PART ONE
GENERAL INTRODUCTION TO COMPUTERS

CHAPTER 1 INTRODUCTION

Personal computers are found in most aspects of our daily life, and for some it is hard to even imagine a world without them. Computers are showing up everywhere you look, and even in places you least expected.

Computers help us run our businesses and institutions, design and build manufactured products, provide instantaneous worldwide communication, publish our newspapers, magazines and books, control the way our car runs, dispense money at the ATM, and supply all sorts of educational and recreational services, the list is endless. In fact, the computer is rapidly becoming, if it hasn't already gotten there, as tightly woven into the fabric of our lives as the automobile.

Computer literacy is becoming a vital skill for all of us, as we move further into the information age. Everyone involved in education has much to gain from the increased productivity that these machines can offer. They can act as a resource for students or lectures as they facilitate access to relevant information on the Internet and on CD-ROM/DVD/Memory Stick/mp3 players, etc. They allow students and teachers to prepare presentations, documents, images and so on. Furthermore, there are specific educational programs, usually containing multimedia and animation, which are designed to teach or support learning in specific subject areas. In fact, the ways in which computers are integrated depends entirely on the imagination of both lecturers and students.

Also, many forms of employment now require some kind of computer literacy to enhance and increase productivity. Whether you realize it or not, computers play an important role in our lives, hence the need for this text.

What is a Computer?

Computers can take many different forms and their capabilities are constantly expanding. The gap between computer technology and other allied electronics is narrowing with each passing day but there are basic characteristics that an electronic devise must possess to become a computer.

A computer is an electronic device that manipulates information or "data." It has the ability to store, retrieve, and process data. You can use a computer to type documents, send email and receive, and surf the Internet. You can also use it to handle spreadsheets, accounting, database management, presentations, games, and more.

We may therefore define a computer as an *electronic device that is programmable to perform specialized tasks and equipped with an*

i) input device
ii) output device
iii) Central Processing Unit (CPU)
iv) Storage device.

In almost all types of computers, the Central Processing Unit (CPU) and the storage devices are housed in a box known as the System Unit. The input devices such as the keyboard and the scanners including the mouse (considered to be a pointing device), and output devices such as monitors and printers are house in their own enclosures and are connected to the computer with cables. Devices like these, that are used by the computer but located outside the system unit, are referred to as *peripherals*.

All types of computers consist of two basic parts – **hardware** and **software**. Hardware is part of your computer that has a physical structure, such as the computer monitor or keyboard. If you can touch it, it is hardware. Software is any set of instructions that tells the hardware what to do. It is what guides the hardware and tells it how to accomplish each task.

Generation of Computers

Since the invention of the first electronic computer in the early 1940s, there has been significant improvement especially in the physical size, cost and the processing speed of these computers. There are different generations of Computers but for the purpose of this course we shall concentrate on the first four generations.

First Generation Computers (1946-1954)

The main material used in the first generation of Computers was the vacuum tubes (electronic valves). Each computer was

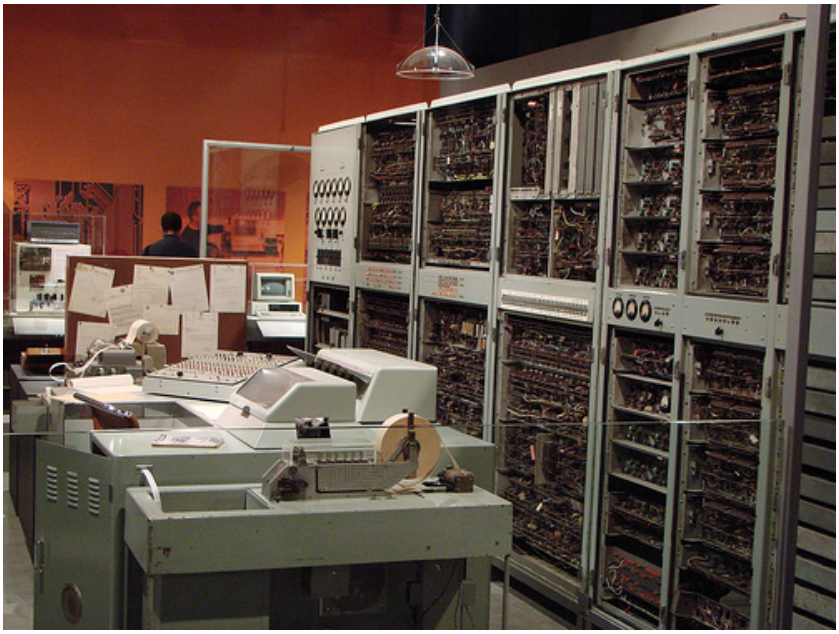

Figure 1.1 First Generation computers (1946-1954) Vacuum tubes

made of hundreds of such tubes. As a result of the vacuum tubes, this generation of computers was huge in physical size. For example, ENIAC - the Electronic Numerical Integrator and Computer - which was developed in 1946 measured 18 feet by 80 feet and weighed 30 tons. The Computers during this generation were very slow in terms of processing speed. The use of vacuum tubes made them to generate a lot of heat and had to be used in air-conditioned rooms. The heat generated actually affected the life span of the computers and also created air conditioning problems. The computers at this time were very expensive and therefore by the end of 1958 only about 2,500 first generation computers were installed world-wide.

Second Generation of Computers (1954-1962)

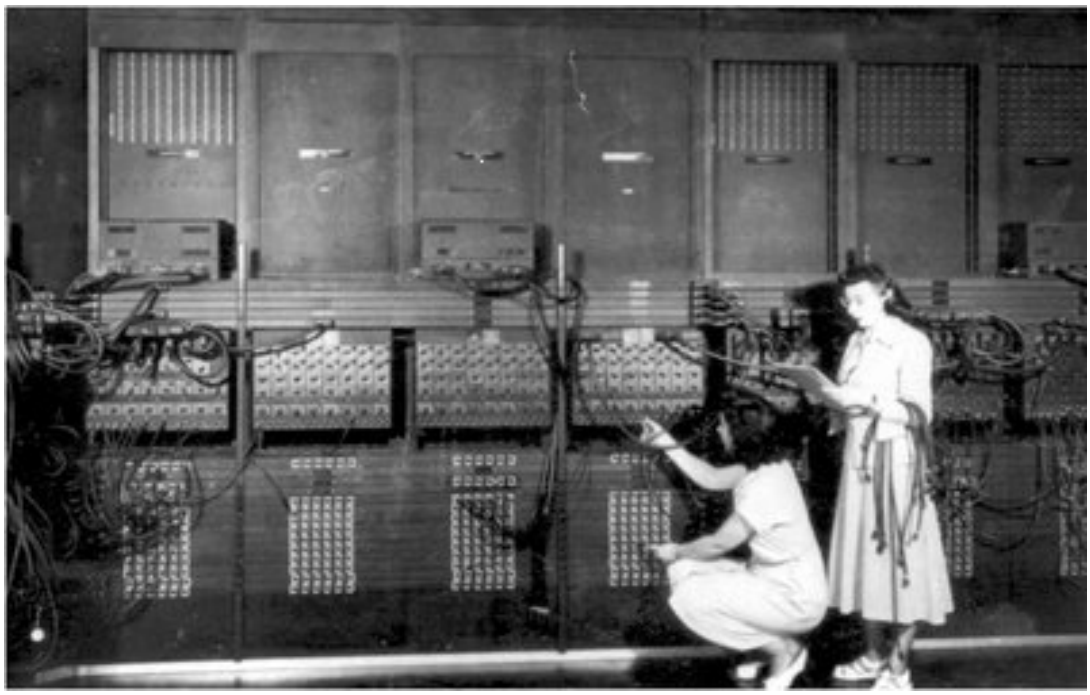

Figure 1.2 Second Generation of Computers (1954-1962)

As a result of the problems associated with the first generation of computers, mid 1950s saw the advent of second generation computers. In the second generation of Computers, the manufacturers replaced the vacuum tubes used in the first generation computers with transistors. These transistors were much smaller in size and more reliable as compared to the vacuum tubes. As a result of the use of transistors, the second generation of computers was much smaller in physical size as compared to the first generation computers. They were much faster in terms of processing speed, less expensive and also generated less heat. Second generation computers started showing the characteristics of modern day computers as they came with utilities such as printers, disk storage and operating systems. Also, the instructions (program) could be stored inside the computer's memory. High-level languages such as COBOL (Common Business-Oriented Language) and FORTRAN (Formula Translator) were used.

Third Generation Computers (1963-1972)

For the third generation of computers, the transistors were replaced with Integrated Circuits (ICs, semiconductor devices with several transistors built into one physical component).This brought a huge gain in computational power. The first ICs were based on small-scale

Figure 1.3Third Generation Computers (1963-1972)

integration (SSI) circuits, which had around 10 devices per circuit. This generation of Computers were cheaper, smaller in size, faster in data processing and generated less heat.

Fourth generation of Computers(1972 – 1984)

Technically speaking these are the modern day computers. The fourth generation of Computers were made of Very Large Integrated Circuits (VLICs). The VLICs (100,000 devices per chip) ensured that millions of components could be fit into a small chip. As such, these computers were cheaper, smaller in size, faster in data processing and generated less heat. What appears to be the next generation of computers which people are referring to as the fifth generation computers are those equipped with hundreds of processors that could all be working on different parts of a single program. The scale of integration in semiconductors continued at an incredible pace around 1990. Modern technology makes it possible to build chips with a million components. Semiconductor memories have now became standard on all computers. Other new developments were the widespread use of computer networks and the increasing use of single-user. In fact, fifth generation of computers is supposed to be intelligent but these types of computers are still in the developmental stage. The goal of the fifth generation is to develop computers that can respond to natural language of man and with the ability to learn and self-organized.

Classification of Computers

Basically, there are three ways of classifying Computers and these are classification by data representation, classification by purpose and classification by processing speed and storage capacity.

Classification by Data Representation

Computers represent data in different forms. Some represent data in continuous form while others represent data in discrete form. Under classification by data representation, there are three types of Computers and these are **Digital**, **Analogue** and **Hybrid**. A digital computer represents data in discrete form (using 0s and 1s) while an analogue computer represents data in a continuous form (uses continuously variable voltages rather than limiting itself to 0 and 1). Analogue computers are measuring devices for measuring quantities such as temperature, pressure, speed and voltages. A typical example of analogue is the speedometer of a car or a thermometer for taking a patient's temperature in a hospital. The hybrid computer on the other hand can represent data in both continuous and discrete forms.

Classification by Purpose

Depending on the flexibility in operations, a Computer can be classified as being either a special or a general computer. Special computers are computers that have been designed for a specific purpose. Apart from this purpose the Computer cannot be used for anything else. They are normally used by the Military, Navigators, Banks, Hospitals and for control process applications. For example, an ATM machine is designed to enable users to get money from the machine. It cannot be used to receive monies from customers or to calculate CWAs of students. Similarly, a device such as a money counter can only count money and cannot be used for any other purpose. Most robots are special computers. General computers on the other hand are computers that are multi-purpose. For example a typical desktop computer can be used for all manner of tasks.

