Certificate I in Information, Digital Media and Technology

Computer Basics

Student Guide | ICA10111

TEIA Ltd, PO Box 358, Charters Towers, Q 4820. Tele./Fax: 07-47871410
Email : admin@teia.edu.au Website : www.teia.edu.au

Software used in the development of this work included Microsoft Word 2007, Microsoft Windows Vista and 7, Adobe Fireworks and a range of freeware applications.

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Table of Contents

Chapter 1: General Concepts

In this chapter you will learn:

- What a computer is
- What computer hardware is
- What software is
- What peripheral devices are
- What information technology means
- What a personal computer is
- What a main frame is
- What a network computer is
- What a laptop is
- What a PDA is
- About the CPU
- About RAM
- About the power supply and cooling system
- About disk drives
- About input/output devices
- About ports
- How CPU speed affects performance
- How RAM affects performance
- How applications affect performance
- How other factors can affect performance

Session 1-1: Basic Terms

In this first session, you will learn what a computer is. You will also receive an introduction to the basic concepts of hardware, software, and peripheral devices.

What is a Computer?

Nowadays, computers come in many forms. When you say the word “computer,” the image that most readily springs to mind is a rectangular box, a screen, and a keyboard sitting on top of a desk. While the computer has indeed become a common fixture on desktops all over the world, they are also frequently found in the form of laptops and hand held devices.

A less obvious but extremely common application for computers can be found in their use as embedded devices in a multitude of electronic products, like cameras, cell phones, toys, appliances, and so on.

Even though computers come in many different shapes and sizes, there are some general ideas that they all have in common. A computer is a machine that processes (manipulates in some way) data or information according to a step by step sequence of instructions. The ability to store and execute sequences of instructions is very important, as it is this ability that allows computers to be applied to a variety of different tasks.

In short, a computer can be described (in a very fundamental way) as programmable machine that can store and execute a sequence of instructions. However, while this definition may be technically accurate, most people use the word computer in a broader sense that refers to the programmable machine, its storage devices, its monitor, keyboard, mouse, and a host of other attachments.

Beyond describing a computer with a definition of what it is, you can also describe a computer in terms of what it can help you do.

On a personal level, a computer can be used to store records and files, communicate locally or internationally, prepare a variety of documents and reports, edit photos and video, and provide you with access to a global network of information. Beyond this, computers are now used in science, health, business, and government to such an extent that it would be extremely difficult to function without them.

What is Hardware?

As you now know, a computer can be described as a programmable machine that can store and execute a series of instructions. A computer’s hardware consists of the actual physical components that are used to store and run the programming instructions. The wires, circuits, and microchips that a computer is built from can all be called computer hardware.

The physical storage devices (machines used to store and retrieve data) and input output devices (like keyboards, monitors, and printers) are also computer hardware components.

Basically, any tangible part of a computer system (a part that you can see and touch) is considered hardware. Furthermore, pretty much any computer hardware component will fall under one or more of the following four categories.

Storage/Memory	The parts of a computer where programs and data are kept.
Input	Devices that help convey data into the computer, such as a scanner, keyboard, mouse, or microphone.
Output	Devices that help the computer output information to the users, such as a printer, monitor, or speakers.
Control/Processing	These very important hardware components interpret the sequence of instructions in the computer's running program. Electronic signals (based on these program instructions are then sent to the other hardware components to control their actions. A computer's Central Processing Unit (often called a CPU or processor) is a good example of a piece of control /processing hardware.

On a final note, it is important to understand that some pieces of computer hardware can simultaneously belong to more than one of the categories listed above. For example, a network interface card (a component that helps facilitate communication between different computers) could be thought of as both an input device and an output device.

What is Software?

A computer program is an organized set of instructions that is designed so that it can be stored and executed on a computer. Collectively, computer programs are often referred to as computer software.

A modern computer can run many different programs, with each program having its own specific purpose. As each instruction in a given program is executed, the computer's control hardware sends messages to the other parts of the computer to cause them to function as directed by the instructions. Unlike hardware components, which are physically tangible ("hard") objects, computer (software) programs are stored and run as electrical signals inside the computer.

Even though you cannot reach out and touch them, these software programs are an essential part of any computer system. It is the software that tells the computer hardware what to do

and how to behave in response to a user's actions. Without software, a computer is little more than a box of complex, but useless, electrical parts.

Software can be written to perform an amazing variety of different tasks on a computer. The fact that many different software programs can be loaded and run on a single computer is what makes modern computers so versatile. Today, a typical office computer can be used for word processing, accounting, sending e-mail messages, and more, depending on what software has been installed.

To summarize, software programs are sets of instructions that are executed on a computer. These instructions are processed in the form of electrical signals by the computer hardware to provide functionality to the computer system.

Here are some helpful insights and information about modern computer software.

- To a large extent, software can be organized in terms of two broad categories: applications software and systems software.
- Applications software refers to programs that are designed for a relatively specific subject area or purpose, like word processing, e-mail, web browsing, spreadsheets, databases, animation and graphics, and so on.
- Systems software generally refers to software programs that are designed to provide and maintain an environment that allows the user (and the applications software) to interact with the computer hardware. Operating systems like Windows, Linux, and UNIX are a few examples of systems software.
- Software can be stored for long periods of time on a variety of different media, including compact disks, DVD's, hard disks, and floppy disks.
- Software can be temporarily stored in a computer's main memory (RAM).
- Software is often published to, and installed from, optical disks like CD's and DVD's. In addition, software can be obtained over network connections, using a method called downloading.

What are Peripheral Devices?

A peripheral device is a piece of hardware that is connected to a computer to expand a computer's functionality. For example, if you want to create paper copies of the work you do on a computer, you could connect a printer. The printer is a peripheral device that, when connected to your computer, can produce printed (hard copy) pages of specific information stored on your computer.

At one time, just about any external device that was connected to a computer was considered to be a peripheral device. More recently, however, a peripheral device has come to mean a piece of non-essential computer hardware. For example, hardware items like a mouse, keyboard, or monitor are considered by many to be essential components of a computer system, and therefore are no longer thought of as peripheral devices.

Some other examples of peripheral devices are microphones, speakers, scanners, digital cameras, DVD drives, flash drives, and music (MP3) devices. Just about anything that connects to a computer to improve or expand its functionality can be referred to as a peripheral device.

What is meant by Information Technology?

Information technology can be described as the design, development, and implementation of information systems especially in regard to the use of computer and telecommunication technology.

Information technology (also referred to as IT) deals with all aspects of information storage, retrieval, transformation, communication, security, and accessibility. Of course, because computers are such great tools for handling information, computer hardware, software, and networking are key components of the information technology field.

Often, the term information technology is used in a business or enterprise context to describe the department or sector of operations that deals with a company's computer hardware, software, networking, and telecommunications infrastructure.

When people speak about occupations in the IT (Information Technology) field, they are often referring to jobs that involve computer networking, network administration, software development, technical support, Internet services, and web development.

Activity 1-1

Objective	To understand terms like hardware, software, and peripheral, as they relate to computers.
Briefing	Your friend, who generally avoids technology at all costs, has finally decided to learn how to use a computer. He has asked you to help him get started with some basic concepts before he goes out and purchases a computer. Your friend has asked you the following questions: ▪ What does a computer do? ▪ What is the difference between hardware and software? ▪ Are peripheral devices hardware or software? ▪ Give an example of a peripheral device. ▪ Why do you need systems software and applications software on your computer?
Task	You are to answer your friend's questions to the best of your abilities.

Try to phrase your answers in your own words, and explain things in a way that your friend (who knows nothing about computers) can understand.

Hints Review Session 1 and you should find the answers that you need.

Session 1-2: Types of Computers

In this session, you will discuss some of the main types of computers that are in use today. These computer types include: the personal computer, the mainframe computer, networked computers, laptop computers, and PDAs (Personal Digital Assistants).

What is a Personal Computer?

A personal computer is a small, affordable computer that is intended for personal or individual use. Typically, the main element of a personal computer system consists of a box that contains the main memory, hard drives, processor (CPU), circuit boards, and related devices required to run software programs.

In addition to this box, a personal computer system will usually require a keyboard, a monitor (screen), and a mouse (pointing device). Often, owners of personal computers will acquire additional peripheral devices, such as printers or scanners.

Personal computers are often called desktop computers, because their size, computing power, and affordability have made them a common fixture on home and office desktops around the world. The familiar view of a rectangular box, with a screen and keyboard sitting on a desk, is what many people envision when they think of a computer.

Because personal computers (PC's) are often purchased for individual use at home, they are also widely known as home computers.

Currently, personal computers can offer an impressive blend of affordability and computing power. For example, personal computers with processor speeds of 2 to 3 gigahertz and with more than a gigabyte of memory can be purchased for a few hundred dollars. (As a general rule, all other things being equal, the higher the speed of the processor, the higher the price of the computer.)

In addition to the personal computer's hardware, an operating system is also required to provide an environment in which users can run software applications. The prices of operating systems can vary, and will depend on what systems are available when you purchase your PC.

Mainframe Computers

Mainframe computers are found at the opposite end of the computer spectrum from the PC (personal computer). Unlike a personal computer, a mainframe computer is large and expensive. A mainframe may be larger than a refrigerator in size, and can cost several millions of dollars.

In general, a personal computer is designed around a single processor (CPU), and is used primarily on an individual basis in an office or home setting.

A mainframe, on the other hand, can be designed around multiple CPUs, and can support multiple (sometimes hundreds) of users. Mainframes also have vast storage capabilities, far exceeding that of a typical personal computer. The IBM Z series mainframes, for example, advertise up to 256 GB (gigabytes) of processor memory, as compared to the 1 or 2 gigabytes of main memory (RAM) found in a high end personal computer. Furthermore, mainframes often use several high capacity hard disk devices to provide vast amounts of secondary storage as well.

Mainframes are typically purchased by large companies and institutions to help manage immense amounts of important data. Because of this, mainframe computers are designed to be very fault tolerant, and can often be serviced without being shut down. As a matter of fact, it is quite common for mainframe computers to be up and running for years at a time.

Another interesting feature of mainframes is that most can run (host) several operating systems simultaneously, whereas a personal computer will typically only be running a single operating system at any given time.

What is a Network Computer?

A network computer is a desktop machine that resembles a personal computer in outward appearance, with a screen, keyboard, and box. However, it does not have the same quantity of hard disk storage, main memory, or processing power that a personal computer can offer.

In a sense, a network computer can be thought of as a kind of light weight workstation that relies on a remote server for its data storage and applications, rather than maintaining and working from its own local hard disks.

The reasoning behind network computers is to provide a more affordable alternative to expensive personal computers. Because the network computer relies on a network server for its storage and applications, it can be more cost effective, requiring less computing power and local data storage than a personal computer (which relies primarily on its own hardware). Moreover, network computers can be more easily controlled and updated and from a central location (server).

However, because personal computers have continued a trend of increasing computer power, while maintaining reasonable prices, they have provided very stiff competition for network computers in most areas.

What is a Laptop?

A laptop is a small portable computer that can be operated on battery power for a period of time without any dependence on an external power supply.

This makes laptop computers a great choice for users who want the processing power of a personal computer, but also require the convenience of a portable, lightweight machine that does not always need to be plugged in. In this regard, laptops are quite versatile, and can be used in cars, on trains, in classrooms, and offices.

The hardware parts inside a laptop are quite similar in purpose to the parts of a regular personal computer; however, laptop components are usually smaller and are designed to require less power.

When a laptop's battery loses power, the laptop can be plugged into an external power source by using an external AC/DC adapter. When plugged in, the laptop is provided with enough power to run normally and charge its battery.

Typically a laptop computer will have a slim LCD (Liquid Crystal Display) screen that folds neatly down to reduce its overall profile, whereas personal computers often use large CRT (Cathode Ray Tube) monitors. In addition, a laptop has a built in keyboard and a touchpad or other pointing device. Most laptops also support the attachment of an external mouse (pointing device) as well.

As mentioned previously, a laptop can have comparable functionality (in terms of computing power) to a larger (desktop) personal computer; however, a laptop will usually be more expensive than its comparable desktop counterpart. Also, because a desktop personal computer has more room to accommodate hard disks, a typical personal computer will often have a greater secondary storage capacity than a laptop.

Laptops are also sometimes referred to as notebook computers.

What is a PDA?

PDA stands for Portable Digital Assistant. It refers to a small hand held device that offers many of the features of larger laptops and personal computers. Many PDAs incorporate a touch screen device into their design, allowing the user to interact with the items displayed on the viewing screen by touching it. Because PDAs are so small, touch screens help to provide a more manageable user interface.

Besides a touch screen, some PDAs actually have built in (though very small) keyboards to facilitate data entry tasks. In addition, they can have scroll wheels to help maneuver around the screen.

Because of its small size, a PDA will have much less processing power, main memory, and storage capacity than a laptop or desktop personal computer. A typical PDA of today may have a processor of 100-600+ megahertz, and anywhere from 32 to 256 megabytes of nonvolatile (safe if the battery loses power) storage.

These devices often have built-in wireless connection abilities, and many can be used to connect to the Internet for web browsing as well as composing and sending e-mail. Many current PDAs provide color screens and audio capabilities, and some can even be used as cellular phones.

A PDA can also be used as a personal organizer and for other more common computing tasks like word processing and working with spreadsheets. Typically, at prices ranging from $150 to $800, PDAs are quite affordable when compared to laptop and desktop computers. However, the computing power, support for peripherals, and storage capacity of these devices still lags far behind desktop PCs and laptops.

Activity 1-2

Objective

To understand the differences between various types of computers.

Briefing

You have recently provided your friend with some basic information about computers. Now your friend wants some advice on the particular type of computer that he should buy.

Your friend wants a computer that allows him to:

- Easily bring the computer with him as he travels
- Do some word processing
- Use e-mail
- Surf the web
- Play a few computer games
- Store a very large number of digital photos
- Work on the computer while he is on a train or subway

Your friend is very wealthy, so money is not really a factor in his decision making.

Task

Review the different types of computers mentioned in the previous session. Prepare a document that details your suggestions to your friend.

Justify your answer based on the requirements your friend listed.

Follow-up Questions

If your friend doesn't agree with you, can you think of a different type of computer that would serve as a viable alternative?

Session 1-3: Structure of a PC

In this session, you will start to get an idea of what is inside the box of a typical desktop PC. You will begin this session by learning about the CPU, which is the "brain" of a personal computer and a major factor in a computer's performance capabilities. Following this, you will be introduced to the concepts of main memory (RAM), buses, input/output devices, and other internal components like fans and the power supply.

The CPU

In a personal computer, the CPU (Central Processing Unit) is responsible for interpreting program instructions, performing calculations, and directing other components. In a sense, the CPU can be thought as the brain or control center of the computer.

A central processing unit can itself contain internal building blocks that handle different types of jobs or tasks. For example, a typical CPU will have an ALU (Arithmetic Logic Unit), a CU (Control Unit), CPU registers, and usually a high speed local storage area called a cache.

The CPU's control unit interprets the instructions of a program and signals/controls the other computer components based on the instruction.

The CPU's arithmetic logic unit is used to perform calculations (arithmetic) and logical operations (i.e. AND, OR, EXCLUSIVE OR, NAND) on values. The arithmetic logic unit (ALU) and the control unit (CU) of a CPU are extremely important factors influencing how the CPU will perform.

The CPU registers are very fast storage areas that often hold the program instruction that is currently being processed (interpreted by the control unit). Typically, a program instruction is loaded from memory into a CPU register at which point the given instruction will be executed by the CPU.

A CPU cache is a fast memory storage area that holds values that are frequently requested from the computer's main (but slower) memory. Because CPU cache memory is faster than main memory, a speed advantage is gained by storing frequently accessed memory values there. The CPU can quickly access the data in its cache, rather than retrieve the same data from the slower main memory every time it is needed.

