installed on one computer, called a dual-boot system, where the user chooses which OS to load when it starts. You can also run a virtual machine, where you run a special application which lets one OS running inside another OS. You can completely reformat the hard drive and add a different OS than the one your computer came with or start up your computer using an OS that loads from a bootable CD.

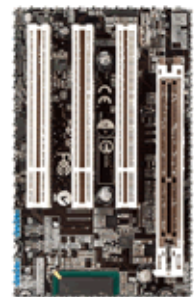
Application software must be specifically written for the operating system it will be run on, but some software vendors will release a program for multiple operating systems; for example, you can download versions of Firefox for Windows, Mac, or Linux. Files are collections of data that can be opened and edited using compatible application software. MS Office 2007 can open up files created by old versions of Office, but you have to install a special compatibility pack for old versions of Office to open Office 2007 files.

Most operating systems we use now utilize a Graphical User Interface (GUI) where you can move, resize, open, and close windows for each of the applications you are running. Icons are little pictures that represent your data files and the folders that your files are organized in. There are also text-based operating systems where you have to type in commands to tell the computer to run, edit, or copy a file instead of just being able to click on it with your mouse. These are generally more common on servers that don't need a pretty GUI in order to function. Whether or not a computer has a GUI or a text-based interface, without an operating system, your computer won't accept input, produce output, store data, or process/manipulate data. The hardware and the application software need an operating system in order to talk to each other.

## Input & Output Devices

Peripheral devices are external devices that connect to the computer through ports, such as USB, Ethernet, and parallel ports. When hardware is installed inside or outside a computer, the operating system needs a special piece of software called a driver to help it understand how to communicate with that device. Drivers either come with new hardware when it is purchased or can be downloaded from the manufacturer's website.

Inside the computer on the motherboard there are slots where other boards, usually called cards, are inserted to allow the computer's functionality to be expanded. These cards often include a port into which a peripheral can be plugged. An example of a peripheral is a monitor, keyboard, or mouse. Each of these components is plugged into the back of the computer case. The CPU knows they are there because the card associated with that peripheral tells it. The number of internal expansion slots a computer has is an indication to how easily the computer can be upgraded. It is important to understand the





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different types of peripherals and what their main uses are in case you need to add a device to your computer. A small PC might fit well on or under your desk, but if you can't upgrade it later or if the processor runs too hot because of inadequate cooling, you may have to replace the entire computer.

One classification of peripherals is input devices. Input devices are the parts that bring information into the computer, like the keyboard, mouse, microphone, and scanner. The input device translates human actions or physical objects (analog data) into an electronic (digital) form the computer can recognize. Other common input devices are joysticks, bar code readers, cameras, fingerprint readers, etc. CD and DVD drives are also input devices, since they read data into the computer.



Another classification of a peripheral is an output device. Output devices translate information stored in the computer and present it in a way that humans can understand it. Typical output devices in a computer system are the monitor, speakers and the printer.



Some devices that perform both input AND output operations are referred to as I/O (input/output) devices and their operations are called I/O operations. Examples of common input and output components are disk drives and modems. A touch screen monitor on an ATM or a videogame controller that shakes when the player is hit can both be considered an I/O device. A CD or DVD burner would also be an I/O device, since it can both read and write data to discs.



## Malicious Software

### Viruses

Viruses are malicious software that comes in various forms with different purposes. Although the term virus is often used to describe all malicious software, there are actually three types, based on how they propagate or spread, a Trojan Horse, Virus, or Worm.

A "Trojan Horse" is a program that looks like it is doing something good, but in reality it is doing something destructive. The user is usually tricked into installing it, thinking it will be useful. On the movie *The Net* there was a Trojan Horse. It looked like it was keeping the system secure, but in reality it was sending private information to people who were using this information to perform illegal acts.

A "Virus" spreads like a biological virus in that some type of contact is made, i.e. copying a file with a virus attached to it, using a floppy disk in a computer with a virus in the operating system, or running a program with a virus attached to it. They can be sent to your friends and coworkers without your knowledge, usually as email attachments from you.

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Some email programs, can block potentially dangerous attachments, but you should never depend on your email software to protect you. Don't open attachments if you are not expecting it, without talking to the sender first.

A "Worm" is a program that travels independently through a network. Most computers are networked, so these can do a lot of damage in a short time. Worms are different from viruses and trojans in their ability to spread without any human intervention. You don't have to open an email attachment or download a file to become infected with a worm. You simply need to be running a computer that is vulnerable to one of the techniques that the worm uses. A few years ago, the Nimda Worm caused all kinds of havoc on many computer systems at Utah State University and other networks all over the world.

Virus protection software will protect your computer and stop most viruses. Virus protection data files should be updated daily to ensure that the latest viruses are being stopped. New viruses are always being created and virus definitions are needed to identify new viruses to antivirus programs. Most antivirus programs can be set to update their data files automatically, so you should take advantage of this feature. Often viruses will spread rapidly before the antivirus vendors have time to release a patch for it, so you should still be careful and not rely on your antivirus to protect you 100%. It is never legal to create a virus, even if it is not harmful. Viruses are created in many different ways. One common way is to use any program that has macro capabilities.