Classification by processing speed and storage capacity

Modern day Computers are often classified into general types based on processing speed and storage capacity. As technology advances, lines of divisions among these types become thinner and thinner. Since the days of ENIAC - the Electronic Numerical Integrator and Computer - which was developed in 1946 and measured 18 feet by 80 feet and weighed 30 tons, computers have undergone such a rapid metamorphosis like we have never witnessed in any other technological area. The on-board guidance computer used by Apollo 11 astronauts in 1969

weighed 31 kg (70 lbs) and could hold just 2000 characters in its memory, the equivalent of one-tenth of what a floppy diskette of today can hold. The Mission Control computer on the ground had only one million characters of memory – about half the capacity of a floppy diskette. And do you know how much that computer cost? $4 million! Besides, it was about the size of a room.

Computers come in variety of types and with a variety of processing and storage capabilities. We may classify computers as follows:

(a) Microcomputers
(b) Minicomputers
(c) Mainframes
(d) Supercomputers

As mentioned earlier, lines of difference between these classes keep getting blurred and blurred as technology advances. However, we shall try to define each of these classes.

(a) Microcomputers

Also known as personal computers (PCs) are small computers that can only be used by one person at a time. Microcomputers come in various sizes and shapes.

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They can be categorized as desktops, towers, laptops and palmtops. Many people use desktop computers or desktops as they are often referred to, at work, home, school, or the library. They

can be small, medium, or large in style, and usually sit on a desk. The term desktop actually refers to the casing**,** or the tower. Once you add a monitor, mouse, and a keyboard, you have what is typically known as a desktop computer. The term desktop computer originated when the computer case was wide and flat, and was designed specifically to fit on your desktop with the monitor on top.

Most desktop computers are easy to upgrade and expand, or add new parts. In addition to expandability, another benefit of desktop computers is the cost**.** If you compare a desktop computer with 128 MB of RAM and a 2 GB hard drive to a laptop with the same features, you will most likely find that the desktop computer is priced lower. PCs are used as stand-alone machines or connected to a network such as Intranet or a Local Area Network (LAN) – a group of PCs and peripherals in an office or a building connected usually by a special cable.

A Typical laptop computer

Another type of microcomputer that you may be familiar with is a laptop computer or laptops as they are often referred to. Laptops are battery or AC-powered personal computers that can be easily carried and used in a variety of locations. A quick glance at the size of a laptop and you might guess that it would be difficult to expand or upgrade**.** While the desktop computer case is relatively easy to open and access internal components, the small laptop case makes this more difficult in comparison; however, the primary benefit of a laptop computer is its small size and easy portability**.** A laptop computer is sometimes called a notebook computer because of its size.

(b) Minicomputers

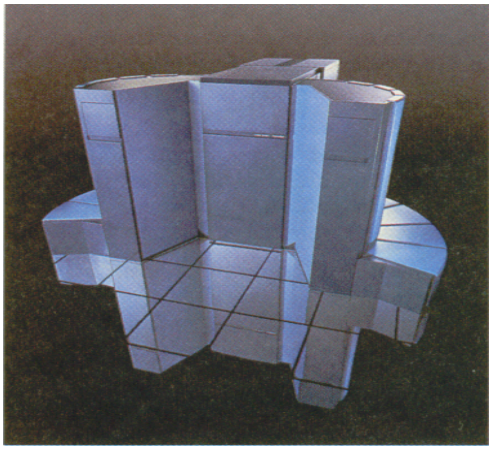
These were the main type of computers available in the late 1950s. Unlike PCs, minicomputers or minis – as they are often called – are multi-user and multi-tasks computers. Multi-user - in the sense that they can accommodate more than one user at the same time and multi-task - as they can be made to be executing more than one task simultaneously. Minis are often larger in size than PCs and possess more than one processor that is also more powerful and faster than those found in personal computers. Users are connected to minicomputers from different locations through terminals – consisting of only monitors and keyboards. A typical mini can accommodate up to 100 users or more and within a radius of up to 200 meter square area making them suitable for Local Area Networks.

(c) Mainframes

Mainframes are an improvement on minis. Very fast medium-to-large size, large-capacity computers introduced in the late 1960s. Their size varies depending on how many people or concurrent users they serve – from few hundred to thousands of people. Because they have larger operational range, they are used in Wide Area Network connecting locations across cities and even countries. Mainframes are used by banks, airlines, insurance companies, mail-order houses, universities and some governmental agencies and organizations.

Figure 1.6 A Mainframe computer

(d) Supercomputers



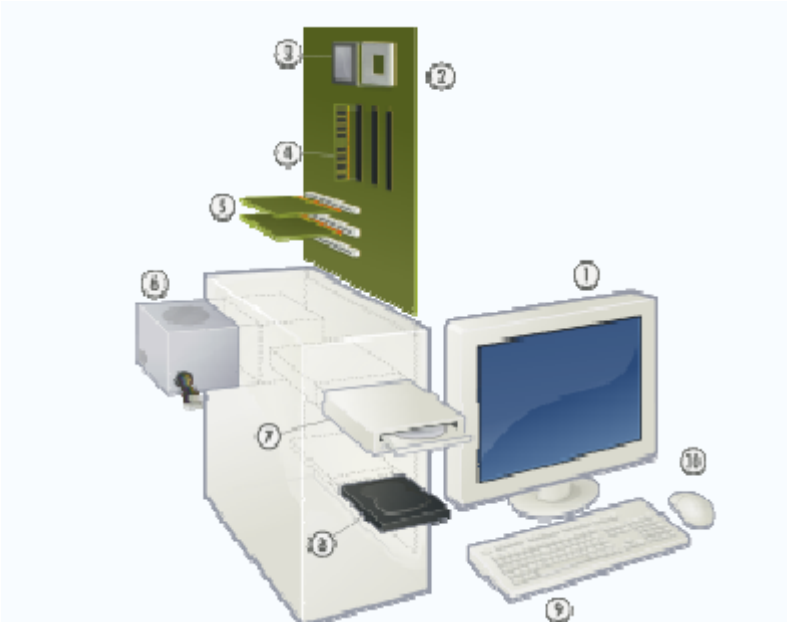
These types of computers were first developed in the 1970s. Supercomputers are the fastest and the highest capacity computers. Their cost ranges from hundreds of thousands to millions of dollars. They may occupy special air-conditioned rooms and are often used for research. Among their uses are worldwide weather forecasting, oil explorations, aircraft design, evaluations of aging nuclear weapon systems and

Figure 1.7A Supercomputer Sandia National Lab., Albuquerque, New Mexico, U.S.A

complex calculations in mathematical research. Supercomputers have hundreds to thousands of processors. One supercomputer Option Red fills about 85 locker-size cabinet of about 1600 square feet at Sandia in Albuquerque, New Mexico in the U.S.A.

Computer Information Systems of modern times consist of a combination of computers – hybrid model. Because microcomputers are generally versatile, increasingly powerful, and more affordable than the other types of computers, they are practical tools for organizations to improve their productivity. Whatever their size, speed, and capacity, all computers operate according to similar principles.

Basic Parts of a Desktop Computer



Exploded view of a modern personal computer:

1. Display	2. Motherboard
3. CPU (Microprocessor)	4. Primary storage (RAM)
5. Expansion cards	6. Power supply
7. Optical disc drive	8. Secondary storage (HD)
9. Keyboard	10. Mouse

The computer case is the metal and plastic box that contains the main components of the computer. It houses the motherboard, central processing unit (CPU), the power supply, and more. Computer cases come in different shapes and sizes. A desktop case lies flat on a desk, and the monitor usually sits on top of it. A tower case is tall and sits next to the monitor or on the floor. The front of the case usually has an on/off switch and two or more drives.

Figure 1.8 Computer Case

Monitor

Figure 1.9 An LCD Monitor A CRT Monitor

The monitor works with a video card, located inside the computer case, to display images and text on the screen. The two main types are cathode ray tube (CRT) and liquid crystal display (LCD) monitors.

The CRT monitor is big, like a tube television, and takes up a lot of desk space; however, it is the least expensive monitor option. The LCD monitor is thin and saves energy, but costs more. Over the years you can expect to see fewer CRT monitors if not completely eliminated

as LCD monitors become the standard.

Your monitor has an on/off button and other control buttons that allow you to change your monitor's display. Control buttons are either visible or located behind a small panel. Additionally, some monitors have built-in speakers.

Power Cord

The power cord is the link between the power outlet and the power supply unit in the computer casing. If the power cord is not plugged in, the computer will not power on. It is a good idea to keep the power cord plugged into an Uninterruptable Power Supply (UPS), which serves as a surge protector with its own temporary power source.

Figure 1.10 Power cord

Keyboard

Figure 1.11 Keyboards

The keyboard is a piece of hardware that resembles a typewriter keyboard. It is one of the primary ways we communicate with the computer and enter data. There are many different types of computer keyboards such as wired, wireless, ergonomic, multimedia, and more.

Although there may be differences in the location of some keys or features, keyboards are very similar and allow you to accomplish basically the same tasks.

The Mouse

Figure 1.12 A Mechanical Mouse

The mouse is a peripheral that is known as a pointing device. It lets you point to objects on the screen, click on them, and move them. Previously, it was considered an optional device, but now all desktop computers come with a mouse.

There are two main types of mice - optical and mechanical. The optical mouse uses an electronic eye to detect movement and is easier to clean. The mechanical mouse uses a rolling ball to detect movement and is more difficult to clean; however, it is less expensive, so many computers come with a mechanical mouse. Another decision you have when choosing a mouse is wired versus wireless. Wireless is popular right now, so it will be up to you to decide which type will work best for you.

Use of All Buttons, Sockets (Ports) and Slots.

Take a look at the front and back of your computer case and count the number of buttons, sockets (or Ports), and slots you see. Now, look at your monitor and count any that appear there. You probably counted approximately 20.

Each computer is different, therefore the buttons, slots, and sockets will vary from computer to computer; however, there are certain features you can expect to find on most desktop computers. Being familiar with the names of each and how they are commonly used will help you when the time comes for you to connect that new printer, mouse, digital camera, or other device.

Figure 1.13 Front of Computer Case

Front of Computer Case

Power Button

The power button is used to power the computer on and off. Additionally, you can use the power button on some computers to place the computer in different energy-saving modes such as hibernate, sleep, and standby. It is a good idea to read your manual to learn how these features work on your computer. The power button is usually directly above the keyboard, but can also be located on any of the four sides of the laptop casing.

- **CD-ROM (Compact Disk Read-Only Memory) Drive**
  A CD-ROM drive, also known as an optical drive, allows you to play a CD-ROM , just like a CD player allows you to listen to music. With a CD-ROM drive you can listen to music (if your computer is sound-enabled), view files, and install software that is located on a CD.

- **A CD writer** is a device that can be used in conjunction with a CD-ROM drive and allows you to copy or burn information onto specific types of CDs called CD-RW (Compact Disk Rewritable) and CD-R (Compact Disk-Recordable) discs.
- **DVD-ROM (Digital Versatile Disc Read-Only Memory) Drive.** A DVD-ROM drive, also known as an optical drive, reads DVD discs, all types of CDs, and can display movies from digital video discs. DVDs can hold more data than a CD, so they are a good storage option. A DVD burner is a device that can be used in conjunction with a DVD-ROM and allows you to copy information onto DVD discs. It is considered a type of storage. In many of the computers you can purchase today, the CD and DVD-ROM and/or burners are combined.