In a personal computer, the ALU, CU, onboard cache, and registers are usually all designed into a single chip. This chip is attached ("plugged in" so to speak) to a motherboard (circuit board) to facilitate communication with other computer components like input/output devices, main memory, and secondary storage (hard disks).

These single chip CPUs are also called processors, and come in a wide variety of models with different features and speeds. A couple of well known manufacturers of CPUs are Intel and AMD (Advanced Micro Devices).

RAM

To execute software programs, a computer must be able to calculate values, perform logical operations, and store (remember) instructions or data. As you have seen, the CPU is used for calculating values and performing logical operations. To a small degree, a CPU can even handle some storage tasks by using its registers and memory cache.

The problem is that modern computers are often required to run huge software programs and deal with vast quantities of data. To meet these demands, additional memory storage is required.

Most personal computers contain a fairly large amount of RAM to meet the computer's working memory needs. RAM stands for Random Access Memory, which means that each individual memory location (the place where an instruction or data item is stored) can be accessed in the same amount of time.

To understand this better, think of how data is accessed when stored on a tape (like a video or audio tape). To reach data at the end or middle of the tape, you have to traverse the length of the tape until you reach the spot that contains the information that you want. The farther your information is into the tape, the longer you will have to wait before you can get to it. With computer RAM, on the other hand, it does not matter where the information is stored. All memory locations can be accessed in the same amount of time.

Typically, RAM is attached (plugged in) to the PC's motherboard in the form of modules. Different modules can have different access speeds and different memory capacities. The instructions for active (running) programs and the data required by these running programs are often stored in the RAM. In this sense, you can say that RAM provides the working memory that a computer needs to store the data and instructions for the programs that are currently running.

There are a few more important things to remember about your PC's RAM. First of all, RAM is volatile, meaning that whatever is stored in RAM will be lost when the computer is shut down. This is because RAM needs a small amount of electrical power to preserve the data and instructions that it stores.

RAM is a lot faster than secondary storage devices like hard disks and optical drives (such as CD and DVD drives). This is part of the reason that modern computers can perform so well; the more RAM that a computer has, the more fast storage is available for programs and data.

RAM is slower than cache memory or CPU registers, but it is also less complex and less expensive. This is why RAM is used as the main working memory of a PC, while cache memory is used for quick access to a relatively small quantity of instructions or data.

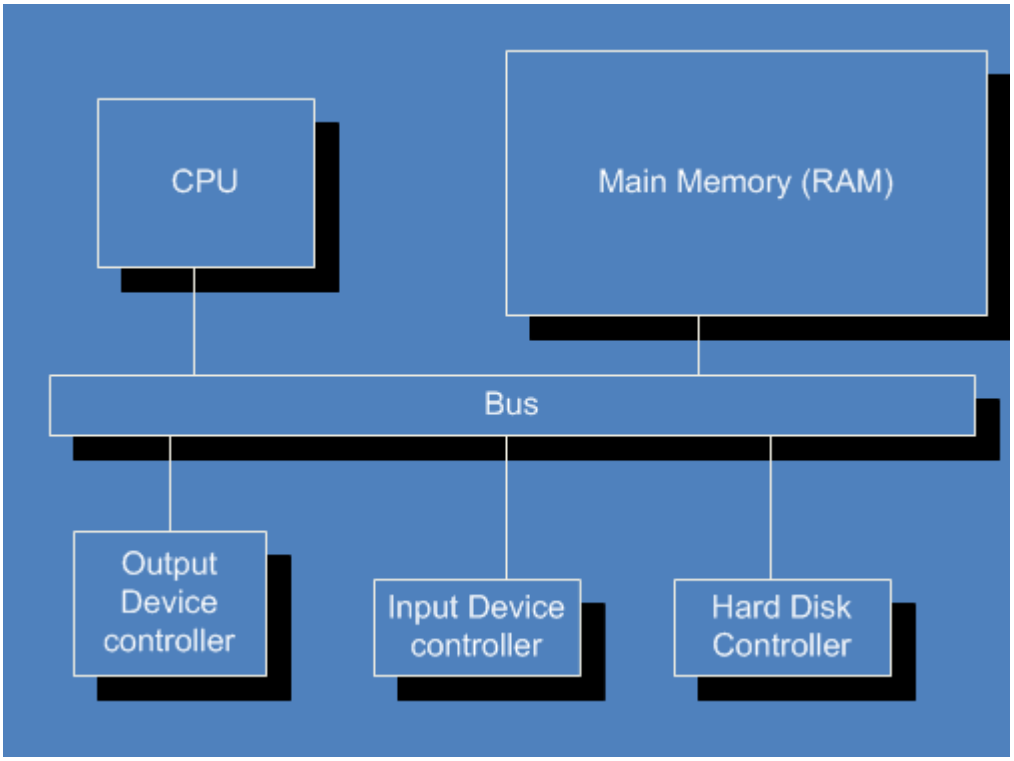
Buses

Simply put, a bus is a transport route for sending information or power between computer components. It is sometimes useful to think of a bus as a parallel series of wires, running between your computer components. These wires can connect the different components so that they can communicate and exchange instructions/signals, and data to each other. (The actual physical construction of a bus does not have to resemble a series of parallel wires.)

Let's imagine a very simple PC design as an example. In our imaginary PC, you have a CPU, some modules of RAM memory, and some input/output devices. For a program to run, instructions must be fetched from the computer's RAM and sent to the CPU.

An instruction that is processed by the CPU may request data or another instruction, in which case that data or instruction will also need to be retrieved from the RAM. The instruction may also direct the CPU to send data to the RAM memory for storage, or to send data to the input/output devices for the user.

Clearly, all of these components must be able to communicate and transport information in some way for even this simplistic computer to function.



As you can see from the diagram of our imaginary PC, the CPU, the RAM, and the input and output devices can send and retrieve information in the form of electrical signals passed over buses.

In reality, the internal architecture of even a simple PC is somewhat more complex than the description and diagram given above. The important point is to understand that components like the CPU, RAM, and various input/output devices rely on buses to communicate and transport data and/or instructions.

Input and Output Devices

Computers would be of very little use to us if people could not communicate with them. To operate a computer, a user must be able to input data and commands, and moreover, see or hear the results that the computer produces.

The devices that are used to feed information into a computer are called input devices. On the other side of the coin, the devices used by a computer to present information to the user are called output devices.

Of course, computers can get information from other sources like hard disks, floppy disks, CDs, and DVDs, but these are generally considered to be storage devices rather than input devices. The main input devices employed by most PC users are the mouse and keyboard.

The keyboard allows the user to enter uppercase and lowercase letters, numbers, familiar symbols, and commands. With a keyboard, you can type sentences, mathematical equations, and enter data into a variety of computer forms and applications.

Keyboards are used for an extensive list of tasks, including but not limited to: word processing, computer programming, composing e-mail, entering data into spreadsheets, and issuing commands.

A mouse is a type of pointing device that translates movements and actions made by the user into the movements and actions of a small symbol (mouse pointer) on the computer screen.

Computer mice have buttons (normally at least two) that can perform various actions when clicked. This means that a mouse can be used to point to objects on the screen and even perform actions on these objects. Frequently computer mice are used for dragging objects (moving them), opening objects (displaying them), or starting or closing software programs.

The limitations of what can be done with a computer mouse are mostly imposed by the type of graphical user interface that is available. In most situations, anything that does not involve the typing of numbers, text, or symbols, can be done with a mouse.

Another type of input device is a scanner. These devices can be used to convert an ordinary photograph, drawing, or sheet of text into a digital image. The object that you want to scan is placed on the scanner, the scanner is activated, and the object (picture, drawing, or a handwritten or typed page) is converted into a digital image that can be stored on your computer.

A computer printer is an output device used to produce a permanent, printed (paper) copy of an image, text document, or other output file from your computer. The user indicates what file or document they want a printed copy of (usually by using a mouse), and then uses a print command to send the specified file or data as output to the printer. At this point, the printer produces a copy of the specified information on paper.

A computer screen, or monitor, is the output device that users rely on most. There are many different sizes of screens available for a personal computer, but larger, higher quality screens are generally more expensive than smaller ones. Nearly all modern computer monitors have full color displays, and support a selection of different screen resolutions.

Human computer interaction is made possible through input and output devices. This is how people and computers communicate. Devices like a mouse, a keyboard, and a monitor are used so frequently that they are now considered by most people to be essential components of a personal computer system.

Disk Drives

Basically, computer disk drives come in two types: optical drives and magnetic drives. Examples of optical disk drives are CD or DVD drives, whereas magnetic disk drives include hard disks and floppy drives.

The main difference between the two drive types lies in how each type stores its data. With optical drives (like CD drives), data is stored as a series of marks (sometimes called pits or lands) on the surface of a very thin disk. If the disk is rotated under a beam of light, the light will be reflected or scattered depending on what type of mark it hits. This means that the information encoded as marks on the disk can be read, converted into electrical signals, and then sent to the computer as data.

With magnetic disks, signals are stored as tiny magnetized areas on a rotating platter (for a hard drive) or on a thin magnetized film (in a floppy). When these magnetic surfaces pass under a read/write head, the magnetic signals can be detected and sent as data to the computer.

Optical drives provide access to CDs and DVDs as publishing media. Because CDs and DVDs can hold so much information, they serve as an ideal medium for publishing computer software, audio or video data, or pretty much anything else.

CD and DVD drives allow you to access the data stored on CDs (Compact Disks) and DVDs (Digital Versatile Disks) with your computer. Furthermore, CD and DVD drives are available that can write to these media, allowing you to store and backup files to compact Disks or DVDs.

The problem with optical drives is that they can be quite slow compared to other drive technologies. On the other hand, a hard disk that stores data on magnetized platters can write or read information at a much higher rate than an optical drive. This is why hard disks are the device of choice for storing software and data that is accessed frequently by the computer.

A modern hard disk is really a stack of disks (platters) that form a kind of cylinder. Each disk in the cylinder has a magnetic coating which allows data signals to be stored on it. Since data can be stored on both sides of a platter, and there are multiple platters in a cylinder, a typical hard disk can hold quite a bit of information.

In a PC, a hard disk is used to store the computer's operating system, application programs, and any other files or data that the user wants to retrieve quickly and easily. Because the hard disk platters are not removable from the drive, hard disk drives are sometimes called fixed disks.

Floppy drives are small drives that are capable of reading and writing information to a small removable disk called a floppy disk. Floppy disks have very low storage capacities (compared to other media), and are not as durable as CDs or DVDs. For these reasons, floppy disks are no longer being used to a great extent. Despite this, floppy drives are still included with many current generation PCs, and they can be useful for the transport and storage of small files.

The following table ranks CD/DVD drives, hard disks, and floppy drives in terms of capacity and storage, retrieval speed.

Drive Type	***Capacity***	***Read /Write speed***
Hard Drive	Extremely high storage capacity (hundreds of gigabytes)	Faster than CD, DVD, or floppy
DVD Drive Note: Many DVD drives can read from CDs (compact disks) as well as DVDs.	High capacity (a writable DVD can have a capacity of 4+ gigabytes). Published (professionally made) DVDs can have even higher capacities	Slower than a hard disk drive Some DVD drives are read only (cannot be used to store data on a DVD), however, writable DVD drives are increasing in popularity
CD Drive	Fair capacity (a typical writable CD can have a capacity of around 650	Slower than a hard disk drive Some CD drives are read only,

	megabytes)	but many newer CD and DVD drives allow you to write to a disk
Floppy Drive Note: Many early floppy disk drives are now obsolete	Very low by current standards (only 1.44 megabytes)	Slower than a hard disk drive

Power Supply and Fans

Nearly every component that you'll find inside a PC, from your hard disk to your CPU, requires electrical power to work. Furthermore, these components require DC (Direct Current) electricity while the power that is available at a typical wall outlet is AC (Alternating Current).

To confound matters even more, different PC components require different amounts of electrical power. For example, a CPU may require 30 or 40 watts of power, while a hard disk drive may require only 5 or 10 watts. If a PC has a lot of components, like multiple drives, fans, a CPU, and various graphics or network cards, all of the power required by these devices adds up. To meet the power demands of current generation personal computing, PCs use a very important device called a power supply.

A power supply is a box like component that rests inside your PC. If you look at the back of a PC, you can often tell where the power supply is located by the presence of a power cord/wall plug, a power switch, and a fan.

Power supplies can generate a lot of heat as a byproduct of converting the AC current from your wall outlet to the DC current that is used by your computer hardware. If your power supply overheats, it could fail, rendering your PC useless. A fan integrated with the power supply helps to circulate air and dissipate heat, to help ensure that the power supply remains adequately cooled.

Typically, a PC power supply will have several small wires that end in connectors. When a PC is put together, the appropriate connector from the power supply is used to connect to the corresponding hardware device inside the PC. The types of power supply used in a given PC will depend on the type of motherboard being used. (A motherboard is the main circuit board, containing buses, which the PC's internal components plug into to exchange data and information.)

If your PC has a lot of hardware components (multiple hard disks, DVD drives, network interface cards, and so on), it is important for your power supply to be able to produce enough wattage to support all of these devices.

Remember, any device that is inside the box in your PC (any device that does not plug into the wall on its own) will get its power from your PC's power supply. Peripheral devices (like printers and scanners) and output devices (like speakers or monitors), will have their own power cords that plug into a wall outlet.

As mentioned above, fans are important to PCs because of the cooling effect they provide. If your power supply overheats, it can fail. Similarly, if your CPU overheats, it can cause errors in program execution, or fail entirely.

To prevent overheating, CPUs often use a physical cooling device (analogous to a car radiator) to help conduct heat away from the CPU itself. These devices are frequently combined with small CPU fans that help to further dissipate heat. Most PCs will have a fan incorporated with the power supply, as well as a CPU fan to help cool the CPU directly. In some PCs, fans are also used to help with the general circulation of air through the PC's enclosed box. When air circulates freely through the PC, heat is more easily dissipated from the internal components.

More on Peripheral Devices

Peripheral devices are additional (non-essential) components that can be added to a computer to provide more functionality. Today, components like keyboards, mice, and monitors (screens) are deemed essential, and are not (arguably) considered to be peripherals.

Devices like DVD drives, printers, speakers, scanners, external /flash drives, and digital cameras that can connect to your PC, but that are not essential to its core functionality, are considered to be peripheral devices.

Printers and scanners were mentioned in the discussion of input/output devices earlier in this session; however, speakers have not yet discussed as an important peripheral output device.

As you already know, computers can output data to a printer for a permanent hard copy, and they can output video data to a screen so the user can see and interact with files and software programs. Not surprisingly, computers can also generate, process, and output audio data. In order to hear this audio data, speakers are required.

Computer speakers are typically connected to a computer by plugging into the computer's sound controller (sound card) with a stereo jack plug in the back of the PC. Often computer speakers will come with their own controls for adjusting the audio tone (base, treble) and volume. Users can also control the volume and tone of the audio output by using software programs on the PC.

Speakers are important if the user wants to be able to hear the audio part of multimedia files. If a user wants to play media types like DVDs, CDs, MP3 audio files or various video file formats, they should have speakers.

Often various Web sites will feature streaming audio and video that can be accessed with an Internet connection. Once again, speakers are required for the user to hear the audio output.

Hardware Ports

Any peripheral device or input output device that you want to use must connect to your computer in some way. To support the wide variety of devices that are available, and to provide backward compatibility with older devices, a variety of hardware ports are usually available on your average PC.

If you look at the back of a PC, you will probably notice a number of different types of ports that you can plug devices into. Sometimes, commonly used hardware ports like USB are located on the front of the PC for easy access.

The following table provides a list of some of the most common hardware ports on a PC, with a brief description of each.