*The following are just a few antivirus products that could be installed to help protect yourself:*

- *McAfee* (free to USU students and staff at [mcafee.usu.edu](http://mcafee.usu.edu), which can be accessed on campus or through the VPN or Proxy servers - call the Helpdesk if you need help setting up the VPN or Proxy server off campus)
- *AVG* (free for personal use at [free.grisoft.com](http://free.grisoft.com))
- *Norton* (one year version often included on new computers)

### **Spyware**

Recently, a new category of malicious software has emerged, called spyware or adware. This software may be installed in various ways, but once it is installed, rather than destroy the contents of your computer like a virus is designed to do, it watches what you do and steals information or causes ads or other undesired programs to run on your computer. Many times users become infected, but they never know there is a problem other than that their computer is running a little more slowly than normal or that occasionally ads pop up on their computer.

*There are various free utilities that can be installed in addition to your virus scanner, to protect yourself against spyware, including:*

- *Spyware Blaster*
- *AdAware*
- *Spybot - Search and Destroy*

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### Patching

Operating Systems need to be updated often. Windows and most other operating systems can also be set to install updates automatically. Updates may be released daily, weekly, or monthly, and may vary in importance; it is good practice to set your computer to update itself automatically every day to make sure no important security fix gets missed.

*Windowsupdate.microsoft.com will detect needed or recommended updates, download them to your computer, and install them at your discretion. If you use another Operating System, it should be able to do the same. Regardless of your OS, set it to update daily.*

### Firewall

A firewall is a security device, either hardware or software, that blocks unauthorized users from connecting to your computer via your network or Internet connection. Network firewalls are usually installed and maintained by network managers. Home computer users can install personal firewalls to secure their PCs and data. Firewalls often take some time to get configured properly and sometimes conflict with other software, but it is worth taking the time to set it up right.

*A firewall should be set to block everything. If a program is not running properly, you may then open an exception in the firewall for that specific program; if you stop using it or use it infrequently, you should turn the exception off. If you need to communicate with a specific computer, you may open an exception to allow only that computer to communicate with you, leaving the rest of the Internet locked out.*

*Windows XP includes a firewall, but make sure your OS updates are installed to keep it up to date. ZoneAlarm [[download](#)] is a good firewall that is free for personal use. Other Operating Systems may have a built-in firewall or third-party firewalls that can be installed.*

### Networks

Networks are a collection of computers and other hardware and software that interact with each other, so that we can share data, applications, and hardware. Computers in a network may be connected to each other by cables or wirelessly. Wireless networks broadcast over radio waves and can communicate with all computers in the area that can receive the signal. Wireless networks are inherently less secure, because it is difficult or impossible to tell who is nearby listening to your data flying by. Most computers will automatically ignore signals that are not intended for them, but there are programs some people use to store all the data being sent over a wireless network to find password and other private information.

A server does what its name suggests; it provides services for remote computers that connect to it. These remote computers are called clients. Clients access servers and request information or request a task to be performed, such as print a document to the network printer or retrieve a data file.

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*Often when many files need to be transferred together through a network, they are compressed using a file compression utility like WinZip. This means that the files are stuck together in a way that they are compressed to take up less space than the individual files originally used. This resulting zip file can be transferred faster and easier from one computer to another than the original files. They must be uncompressed or unzipped again before they can be used.*

Networked computers that are located near one another, like in a computer lab, are connected via a LAN, or Local Area Network. Networks may also spread over a much broader range. A WAN, or Wide Area Network may span countries, continents or even oceans. The Internet connects LANs and WANs from all over the world. It is a network of networks.

A modem allows a computer to connect with other computers via phone lines or coaxial cable by converting the digital signals inside the computer to an analog signal and vice versa. A dial-up modem connection is a much slower connection, but allows users to connect from more remote locations. There are two types of high-speed Internet connections available for home usage in many areas. Cable modems use coaxial TV cable lines to connect to the Internet, and DSL service connects via existing telephone lines. Both use frequencies that do not interfere with TV or voice service running over the same lines. Cable and DSL modems usually connect to your computer's network port or an available USB port. A router is a device that can be hooked up to a modem to allow multiple computers to share the same internet connection. A firewall is used to prevent unauthorized access to a network resource.

Networks should be protected from unauthorized usage and often require each user to login with a username and password. Passwords should be difficult to guess, long, and contain a combination of letters, numbers, and symbols. A good password will typically not be a word found in a dictionary. A bad password is something like the word "password", your cat's name, or your birthday. Just adding the number 1 to the end of your name does not make it a secure password either. It is a good idea to change your passwords occasionally, but not so often that you forget them.

It is very important to understand that information sent over a network is not secure -- meaning that anyone can see the data. Secure connections are used to encrypt the data sent to make it harder for other people to interpret it. Many times users can specify the level of security used when connecting to a network. The more secure, the better, but it is slower because all of the transactions have to be encrypted and decrypted.

*As personal information becomes more readily available, the crime of identity theft has become more common. Protect yourself from identity theft, by keeping your personal data, such as your SSN, passwords, and PINs secret. It is against the law to access areas of a network for which you do not have authorization, regardless of the situation, but you should always be careful about what you transmit over the Internet.*