Audio In/Audio Out

Every computer has a bank of audio ports where you can connect various devices, including speakers, microphones, headsets, and more. This port may also be located at the back of the computer case.

Back of Computer Case

Ports

Ports serve as connecting nodes for peripheral devices. A port is a socket on the outside of the system unit that is connected by a bus to an expansion board on the inside of the system unit. It can also be connected directly to integrated circuitry on the motherboard. Through ports, peripheral devices like the monitor, keyboard, mouse and the likes are plugged in using a cable to set up communication with the computer system.

Microcomputers have different types of ports depending on the platform on which they are used – whether IBM / IBM-compatibles or Mac. On the back of the computer case are connection ports that are made to fit specific devices. The arrangement of these varies from computer to computer, and many companies have their own special connectors for the specific devices. Some of the ports are color coded to match a color on the device, which will help you determine which port is used with a particular device. . Some types of ports are described below.

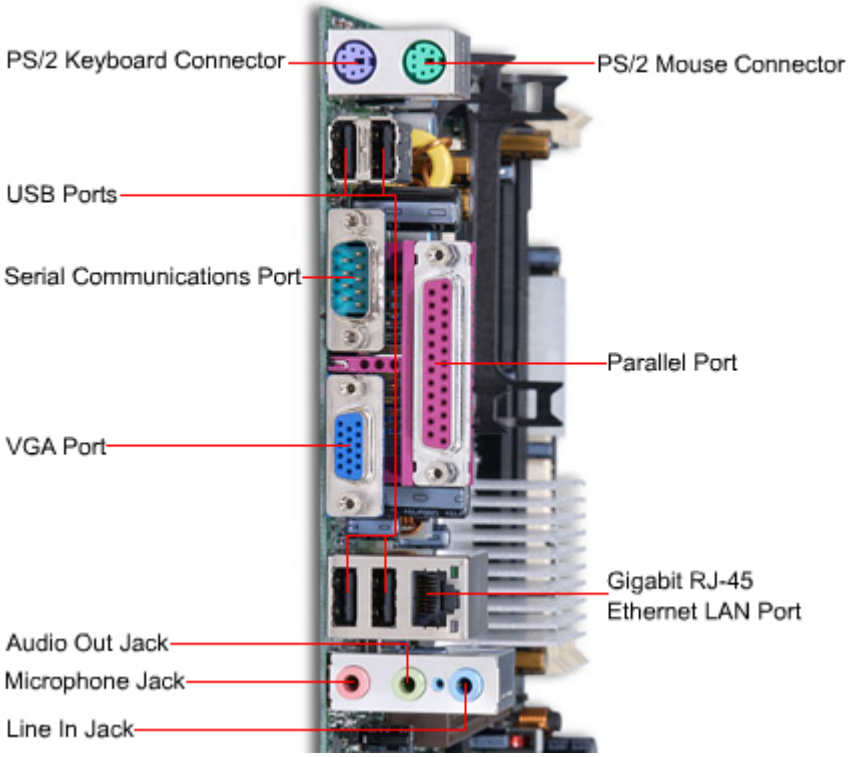


Figure 1.14 Labeled Back View of Computer Case

USB Port

The Universal Serial Bus port is one of the newest ports, but is also one of the most useful. These USB ports let you attach a variety of devices such as mice, printers, keyboards, web cameras, USB/flash drives, and digital cameras to your computer quickly. Almost every peripheral made comes in a USB version, and installing the devices using USB ports is much easier than connecting devices using parallel and serial ports. This is primarily because USB ports do not require you to reboot your computer before you can use the new device.

The Universal Serial Port typically appears on the back of the computer case, but can sometimes be found on the front of the case, or hidden under a panel on the front of the case.

PS/2 Port

These ports are called PS/2 ports and are used for the mouse and keyboard. Many people refer to them as the mouse port or the keyboard port.

Ethernet Port

This port looks a lot like the modem or telephone port but it is actually wider. You can use this port for networking and also connecting to the Internet. Ethernet

VGA Port

Your computer monitor can be connected to this port.

Labeled Back View of Computer Case (CONTINUED)

Figure 1.15 Labeled back view of Computer Case

Parallel Port

The parallel port is one of the two original ports on the first personal computer. It is commonly known as the printer port since this port is used to connect your printer to your computer; however, with the rise in use of the USB ports, you can expect to see a decrease in the use of this port. Currently, a large number of parallel port printers are still manufactured and used on older computers that don't have USB support.

Serial Port

The serial port is the other original port on the first personal computer. Serial ports can be used to plug in devices such as dial-up modems and other devices. On recent computers, the serial port has been replaced by the USB port. This is due to the fact that most peripherals use the USB drive.

SCSI ports: SCSI is an acronym for Small Computer System Interface and it is pronounced "scuzzy". In a *daisy chain* – linked SCSI-compatible devices that may include external hard

disk drives, magnetic tape, back-up units, scanners, or CD-ROM drives – transfer of data at high speed rate for up to fifteen SCSI-compatible devices is made possible by the SCSI port providing an interface.

Games ports: Game ports enable the attachment of game-playing devices like the joystick to the system unit.

Infrared ports: These are wireless, data-transfer ports on some state-of-the-art computers and hardware peripherals such as printers. Certain frequency of radio waves that require unobstructed line of sight between the transmitter and the receiver is used to transmit data in this type of connection.

FireWire Port: FireWire is actually the Apple brand name for the IEEE 1394 port, but the term caught on and this port is commonly referred to as the FireWire port. It is the standard port used with digital video cameras and high-resolution scanners. FireWire replaced the Parallel SCSI, but it is not on every computer; however, you can buy an adapter card to add FireWire ports to your computer. The labeled image does not include a FireWire port.

CHAPTER 2
Inside The Microcomputer

The box that contains the microcomputer's processing hardware and other components is called the system unit. The monitor, keyboard, and printer are not contained inside the system unit. Components that are inside the system unit includes the power supply, the motherboard, the microprocessor, specialized processor chips, RAM chips, ROM chips, other forms of memory – cache, VRAM, flash – expansion slots and boards, ports, bus lines, PC slots and cards. After all that have been said about the computer, it will serve a useful purpose if we could further take the mystery out of the computer by examining what is contained inside the box one after the other. Apart from the components listed above we also have the hard disk drive, a diskette drive, and a CD-ROM drive among components that are found inside the system unit. We shall however reserve discussion on secondary storage and other peripheral devices till next chapter. For now let us concern ourselves with the following parts of the system unit:

- ✓ Power supply
- ✓ Motherboard
- ✓ Microprocessor
- ✓ RAM chips
- ✓ ROM chips
- ✓ Other forms of memory - cache, VRAM, flash
- ✓ Ports
- ✓ Expansion slots and boards
- ✓ Buses, PC slots and cards

You might have heard some of these components or terms mentioned in advertisements for PCs and been wondering what all these jargons are. Hold it a second. We are going to demystify them all now.

The Power Supply

The power supply is the device that converts power from AC to DC to run the computer. The electricity available from a standard wall outlet is an alternating current (AC) but

microcomputers run on direct current (DC). The on/off switch in the computer turns on or shut off the electricity to the power supply. As electricity generates lots of heat, a fan is provided to cool the components and prevent them from getting too hot.

For precaution sake, it is advisable to connect your computer to an uninterrupted power supply (UPS) or surge protectors instead of connecting it directly to the electricity power outlet. This is because electricity from a standard AC can be quite uneven and a sudden surge in voltage can burn out the low-voltage DC circuitry of the machine, thus "fry the motherboard".

The Motherboard

The motherboard (or main board or system board) is the primary circuit board for a personal microcomputer. Many other components connect directly or indirectly to the motherboard. Motherboards usually contain one or more CPUs, supporting circuitry and ICs for CPU operation, main memory, and facilities for initial setup of the computer immediately after being powered on (often called boot firmware or a BIOS). In many portable and embedded personal computers, the motherboard houses nearly all of the PC's core components. Often a motherboard will also contain one or more peripheral buses and physical connectors for expansion purposes. Sometimes a secondary daughter board is connected with the motherboard to provide further expandability or to satisfy space constraints.

If you decide to open the computer case and take a look, be sure to touch a grounded metal object to discharge any static buildup. Static electricity can be transmitted through the computer circuits and ruin them.

The Microprocessor (CPU/Processor)

The Central Processing Unit (CPU), also called a processor, is located inside the computer case on the motherboard. It is often called the brain of the computer, or the computer's engine. Its main function is to interpret the various instructions in a given program. After the interpretation it may either carry out the instructions or sees to it that the component responsible for carrying out such an instruction carries it out accordingly.

The processor has two main components namely the Arithmetic-Logic Unit (ALU) and the control Unit (CU). The ALU is the component that performs all the arithmetic and the logical operations, that is, operations such as addition, subtraction, multiplication, division and comparison of two or more items are all done by the ALU. The ALU has a number of registers and an interconnection between the different components of the Computer. The CU is the unit that fetches the next instruction to be executed from the main memory. It decodes the fetched instruction and issues appropriate command to the ALU, the memory or the input/output controllers for the execution of the instruction.

The CPU is generally a 2 inch ceramic square with a silicon chip located inside. The chip is usually about the size of a thumbnail. The CPU fits into the CPU socket, which is covered by the heat sink, an object that absorbs heat from the CPU. There are many processor manufacturers for personal computers including Intel, Cyrix, VIA, and AMD.

Today, the clock speed of a processor is measured in giga Hertz (GHz). Two identical processors having different clock speeds will run at different speeds. The processor with the higher clock speed will execute instructions faster than the one with a lower clock speed.

The market of microprocessor is shared between the two giants in the hardware industry – Intel and Motorola. While Intel develops processor chips for IBM and IBM-compatibles, Motorola chips power Apple Macintosh computers.

Microprocessors are “downward compatible” with older chips meaning one can run software for old version chip on a newer version. That is, that your word processing software and files running on Pentium II machine will continue to run if you upgrade to Pentium III.

Primary storage

Primary storage, or internal memory, is computer memory that is accessible to the central processing unit of a computer without the use of computer's input/output channels. Primary storage is used to store data that is likely to be in active use. Primary storage is typically very fast, in the case of RAM which is also volatile, losing the stored information in an event of power loss, and quite expensive. ROM is not volatile, but not suited to storage of large quantities of data because it is expensive to produce. Typically, ROM must also be completely erased before it can be rewritten, making large scale use impractical, if not impossible. Therefore, separate secondary storage, or external memory, is usually required for long-term persistent storage.