LPT (Parallel Port)	LPT ports look fairly large (long) compared to other ports, and they contain 25 small holes, designed to receive the pins at the plug end of a printer or scanner's connecting cable. For the most part, these ports are used to connect printers and scanners, and they are commonly referred to as printer ports. Data transfer rate for traditional LPT port is up to about 150 kilobytes per second. However, the newer enhanced parallel ports (EPP) support higher data rates of 500 kilobytes/sec, up to 2 megabytes (2000 kilobytes)/second. Parallel ports are becoming obsolete as USB's faster rate of data transfer takes over.
Serial Ports	A serial port typically has 9 (but sometimes 25) small metal pins. A device that connects to this port will have a plug with holes designed to receive the pins. Serial ports differ from parallel ports in that they exchange information one bit at a time, rather than several bits at a time in parallel. Serial ports were most often used to connect to external modems, and sometimes for connecting to a mouse. In recent times, serial ports are not used as much. In very new PCs, they may not even be present. Data transfer rate for serial ports is typically less than 60 kilobytes per second.
USB Ports	USB stands for Universal Serial Port, a type of port that is commonly used in current generation PCs. These ports have a small rectangular socket that the connecting wire from the USB

device plugs into.

USB ports can be used to connect to a wide variety of devices like cameras, external flash drives (and other drive types), mice, keyboards, printers, and more. Because USB ports are so widely used, they are rendering serial ports (and to an extent, other ports) obsolete.

Currently, there is a second and third generation USB ports (USB 2.0 and 3.0) available on PCs which offers higher data transfer rates than the first USB version. Fortunately, USB devices that are designed for the original USB ports will work with the new USB ports (but at a slower data rate). Also, devices designed for the new USB ports will work with the older style USB ports (but also at a lower data transfer rate). The first versions of USB had transfer rates up to 1.5 megabytes per second. USB 2.0 has transfer rates of up to 60 megabytes per second.

PS/2 Ports

A PS/2 port is used to connect a mouse or keyboard to your computer. These ports have small circular socket that contains smaller holes inside to receive pins from the plug end of the connecting device. PCs may have two PS/2 ports: one for a mouse and one for a keyboard. Though these are being phased out as USB connections take over. PS/2 ports are nearly obsolete.

DB9-15 Video Port

This port is used to connect a computer screen (monitor) to your PC. The port has 15 holes (three rows of five each) that are designed to receive the pins from the monitor's connecting wire.

A 15 pin video port looks a lot like a serial port, except that the video port has holes whereas the serial port has pins.

1394 FireWire Port

These ports look like small rectangular sockets, but they are squarer looking than USB ports.

FireWire ports can be used to transfer large amounts of data at a high rate of speed. They are often used to connect to such peripheral devices as digital video cameras, and external hard drives.

Fire wire ports typically have transfer rates of up to 50 to 100 megabytes per second (depending on the version).

Ethernet (network) Port

An Ethernet port is a rectangular socket that looks a lot like the

type that a phone jack is plugged into, but a little bigger.

Network cables can be plugged into this port to provide access to high speed Internet modems or local area networks. Ports of this type can provide can provide high data transfer rates like 10 megabits, 100 megabits, or even 1000 megabits per second.

The transfer rate that an Ethernet port provides depends on the type of network interface card being used and the overall speed of the network itself.

Activity 1-3

Objective To understand the basic component parts in a personal computer system.

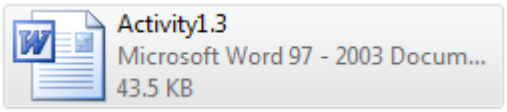
Briefing Your manager has received a list of available computer parts from inventory, and it is her responsibility to ship the parts to the correct destinations within the company. Unfortunately, she does not know very much about computers and she has asked you to categorize the items on the list in terms of their place and function within a computer.

Your manager has provided a table with headings that will help her understand what the parts are for. It is your job to enter a “yes” or “no” under each heading for each category of parts from the inventory list.

Here is the list:

- CPU
- RAM modules
- CD drive
- Monitors
- Printers
- Power Supply
- Cooling Fans
- Hard Disk
- Floppy disks
- Printer

Task Obtain the Activity 1-3 handout from your trainer/teacher.



In the left most column of the table (under the “Item” heading), enter the name of each component that is listed above. Then, enter Yes or No in the remaining columns depending on whether the item belongs under the given column heading, or if it doesn’t.

Hints Here is what a row in the table might look like.

Item	Internal component? (inside computer tower/box)	External component? (outside computer tower/box)	Plugs into a wall outlet?	Storage device?	Input Device?	Output device?
Scanner	No	Yes	Yes	No	Yes	No

Session 1-4: How a PC Works

In this session, you will learn about CPU speed, how RAM impacts on performance, how software applications affect performance, and how other factors like your hard disk or network connection speed can affect performance.

CPU Speed and Performance

The two main factors that have the most impact on computer performance are speed and storage. As such, you will begin this session by learning how CPU speed affects performance.

The CPU (processor) serves as the central manager or "brain" for your PC. With this in mind, it should come as no surprise that the faster your CPU works the better your PC will perform.

CPU speed is often specified in terms of something called clock speed. Each CPU has an internal clock that ticks at a certain rate. Any given CPU will require a certain amount of ticks to execute an instruction. Since computers run a program by executing the sequence of instructions that is specified in the program's code, the faster an instruction can be executed, the better the computer will perform.

Clock speeds are measured in terms of Hertz (Hz). 1 Hz means one complete cycle per second. When something is so fast that it can perform one million cycles in a second, you can say that it has a speed of 1 Megahertz (MHz). If something was so fast that it could complete one billion cycles in a second (1000 megahertz), you could say that it has a speed of 1 Gigahertz (GHz).

If a CPU has a clock speed of 500 MHz, it is capable of performing 500,000,000 clock cycles (ticks) in a second. If this same CPU takes 100 ticks (clock cycles) to execute an instruction, it could (in theory) perform 5,000,000 instructions per second.

Now suppose another CPU that also needs 100 clock cycles to execute an instruction. If this CPU has a clock speed of 1 GHz, it will be able to perform 1,000,000,000 clock cycles in a second. At 100 cycles per instruction, it would be able to execute 10, 000,000 instructions in a second.

In general, the CPU clock speed is a good indication of how fast a given processor can execute instructions. However, CPU clock speed is best used to compare CPUs from the same basic family. This is because different CPU architectures (designs) can require different amounts of clock cycles to execute a single instruction. It can be possible for a CPU that can execute an instruction on only a few (or one) clock cycle to outperform a CPU with a higher clock speed, but that also requires many clock cycles to execute a single instruction.

In today's PC, CPUs with speeds of 2 to 3+ GHz (gigahertz) are not uncommon.

RAM and Computer Performance

The amount and type of RAM (main memory) used in a computer can also affect the computer's performance.

As you may remember, RAM is volatile memory that the computer uses to temporarily store the programs and data that are in use currently. Because the processor may frequently request that data be moved to and from the RAM, the speed at which the RAM can respond to these requests is important.

Data in RAM can be accessed (read or written) much faster than the data on a hard disk. Random access memory is made of integrated circuits (chips) and therefore does not require moving mechanisms like read and write heads that scan over rotating disks.

The actual speed of RAM can depend on the type of RAM used and the speed of the connecting buses that the data must travel when the RAM is accessed. The two main categories of RAM are static RAM (SRAM) and dynamic RAM (DRAM).

DRAM is the most common and inexpensive type of RAM found in a typical PC. This RAM is made up of a vast number of tiny capacitors. These tiny capacitors can store electrical information which can be interpreted by the computer as values. Because a capacitor loses the electrical power that it holds over time, the many capacitors in a DRAM memory module must be refreshed with electricity at regular intervals to prevent information loss. For this reason, this type of RAM is said to be dynamic, or DRAM.

You can think of SRAM as being made from many tiny switches that can store data. Because the switches don't need to be refreshed with electrical power once they have been set, the information in SRAM is static (in other words, it does not have to be refreshed like DRAM).

SRAM is faster than DRAM, but it is also more complex and expensive. For this reason, it is used primarily for external (outside the CPU) cache memory.

DRAM can be made very dense (lots of memory storage in a small size) and it is also relatively inexpensive. For these reasons, it is used for the vast majority of RAM storage in a typical PC.

The access speeds of RAM are measured in nanoseconds (billionths of a second) whereas the access speeds of a hard disk drive are measured in milliseconds (thousandths of a second). This means that RAM is on the order of a million times faster than a hard disk.

Another aspect of RAM that affects your computer's performance is the quantity that you have available. Basically, programs and instructions that are stored in RAM do not have to be loaded from the much slower hard disk drive. The more information you can fit into your RAM, the fewer hard disk accesses (which are comparatively very slow) will be required.

With fewer hard disk accesses, your overall computer performance will be much better. This is because the computer will be accessing storage in nanoseconds (RAM speeds), instead of milliseconds (hard disk speeds).

How Applications Affect Computer Performance

The type of applications that you run can also affect your computer's performance. Different types of applications make different demands on your CPU and RAM. Some software applications, like a word processor, are I/O bound (input/output bound). This means that the rate the computer works on a task is dependent on the user.

With a simple word processing program, the computer spends most of its time waiting for the user to type characters and view what is being output to the screen. Though these waits do not seem like much to the user, a one GHz CPU might be able to perform millions of instructions during these idle times. So, while waiting for the user, the CPU has a lot of clock cycles that it can use to work on other software programs that may also be running.

Some programs, however, can be CPU bound. This means that these programs involve a lot of heavy calculation (number crunching) more than user input. When this type of program is running, the CPU may not have as much idle time to spend on other running programs.

As an example, a user may be able to use a word processor, a spreadsheet program, surf the web, and listen to an MP3 file all at the same time without noticing any decline in performance.

If, on the other hand, you are using a program that converts between digital video formats while listening to an MP3 audio file and playing a graphically intense video game, you may notice a decline in your computer's performance.

In addition to the type of software that is running, the amount of software that is running is also important.

Each software program that you have running will require some space in main memory (RAM). If there are a lot of different software applications that require space in RAM, there will be less space available for each. This means that there will be more frequent hard disk accesses as information is exchanged between main memory and the hard disk drive. More hard disk accesses leads to more waiting by the applications for the instructions or data that they need.

If your software applications are frequently accessing your hard drive, you may find the performance of your computer to be sluggish.

Other Factors

There are some other factors that can affect the performance of your computer system. For example, the speed at which your buses can transfer information can be an important factor. Your bus's speed will depend on its width and its design architecture.

Also, a larger amount of cache memory (high speed SRAM) and CPU cache (onboard the processor) can improve a computer's performance as more data or instructions will be stored in these fast access areas.

Hard disk drives with very high rotation speeds and reduced seek times can help reduce hard disk access times and thereby improve overall system performance.

There are also other components like video (graphics) cards that can help computer performance for applications that involve a lot of video/ graphics processing. These cards often contain their own RAM and other hardware optimizations that reduce the workload placed on the CPU by intense graphics-oriented software (like some PC games).

Finally, not all software is created equal. There are often many ways to write a program that performs the same task, and some ways of writing software to perform a task are more efficient than others. Some software may even be optimized to take advantage of certain types of hardware (as is often the case in video game consoles).

Activity 1-4

Objective	To understand how factors like CPU speed and components like RAM can affect computer performance.
Briefing	Your manager is considering buying computers for the office. He has given you some information about the different computer models he is considering, and he would like you to give your opinion on what model is the best and why.
Task	Examine the information provided below. Write down your recommendation for which model to purchase and a justification for your choice.
Sample Data	***Model One*** 1Ghz CPU 512 Megabytes of Ram 80 gigabyte hard disk with very fast access times (tens of milliseconds) Requires 100 CPU clock cycles to execute an instruction

Model Two
1.5Ghz CPU
1 Gigabyte of RAM
280 gigabyte hard disk with slow access times (100 milliseconds)
Requires 200 CPU clock cycles to execute an instruction

Model Three
2Ghz CPU
1 gigabyte of ram
180 gigabyte hard disk with medium access times (40-50 milliseconds)
Requires 150 CPU clock cycles to execute an instruction

(Assume that for all three computer models, the work accomplished by executing a single instruction is the same.)

Follow-up Questions What other factors or information could influence or perhaps change your recommendation?

On-line Quiz

Ask your teacher for access to the online quiz so that you can test yourself in Quiz 1.

Chapter 2: Hardware Devices

In this chapter you will learn about:

- What the CPU does
- How CPU speed is measured
- What RAM and ROM are
- How computer memory is measured
- The keyboard
- The mouse
- The scanner
- The microphone
- Other input devices
- The computer screen
- Touch screens
- Printers
- Plotters

- Speakers
- Internal and external hard drives
- Floppy disks
- CDs and DVDs
- Zip disks
- USB drives
- Data cartridges and tape drives

Session 2-1: CPU and Memory

In this session, you will learn more about the CPU and what it does. You will also learn how CPU performance is measured, and about the differences between RAM and ROM. Finally, to close the session, you will learn how to understand the units used to measure storage capacity and file size.

What is a CPU?

The CPU is the control center and main workhorse for a computer. This single component is responsible for executing instructions from software programs, and then directing the other parts of the computer based on these instructions. The CPU also handles logical operations and mathematical computations, serving as the "brain" of the computer.

A typical CPU can be subdivided into different units that handle different tasks. For example, a typical CPU may have a control unit, an arithmetic logic unit, a data-path logic unit, CPU registers, and an onboard memory cache.

A powerful CPU can perform a lot of tasks at a very high rate of speed. All things being equal, the more powerful the CPU, the better the performance of the computer. Some computers (like mainframe computers) can have several CPUs running in parallel, to further increase performance.

What Does the CPU Do?

A computer is a programmable machine. This means that it can perform many different tasks depending on the instructions that are given to it. The main purpose of the CPU is to interpret these instructions and then control what happens next based on what the instructions specify.

To get a better idea of what a CPU does, let's take high level walkthrough of the execution of a simple software program.

A software program is a sequence of instructions for performing a specific task. When a software program starts, it is loaded into main memory (RAM).

To start execution, the first instruction from the program is retrieved from main memory and loaded into a CPU register in the control unit. This "instruction register" stores the instruction temporarily while the control unit processes it.

This instruction contains information that the CPU's control unit can break down and interpret. Once the control unit interprets the instruction, it sends signals out that direct the other parts of the CPU (or other hardware components like input output devices) on what to do.

In a sense, you can think of the control unit as a kind of puppet master; pulling the strings that cause other components to act, based on the instruction that has been interpreted.

Once the control unit processes an instruction, a special CPU register called the program counter is incremented (its value is increased) so that it now holds the memory address (the address corresponding to a location in RAM) of the next instruction in the program.

The instruction corresponding to the memory location specified in the program counter is loaded into the instruction register, and the control unit interprets this next instruction to repeat the cycle. In this way, the sequence of instructions in the program is executed until the program ends, or is halted by the user.

Sometimes, an instruction may specify that another instruction, other than the next one in sequence, be executed. In this case, the address of the new instruction is loaded into the program counter, and then this new instruction is retrieved from the memory location corresponding to that address. This means that program execution can skip to other instructions out of sequence if that is what the program instructions specify. This ability to jump around within the sequence of program instructions permits the use of subroutines and branches in the program.

Now, let's say that the control unit interprets an instruction that specifies a mathematical operation; suppose that two values are to be added. The control unit gets the memory addresses for the values from the instruction, and then has these values loaded from RAM into CPU registers.

At this point, the ALU (arithmetic logic unit) can take over as directed by the control unit and add the two values together. The result of the addition is placed in another CPU register, and then sent to the main (RAM) memory for storage. If needed, the ALU can perform other mathematical operations besides addition. It can also compare values and perform logical operations on them as well.

If a certain sequence of program instructions is repeated over and over (like a subroutine, for example) these instructions may be loaded into the CPU's cache memory. This will allow the control unit to access the instructions faster than if they had to be fetched from the main memory (RAM) every time.

Every software program that you run on your computer, no matter how complicated, must be executed as a sequence of instructions through a process something like the one just described. With this in mind, it is not hard to see how the speed of your CPU can have a clear effect on your computer's performance.

The following table briefly summarizes the CPU's components in the context of the previous discussion.

Component	Role
Control Unit	Interprets instructions and directs other components accordingly.
ALU	Performs arithmetic operations, comparisons, and logic when required by the program instructions.
CPU Registers	These are temporary storage areas for data (like memory addresses or mathematical operands) or for program instructions. CPU registers provide components like the control unit or ALU immediate access to the data and/or instructions that are currently being processed.
CPU Cache	The CPU Cache can be thought of as very high speed RAM. It is used for quick access to frequently used instructions or data rather than fetching these instructions from the main memory (RAM).

CPU Performance Measures

Sometimes, CPU performance can be hard to gauge. Just because one CPU has a higher clock speed than another does not necessarily mean that it will perform better. CPU performance can be influenced by a number of factors, including the number of clock cycles required to execute an instruction, how complex a single instruction is, and the overall instruction set architecture of the CPU.

For example, a CPU with a CISC architecture (**C**omplex **I**nstruction **S**et **C**omputing) can perform a number of tasks (like loading a value into a register, and then loading another value into another register, and then adding the values together), by executing a single instruction. However, each complex instruction in a CISC CPU may take several clock cycles to complete.

On the other hand, a CPU with RISC architecture (**R**educed **I**nstruction **S**et **C**omputing) will perform only single or simple tasks with each instruction. For example, a RISC processor may require one instruction to load one value into a register, another instruction to load another value, and then a third instruction to add the values and place the result in a register. This means that a single instruction may not do as much (when compared to a CISC instruction), but it will probably take fewer clock cycles to perform.

Because of the possible differences in CPU architecture, using clock speed alone to gauge performance differences between CPUs from different families or manufacturers is not a great idea.

Luckily, there are other indications of CPU performance besides CPU clock speed. One such measure is the rate at which a CPU can execute instructions. The rate at which a CPU can execute instructions is measured in MIPS (millions of instructions per second).

If a CPU can perform 100 MIPS, the CPU can execute 100 million instructions per second. If one CPU can perform 150 MIPS, and a second CPU can perform 200 MIPS, the second CPU can perform 50 million more instructions in a second than the first.

At first, this seems like a good way to measure CPU performance, but upon closer examination, there are some drawbacks. As mentioned before, one CPU may be able to do more on a single instruction than another based on the CPU's instruction set architecture. This means that even though one CPU may perform more MIPS than another, there may not be that much difference in the actual work that gets done.

Another measure of CPU performance is called megaflops. When speaking about CPUs, a FLOP stands for floating point operation. Floating point numbers are numbers with fractional parts. For example, the number 3 is an integer (a whole number) and the number 3.1415926535 is a floating point number.

Operations involving floating point numbers require more work by the CPU than simple integer operations, and so as a measure of CPU speed, they can indicate how well the CPU will perform with heavy number crunching or calculating tasks.

The rate at which a CPU can perform floating point operations is typically measured in megaflops (Million **Fl**oating point **O**perations **p**er **S**econd). If a CPU can perform 100 megaflops, it can perform 100 million floating point operations in one second.

Though these measures may not be entirely good indicators taken on their own, they can be significant if taken together. That is to say, if one CPU has a higher clock speed, can complete more MIPS, and can perform more megaflops than another; it will probably have better overall performance.

It is important to remember that the CPU is just one component in a computer system, and overall computer performance can depend on many factors including the bus speed, how much ram is available, how much cache memory is available, and even the speed of the hard disk drive.

RAM and ROM

The concept of RAM (Random Access Memory) was introduced in Session 1.3. Basically, RAM is volatile high speed memory that the computer uses to temporarily store data and instructions. RAM is made of integrated circuits that contain millions of tiny storage capacitors. Electrical signals that can be interpreted as ones and zeros are stored in these capacitors as data. A single 1 or 0 is referred to as a bit, and a sequence of 8 bits is referred to as a byte.

RAM memory is broken up into addressable memory locations, with each location able to hold a single value or instruction. The CPU and other components can access the values (instructions or data) in RAM by referring to the memory address that corresponds to the stored value.

Some computers may have RAM that has an address resolution of 1 byte, meaning that each addressable memory location can store a single byte of data. Other computers can have an address resolution of a single "word" which refers to a specific number of bits. In many modern computers, the word size is 32 bits (four bytes), which means that RAM with an address resolution of a 32 bit word can store four bytes of data in each addressable memory location.

An important feature of RAM memory is that it is rewritable, meaning that data can be stored in a memory location, and then overwritten in that same location with a new value. Also, any particular memory location in RAM can be accessed in the same amount of time as any other location in RAM.

There is also another type of memory called ROM (Read Only Memory) which is frequently used in computers.

ROM memory has the advantage of being nonvolatile; that is to say, it will not be erased when the power is shut off. On the other hand, it also has a disadvantage in that it cannot be easily rewritten (hence the term "Read Only Memory"). A ROM chip will always provide the same data or instructions every time it is accessed, unless it is explicitly reprogrammed or rewritten through an intensive process.

Although some modern varieties of ROM can be rewritten (like flash ROM), it is generally a more time consuming and intensive process to write instructions or data to ROM than to RAM.

Because ROM is not easily or quickly rewritable, it is mostly used for storing data or instructions that very rarely need to be changed. RAM, on the other hand, is used for the opposite purpose; that is to say, RAM is used to store data and instructions that may have to change frequently and rapidly.

Measuring Memory

As mentioned above, information that is stored in computer memory can be thought of in terms of ones and zeros. A single one or zero is referred to as a bit, and a sequence of 8 bits is referred to as a byte. A single character like a letter or symbol will typically require a single byte of storage space.

A typical computer file, like a word processing document or a digital image, will require thousands of bytes of storage space. Thousands of bytes use the term Kilobytes (Kb). One kilobyte of memory will hold 1024 individual bytes. You will often see individual files on a computer, like documents or image files, that range in size from a few to several hundred kilobytes.

If a file is quite large (more than 1000 kilobytes) it size can be referred to in terms of megabytes. One megabyte is equivalent to 1024 kilobytes, or 1024 x 1024 =1048576 bits. A typical floppy disk can store about 1.44 megabytes, or 1.44 x 1024 =1474.56 kilobytes.

Since one kilobyte is equivalent to 1024 bytes, a floppy disk can hold about 1474 x 1024 = 1,509,949 bytes, (or individual characters).

A typical computer folder that contains several files will often have a storage size of a few to several hundred megabytes.

If a file or folder is very large, taking up more than a thousand megabytes of space, it is referred in terms of gigabytes. One gigabyte is equivalent to 1024 megabytes, or 1024 x 1024 kilobytes. Current generation computers often have between several hundred megabytes and one or two gigabytes of RAM memory.

The following table summarizes these memory and storage space measurements.

Measurement	**Explanation**
Bits	Can store a 1 or a 0
Byte	Can store 8 bits. This is enough room to store a single letter or symbol.
Kilobyte (Kb)	Roughly a thousand bytes. Files like spreadsheets, word processing documents, and images are often a few to a few hundred kilobytes in size.
Megabyte (Mb)	Roughly a thousand kilobytes (or a million bytes). Folders and very large files may be several megabytes in size. A floppy disk can hold about 1.44 megabytes. Frequently, computers will have 256 or 512 megabytes of RAM. A CD can hold about 650 – 700 megabytes of information.
Gigabytes (Gb)	A gigabyte is roughly a thousand megabytes (or roughly a billion bytes). Current generation computers often have 1 to 2 gigabytes of RAM. A DVD can typically hold 4+ gigabytes of information. A hard disk drive can store hundreds of gigabytes of information.
Terabytes (Tb)	A terabyte is roughly a thousand gigabytes (or roughly a trillion bytes). Some large capacity hard disks have terabytes of storage space.

Activity 2-1

Objective To get a better idea of how file sizes and storage space is measured.

Briefing At the machine level, a computer deals with ones and zeros in the form of electrical signals. This system is referred to as binary, because it involves only two numbers: one and zero.

This system is appropriate for computers because it is easy to represent a one (a one may be a high voltage) and a zero (a zero is a low or almost no voltage) in a computer's electrical components. These electrical signals (ones and zeros) can be stored in RAM memory or processed by the CPU.

For example, according to the ASCII standard (American Standard Code for Information Interchange), the letter A can be represented by a computer as the binary string 01000001. The letter C can be represented as 01000011 and the letter T as 01110100.

This means that the word CAT can be stored in a computer as the binary string 010000110100000101110100.

In our example, the word CAT takes up 24 bits (ones or zeroes) or 3 bytes (having 8 bits to a byte).

Using these numbers as a reference, please answer the following questions:

- Roughly how large (in bits) would a simple text file be, if it looked like the following?

CATCATCATCATCATCATCATCATCATCATCATCATCATCATCATCATCATCATCATCATCAT

- Roughly how large would a simple text file be (in kilobytes); if it contained 50 lines exactly like the one above?

Session 2-2: Input Devices

In this session, you will take a closer look at some of the more common input devices, such as the keyboard, the mouse, the scanner, and the microphone.

The Keyboard

One of the most common devices that people use to input data is the keyboard. A keyboard allows the user to enter uppercase and lowercase letters, numbers, familiar symbols, and commands by typing them.

A typical keyboard contains the 26 letters of the alphabet, a space bar, common punctuation symbols, the digits from 0 to 9, the basic arithmetic operators, as well as a variety of command oriented keys like Delete, Backspace, Enter (sometimes called Return), and Shift and Control keys.

Most computer keyboards use the “qwerty” layout (where the alphabet is presented in the same way as with a traditional typewriter); however, other types of keyboards with a friendlier (more ergonomic) layout are obtainable.

When you press a key on your keyboard, a signal is sent from the keyboard to the computer along a wire that runs from the keyboard and plugs into the computer (typically through a PS/2 port). There are also keyboards that can communicate with the computer using a wireless connection or through a USB port. Each key on the keyboard, when pressed, causes a different signal to be sent out, so that each key can be uniquely identified.

When the computer receives a signal from the keyboard, the signal is translated into the character that corresponds to the key that was pressed on the keyboard. At this point, the character is output to the computer’s display screen so that the user can see what they have just typed.

Keyboards are use wherever the user has to enter textual or numerical data. Together, the keyboard and mouse are the most frequently used input tools for personal computers.

The Mouse

A mouse is used by moving it over a typically flat surface. When it is moved over a surface, information about how the mouse’s position has changed is sent through a wire to the computer. (Just as with keyboards, there are also wireless mice available.)

When the computer receives this information, the mouse movements are translated into coordinates that can be applied to the computer’s display screen. This information is used to output a small image (called a mouse pointer) to the display screen. The movements of the

mouse pointer on the computer screen will mirror the movements made by the actual mouse when it is moved about on a surface.

A mouse can be used to point to various items that are displayed on a computer screen. In addition, a mouse will have buttons and sometimes wheels, which relay an action command to the computer. This allows the user to point to an item with the mouse, and then click a button to perform an action on that item. In this way, a mouse can be used to start and stop programs, view the contents of folders, explore user interface components, and access software functions.

The Scanner

The scanner is a very interesting input device. This type of device can be used to convert an ordinary photograph, drawing, or sheet of text into a digital image. Basically, the object that you want to scan (drawing, document, or photo) is placed flat on the scanner, and then the scanner is activated by the user.

Once activated, the scanner's optical sensing device records image information from the object that is being scanned (i.e. a photo or a drawing). This image information is processed by the scanner, and is then fed into the computer through the scanner's connecting wire to a computer port.

Once received by the computer, the scanned image can be viewed on the computer screen, printed, stored on the computer's hard disk drive, or modified by using the appropriate software. As with many other input/output devices, the computer may require special software in order to communicate with the scanner.

In addition, the software packaged with some scanners will even help convert a scanned sheet of text into to an actual text file that can be edited and formatted, rather than just an image of the text.

Microphones

When it comes to audio data, computer speakers are probably the first device that springs to mind. However, while speakers make it possible to hear audio data that is output from your computer, another device, the microphone, allows you to input audio data into your computer, just by speaking into it!

With a microphone, any sound (voice or other) that is made near the microphone can be stored on your computer. The microphone converts the mechanical energy of a physical sound wave into electrical signals that can be processed and stored on a computer. With VOIP technology, (Voice Over IP), a computer with a microphone and speakers can even be used much like a telephone. (There are also special VOIP phones available.)

Typically, a microphone will plug into a socket in the back plate of your computer's sound card. (The sound card is a device that plugs into your motherboard to help your computer process, input, and output sound. There are also USB microphones available that can simply input audio data through your computer's USB port, and also wireless microphones.

When you speak into the microphone, your voice (sound data) can be recorded and stored on your hard drive. Microphones are often used with computers to add voice/narration to video clips, as narration or instructions, and to work with software applications that recognize speech.

Other Devices

For completeness, there are a few other input peripherals that are should be mentioned.

Trackball

A trackball is a pointing device that works like a computer mouse in reverse. With a trackball, you rotate a ball with your hand (fingers/thumb) to direct a pointer on your computer screen.

Unlike a mouse, which must be moved over a flat surface, a trackball mechanism is stationary. The movement data is generated by rotating the trackball within its stationary frame.

This means that the trackball does not require as much space as a mouse, and moreover, it will work on pretty much any type of surface.

Joystick

A joystick is another type of input device that feeds directional (and other information) into your computer.

The traditional joystick design consists of a bottom with a vertical hand grip that extends above it. When the hand grip is moved (tilted) in a particular direction, data is sent to the computer indicating this.

Joysticks are often used to play video games, or as a control for flight simulator software.

In addition to feeding directional information to the computer, a joystick will usually have one or more buttons to input other signals as well.

Touchpad

A touchpad is another type of input device that is used to help users navigate their computer screen.

Most often, touch pads are found on laptop computers, as they are relatively flat and only a few square inches in area. They are used to detect and translate the motions of a user's finger over the pad into corresponding movements of a pointer on the laptop screen.

Touch pads are used as mouse substitutes in laptops because they have a small profile that can be integrated with a laptop's compact size.

Computer Stylus/Pen

A stylus pen is another pointing device that is used to interact with a computer in a way that is similar to the use of a mouse or a touch pad.

The main difference is that the pen/stylus is used to "touch" or point directly to the object that you are interacting with (where it appears on your screen).

This means that that the pen is a direct or absolute pointing device, as compared to a relative pointing device like the mouse.

Pens or styluses are most often used with tablet PCs, graphics tablets (a kind of computer drawing pad), and with PDAs.

Digital Cameras

A digital camera can be used to capture digital images, which can then be stored on your computer for editing or display.

A digital camera is similar to a traditional camera in that it focuses light through a lens onto a specific area within the camera.

In a traditional film camera, the light is focused through the lens onto a chemically treated film. The chemicals on the film react to the light and form (record) an image.

In a digital camera, light is focused onto sensors that convert the light energy into signals. These signals can be recorded as discrete values representing red, green, and blue color components. By recording color values for many small areas (pixels), a digital image is formed. These digital images can be stored on removable memory cards in the camera, or they can be fed into your PC (often via a USB connecter).

Many digital cameras can record videos and audio data as well as still pictures.