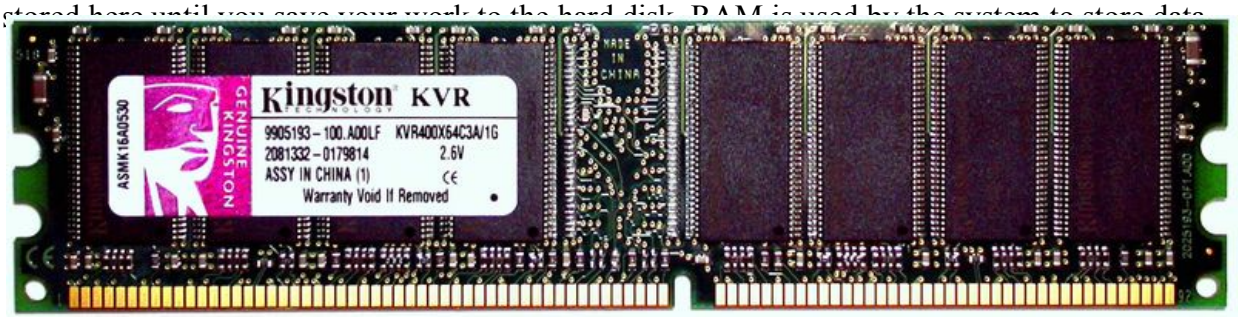
Confusingly, the term primary storage has recently been used in a few contexts to refer to online storage (hard disks), which is usually classified as secondary storage. Primary storage may include several types of storage, such as main storage, cache memory, and special registers, all of which can be directly accessed by the processor. Primary storage can be accessed randomly, that is, accessing any location in storage at any moment takes the same amount of time. A particular location in storage is selected by its physical memory address. That address remains the same, no matter how the particular value stored there changes.

Today, primary storage is typically random access memory, a type of semiconductor memory. Over the history of computing hardware, a variety of technologies have been used for primary storage. Some early computers used mercury delay lines, in which a series of acoustic pulses were sent along a tube filled with mercury. When the pulse reached the end of the tube, the circuitry detected whether the pulse represented a binary 1 or 0 and caused the oscillator at the beginning of the line to repeat the pulse. Other early computers stored primary memory on rapidly rotating magnetic drums.

RAM Chips

The main memory or the RAM (random access memory), is the temporary work space for the processor. Remember we said the main memory is the workbench for the processor. It temporary holds data and instructions that will be needed shortly by the processor. RAM is like a notepad that is constantly being written onto, then erased, and then written onto again.

RAM (Random Access Memory) is your system's short-term memory. Data is temporarily stored here until you save your work to the hard disk. RAM is used by the system to store data



that is processed by a computer's CPU. The computer's work takes place in RAM. This is where programs run when you are using Word to create a letter, or Excel to produce a company spreadsheet.

This short-term memory disappears when the computer is turned off, so always save your file before turning off the machine. When you save a file, you are saving it to long-term storage that does not disappear when the computer is turned off.

The more RAM you have, the more things your computer can do at the same time, and the faster your computer performs certain tasks. RAM is measured in megabytes (MB) or gigabytes (GB). In many cases, additional RAM chips can be added by plugging a memory-expansion card into the system board. If the RAM is insufficient to run software, the computer will place part of the software and data on the secondary memory. This means that the computer will constantly be swapping data back and forth between RAM and disk thereby slowing down rate of processing. A Microcomputer or PC will need at least 32 MB of RAM to run most of today's software. Having enough RAM has therefore become a determining factor for processing power of the microcomputer.

To understand megabytes and gigabytes, you need to know about bits and bytes. A bit is the smallest unit of data in computer processing. A byte is a group of eight bits. A megabyte is about one million bytes. A gigabyte is 1,024 megabytes. To put this into perspective, consider that a printed page of single-spaced text contains about 3,000 characters. One MB holds about 400 pages of single-spaced text.

ROM Chips

The Read Only Memory (ROM) chips also called firmware, cannot be written on or erased by the computer – as the name suggests, its content can only be read. Firmware is the term that is used for software permanently stored on a chip – microprogrammed. If we say that RAM chips temporarily remembers (information supplied by the user or software), then ROM chips can be said to permanently remember (information supplied by the manufacturer). ROM chips contain instructions that need to be available at all times for the computer to "get up and run". One of these is the *bootstrap* – instructions that tell the computer what to do when it is switched on or booted. To get the computer going, a ROM also performs a "power-on-self-test" (POST). Another ROM contains the BIOS (Basic Input/Output System) – instructions that oversees the transfer of information to and fro the input and output devices and other peripherals to ensure that all units function properly. Fundamentally, ROM BIOS is an interface, a connector, and translator between the computer hardware and the software that you run. Yet another ROM chip tells the computer how to construct each character displaying on the screen.

There are three variations of ROM chips that are used in special situations. The three variations are PROM, EPROM, and EEPROM.

PROM: Programmable Read - Only Memories are blank chips on which instructions or programs are written using special equipment. Once the program is written, it cannot be erased. Some microcomputer software packages come on PROM units.

EPROM: Erasable Programmable Read Only Memories are like PROM chips except that the contents can be erased, using special equipment and new data or instructions can be written. A special device that uses ultraviolet light is used to erase its content.

EEPROM: Electronic Erasable Programmable Read-Only Memory can be reprogrammed using special electrical impulses. The advantage of EEPROM chips is that they need not be removed from the computer to be reprogrammed.

Other Forms of Memory

In trying to further enhance processing speed, one of the means devised was to find a faster way in which data can be transferred to and fro between the processor and the main memory. In the most powerful computers and in high-end microcomputers, RAM is divided into two sections with one section relatively large and called the *main RAM*. The other section called

the *cache memory* being tiny and containing few but more expensive chips. Cache memory is a special high-speed memory area that the processor can access quickly. It serves as a buffer (or bridge) between the processor and the main RAM. A special program transfers data and instructions that were transferred to the RAM from the RAM to the processor to minimize swapping of instructions back and forth the secondary storage by the processor and thus enable it run faster.

Video RAM (VRAM) or video memory chips are used for storing and displaying images on the monitor. The capacity of VRAM determines how fast images are processed and how many colors can be used to display images. VRAM chips are mounted on a special but small board known as *video adapter card.* Video adapter cards are usually inserted in an expansion slot on the motherboard.

Another form of memory is the *flash RAM cards* that consist of circuitry on a credit-card-size plate or card. Flash RAM cards are derived from EEPROM and are non-volatile. They are used to simulate main memory and also to back up or supplement the hard disk drives. Connection is by means of insertion in slot on motherboard.

Expansion Slots

Modern microcomputers are built in such a way that they can be opened for users to add new devices to enhance existing capabilities. This type of computer architecture is known as *open architecture* and it spares users from having to change to a totally new computer anytime they want to upgrade their system. *Expansion slots* are sockets into which you can plug expansion cards. These sockets connect to buses.

Expansion Boards (or Cards)

Expansion boards, otherwise known as add-on boards are circuit boards that provide more memory or control peripheral devices. Boards and cards are sometimes used interchangeably. Types of expansion cards include expanded memory cards, display adapter or graphic cards, and controller cards that enable the microprocessor to work with different brands of some particular devices. There are also some other add-ons such as cards for modems, fax, video capture and networking. Expansion cards are inserted into expansion slots on the

motherboard. For example, your computer's video card is an expansion card plugs into the expansion slots.

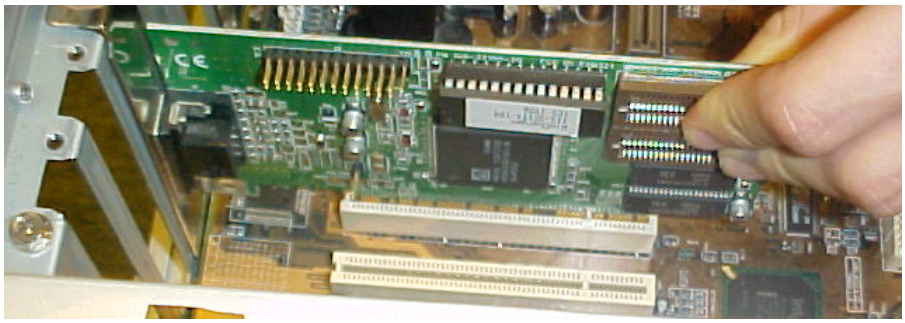


Figure 2.6 An Expansion Board

Video card

The video card is responsible for what you see on the monitor. If you like playing graphic-intense games on the computer, a good video card is important to you. The main function of the video card is to generate and output images to the computer screen. Better graphics card equals better performance when playing games or working on a high resolution monitor.

Sound Card

The sound card, also called an audio card, is another type of expansion card. It lets the computer play sounds through speakers. Some motherboards feature integrated sound, and do not require a separate sound card.

Network card

The **network card** allows your computer to **communicate** over a network. With the network card you can set up a home network with a few computers and connect them by via Ethernet cords or wirelessly. Network cards used to be expansion cards that plugged into the motherboard; however, most new computers have a network interface built into the motherboard.

Figure 1.17 A network card

Communication Devices

Communication devices make it possible for computers to communicate with each other and share information and other resources in a network environment. When computers are linked together to facilitate some form of communication, such a set up is referred to as a Network. When the radius of the network is within a short range, the network is called a Local Area Network (LAN) and if the radius spans over long distances like cities and even countries, it is called a Wide Area Network (WAN).

Computers, though can be "stand-alone" machines, that is, they are not connected to any other computer, connecting computers to communicate and share resources like information and hardware vastly extend the computers range and utility.

Computer communication is accomplished in two ways. We have wired connection and wire-less connection. Wired connection is implemented with the use of telephone lines and cables and wire-less connection with the use of microwaves and radio waves. In the transmission of information from one computer to another, particularly wired connection which is most predominant, a piece of hardware known as modulator-demodulator and commonly called a *modem* is needed for conversion of signals from digital form into analog form and vice-versa as transmission over telephone lines is in analog form while computer data to be transferred are usually in digital form. Other forms of channels are the cables. In this category, we have the coaxial cable and the fiber- optic cable.

Coaxial cable commonly called "co-ax", consists of insulated copper wire wrapped in a solid or braided metal shield, then in an external cover. Co-ax is mostly used for cable television and to connect parts of a LAN over a long range. A fiber-optic cable consists of hundreds of thousands of thin strands of glass that transmit pulsating beams of light rather than electricity. These very thin strands – as thin as human hair – can transmit billions of pulses per second with each "on" pulse representing one bit, that a 0 or 1 digit. Remember that we said data are represented digitally in series of 0s and 1s.

In wire-less connection, microwaves system devices are used. Microwave systems transmit voices and data through the atmosphere as high-frequency radio waves. Microwaves are electromagnetic waves that vibrate at 1 billion hertz per second or higher. These frequencies

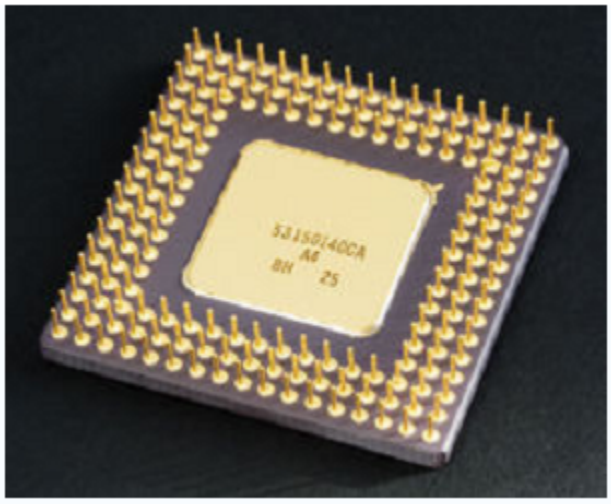
are used to transmit messages between ground-based earth stations and satellite communications systems.