Activity 2-2

Objective	To get a better grasp of how different input devices are used.
Briefing	You have been hired to set up some computer workstations in an office. One of the employees that will be using a computer has limited use of their hands, and they must be able to point to objects on their computer screen. The input device must be workable on pretty much any surface and require limited movement. Another employee is developing speech recognition software, and she must be able to feed voice data into the computer. Another employee must input digital images into his computer. He must be able to capture/create his own images and store them as files on the computer. He must also be able to store existing images that were taken with a traditional film camera on the computer.
Task	Write down what types of input peripherals you would set up on the computer work stations to meet the user requirements as specified above.
Hints	Review the previous session. Consider the type of data that each user must enter and the limitations the user has to work within.

Session 2-3: Output Devices

In this session, you will learn about such common output devices as computer monitors, touch screens, printers, plotters, and speakers.

Monitors

Computer monitors or screens are probably the most essential of all the output devices. Modern monitors can provide a full color visual display of whatever the user is currently doing. When a user types something at the keyboard, it appears on the monitor. If a user clicks their mouse to open a file, the file contents are displayed on the monitor.

For the vast majority of personal computer users, human computer interaction is made possible through the combination of keyboard and mouse as input devices, coupled with a monitor as an output device for visual data.

Monitors come in different shapes and sizes. Most monitors are either CRT monitors (cathode ray tube) or LCD monitors (liquid crystal display). A CRT monitor relies on a kind of electrical gun that shoots a beam of electrons across the back of the viewing screen. Once the electron beam hits the back of the viewing screen, phosphorescent material on the screen glows.

Different colors of light (red, green, and blue) can be emitted depending on the phosphors that are energized by the electron beam. It is this combination of red, green, and blue light, emitted by the phosphors as the electron beam scans over them, that create a visual image on the CRT screen.

All of the colors that you view on your computer screen are made from combinations of red, green, and blue light. Furthermore, each computer screen is broken up into tiny discrete parts called pixels. Each pixel (picture element) on a CRT screen can be made to emit light as described above. Anything you view on your computer screen is just a combination of specific pixels emitting different colors of light.

In a color LCD monitor, red, green and blue light are used to create a color display as well, but the mechanism is different from a CRT monitor. In an LCD monitor, there is no “gun” that shoots a beam of electrons. Instead, liquid crystal molecules trapped between two plate-like surfaces are realigned by passing electrical energy through them.

When light is shone through the plates and liquid crystal molecules, it can be blocked or allowed to pass through, depending on the alignment of the molecules. This light is then filtered to produce combinations of red green and blue.

An important aspect of any monitor is its resolution. Resolution is a measure of how many picture elements (pixels) the viewing screen will be divided into. To some extent, if the screen resolution of the monitor is higher, the number of pixels used will be high and the display quality will be improved. (Of course, there are several other factors besides resolution that can affect display quality as well.) Typically, current CRT and LCD screens will support multiple screen resolution settings.

LCD monitors are often used with laptops because they have a much thinner physical profile and also because they require significantly less power. (LCD monitors do not require a heavy glass tube and electron gun.) For these same reasons, LCD monitors are also becoming increasingly popular with full desktop PC systems.

The Printer

A computer printer is an output device used to produce a permanent, printed (paper) copy of an image, text document, or other output file from your computer.

Typically, a file is selected on your computer (an image file or word processing document, for example) and then a print command is executed. When the user performs a print command, the computer sends the data from the selected file through a wire to the printer for output.

What the printed copy of the file looks like can depend on what software program is being used to create or modify the file on the computer. Furthermore, different printers can produce hard copies of files with different quality levels and print speeds.

The main differences between various computer printers involve the mechanisms by which the printer produces its hard copy.

Probably the two most common types of printers in use today are laser printers and inkjet printers, both of which are capable of producing good quality printouts. Laser printers use a toning compound similar to photo copiers, while inkjet printers use a very thin and precise spray of ink.

In addition, most current generation printers are capable of producing full color printouts as well as printouts in black and white. For example, a color inkjet printer will use combinations of cyan, magenta, yellow, and black ink to produce color printouts.

Touch Screens

Touch screens are an interesting device in that they allow a user to input data, while at the same time outputting a visual display. Because of the input/output ability of touch screens, they are ideal for situations where you may not want a full keyboard or mouse as the primary input devices.

PDAs, for example, can benefit from touch screens because as an input/output device, the touch screen can minimize the need for a full size keyboard or mouse (which helps to maintain the PDA's small size) while still providing the user with a display screen.

There are several ways that touch screens can be implemented, all revolving around the mechanism by which the point on the screen that is touched is determined.

With resistive touch screens, a change in electrical current, caused by the electrical resistance created when the screen is touched, is used to determine the location of the touch.

In capacitive systems, the electrical field of the touch screen is altered by the electrical capacitance of the object that touches it, like a finger or a conductive stylus held in the hand.

Other systems rely on such things as mechanical strain in the screen or optical sensors located on the screen's perimeter to pinpoint the location that an object touches the screen. Whatever the choice of technology, once the location of the touch is determined; the information can be

input into the computer to interact with the object displayed on the screen at the location of the touch.

Speakers

Monitors and printers are probably the most obvious output devices; however, there is still another important output device that should be mentioned: speakers.

As you already know, computers can output data to a printer for a permanent hard copy, and they can output video data to a screen so the user can see and interact with files and software programs. Not surprisingly, computers can also generate, process, and output audio data. In order to hear this audio data a PC will require speakers of some kind.

Computer speakers are typically connected to a computer by plugging into the computer's sound controller (sound card) with a stereo jack socket in the back of the PC. Often computer speakers will come with their own controls for adjusting the audio tone (base, treble) and volume. Users can also control the volume and tone of the audio output by using software programs on the PC.

Speakers are important if the user wants to be able to hear the audio part of multimedia files. If a user wants to play media types like DVDs, CDs, MP3 audio files, or various video file formats, they should have speakers.

Often various Web sites will feature streaming audio and video that can be accessed with an Internet connection. Once again, speakers are required for the user to hear the audio output.

Plotters

A plotter is a type of output device that is very similar to a printer. The main difference is that plotters use a pen like device to draw continuous lines on the plotter paper, corresponding to positional information that is output from the computer.

Printers, on the other hand, produce image printouts based on a rectangular grid of pixels that taken together to form a larger image. Also, printers have a relatively narrow spectrum of paper sizes that they can accommodate, as they are often primarily used for printing text.

As a result, plotters can create a more finely resolved technically precise image or drawing than a typical printer. They can also create a much larger drawing because they are not as restricted as a printer in terms of paper size. As a drawback, though, they are also more expensive than printers. Today, plotters are most often seen in scientific, engineering, and architectural settings where very precise (and sometimes large) drawings or schematics are required.

By using multiple pens, each having its own color, a plotter can create multi-color drawings.

Activity 2-3

Objective

To get a better idea of the purpose for various output devices.

Briefing

The computer company that you work for has several contracts for supplying a variety of computer equipment.

You have been given a list of requirements from your clients, and you must select the most appropriate computer output devices for your client's needs.

Task

Using the list of client requirements provided below (Sample Data), prepare a brief document that matches each client with an appropriate output device.

Sample Data

Client One
Provides automated ticket machines to movie theaters. They need an output device that visually displays data and also accepts input corresponding directly to the graphical data that is displayed. The client would like to see the output and input functionality incorporated into one single device without the need for pointing devices like a mouse or a tracking ball.

Client Two
This client is an architectural firm. They require an output device that can produce precise drawings and plans based on architectural information and designs. The plans will have to be output in a very large size so that they can be easily read by engineers and construction workers at the jobsite.

Client Three
This client is a sound recording studio. They provide computer based digital recording services to its customers. It is very important that the client and their customers can get a good idea of the quality of the audio data that is being recorded and edited.

This client must also be able to see video (TV commercials and movies) as they often mix and edit soundtracks as background sound/music for commercials and films.

Session 2-4: Secondary Storage Devices

Storage devices are very important in a computer system. After all, one of the main uses for computers is for the storage and retrieval of information. In this session, you'll take a closer look at computer storage devices, including internal and external hard drives, floppy disks, CDs and DVDs, Zip drives, USB /flash drives, as well as tape drives and data cartridges.

Common Terms

A secondary storage device is a piece of hardware that is used to store data or programs that must be preserved if the computer's main memory fails or is shut down (powered off). This means that secondary storage devices must be able to retain data for some period of time even if there is no electrical power to the device.

Secondary storage devices all require some sort of medium to store data on. In a hard disk, data is stored on rotating disk platters. In a tape drive, data is stored on a long roll of tape. In a USB flash drive, data is stored in millions of tiny memory cells on a chip.

As an introduction to secondary storage devices, the following table lists some important terms that are used frequently used in the context of these devices.

Formatting	Formatting refers to the preparation of a storage device for use. Formatting often consists of the creation of an indexing system that allows the data items written on the storage medium to be organized and accessed in a consistent, efficient manner. The term formatting is most often used when speaking of disk drive devices (floppy disks, hard disks, and CD or DVD drives). In terms of hard disks, the formatting can vary depending on what file system the chosen operating system uses (such as FAT or NTFS).
Reading	The transfer of data from the storage medium into the computer's main memory.
Writing	The process of transferring data to the secondary storage medium.
Seeking	When speaking of hard disks and optical drives, seeking is the process of aligning the device's read write/heads over the correct part of the storage medium in preparation to read or write data.
Direct Access	This means that any part of the storage medium can be accessed directly. That is, the device can jump or move directly to the location of the data, as opposed to sequential access.

A CD is an example of direct access.

Sequential Access The storage medium must be traversed in a sequential way to access the data. This means that some data can be accessed much more quickly than other data, depending on its location in the medium with respect to the reading mechanism.

A cassette tape is an example of sequential access.

Hard Disk Drives

A hard disk drive is a device that stores data on a stack of rotating magnetized platters. When the hard drive is in use, the platters rotate at a constant angular velocity (CAV). This means that when reading or writing data, the speed of the magnetic surface under the read write heads is constant.

To write data, information is sent from the computer to the read/write heads. These read/write heads, once they are in position, hover with only a tiny distance between them and the rapidly rotating surfaces of the platters. The information is then written by the write heads as electromagnetic signals on the surface of the rotating platter.

Because the read write heads are so close to the platters, and the platters rotate at a high rate of speed, hard disk drives can crash and fail if dust or dirt lodges between the read/write heads and the platter, or if the read/write heads contact the platters while they are rotating.
Hard disk drives have very large storage capacities; today, they are often in the hundreds of gigabytes range, and they can even be as large as 1 terabyte (roughly a trillion bytes) in capacity.

To read data from a hard disk, the file indexes created during formatting (tables that contain the locations of the data files on the hard drive) are checked. Once the location on the drive is known, the read/write heads seek (travel across the radius of the disk) until they are in the correct position. When the platters rotate under the read/write heads, the electrical signals are read from the disk and are interpreted as logical ones and zeros (data).

With a hard drive, a typical disk access requires two mechanical operations. First, the heads must perform a seek operation to get into position, and then the disks must rotate under the heads for the data to be written or read. This introduces time lag into a hard disk data access, in the form of a seek time and a rotational latency. This makes hard disk drives much slower than main memory (RAM).

Hard disks provide fairly good access times for a secondary storage device, with data being accessed in times on the order of milliseconds (thousandths of a second). Also, hard disks

provide direct access to the data that is stored on them. That is, the reading/writing mechanism can access any addressable part of the storage medium by moving directly there; the entire medium does not have to be traversed.

Basically, hard disk drives come in two major types: external and internal. Internal drives are housed inside the computer's box or tower, while external drives are enclosed in their own housing outside of the computer. An internal drive will generally offer data higher transfer rates and will be powered by a direct internal connection to the computer's power supply. An external hard drive will generally connect to the computer through a USB or FireWire port.

One advantage of external hard drives is their portability, which allows the user to store or backup data from their computer onto the drive, take the drive to another computer system, connect it through a USB or fire wire port, and then access the stored data.

Floppy Disks

These storage items are obsolete but you may find some still in use. Floppy disks work on a basic principle that is similar to hard disk drives. That is, a formatted magnetic disk rotates beneath read/write heads to transfer information to and from the main memory of the computer. Like hard drives, floppy disks can provide direct access to stored data. The main difference is that the disk itself is a removable thin flexible film enclosed in a protective plastic shell, as opposed to a fixed stack of rotating platters.

This slim plastic case, usually only seven and half centimetres wide, can be inserted into a slot at the front of the floppy drive. At this point, files can be written to the floppy disk or read from it by the read/write heads.

Though floppy disks are quite portable, they had serious storage limitations, with room for only about 1.44 megabytes of data on each disk. In addition, they were be significantly slower than hard disk drives because of slower data transfer rates (read speed) and slower seek times. Also, the flexible magnetic film in a floppy disk can be easily damaged, leading to data loss.

USB Flash Drives

Currently, USB flash drives are best device for portable secondary storage. USB flash drives can come in many shapes and colours but one end always is in the form of a USB interface (connector).

Inside the USB's housing, chips containing a type of EEPROM (Erasable Electronically Programmable Read Only Memory) are used to store data. These memory chips provide nonvolatile storage like traditional ROM memory, but unlike traditional ROM, the stored data or programs can be erased with relative ease, and new data or programs can be written in their place.

To use the USB flash drive, a user just plugs it into a USB port, at which point it can be accessed through the computers operating system interface.

USB flash drives have storage capacities ranging from tens of megabytes to several gigabytes. Also, flash drives can provide read access times that are faster than hard disk drives. Because the flash drive has no moving parts, there is no seek time or rotational latency to account for as there is in hard drives. However, current hard disk drives still far exceed USB flash drives in terms of storage capacity. Like a hard disk drive, a USB flash drive can provide direct access to the stored data.

Another advantage to USB flash drives is that they are fairly durable and they are relatively inexpensive. This combination of durability, speed, price, and capacity, makes USB flash drives popular.

Data Cartridges and Tape Drives

Tape drives are mechanisms that are in many ways much like a traditional tape recorder or video cassette recorder. Basically, a long spooled magnetized tape is passed under read/write heads to record or read data.

Tape drives provide sequential access to the stored data. This means that if the data that you want is positioned in the middle or end of the magnetic tape, and the tape is has been rewound to the beginning, you must traverse the length of the tape until you get to the part that contains the data you are after. Because of this, they are much slower then direct access storage devices like hard disks and USB flash drives. However, the data that is stored on a tape can be preserved for a long time, and in addition, magnetic tapes are a relatively inexpensive storage medium. For these reasons, even to this day the servers in many companies, universities, and other institutions still use tape drives to back up and archive their data.

Tape drives will typically use some type of data cartridge for storage of the actual magnetic tape medium. These tape cartridges usually consist of protective plastic housings around the spooled magnetic tape. The cartridges can be removed from the tape drives and archived for extended periods.

While tape drives may not provide fast direct access to data, they do provide a relatively inexpensive means of archiving very large quantities of data for extended periods of time.

CDs and DVDs

CDs (Compact Disks) and DVDs (Digital Versatile Disks) are two forms of optical storage media. Unlike most other secondary storage media, CDs and DVDs do not retain data in the form of electromagnetic signals on a magnetic surface. Instead, CDs and DVDs store data as physical features (called pits and lands) on the surface of a slim plastic disk.

When a sequence of pits and lands on a disk rotates under a beam of light, the light is reflected or scattered depending on what physical feature of the disk it is incident on (pit or land). These different light responses can be interpreted as binary data (a logical one or zero).

Unlike hard disk drives, CD and DVD disks can be loaded or removed from their drives for portability, or archival purposes. These inexpensive disks are quite durable, and data can be safely preserved on them for a long period of time. This makes CDs and DVDs a great choice for publishing music, software, and video.

CDs were originally designed as a publishing medium for music, so CD drive speed is measured relative to the standard established for audio CDs. A 1x speed CD drive will work at the same speed as a music CD, but a 4 x CD drive will work at four times the speed of an audio CD. Today, it is not uncommon to see CD drives with speeds exceeding 12x audio CD speed.

CDs and DVDs come in many varieties. A CD-ROM disk (Compact Disk-Read Only Memory) is a disk that data can only be read from. A CD-R disk is a disk (blank at first) that can be written to once (though not necessarily all at one time), and then read many times. A CD-RW disk can be written to, erased, and rewritten repeatedly.

DVDs can be purchased in similar formats, with DVD-ROMs being used primarily for publishing of video, music, and software. There are also writable DVD-R and DVD +R disks, as well as rewritable DVD+RW disks.

The main difference between DVD disks and CD disks is storage capacity. A CD can typically hold between 600 and 700 megabytes of data, whereas a DVD can hold 4 gigabytes to 8+ gigabytes of data (depending on the type of DVD disk). Most computer DVD drives can also read CD disks.

A CD or DVD drive is typically located in the computer's box or tower with the front loading mechanism accessible. From the back of the CD or DVD drive, a power cable will connect to the computer's power supply, and a data cable will connect to the computer's motherboard.

As you may remember from the discussion on hard disk drives, a hard disk rotates at a constant angular velocity, meaning that the disk always rotates at the same speed. In a CD or DVD drive, the disk must rotate with a constant linear velocity. This means that the line or track on the disk that is under the read heads must maintain a constant speed. (A constant speed is necessary for data encoded in the pits and lands to be read properly.) The problem is that a track (sequence of pits and lands) at the outer edge of a CD is longer than a track near the inner edge of a CD (because the outer rim is a longer distance around than the inner rim. To maintain a constant linear velocity over the track, the rotation of the disk must slow down and speed up, depending on the position on the track on the disk's radius.

This means that access times for CD and DVD drives are significantly higher than for hard disks because the optical drives must find the correct rotational speed for the disk depending on

what part of the disk is being accessed. A hard disk, on the other hand, always uses a constant angular velocity (meaning a constant speed of rotation).

Because of their affordability, storage capacity, portability, and durability, CDs and DVDs are the media of choice for publishing software, and many other forms of digital information.

Storage Comparisons

To help you understand the wide variety of computer storage types, the following table provides information on a few of the more commonly used memory/storage devices, in the context of speed, capacity, and relative expense.

Storage/Memory type	***Access Speed***	***Storage capacity***	***Expense***
SRAM (cache memory) Volatile Not portable	Extremely fast (nanoseconds) Provides random access	Relatively low capacity (often only a few megabytes)	Price per megabyte is the highest
RAM (main memory) Volatile Not portable	Very fast (measured in nanoseconds, but is slower than SRAM) Provides random access	Fairly high capacity (in most PCs, hundreds of megabytes to 1-2+ gigabytes)	Price per megabyte is quite low, much more affordable than SRAM
Hard Disk Nonvolatile Not portable	Moderately fast, (quite slow when compared to RAM) Access times measured in milliseconds Provides direct access	Very high capacity; hard disks with hundreds of gigabytes of storage are now common	Price per megabyte of capacity is very low, works out to be less than the cost of RAM
USB Flash Drive Nonvolatile Portable	Quite fast (faster than a hard disk, but slower than RAM)	Good capacity; USB flash drives now offer capacities measuring in tens of gigabytes	Price per megabyte of storage rivals that of hard disk drives

	Provides direct access		
CD Drives Nonvolatile and portable Portability, durability, and affordability make it a good data publishing medium	Slower than a hard disk. Best used as a publishing medium or for archival storage/backup Provides direct access	Moderate capacity, with each disk holding about 600 - 700 megabytes	Price per megabyte of storage is quite low
DVD Drives Nonvolatile and portable Great medium for publishing and/or archiving all kinds of digital information	Slower than hard disk Best used as a publishing/archival medium Provides direct access	Good capacity (4+ gigabytes)	Price per megabyte of storage is quite low

In general, the price of storage or memory will decease with access speed and memory density. (Fast, low capacity memory is more expensive than slower, high capacity storage.)

Activity 2-4

Objective

To understand several different types of computer storage technologies.

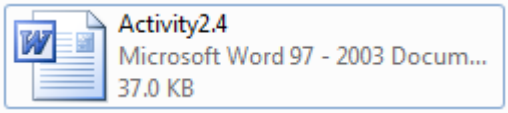
Briefing

You are to give a presentation to your co-workers about computer storage technologies.

As part of the presentation, you will show your audience a storage hierarchy table that gives an overview of storage types in terms of capacity, relative cost, and access speed.

Task

Obtain the Activity 2.4 handout.



You will see an empty storage hierarchy table. Your task is to complete the table by filling in the missing information.

Chapter 3: Software

In this chapter you will learn about:

- Operating systems
- Application software
- Software versions
- Software updates
- GUIs
- What an operating system does
- Some common operating systems
- What software applications do
- Some common applications
- Software analysis, design, programming, and testing
- Shareware
- Freeware
- EULAs
- Copyright
- Data protection legislation
- What to be aware of when downloading computer files and programs
- What to be aware of when sharing computer files and programs

Session 3-1: The Basics

Modern computers can help us with a many tasks at home and at work. Furthermore, computers form a key part of the global information/communication infrastructure. Computers are now essential tools in almost all sectors, including health, transportation, communications, education, science, engineering, and business.

With this in mind, it is important to remember that the power of computers comes from their programmability. That is, computers are tools that can be programmed to do a wide variety of tasks, allowing one computer to perform a variety of different functions.

Software is a term that collectively refers to the programs (instructions) that provide useful functionality to a computer system. Software is built from organized sequences of instructions that are interpreted by the computer's CPU to tell the computer what to do.

Software can be differentiated form hard wired instructions (ROM) in the sense that software can be loaded into a computer's memory and run, and then removed from memory so other software can take its place.

Because multiple software programs can be stored in RAM at the same time, and because a CPU can quickly switch from executing the instructions of one program, to executing the instructions of another, modern computers are capable of running multiple programs at the same time. When multiple programs are running on one computer, each program gets its turn to access the CPU based on the management of the computer's operating system.

You have already learned about many types of computer hardware devices. In this session, you will start to learn about software, the other main facet of computers. You will learn what an operating system is, what applications are, what versions mean, and what software updates are. Finally, you will also be introduced to the very important topic of GUIs (Graphical User Interface).

What is an Operating System?

An operating system is arguably the most important software program that will run on a computer. An operating system provides an environment in which other software programs can run, while also providing functionality that allows users to interact with the computer.

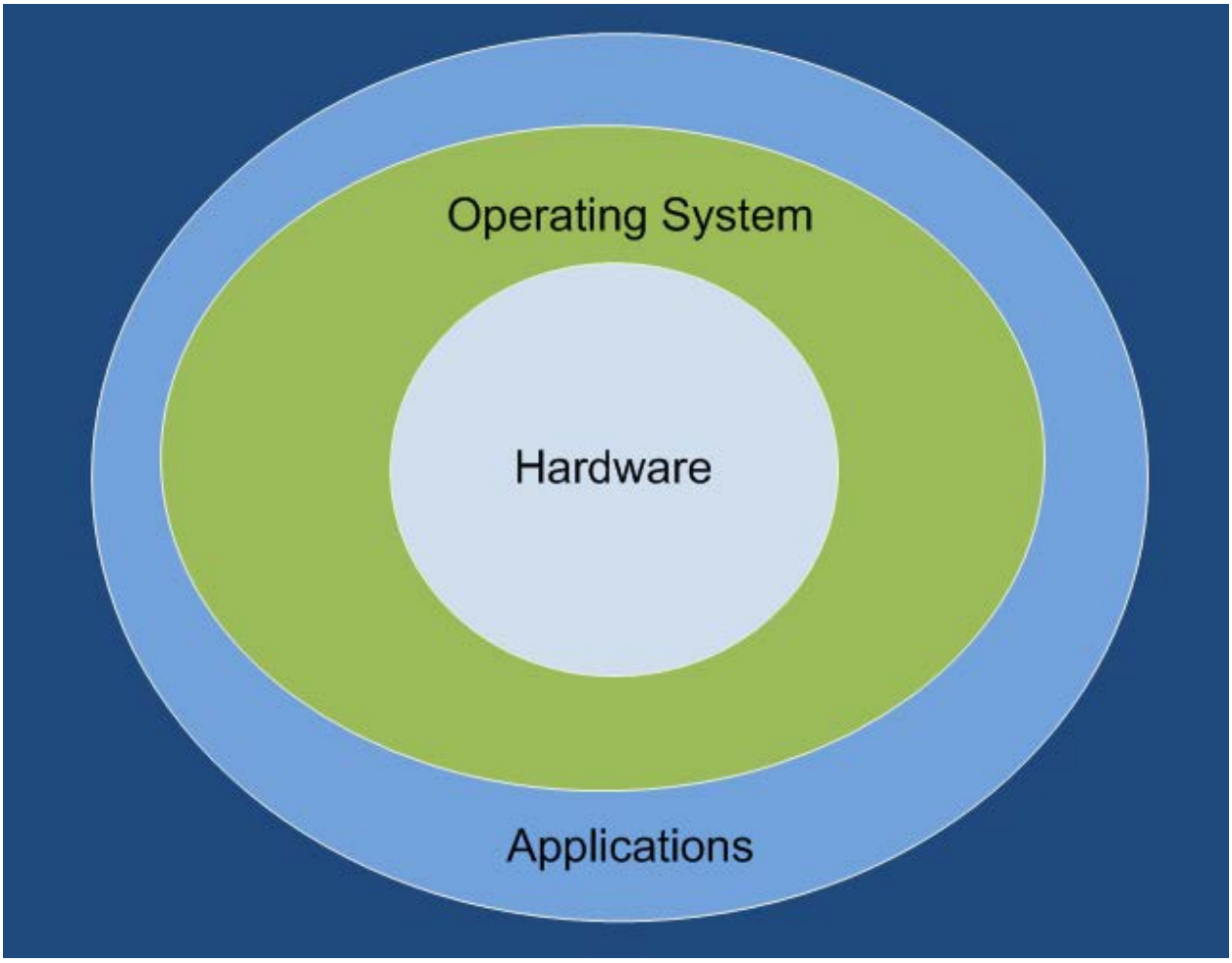
The tasks that an operating system performs can be thought of as services. Some services are provided for users of the computer system, while other services are provided for the computer system itself.

Operating systems can vary to a great degree, depending on their intended purpose. Some operating systems are designed for multiprogramming environments or server systems, where

multiple users log in and use system resources at the same time. Other operating systems are designed to provide a very user friendly environment with easy access to system files, application programs, and functions. Whatever the case, all operating systems provide users with controlled access to the data files, software programs, and hardware that make up the computer system.

More specifically, the operating system is that program that is always running, whenever the computer is turned on. Other application programs may be arbitrarily started or stopped, but the operating system is always running until the computer is shut down.

You can think of an operating system as the software that is closest to the computer's hardware. The application programs that run on the computer (and the users who use these application programs) access the computer hardware either through, or with the help of, the operating system.



Often, operating systems are very large and complex pieces of software, with many thousands (or even millions) of lines of programming code. An operating system also has the important job

of managing how the CPU accesses the instructions in different programs, when multiple programs are running at the same time.

What is an Application?

An application is a software program that is designed to perform a specific task or set of related tasks. For example, there are applications that are designed to manage or interpret data (spreadsheets and databases), while some other applications are designed to help users create and modify text documents or drawings (such as word processors and vector graphics programs).

There are so many applications in use today that it can be difficult to list them all, but it is possible to differentiate between application software and the underlying systems software.

In simple terms, the job of the operating system is to create a working (operable) environment and at the same time manage and coordinate the resources of the computer system. An application, on the other hand, employs the system resources to accomplish a specific user oriented task or set of related tasks. Furthermore, an operating system can function without any running applications, but applications cannot function without an underlying operating system.

Some software applications can be very large and complex, depending on their purpose, and they may require substantial time to be mastered by a user. Word processors, spreadsheet programs, and Web browsers are examples of common software applications that are in widespread use in businesses and in homes.

What do Versions Mean?

History shows that computer technology has evolved very quickly over time. Sometimes, after a software program has been created, new developments in computer performance, hardware, and software design can make the software outdated or even obsolete.

Furthermore, it is also possible for software development companies to add additional functionality to their applications to stay even with competitors, to fix bugs (errors) in the program, or to accommodate requests and feedback from users or clients.

For whatever reason, software applications will often evolve over time as do the other aspects of computer technology. This means that a given software program can be available in many different versions.

Typically, software versions are indicated by a numbering system involving three or more digits separated by periods (as in a decimal number like version 2.4.0). Sometimes, the digits are combined with letters, as in version 2.5b. In general, a higher version number for the software will indicate a more recent version.

Often when a software program uses the dotted number versioning system (for example, version 1.2.0), the first number indicates the major release of the software (the digit one, in this example). If there is a relatively minor change to the version, the second number will be incremented. In this example, a minor change to the software might result in a number like version 1.3.0.

The third number might be changed to reflect a small revision like the correction of an error or program fault. In our example, if an error was found in the program and then the error was fixed and the program re-released, the version number might be version 1.3.1.

Finally, if there has been a major change in the programs functionality or appearance, the first number in the dotted number notation could be changed (for example, from version 1.3.1 to version 2.0).

What are Updates?

It can be a very difficult (if not impossible) task for program developers to create large applications or operating systems that have no faults, flaws, security concerns, or other issues. Moreover, as mentioned previously, it is often the case that new versions of a software program will evolve due to changes in technology and competitive pressures in the marketplace.

Sometimes, an older version of a software program can be converted to a newer version by installing a software update. Updates allow the user to upgrade his or her existing software to the latest version (or at least a more recent version) without having to install the new version from scratch.

Often, when a large software program (like an operating system) is released, there are a number of updates that follow as various security vulnerabilities, bugs, or incompatibility issues with the software become known. Typically, these software updates are available over the Internet on servers provided by the company that makes the software. These updates can be downloaded to the user's computer, and then installed to fix, improve, or otherwise update the given software program.

What is a GUI?

In the early days of computers, human-computer interaction took place on the command line. A user would type a specific command on his or her keyboard to execute some corresponding task on the computer system.

In these situations, a typical user had to memorize a number of commands and command argument rules to interact with the system on even an elementary level. To be a truly advanced

user, in-depth knowledge of the computer's file system, operating system commands, and even some programming knowledge might be required.

Today, however, things have changed. Now, most computer users interact with their operating systems and applications through the use of GUIs.

A GUI (pronounced gooey) stands for Graphical User Interface, and it is the part of the application or operating system software that provides the user with access to the software's functions. Basically, a GUI consists of those objects on your computer screen that you interact with by dragging or clicking your mouse or by entering data with your keyboard.

If you break the phrase "Graphical User Interface" down, the term Graphical refers to the graphics or images that appear on your screen representing underlying object in the system. The term User refers to the person that is interacting to the computer, and the term Interface refers to a mechanism that facilitates the interaction between the user and the underlying system functions.

Putting this together, a Graphical User Interface uses **graphical** symbols corresponding to system components and functions, to allow the **user** to interact (**interface**) with these same system components and functions.

Because a graphical user interface relies on graphical symbols to represent underlying functionality and resources, the user can interact with the computer largely by using a simple pointing device (like a mouse). This allows the user to view data, devices, and applications on the computer as physical or tangible objects that can be easily opened, started, stopped, and removed, and so on.

GUIs are used as an operating system interface and as an interface to the commands and functions within a software application. Different operating systems and applications can all have different GUI designs, but here are a few components that are fairly consistent across most GUIs

The following table describes some commonly used GUI components.