Buses

A bus is simply an electronic highway by which bits of data are transferred within the processor and also between the processor and other peripheral devices in the system unit. The computer's internal bus or the processor bus takes care of data transfer within the processor and the other type – expansion buses – takes care of data transfer between various peripherals connected to the computer systems through expansion cards inserted in the system board and the processor. A bus has two parts namely the address bus and the data bus.

Computers transmit data in parallel form. That is, in groups of bits. For example, a 16-bit bus will transmit 16 bits (2 bytes) of data at a time and a 32-bit bus will transmit 32 bits (4 bytes) of data at a time.

CHAPTER 2 CENTRAL PROCESSING UNIT



The central processing unit (also called the processor or CPU) is the brain of the computer. It receives all program instructions, performs the arithmetic and logical operations necessary to execute them, and controls all the other computer components. In a microcomputer or PC, the processor consists of hundreds of thousands of transistors residing on a single chip the size of a large postage stamp and plugged into the computer's main circuit board, the motherboard. Since the mid-1970s, single-chip microprocessors have almost totally replaced all other types of CPUs, and today the term "CPU" is usually applied to some type of microprocessor.

More than any other component, the CPU distinguishes one computer from another. In the kind of computer you will be using (technically known as Window-based or IBM-compatibles for reasons we shall discuss later), the processors are usually referred to by their part numbers; for example, 80286, 80386, or 80486 – the larger the number, the more powerful the CPU. The 80286 was a 16-bit chip (remember a bit is either a 0 or 1) because it can process 16 bits of information at a time. The 80386 and 80486 were 32-bit processors. The latest most powerful in the line of CPUs for IBM-compatibles is the Pentium family of processors comprising of Pentium, Pentium II, Pentium III, and Pentium IV. These are 64-bit chips.

Processors are also distinguished from one another by speed (in megahertz, MHz and Gigahertz, GHz) at which they can process information. Thus, in an advert for a processor, you may see it referred to as 550 MHz Pentium III, or 800 MHz Pentium III machine. This is shorthand for a computer equipped with a Pentium III processor running at 550 megahetz (MHz) or a Pentium III processor running at 800 megahetz (MHz).

Data and Program Representation

As we had mentioned earlier, the computer uses binary digits - which simulates its digital mode of operation – to represent characters. This is the language that the computer "speaks and understand" – the machine language. Capacity of a computer is expressed in bits, bytes, kilobytes, megabytes, and gigabytes. The two common binary coding schemes normally used in data representation are the ASCII- and EBCDIC-codes. There are also the Parity-bit schemes that are used for accuracy.

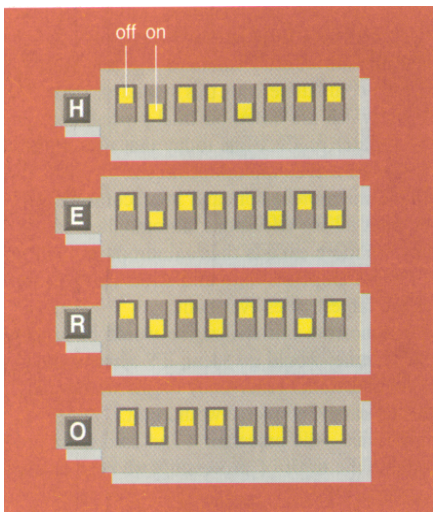


Figure 2.1 Digital representation of data

Unlike the decimal system that we are accustomed to, which has 10 digits: 0, 1, ..,9, the binary system has only two digits; 0 and 1. Thus, in the computer, the 0 can be represented by the current being off (or at low voltage) and the 1 by the current being on (or at high voltage). All characters, in other words, data that go into the computer are represented this way. For example, the letter H has a representation of the electronic signal 01001000, or off-on-off-off-on-off-off-off. So that when you enter the letter H from the keyboard, the character is automatically converted into series of electrical impulses that the computer is able to recognize.

Binary numbers consisting of series of 0s and 1s are the basis of all the "miracles" that the computer performs. The binary digits, bits, are stored as charged and uncharged memory cells in the computer memory. These bits are stored as positively and negatively charged magnetic spots on magnetic tapes and disk. For output, the bits are converted into visual characters by the monitor and printers. However, the data that are entered into the computer from the input devices are encoded using *binary* or *digital coding schemes* to represent letters of the alphabets, numbers, and special characters.

The two most common coding schemes are ASCII and EBCDIC. In each of these schemes letters, numbers and all special characters are assigned unique numbers that are translated into

hexadecimal numbers and represented using binary digits. Thus, 8 bits – 1 *byte* – are used to represent a character. In other words any single character occupies 8 bits or 1 byte of memory space.

ASCII, which is an acronym for ***American Standard Code for Information Interchange***, and pronounced as *"as-key"*, was later extended to accommodate more special characters and the latter version was referred to as *extended ASCII* or ASCII-8. The latest of the versions is the ASCII-16 coding scheme which uses 16 bits. ASCII is the most widely coding scheme used in microcomputers.

ASCII originally uses 7 bits but microcomputers use 8-bit bytes, so a zero was added in the left positions to provide an 8-bit code, providing 256 combinations with which to from letters, numbers, and characters, such as mathematical symbols and Greek letters. Although ASCII is able to handle the English language well, it cannot handle all characters of some other languages like Chinese, Japanese, and Arabic, hence the need for its extension.

Unicode or **ASCII-16** which is a version of ASCII uses 2 bytes (16 bits) to represent a character, instead of 1 byte (8 bits) and therefore can handle 65,536 characters rather than just 256. As both hardware and software engineering advance to support multi-lingual applications conversion to Unicode seems likely but might still takes some time. The disadvantage of Unicode or ASCII-16 is that characters takes up twice as much memory space and disk space as each ASCII character.

EBCDIC, pronounced as *"eb-see-dick"*, and stands for ***Extended Binary Coded Decimal Interchange Code*** is the most widely used scheme in mainframe computers. Table 2.1 shows the codes for the uppercase alphabetic letters and numerical digits, 0 to 9. (See Table 2.1)

Character	***ASCII***	***EBCDIC***	***Character***	***ASCII***	***EBCDIC***

A	0100 0001	1100 0001	**N**	0100 1110	1101 0101
B	0100 0010	1100 0010	**O**	0100 1111	1101 0110
C	0100 0011	1100 0011	**P**	0101 0000	1101 0111
D	0100 0100	1100 0100	**Q**	0101 0001	1101 1000
E	0100 0101	1100 0101	**R**	0101 0010	1101 1001
F	0100 0110	1100 0110	**S**	0101 0011	1110 0010
G	0100 0111	1100 0111	**T**	0101 0100	1110 0011
H	0100 1000	1100 1000	**U**	0101 0101	1110 0100
I	0100 1001	1100 1001	**V**	0101 0110	1110 0101
J	0100 1010	1101 0001	**W**	0101 0111	1110 0110
K	0100 1011	1101 0010	**X**	0101 1000	1110 0111
L	0100 1100	1101 0011	**Y**	0101 1001	1110 1000
M	0100 1101	1101 0100	**Z**	0101 1010	1110 1001
0	0011 0000	1111 0000	**5**	0011 0101	1111 0101
1	0011 0001	1111 0001	**6**	0011 0110	1111 0110
2	0011 0010	1111 0010	**7**	0011 0111	1111 0111
3	0011 0011	1111 0011	**8**	0011 1000	1111 1000
4	0011 0100	1111 0100	**9**	0011 1001	1111 1001

Table 2.1 ASCII and EBCDIC coding Schemes

Machine Language

Machine language – the language that the computer "speaks and understands" – is the binary programming codes which can be processed directly. Instructions in machine language consist of series of 0s and 1s which could be quite tedious to read and write to humans. One may ask, however, if this is the case why then will a program run on one computer and not on another. Software package that run on IBM compatible PC running Windows may not work on Apple Macintosh. This is due to differences in their underlying hardware, particularly, the processor on which they are running. Thus each model or family of processors has a unique machine language. If this so wouldn't it be too horrendous and difficult for programmers to write computer programs in series of different machine languages.

To circumvent this problem, programmers write in special programming languages – high level languages – that more closely resemble human languages. Codes in these high level languages such as BASIC or C++ are then translated by system software programs called language *translators* or *compilers* into the machine language that the particular type of processor can "understand". However, because this translation occurs virtually instantaneously, the user is not aware of it.

Computer Memory Capacity

How much data – in other words, how many 0s and 1s – a computer memory or a storage device can hold is very important for its operation. As we already mentioned, a 0 or 1 occupies one ***bit*** of memory space. A character consists of eight bits thus occupies eight bits of memory space. As data are keyed into the computer in characters, bits are grouped into eight bits – 1 byte. A ***Byte*** is used to hold a letter, number, or a special character (such as *, &, $, etc).

Bytes are grouped into larger denominations of kilobyte, megabyte, gigabyte, and terabyte. Just hold your breadth at these jargons. We shall demystify them now. Because, we are dealing with a code in binary forms – base 2 – we do not have a number which is a power of 2 that is precisely 1000, the closest number, 1024 (which is 2^{10}) is therefore used. Thus 1024 or 2^{10} bytes are grouped together to form 1 ***kilobyte (KB).*** The kilobyte is the common unit of measure for internal memory of microcomputers. An average printed page such as in this book would take up about 2500 bytes or 2.5 kilobytes of memory space.

A ***Megabyte (MB)*** is about 1 million bytes. Precisely 2^{20} bytes (1,048,576 bytes) or 2^{10} KB. Capacities of secondary memory devices – such as floppy diskettes – are often expressed in megabytes. A floppy diskette for example has a capacity of 2 MB.

A ***Gigabyte(GB)*** is about 1 billion bytes. Precisely 2^{30} or 1,073,741,824 bytes or 2^{10} MB. This measure is often used to measure the capacity of hard disks of microcomputers or PCs, CD-ROMs and main memory capacity of mainframes and supercomputers. A typical CD-ROM has a capacity of about 740 – 800 MB approximately text document that will consume about 300,000 sheets of paper.

A ***Terabyte(TB)*** represents 1 trillion bytes or 2^{40} bytes or precisely 1,009,511,627,776 bytes. Supercomputers main memory capacities are expressed in terabytes.

RAM Capacity, Word Size and Processing Speed

RAM capacity

The power of a computer is determined by the capacity of its main memory (RAM), the number of bits it can handle at one time, and the speed at which it can execute a machine cycle plus the capacity of its secondary memory - or the hard disk. You will recall in Chapter 1 that we classified computers according to how powerful they are: supercomputers, mainframes, minicomputers, workstations, microcomputer, and microcontrollers. Their power is measured according to three main parameters: RAM capacity, wordsize capability, and processor speed. There are other deciding factors, though these three are the most important.

Remember we said the main memory to the computer is what a workbench is to the craftsman or the carpenter. The more spacious the workbench is the more convenient and voluminous the work that can be done on it. The capacity of the RAM therefore determines how large the software that can be run on any computer and how fast it can run. As we mentioned earlier, the main memory of most microcomputers are measured in megabytes (MB). If a microcomputer has less than 16 MB RAM, it will not be able to handle Windows and many Window-based application efficiently. Many software manufacturers recommend 32 MB and above of RAM space for microcomputers. In fact, today some high-end microcomputers have as large as 512 MB RAM. The RAM capacity of mainframes and supercomputers is measured in gigabytes (GB) and supercomputers' RAM capacity runs into terabytes (TB).

Wordsize

The next deciding factor of the power of a computer is its *wordsize* – the number of bits its register can hold and process at one time and can be transferred to and from memory, output / input devices and remote sites through its internal bus – electronic highway. A 32-bit processor will process data and instructions in 32-bit chunk and a 64-bit processor in 64-bit chunk thereby being twice faster.

It should be noted that *expansion bus capacity* (also measured in word size), the capacity of the bus that connects the processor, RAM, and registers to the peripherals of the computer also plays a major role. We may therefore characterize a processor by how many bits it can process at any one moment and how many bits it can send or received at a time. All these are main determinants of the speed of the processor.

Processor speed

With transistors of the processor switching on and off at perhaps millions of times per second, the repetition of the machine cycle occurs at a blinding speed. Processor speed is measured in three ways with respect to the frequency of its system clock (in megahertz), the number of instructions processed per second and floating-point operation per second.

Every computer contains an internal timing device that is switched on when the power of the computer is turned on. This device is called the system clock. The system clock controls the pace at which all operations take place. The device uses fixed vibrations from a quartz crystal to deliver a steady stream of digital pulses to pace the processor. The faster the clock, the faster the processing. Microcomputer processing speeds are often measured in megahertz (MHz), with 1 MHz equal to 1 million machine cycle or beats per second. Average speed of PCs of toady ranges between 550 – 800 MHz. It is not uncommon today to find PCs running on Pentium IV processors at 1800 MHz (1.8 GHz) or even faster.

Processing speed of Workstations and Mainframes are often measured in number of instructions processed per second (IPS) which currently runs into millions. Thus, MIPS (million of instruction per second) is a measure of computer processing speed. As technology advances high-end microcomputers like Pentium IV processors are able to attain a speed of millions of instructions per second with workstations and mainframes running at a blinding speed of billions of instructions per second (BIPS).

For Supercomputers, processing speed is often measured in *flops* – floating-point operation per second. Floating-point operation is a special kind of mathematical calculations. This measure is often expressed in *megaflops* (millions of floating-point operations per second), *gigaflops* (billions of floating-point operations per second) and *teraflops* (trillions of floating-point operations per second). The Option Red supercomputer runs at amazing 1.8 teraflops. If you did one arithmetic operation every second, it would take you more than 31,000 years nonstop to do what Option Red will do in second or what whole world population will do in $3^1/_2$ years!

CHAPTER 3 INPUT / OUTPUT DEVICES

Input / Output devices or simply I/O devices translate all data going into the computer into series of binary digits of 0s and 1s which is what the computer understands. They also translate back these binary digits coming out of the computer into characters that are understandable by humans.

Input devices consist of devices that translate data which are usually in humans' natural languages into the form that can be processed by the computer. Whereas the language of human beings consists of words and sentences the computer language otherwise called machine language consists of 0s and 1s.

Output devices are devices responsible for conversion of computer-processed information which are in the machine language into human readable form of characters, words and sentences of natural language. We shall cover a few more input devices next.

Input Devices

Input devices include keyboards, pointing devices, and source-data entry devices like scanners and digital cameras as well as voice and audio/video input devices like microphones and video cameras. The most common input device and the one you will probably have to learn how to use is *the keyboard*. The computer keyboard unlike the ordinary typewriter keyboard converts letters, numbers, and other characters into electrical signals in machine language and can be processed by the computer processor. The computer keyboard looks like the typewriter keyboard though with some additional special characters.

Other devices that are commonly used in conjunction with the keyboard are pointing devices like the mouse. These devices control the position of the cursor – pointer on the screen. Pointing devices include:

- Mice, trackballs, and joysticks
- Light pens
- Digitizing tablets
- Pen-based systems

Data-entry devices that do not require keyboard for inputting data include the following:

- Scanners
- Voice-recognition devices
- Audio input devices
- Video input devices
- Digital cameras

Often times we find keyboard, pointing device and other source-data entry devices like scanners combined in a single computer systems. For example, in typesetting this textbook using wordprocessor, we combine keyboard, a mouse, and an image scanner.

The Keyboard

The keyboard is the commonest input device. It is usually connected to the system unit of the computer through a serial port with a cable. You do not have to be a touch typist to use the computer keyboard. It much resembles the ordinary typewriter keyboard but with additional keys to perform some special functions (Figure 3.1). The keys on the keyboard can be divided into four groups namely:

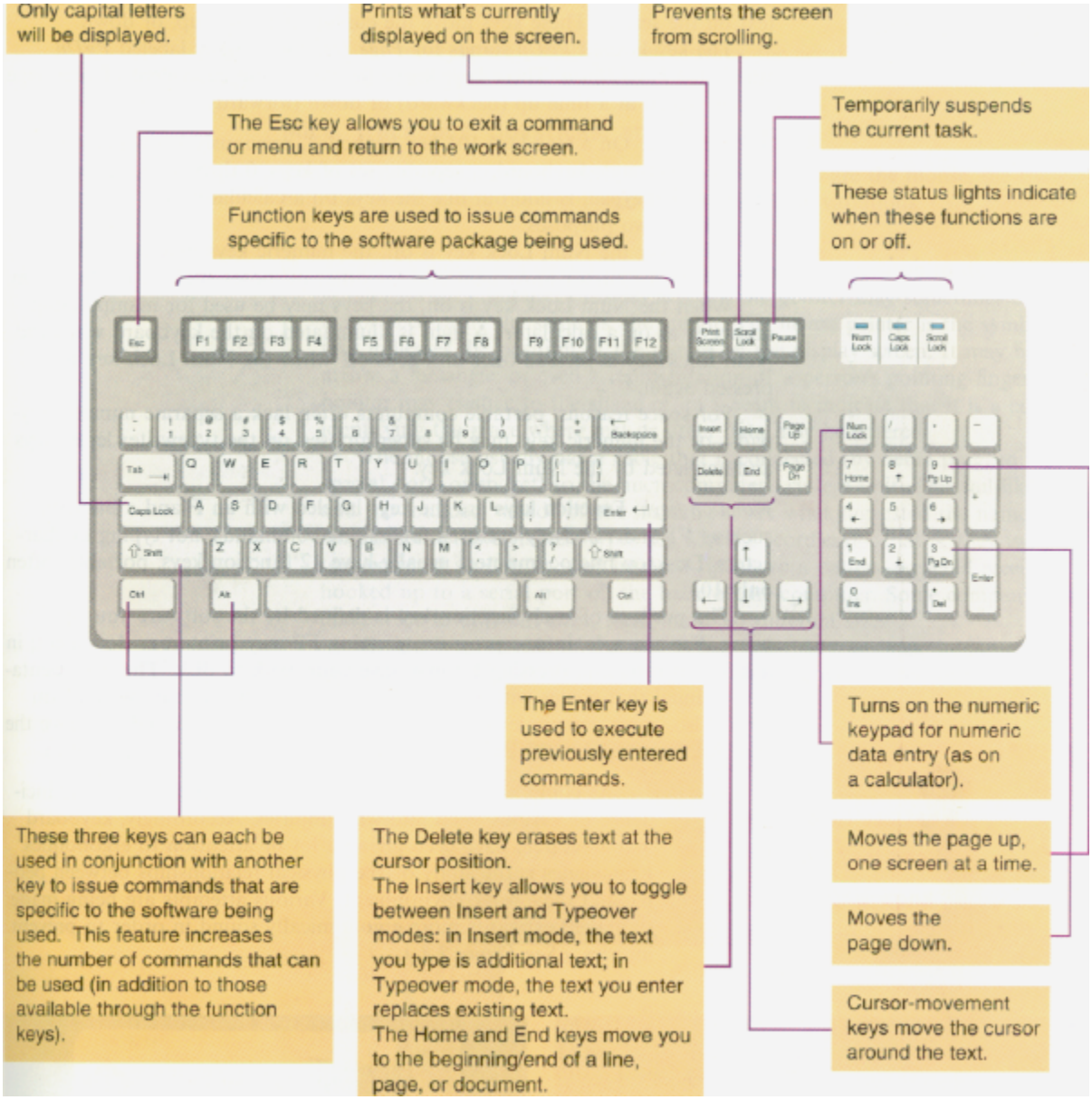
- Standard keys
- Cursor-movement keys
- Numeric keys
- Function keys

The ***Standard typing keys*** are similar to that of the typewriter with the familiar QWERTY arrangement of letter, number, and punctuation keys. QWERTY refers to the alphabets in the top left row on the standard typewriter keyboard. On the computer keyboard, it can be found on the third row. The Caps Lock, Shift, and Tab keys and also the Space bar work the same way as they do on a typewriter keyboard.

The Caps Lock key is a toggle key. When it is pressed the caps lock light is turn on to show you are typing in ALL CAPITAL mode until it is pressed again to reverse it to lower case letters. The Enter key that works like the return key on a typewriter – and even often referred to as the Return key – is used to send commands to the computer, in addition to beginning a new paragraph in a word processing environment.

Cursor-movement keys – sometimes called the arrow keys – are use to move the cursor around the text on the screen. The cursor is the blinking vertical bar on the screen that indicates insertion point or where data may be entered next. The cursor-movement keys move the cursor left, right, up, or down. Keys labeled Page Up and Page Down move the cursor the equivalent of one screen (page) up (backward) and down (forward) at a time respectively.

Figure 3.1 The Keyboard



Numeric keys are laid out separately on the *numeric keypad* – a separate set of keys, 0 through 9 like those on a calculator – on the standard 101-key keyboard previously known as the AT-style keyboard. The numeric keypad serves two purposes.

With the Num Lock key off, the numeric keys duplicate as arrow keys for the movement of cursor and perform other functions such as Page Up and Page Down. And when the Num Lock is on, the keys may be used for entering numbers, as on a calculator. The Num Lock key is also a toggle key like the Caps Lock key. However, to maintain keyboard standard the numeric keys can also be found on the second row of keys with other special characters just like the typewriter keyboard.