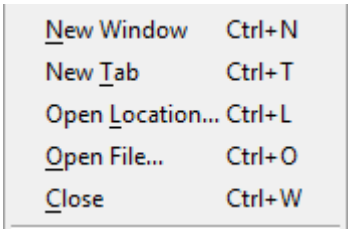
Icon

An icon is a symbol in the form of a small graphical image that corresponds to a device, a folder, a file, a program, or some other component of the computer system.

By interacting with the icon, the user can manipulate the underling resource that the icon corresponds to.

Icons are frequently used in operating system GUIs to allow users to access the computer's disk drives, files, applications, and more.

Menu



A menu is a panel of options that appears when a user clicks on a given menu heading or symbol.

Menus are often used as a means of providing access to the functions and commands in a software application.

To perform a command, the user clicks the corresponding menu item.

Button

A button is a small graphical item that gives the visual effect of being pressed when you click on it (using a mouse or other pointing device).

Buttons are frequently used to access commands and functions in software applications.

In a typical software application, most of the functionality of the application can be accessed through groups of buttons and/or menus.

Pointer

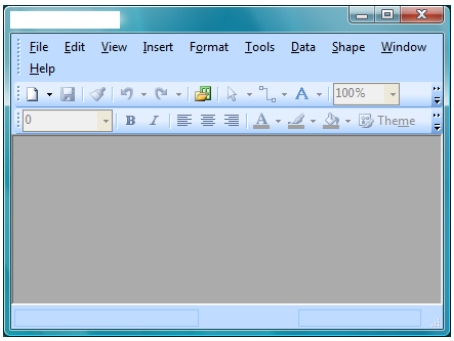
A pointer is a small graphic (often in the shape of an arrow head) that is used in GUIs to show the current location where mouse commands (clicks or dragging) will be implemented.

The position of the mouse pointer will change on the screen corresponding to how the mouse is moved by the user.

Cursor

A cursor is usually a simple vertical line, underscore, or other symbol that flashes to indicate the location on the screen where any typed data will be entered.

Window



A window is a square or rectangular bounded area that encloses GUI components, data, and/or the working area associated with a given application or system component.

Windows of one form or another are used to access most programs and data on computers that use GUIs.

Typically, windows can be minimized, restored, and resized to accommodate the user's preferences for how the items on the display screen should be arranged.

There are many other GUI components available beyond what is shown above. A typical GUI will often include items like checkboxes, radio buttons, text fields, scroll bars, dialogue boxes, tool tips, and list boxes.

Activity 3-1

Objective

To better understand the relationship between computer hardware and software.

Briefing

Your friend has asked you to explain (in a very general sense) how software and hardware work together in a computer system.

Your explanation should provide a general idea of:

- What is a software program?
- What does a program instruction do?
- What does it mean for a program to be running?
- Where are software programs stored on a computer system?
- Which software program is always running when the computer is on?
- Where are the instructions for a software program stored when the given program is running?
- What part of a CPU interprets a program instruction?
- What is a graphical user interface for?
- What is the difference between data and instructions?

Task

Team up with one of your classmates, and in your own words, explain to them the relationship between hardware and software.

In your explanation, try to deal with all of the questions mentioned above.

Hints

You may find helpful information in the session on the CPU (Session 1.3) as well as in this session.

Session 3-2: Operating Systems and Applications

In this session you will learn what an operating system does and what a software application does. You will also be introduced to some of the most common operating systems and applications in use on today's personal computers.

What Does an Operating System Do?

An operating system provides an environment for application programs to run in and provides access to the underlying hardware devices and file system to both the program applications and the users.

The many functions of an operating system can be thought of as services that are provided for the user and for the computer system itself. Some of the more important services that an operating system provides are summarized in the following table.

System Services	*User Services*
The operating system provides CPU scheduling and management services. These important services essentially decide what programs have access to the CPU, and in what order, and for how long.	The operating system provides the user with access to the underlying computer hardware. Generally, to access the functions of the systems hardware, users must go through the operating system.
The operating system provides memory management services. This involves sharing the available memory among the various programs that may be running, and allotting additional memory to programs that may require it. Memory management involves controlling access to main memory (RAM) and the use of secondary (hard disk) storage as well. By providing a virtual memory environment, operating systems can combine physically separate RAM storage and hard disk storage into one large addressable memory space.	The operating system provides the user with an interface to access to stored data. Users can access data through the operating system by using an interface (often a GUI) to navigate through the directories and files in the underlying file system. The operating system also allows users to access stored files through an appropriate application (like a text editor or database).

The operating system provides error handling services.	The operating system allows users to run applications.
If a program causes an error during its execution (usually detected by hardware), this error is sent to the operating system to be dealt with. The program can be stopped by the operating system or allowed to continue depending on the type of error. In some cases a message about the error will be output to the user.	An operating system provides an environment (often a GUI) that allows users to start, stop, and run programs that have been installed on the system.
The operating system provides control over the input/output devices.	The operating system can provide security services for the user.
In this regard, the operating system manages how programs access input and output devices, and resolves conflicts that may arise.	An operating system can help protect a user's programs and files from unauthorized access (often using accounts with username and password combinations).

Essentially, an operating system controls and manages the available resources (memory, disk storage, CPU access, input/output devices) based on input from both software programs and users. The operating system maintains and manages a disk file system for storage of programs and data, provides an operating environment in which programs can run, and provides an interface for the user to access programs, data files, and hardware.

What are Some Common Operating Systems?

There are different types of operating systems that have been designed for different types of computer systems. An operating system that manages resources on a PDA or cell phone does not necessarily require the same design strategies as an operating system for a PC or for a mainframe computer.

Even for a single category of computer system, there can be multiple operating systems available. The following table offers a brief description of some of the more well known operating systems.

Microsoft Windows

There are several versions of the Microsoft Windows operating system, including Windows 98, Windows 2000, Windows ME, Windows XP, Windows Vista and finally Windows 7. Windows 8 is due out sometime in the 2013 – 2014 period.

Microsoft Windows operating systems are currently the most commonly used operating systems on desktop personal computer systems.

Windows operating systems feature a very user friendly GUI and wide compatibility with many software applications and PC Games.

UNIX

UNIX is a very powerful and flexible operating system. It is often used on servers and in multi user/programming environments.

With UNIX, the user can access the underlying system resources through a command line shell.

There are GUIs available for UNIX systems, but many UNIX users enjoy the power and flexibility of the UNIX command line tools.

UNIX is often used for large servers in businesses, universities, and other institutions.

Linux

Linux is another operating system that is very closely related to UNIX. Linux comes in many different versions, and in most cases, it supports a GUI of some kind. However, just like UNIX, Linux users often prefer the power and flexibility afforded by the command line.

Linux is becoming increasingly popular as an alternative to Windows operating systems for personal computers.

Linux, like UNIX, can also be used on servers.

Arguably, there is not as many desktop software applications available for UNIX or Linux systems as there are for Windows.

Apple Mac OS and Mac OS X

The Mac OS line of operating systems is designed for Apple's

Macintosh computers.

Apple Macintosh computers (often called Macs) are personal computers that have a different architecture than most other PCs

Apple provided its own user friendly GUI driven operating system, the Mac OS, for this, its own line of computers.

Later, Apple developed a more robust operating system, the Mac OS X, which incorporates UNIX-like design elements. This operating system is used on more recent Apple personal computers. It provides a GUI as well as a UNIX or Linux like command line environment.

Apple computers and the Mac OS X form a popular alternative to PCs running Windows.

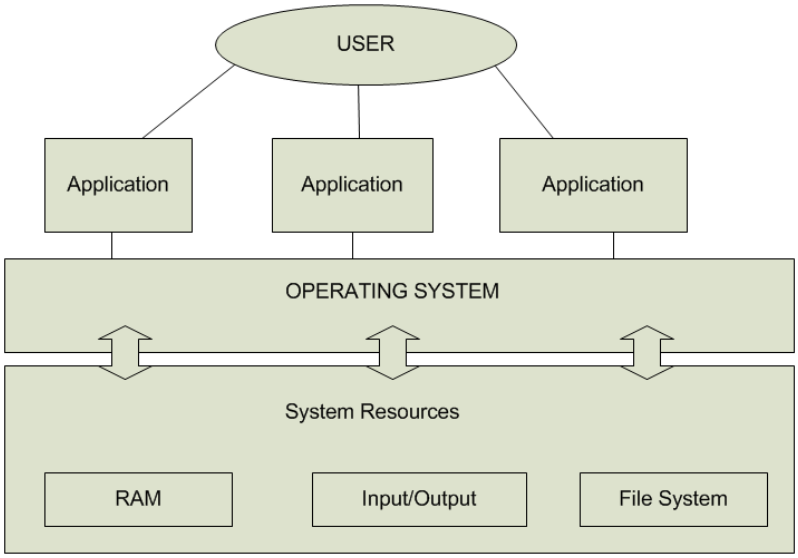
What Does a Software Application Do?

While it is the job of the operating system to act as overall manager of the computer system, the job of a software application is to use the system resources to accomplish more specific, user oriented tasks.

An operating system typically performs a wide variety of tasks without having to be directed by the user. Software applications, on the other hand, often require extensive user interaction to accomplish the goal for which the given application has been designed.

For example, a typical operating system will manage main memory, as well as maintaining and managing the file system without being explicitly told to do so. An application such as a Word processor will not accomplish much of anything if the user does not interact with it.

You can think of applications as the individual software tools that that help a user to accomplish specific goals, like creating a chart, editing a digital photo, or preparing a report. Typically, software applications access system resources (like files or hardware) in response to user actions and commands. The application is able to utilize these resources successfully because of the services provided by the operating system.



What Are Some Common Applications?

Because there are so many tasks that people want to perform on their computers, there are a variety of applications available to accommodate them. The following table describes some of the more common application types in use today.

Word Processors	A word processor provides a user with options for creating, editing, and formatting text based documents. With a word processor, users can choose from a wide variety of text fonts, sizes, and colors. Users also have fine control over page layout, margins, styles, alignment, and text effects. Modern word processors often include features like thesauruses and spelling dictionaries, and can even automatically detect spelling mistakes and questionable grammar. Some widely used word processing applications are Microsoft Word and Corel WordPerfect.
Spreadsheet Applications	Spreadsheet applications are numerically oriented software programs that help users store, organize, analyze, track, and report data. Typically, spreadsheet applications use small indexed data cells to store and organize data, functions, and formulas. These cells are organized as columns and rows in a grid pattern. Typically, a cell is indexed according to what column and row it is found

in. For example, cell A1 would be the cell in the first column of the first row.

A function or formula in one cell can reference the contents of another cell by using the cell indexing system. This means that a complex formula or function can be defined in one cell that involves the values in many other cells.

Spreadsheet programs are often used to create and calculate budgets, analyze numerical trends, and perform a host of other accounting and financial tasks.

Some well known spreadsheets programs are Lotus 1-2-3, Microsoft Excel, and Corel Quattro.

CAD Applications

CAD stands for Computer Aided Design. CAD applications are frequently used in engineering, architectural, construction, and surveying/mapping settings.

CAD software can be used to create architectural plans and engineering schematics, and for modeling three dimensional objects and surfaces.

CAD software can be quite complex, and it is usually employed by users with knowledge in a specific (often technical) field.

AutoCAD is an example of a CAD application that is frequently used in industry.

Photo/Image Editing Applications

Photo editing software allows users to modify, enhance, edit, and combine digital images.

A couple of well known digital image/photo editing applications are Adobe Photoshop and Corel Paint Shop Pro.

Software Development Applications (IDEs)

Software development applications (IDEs) provide environments that help programmers organize, create, compile, and test programming code. (IDE stands for Integrated Development Environment.)

IDEs will typically provide an editing window where programmers enter code. This editing window will help the programmer by color coding different statement types, language keywords, and variables.

Furthermore, these development environments can help the programmer organize the components of a code project and provide

tools that can assist in finding programming errors.

Some well known IDEs are Microsoft's Visual Development Studio and the open source program Eclipse.

Database Applications (DBMS)

Database applications or DBMS (Database Management Systems) are used to store, organize, and retrieve fields and records of data. This data is stored in an organized interrelated database often consisting of multiple tables of related information. Often, databases are queried (meaning data is requested) by other software programs.

Because databases can relate the stored information in a way that facilitates the query process, they allow programs and users to retrieve or filter data based on an extensive variety of criteria.

Database applications (DBMS) are used by many organizations wherever there is a requirement for large amounts of stored, but readily accessible information.

The term database can be used to refer (sometimes confusingly) to both the DBMS application and the actual stored data itself.

Some common database applications in use today are Oracle, Postgres, Mysql, Access, and Paradox.

Web Browsers

Web Browsers are applications that provide users with access to the World Wide Web. A modern web browser is capable of understanding and rendering web pages authored with a variety of web development languages and technologies.

With the current popularity of the Internet, web browsers are probably one of the most frequently used applications that are found on desktop computers.

Today, the most commonly used Web browsers are Internet Explorer, Netscape Navigator, Opera, and Mozilla Firefox.

Other Applications

There are many other software application types in use today, including but not limited to:

- Video editing applications
- Security applications (firewalls and anti-virus programs)
- Computer animation programs
- Peer to peer (also known as P2P) file sharing programs
- Optical disk authoring (burning) programs

- Audio/music recording and editing software

Activity 3-2

Objective	To understand the differences between applications and operating systems.
Task	Form into groups of two to four people. As a group, try to come up with some obvious differences and similarities between applications software and operating systems software. List as many differences and similarities as you can.
Hints	While you are making your list, keep the questions below in mind. ▪ What program is the first to load and start? ▪ What program is always running? ▪ What happens to your computer when you shut down an application? ▪ What happens to your computer when you shut down the operating system? ▪ Where is the operating system stored when the computer is off? ▪ How about when the computer is on? ▪ Where are applications stored? ▪ Which type of software (operating system or application) do you think would be larger (have more instructions)? ▪ How does a user interact with an operating system? ▪ How does a user interact with an application?

Session 3-3: Types of Software

There are many different software programs available to PC users. Some can be downloaded over the Internet, while others can be purchased on a CD or DVD. Some software, like an operating system, will often come pre-installed on a computer that you purchase.

In this session, you will look at some of the different categories that software falls under, like shareware and freeware. You will also consider other aspects of acquiring software, such as EULAs (End User Licensing Agreements) and how to check the version and the product ID number of a software application.

What is Shareware?

Shareware is software that is available for users to try for free, usually by downloading and installing it from the Internet. With shareware, after a certain period of time, the user will typically be required to pay a fee for the software if they find the application to their liking and would like to continue using it.

Often, the payment of a fee for shareware is voluntary, and in some cases individual users will not be prevented from using the software if they do not pay for it. However, in many cases, if the user does pay the fee and register the shareware product, they will be able to take advantage of improved or additional functionality in the program.

Unlike traditional commercial software, the copying and distribution of shareware is not always discouraged. The general thinking is that the more users who try the software, the more users will pay the requested fee for it.

Shareware is often developed by individual programmers or sometimes small groups of programmers, so shareware programs may not be as large or comprehensive as applications produced by a major software company. Nevertheless, shareware programs can have a high standard of quality.

In recent times, limited time trial versions of software have also been labeled as shareware, although there is some debate over whether this type of demo software is really shareware or not.

To summarize, the basic idea behind shareware is to give the user an opportunity to try the software before they buy the software.

What is Freeware?

Freeware is computer software that is freely available for an unlimited time and at no cost. Often, freeware is developed by community minded programmers who would like to see their software more widely distributed among other users.

Just because freeware is free does not mean that the user can do whatever he or she wants with it. Freeware can still have license agreements that discourage unauthorized distribution or modification of the software. Typically, freeware is copyrighted, so the creator of the freeware program remains in control of the future development of it.

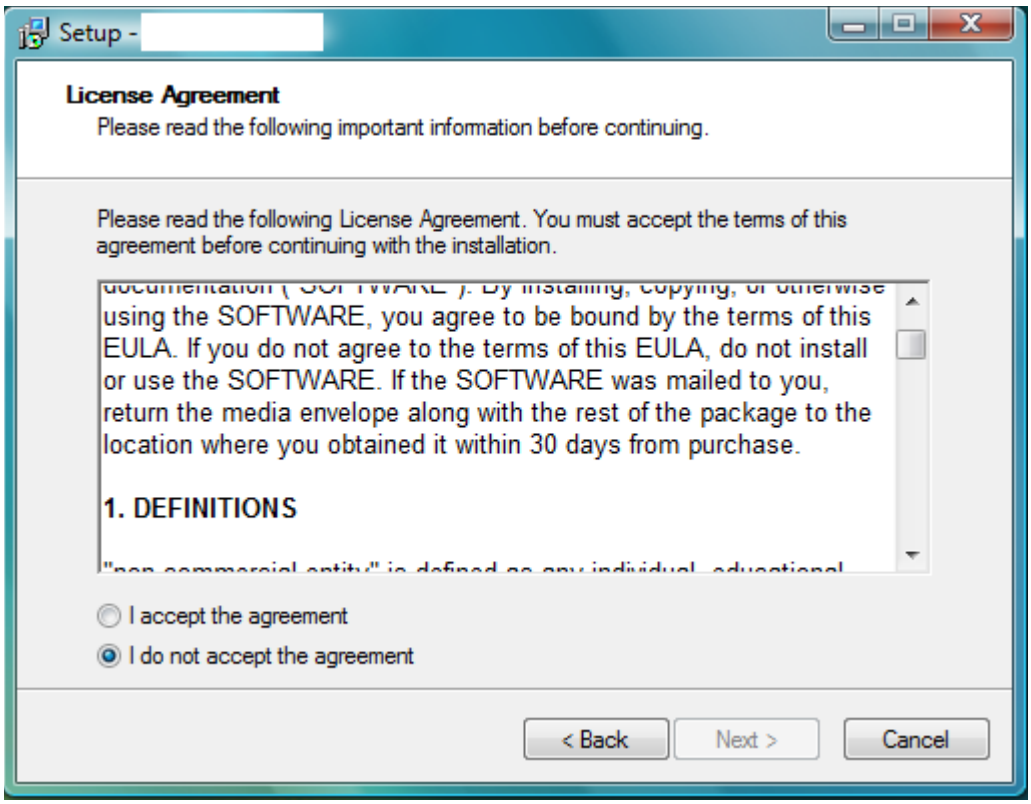
Like shareware, freeware is often distributed to users by making it available in a downloadable form over the Internet.

What is a EULA?

EULA stands for End User License Agreement. Most commercial proprietary software will include some form of user agreement specifying the conditions of the software's use.

Most EULAs are integrated with the installation process and appear near the beginning of the installation of the software in the form of an electronic document. Normally the document details the copy, distribution, and usage rights that the software producers want the users to adhere to.

If the user wants the software installation to continue, they will typically have to signify agreement to the terms of the document by clicking a checkbox, radio button, or an "I Agree" button. Once it has been indicated that the EULA has been agreed to, the installation of the software will continue.



The image above shows a EULA document window during the initial stages of software installation.

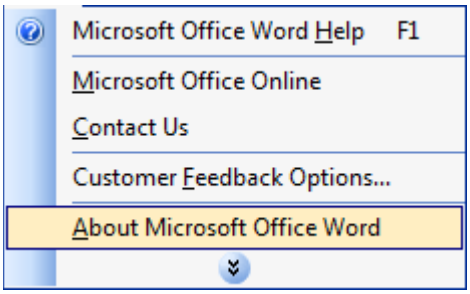
Currently, debate over the enforceability of EULAs continues. However, they are in very widespread use whenever software is being sold or distributed.

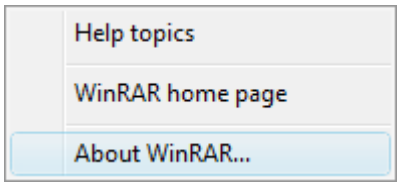
Some EULAS may appear as a hard copy paper form, packaged with the installation disk (CD or DVD) for the software.

How Do I Check the Software Version?

There may be times when you want to check the version number for a software application that you use. Typically, you can check the software version from within the application itself.

With the application started, you should search the user interface for an option that will provide information about the application. Often this option will be found on the program's Help menu and will be labeled with the word "About," followed by the name of the application.



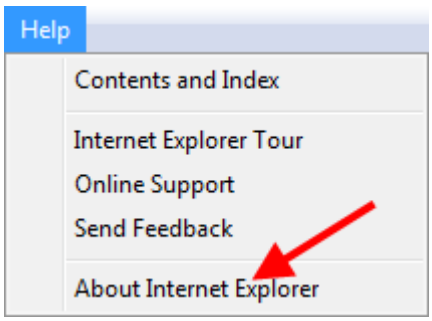


When you click the About option, a window will appear that will typically display the name and version number of the software.

How Do I Check the Product ID Number?

Many software applications have a product ID number. This number can be used to identify the software, and in some instances, to determine if your copy of the software is a valid and licensed. In some cases, a valid product ID might be required for you to receive updates for the software.

The product ID can often be found in much the same way as the Version number. To start, look for a Help menu, and choose the "About" option if there is one.

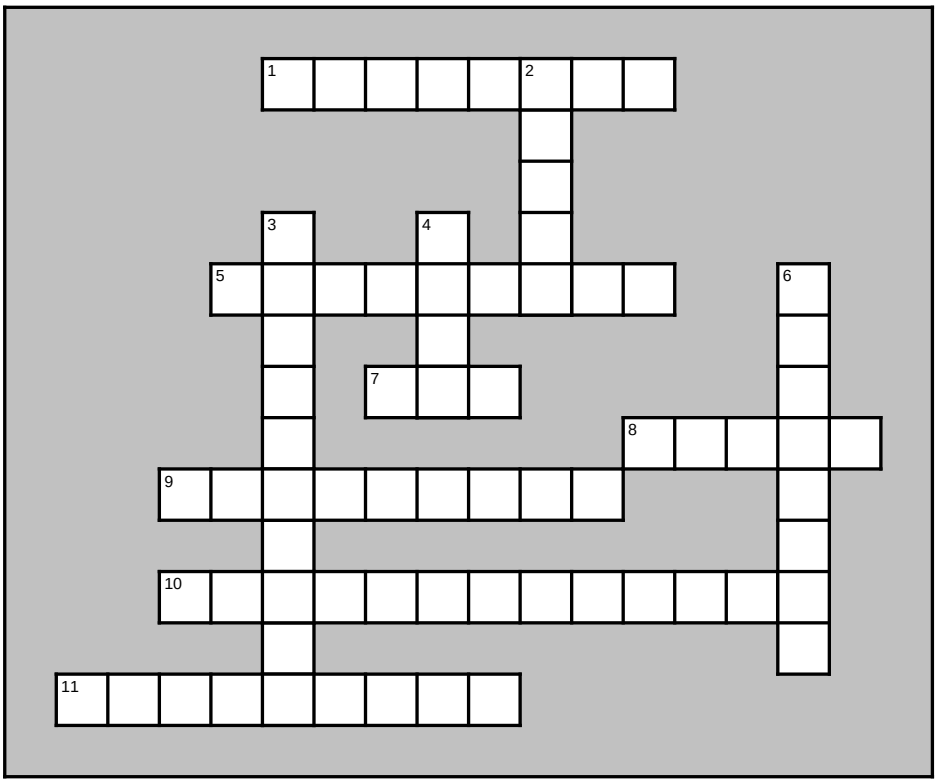

Help
Contents and Index
Internet Explorer Tour
Online Support
Send Feedback
About Internet Explorer

At this point, a window will typically open that displays the version number and the product ID.

For the Microsoft Windows operating system, you can find the Product ID by choosing the Start menu on the desktop, and then right clicking the Computer (sometimes called “My Computer”) option, and then choosing the Properties option from the popup menu.

Activity 3-3

Crossword



Across

1. Software that is distributed at no charge
5. The number used to identify your copy of software
7. If you like a shareware program, you should _____ for it.
8. Typically you must _____ to a license agreement before you install software.
9. Programs that can be distributed among many users
10. Shareware programs may be less _____ than other programs.
11. Legal term detailing rights to copy software

Down

2. Menu option you would typically pick to see a product's version
3. The job title of a person who develops computer software for a living
4. The acronym for End User License Agreement
6. Shareware and freeware is often distributed to users by making it available in a downloadable form over the _____.

Session 3-4: Legal Issues

Software piracy is a major concern in today's software market. The very nature of software makes it particularly vulnerable to copying because of the way software is published, distributed, and used.

In this session, you will learn about copyright and how it applies to software and other digital media files. You will learn about data protection legislation, and what you should be aware of when downloading, using, or sharing software materials.

What is Copyright?

Copyright can be described as a set of rights that can control how a particular creation is used or copied. For example, if you write a book or story and it is copyrighted, there will be legal limitations imposed on how others can use your book or story. Only you will have the exclusive rights to copy and/or distribute your literary work as you see fit. The limitations on what others can do with your literary work are intended to ensure that you are benefiting from what you have created.

There are, however, certain materials that a copyright does not protect. For example, materials that lack originality and are just compilations of public data (like a phone book) cannot be copyright protected. As well, a reprint of material that is already in the public domain cannot be protected by copyright.

Any material that is in the public domain (can be freely used by anyone) is not copyright protected. These materials include works that were created and published a long time ago (several decades) and most government documents.

Copyrighted software is treated much like a copyrighted literary work (even though, in reality, there are many significant differences between software and a literary work). As such, the unauthorized copying or redistribution of copyrighted software is forbidden and is deemed a copyright infringement. If a software user performs a copyright infringement on the exclusive rights granted to the creator of the software, the user may be held liable.

Some examples of possible copyright infringements are:

- Making unauthorized copies of the software
- Deliberately using an unauthorized copy of a software application
- Distributing unauthorized copies of the software (sharing with friends, coworkers, and so on)
- Purchasing a software application that is licensed for a single computer, and then using it on multiple computers

Typically, it is understood that a user must make at least one copy of a software application when they install the program from a CD or DVD to the computer's hard disk (a copy of the information on the publishing medium is made and saved on the computer's hard disk drive). Beyond that, a user should consult the EULA provided with the software for further details.

What is Data Protection Legislation?

Data protection legislation typically refers to government legislation that upholds the rights of citizens to have data privacy. With the advent of computer technology, tremendous amounts of private data are being stored on computers everywhere.

Some of the private information stored on computers may include:

- Personal information, like names , ages, and addresses
- Credit reports
- Phone numbers
- Credit card numbers
- Resumes
- Health records
- Various financial/banking data
- Criminal records
- Tax information

In order to keep this growing amount of stored data in check and to protect people's privacy, many countries have adopted data protection legislation that specifies guidelines for how this data is to be maintained. In Europe, for example, the data protection legislation specifies that data and data collection must be:

- Fairly and lawfully processed
- Processed for limited purposes
- Adequate, relevant, and not excessive
- Accurate
- Not kept longer than necessary
- Processed in accordance with the data subject's rights
- Secure
- Not transferred to countries without adequate protection

This legislation helps to enforce that organizations give people notice when they collect data, that the collected data is only used for the purposes stated, that the data will only be disclosed with the given person's consent, and that people will have the option of seeing what data an organization keeps on them.

Though this type of legislation is implemented throughout Europe and similar legislation is in place in Canada, data protection legislation of this kind is not yet in place in the United States. Though there are some data protection regulations in place in the US (like online privacy laws for children), a comprehensive set of data protection rules is not yet legislated.

How Does Copyright Apply to Software vs. Files?

There are many types of files that a computer user may have to work with. More often than not, the files that are used on a computer will be created with software that is protected by copyright law. What does this mean for the files that you create?

A file that you create consisting of you own original content is your creation, even if the software you used to create the file is copyrighted. You can copy the content of such files as much as you wish and distribute them as much as you like. There are files, however, that you should not copy or distribute without the permission of the files owners or creators.

Just as with software, computers make it very easy to duplicate music, video, and practically any other digital (computer) files without losing any quality. Moreover, peer to peer file sharing applications make it very easy to distribute these files over the Internet. Just as with software, the unauthorized copying, sale, or distribution of copyrighted digital files may be considered to be copyright infringement.

Some common files (copyrighted materials) that are frequently copied and distributed without authorization are:

- Music files (MP3 files)
- Video files (DVD movies, MPEG videos)
- Digital Images (JPEG and bitmap files)
- Software program files (.exe files)

What Should You Download?

Currently, there are vast amounts of files available for download over the Internet. The files may be available on Web sites, available through various peer to peer sharing programs, or hosted on various file sharing servers.

When you download a file from an unknown source, you really have no idea what you are getting. The file may contain a virus that can damage other files on your computer and render your operating system inoperable. Another possibility is that the file you download may be copyrighted, and as such, you risk copyright infringement by downloading it and using it without authorization.

To avoid viruses, spyware, and other malicious code that can hide in downloadable programs, avoid downloading files from Web sites that you do not trust completely. For example, if you want to download and install an update for a Microsoft operating system, download it from the official Microsoft Web site.

When you download software to install on your computer, make sure you read and understand the EULA that comes with the software. If you are not comfortable with the terms of the agreement, you will have the option of canceling the installation.

Remember, if you download a software application from any source other than the software company's official site, there is a chance that you could be downloading an unauthorized copy.

Furthermore, if you find a well known software application available for download through peer to peer file sharing or any other source than the manufacturer's Web site, it is very likely unauthorized.

What Should You Be Aware Of When Using Materials?

If you are using proprietary software applications or other files that are copyrighted, make sure that you are using them within the constraints of the accepted agreement. You should not try to reproduce or distribute these materials in a way that leads to copyright infringement. Unauthorized use of computer software (and other digital files) may deprive the developers of the rewards which they are entitled to.

Furthermore, using unauthorized computer software, or viewing and duplicating copyrighted music or video files (or any other copyrighted files for that matter) is, at the least, deemed unethical by many, and may even make you liable for copyright infringement.

What Should You Be Aware Of When Sharing Materials?

When you share materials, you should realize that unless the materials have been created by you, or unless you have explicit permission from the material's actual creator to share them, you may be performing copyright infringement.

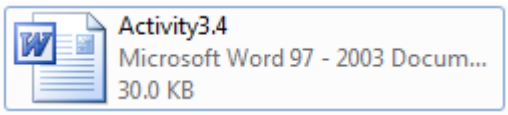
This is especially true when it comes to computer software and other digital files. When you share copies of an operating system or other software application, make sure you are doing so in accordance with the software's licensing agreements. For example, if you are installing an operating system on multiple computers at your office, make sure that the number of installations does not exceed the number that is permitted by the terms of your licensing agreements. If you are taking copies of software home from work to install on your home computer, you may be infringing on software copyrights.

Similarly, if you take a copy of a software application that you have purchased, copy it to another CD or DVD, and give it to your friend to install on his or her computer, this may be considered pirated software.

Finally, if you download software, music files, or videos over the Internet to share with other users (perhaps with a peer to peer file sharing application), you are likely distributing unauthorized copies of copyrighted material. Modern computer technology makes it very easy to copy and distribute all kinds of materials in a number of ways (CDs, DVDs, and over the Internet). But, just because copying and sharing digital material is easy, it is not necessarily ethical or legal.

Activity 3-4

Objective	To appropriately judge what material is copyright protected.
Briefing	The employees in your company love to download materials from the Internet. Since you are one of the company's IT gurus, your fellow employees are frequently asking you if what they are downloading is copyright protected.
Task	Obtain the Activity 3.4 handout from your teacher/trainer.



Look at the questions posed in the document and give your opinion as to whether or not the materials in question are copyright protected.

Index