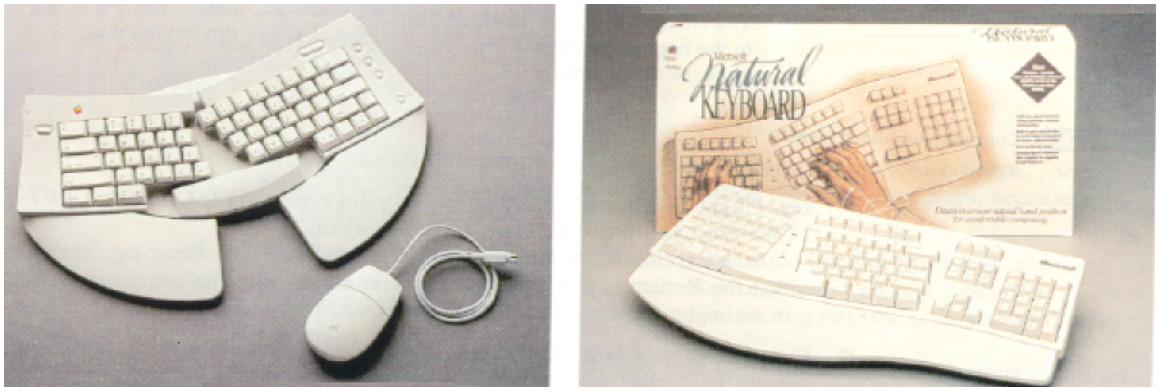


Figure 3.2 Some ergonometric keyboards

Function keys are the keys labeled F1, F2 through F12. These keys are not used for typing but rather for issuing commands. Desktops normally have 12 function keys while some portables like notebooks have only 10. The function that each of these keys perform are however software-specific.

Keyboard manufacturers, in recent years have been giving a lot of attention to ergonomics – the study of physical relationships between people and their working environment. Various designs of keyboards have been introduced to make working with keyboards more ergonomically sound.

Audio Input Devices

An audio input device records or plays analog sound and translates it for digital storage and processing. Voice-recognition devices are only one kind of audio input device which can translate music as well as other sounds. Analog sound is converted to digital data through sampling – the number of times per second analog sound is turned into binary digits.

In digitizing voice the computer samples the sound waves 8,000 times per second to attain FM-radio-quality output. Music is sampled 44,000 times per second to attain CD-quality output.

Video Input Devices

Like sound, video or photographic images are captured in analog forms with the signals being continuously varying waves. The signals that come from a VCR or a camcorder has to be converted into digital form through a special video card installed in the computer. The most common video cards are Frame-grabber and Full-motion video cards. Frame-grabbers can capture and digitize only one frame at a time. Full motion cards can convert analog to digital signals up to 30 frames per second (TV quality), giving effect of continuous flowing motion picture.

Figure 3.7 Webcam

Output Devices

Information processed by the computer is translated into human readable form by Output devices. These devices include printers, plotters, and multifunction devices; display screens and audio output devices. The most common of these however, are the monitor and printers. We may categorize output devices by their method of presentation – audio, softcopy, and hardcopy.

Audio output devices are devices that present information in sound form. Softcopy output devices present information on a screen, and hardcopy devices present information on paper.

Audio Output Devices

Audio Output devices are those devices that let you hear information in sound form. These include sound output devices and speech synthesis devices. Audio output devices use two forms of hardware:

- A sound card that translate the digital recording of sounds
- A set of speakers (any speakers at all, you may even hook up your Blaster speakers to get high-quality sounds)

Sound output devices reproduce recorded sounds whereas speech synthesis output devices actually 'create' speech output. A speech output system takes a text of sentence and produces the equivalent speech sound for human hearing.

Figure 3.9 Headphones

Figure 3.10 Loudspeakers

Softcopy Output Devices

These devices are the display screens or monitors. Monitors are the most popular softcopy output device. There are basically two types of monitors – the Cathode-Ray Tube (CRT) and the Flat-panel display (sometime referred to as Liquid-crystal display or LCD).

LCDs used to be mostly used in portables like laptops even though they are now becoming increasingly available for desktops computers too. Monitors, regardless of whether they are CRT or LCD are often described by their use of color and resolution. There is the olden type of monitors that uses only one color – monochrome – while we have modern type of monitors that can produce up to 17 million colors.

Resolution – sharpness of image – is determined by the number of pixels a screen contains. A pixel – short of picture element – is the smallest display unit on a screen that can be switched

on or off and made different shade of colors. Pixel resolution is measured in terms of the number of rows and columns that make up the matrix of a screen. For example, 1024 x 768 resolution implies that a screen has 1024 rows and 768 columns of pixels totaling 786,432.

Other properties of a monitor that determine clarity are *Dot-pitch* and *Refresh rate*. Dot-pitch is the amount of space between pixels, the closer the dots the crisper the image. For example a monitor with 0.25 dot-pitch – implying pixels are 0.25 mm apart – will produce a crisper image than a monitor with 0.30 dot-pitch. Refresh rate is the number of times per second that the pixels are recharged so that their glow remains bright. The higher the refresh rate the more solid the image looks on screen.

In reality however, type of monitor only partly dictates the use of color and resolution, what really determines color and resolution is the graphic board or graphic adapter card – the interface board that connects the monitor to the rest of the hardware. The best softcopy output device therefore is a monitor connected to a graphic adapter card that supports the largest number of colors and shades for that will produce the crispest and the most colorful image.

Figure 3.11 A CRT monitor

Hardcopy Output Devices

Hardcopy output devices produce output on some tangible medium like paper. They include printers and plotters. The most popular hardcopy output device is the printer. Plotters are special hardcopy devices capable of creating high-quality freehand drawing and pictures. Often used by graphic designers and architects to produce outputs such as drawings and home designs.

Printers are often categorized in terms quality of output and process of output. *Quality of output* is the sharpness of the images and text produced. Output quality can be draft, near letter quality, and letter quality. *Process of output* is how the printer records images and text on paper – impact or non-impact. Impact printers are those that strike the surface of paper with pre-arranged (matrix) pins to record images and texts. These types of printers are also referred to as *dot-matrix* printers. The quality of dot-matrix printers are either draft or near letter quality. Non-impact printers do not strike the surface of paper to produce texts or images. There are two categories of non-impact printers – ink-jet and Laser.

Figure 3.12 Laser Printer

Figure 3.13 Ink jet printer

Ink-jet printers are letter quality non-impact printers that spray ink onto the page. These ink droplets are formed by a special nozzle to form characters of text and images. The nozzle can also spray different colors. Laser printers use a laser beam source to create images on a drum. These images are magnetically charged to attract ink-like toner. The toner is then heated and a piece of paper passes over the drum to capture the images. Laser printers produce letter quality outputs.

Figure 3.14 Dot-matrix Impact Printer

Dot-matrix printers are the oldest of the three print technologies, cheapest and the noisiest; they also produce the poorest quality of output. Dot-matrix printers however have two market advantages that will make them survive for a long time to come. First, because they are impact, they work extremely well for multi-page forms. Second, you can purchase a dot-matrix printer with a speed of 10 ppm

(pages per minute) for less than $100. Speed at that price is not possible for ink-jet or laser printers.

Plotters are special hard copy output devices for creating non-text images like architectural drawings, maps, diagrams, and charts. Plotters are letter quality output devices that use special writing instruments attached to an arm that moves over the page and writes or draws the output.

Figure 3.15 A Multi-function Printer

Multi-function Printers. Everything is now becoming something else, and even printers are becoming devices that do more than print.We now have state-of-the-art printers that are multi-function – sometime referred to as hydra printers. These combine several capabilities such as printing, scanning, copying, and faxing, all in one device. An example is Hewlett-Packard's OfficeJet, which combines four pieces of office equipment – photocopier, fax machine, scanner, and laser printer – in one.

Pointing Devices

The act of pointing has been one of the most common natural human gestures for ages. Hardware manufacturers have therefore tried to incorporate the act in several kinds of input devices. The principal pointing tools used with microcomputers are the mouse, the trackball, the joystick, and the touchpad.

Mouse:

A mouse is a device that is rolled about on a desktop to direct a pointer on the monitor. The mouse pointer is the symbol that indicates the position of the mouse on the display screen. It may be an arrow, a rectangle, or even a representation of a person's pointing finger. It may change to an I-beam to indicate that it is a cursor identifying the place where text or other data may be entered.

The mouse is usually connected to the system unit by plugging it into a port or socket at the back of the unit using a cable. We however have state-of the-art mice that are wireless and use infrared signals to send input to the computer through a battery-powered receiver hooked up to a serial port at the back of the system unit. Mice come in different sizes to fit hands of different sizes. A ball under the mouse translates the mouse movement into digital signals and on top of the mouse are one to four buttons depending on the variation of the mouse. Whereas the first button is the most commonly used for common functions such as clicking and dragging, the second, third, and forth are software-specific.

Trackball:

The trackball is another type of pointing device. It is a variation of the mouse. A trackball is a movable ball, on top of a stationary device, that is rotated with the fingers or palm of the hand. It looks like the mouse turn upside down; instead of moving the mouse around, you move the trackball with the tips of your fingers. Trackballs are specially suited for portable computers like laptops which are often used in confined working environments such as airline tray tables. It may appear at the middle of the keyboard as in some laptops or centered below the space bar, as on the Apple PowerBook or built into the right of the screen. It also comes in the form of a separate device clipped to the side of the keyboard in some portables.

Joystick:

A joystick is a pointing device that consists of a vertical handle like a gearshift lever mounted on a base with one or two buttons. Joysticks are principally used in some computer-aided (CAD) systems, computerized robot systems, and in video games. There are also specially designed joysticks for the handicapped that are unable to use the mouse. A typical example is SAM-JOY stick from RJ Cooper & Associates.

Touchpad:

Mostly found on laptops, touch pads are flat-top rectangular devices that let you control the cursor/pointer by rubbing your finger on the surface of the pad. The touchpad uses weak electrical field to sense user's touch.. The cursor follows the movement of the user's fingertips as they are rubbing on the surface of the pad A click action is accomplished by tapping on the pad's surface

Light Pen

The light pen is a light-sensitive device that is connected to the computer terminal. The user points to a desire location on the monitor and presses the pen which then sends the signal corresponding to the location to the computer. Light pens are used by graphic designers, engineers, and architects.

Figure 3.4 A light pen in use

Figure 3.5 A digitizing tablet

Digitizing Tablets

A digitizing device consists of a digital tablet that is connected to a stylus or a puck. A stylus is pen-like device that is used to sketch images in digitized form. A puck is a copying device that the user uses to copy or trace an image.

A digitizing tablet used with a stylus enables the user to paint "naturally" and achieve effects similar to what an artist will achieve using pen, pencil, or charcoal. Alternatively, a digitized copy of a painting can be traced and stored into the computer by laying the painting or drawing on the tablet. Digitizing devices are used primarily by artists and graphic designers.

Scanning Devices

Hardcopies of graphic images such as drawings and photos are translated into digital form by scanners using laser beams and reflected light. The images can be processed by a computer, displayed on a monitor, stored on a storage device, or communicated to another computer. Types of scanners include Bar-code readers, Mark- and character-recognition devices, Fax machines, and Imaging systems.

Figure 3.6 Bar-code readers in use

Figure 3.8A digital camera

Digital Cameras

Unlike analog video cameras which convert light intensities into infinitely variable signals, digital cameras convert light intensities into discrete 0s and 1s. With the appropriate software, digital cameras (whether video or still) can be transmitted (downloaded) directly to the computer. The main limitation in capturing full video is not input but storage. It takes a huge amount of storage space to store just 1 second of video.

Digital cameras have enjoyed wide popularity in industr ism because the images are instantly available, can be deleted to make storage available for more photos, and can be transmitted over telephone lines.

CHAPTER 4 STORAGE DEVICES

Storage devices are media for storing data. Often referred to as secondary storage, storage devices can range from a personal computer diskette drive with a diskette holding the text of a letter to a giant video server of the type being developed to store and distribute thousands of movies over cable channels

As we learned in the previous chapter, the data you are working on is stored in the RAM (primary storage) in an electrical state during processing. Because RAM is an electrical state, data in RAM disappears when you turn off the power to your computer. For this reason, you must save your work onto a storage device that stores data permanently –until it is intentionally or accidentally erased – such as a floppy diskette, a pen drive or a hard disk before you turn off your microcomputer. Saved to a secondary storage device, your data remains intact even when the computer is turned off.

Computer software or programs in additions to data must be stored in a computer-usable form. Software instructions must be retrieved from a permanent storage device and placed into RAM for any processing to take place. Special software – the operating system – is responsible for the way data and programs are stored on the secondary storage devices.

Generally, a secondary storage can be likened to a file cabinet in which files (data) are stored until they are needed. Then you open the drawer, take out the appropriate folder or file, and place it on top of your desk (in primary storage, or RAM), where you work on it – either to write some few things on it or to remove and throw some few pages away. However, in the case of electronic documents, you are actually taking out a copy of the desired file and putting it on the desktop. The original file remains in the file cabinet (secondary storage) while the copy of the original is being edited or updated on the desktop (in the RAM). After working on the file, you take it off the desktop (out of primary storage) and return it to the cabinet (secondary storage). Thus the updated file replaces the original file.

Data Representation and Storage Capacity

In fact all forms of data whether text, numeric, or graphic objects are transformed and represented in the computer memory as binary digits character by character or point by point in the case of graphic objects such as pictures. Each character occupies one byte of memory

space. As explained in the previous chapter, these bytes are grouped into higher denominations such as kilobyte, gigabyte, and terabyte for ease of computation.

- Kilobyte (KB): 2^{10} or 1024 bytes.
- Megabyte: (MB): 2^{20} or 1 million bytes (round off)
- Gigabyte (GB): 2^{30} or 1 billion bytes (round off)
- Terabyte (TB): 2^{40} or 1 trillion bytes (round off)

Hence, the amount of data in a file in your personal computer might be expressed in kilobytes or megabytes. Files containing musical data or video clip could run into gigabytes and remote databases accessible to you over communication lines could run into terabytes.

Types of Files

A file is a collection of related data or information that is identified by a unique name and treated as a unit by the computer. Not all files however, can be used by all software. The format in which a file is saved must be compatible with the particular software for the software to be able to use or process the file. Each file is given a unique named and a "tag" (PC-based) or extension names added after a period such as .DOC added onto the name of a Microsoft word-processed document file (MYFILE.DOC). Normally, the applications software automatically adds an extension to file names.

The following are some common types of files:

- ***Program files***: These are files containing software instructions. *Source program files* contain high-level computer instructions in their original form, written in a programming language by computer programmers. These instructions are translated into machine language instructions in order for the processor to use them. Files that contain the machine language instructions are called **executable files** (or binary files). Source program file names may have the extension .COM; executable files often have .EXE extensions. Some systems that support files that also contain machine-language instructions are given .DLL and .DRV extensions.

- ***Data Files***: Data files contain data, not programs – that is, they contain user-created text documents. Such documents are often created using application software programs. These files are given extension names by the software that was used to create them.

Example is spreadsheet files created with *Excel* having *.xls* extensions or documents created using word-processing software, such as Microsoft *Word* having *.doc* extensions.

- ***ASCII Files***: Also referred to as ***text files***, these are plain text-only files. They contain no formatting such as boldface or italics, and no graphics. The characters are in ASCII code. This file format is used to transfer documents between incompatible platforms, such as IBM and Macintosh. ASCII or Text file usually have *.txt* extensions.

- ***Image Files*:** These file types hold digitized graphics. They often have many different extensions, depending on the software used to create them. Some examples are .JPG (still images compressed according to standards of the Joint Photographic Experts Group), .GIF (graphics interchange format), and .BMP (bitmap) files that use standard Windows graphics format.

- ***Audio Files***: Audio files contain digitized sound. Common extensions are .WAV and .MID

- ***Video Files***: Video files contain digitized video images. Common extensions are .MPG (Moving Pictures Expert Groups) and also .AVI.

There are more types of files that are not listed here, however those listed and described above are the most common ones you are likely to be working with.

Storage Devices

Storage devices can be said to consist of two physical parts namely the ***storage medium*** on which information and software are stored, and the ***device*** that reads and writes to and from the storage medium. When listening to a tape or a CD, the storage medium is the cassette or CD and your cassette or CD player is the device that reads from the cassette or CD.

Storage devices can be categorized in two ways. One is by their method of storage the other is by method of access. Method of storage implies the technology used for storing or writing information onto the storage medium. Most popular types of technology include magnetic,

optical and magneto-optical. Method of storage can be likened to the method you use to record information on paper – writing with a pen or pencil or typing.

Method of access implies the order in which information is written to and read from the storage medium. Basically, we have two main types of access methods which are sequential and direct. To understand access methods, think about the difference between cassette tapes and CDs. Cassettes use sequential method; music tracks are stored sequentially on them. You cannot play or listen to a certain track without first listening to or passing over (fast forwarding) all the tracks preceding it. On the other hand, CDs use direct access as such you can play any track by going directly to it without having to fast forward or rewind to the track.

Storage devices fall into families of cassettes or CDs – tape or disk. Tape storage devices use sequential access method and magnetic storage method while disk devices use direct access method and magnetic, optical or magneto-optical storage methods.

Tape Storage Devices

Magnetic tapes – simply called tape drives – used to be a common secondary storage medium for large computer systems. However, these days magnetic tape is used mainly on large systems for backup and archiving – maintaining historical records – and on some microcomputers for backup.

Tape storage devices use a magnetic method of storage and a sequential method of access to read and write information to and from a magnetic tape. These are similar to cassette tapes. A magnetic tape is a thin plastic with magnetic coating on one side on which data or information is stored. The magnetic surface of a tape is split into columns that run vertically across the tape and tracks that run the length of the tape. A read-write device stores in or reads a character or byte from each column. Each track in a given column is used to store one bit. A cell – intersection of a track and a column is either magnetized or un-magnetized to represent on or off – 1 or 0.

Disk Storage Devices

Disk storage devices are the most common storage device in use today. These types of devices are so named because of the shape of their storage medium. The storage medium is called a disk – round platter on which information is written on tracks in the form of concentric circles.

Reading and writing to and from the disk is done by the disk drive. The disk is rotated by the disk drive that moves the read-write head over the concentric tracks.

As we mentioned earlier, the disk storage devices can use magnetic, optical or magneto-optical storage method to write information onto disks. More specifically, data is stored as electromagnetic charges on a magnetized spots on the metal oxide film that coats the surface of the disk. Data is represented by the presence (indicating 1-bit) or absence (indicating 0-bit) of these charges, following standard patterns of data representation such as ASCII. The electromagnetic charges on the disk can easily be changed by the disk drive read-write head. The storage capacity of disk storage devices is measured in the same way as the internal memory – kilobytes (KB), megabytes (MB), and gigabytes (GB). The storage capacity of magnetic disks ranges from few megabytes to several gigabytes – billions of characters. Variations of magnetic disks include the floppy disks, internal hard disks, compact disks and hard cards.

Floppy Disk

Floppy disk, popularly known as diskette is a removable, round, flat piece of circular plastic that is place inside a hard jacket – a squared plastic case – to protect it from being touched. Diskettes are often called floppy because of their fragile nature. The disk is rotated within the jacket while inside the disk drive. Floppy disks come in 5.25” and 3.5” sizes. However, the smaller 3.5” disks have replaced the 5.25” as the predominant floppies in microcomputers and workstations.

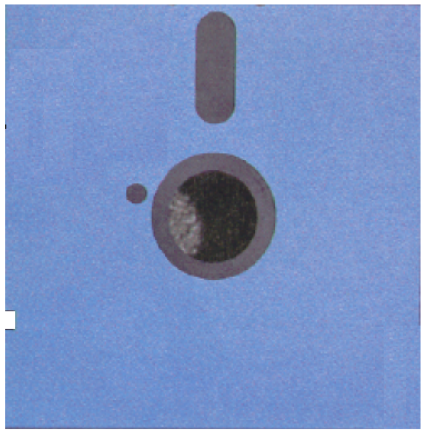


Figure 4.1 5.25 Floppy diskette

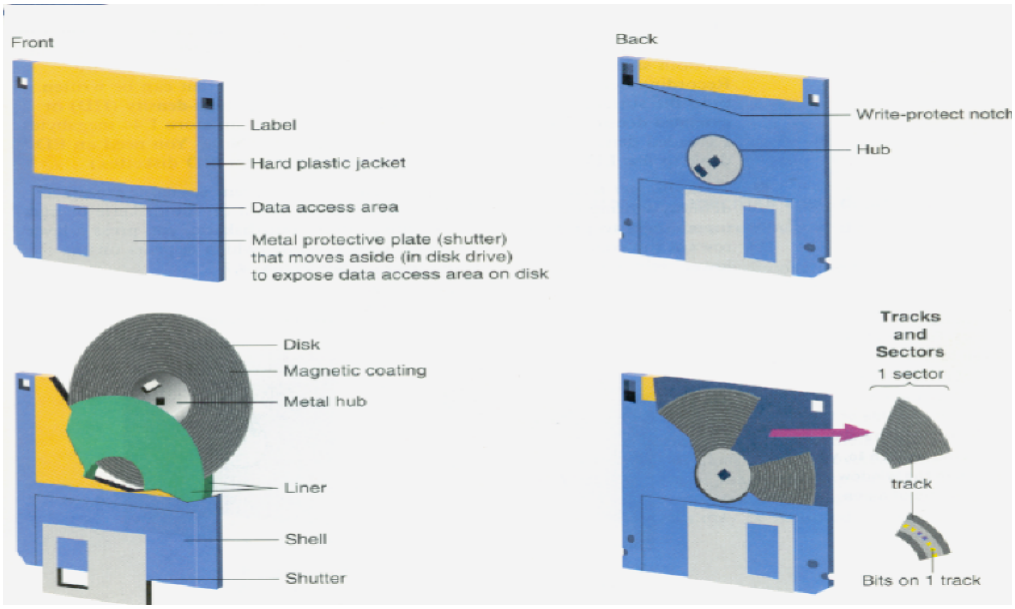


Figure 4.23.5" Floppy diskette

A typical 3.5" floppy disk can store up to 1.44 MB of data (Figure 4.2). Advantages of these diskettes are that they are smaller and therefore easier to carry and since they are contained in hard plastic jackets, they are less susceptible to physical damage. The use of diskettes is however fast fading out due to the availability of more reliable, high capacity, robust, portable and yet cheap storage devices such as the Pen drive.

Characteristics of Diskettes

Floppy diskettes have the following characteristics:

- ***Tracks and sectors***: Data is recorded on diskettes in concentric rings called tracks. These tracks too tiny to be visible to human eyes and they are closed concentric rings rather than visible grooves nor a single spiral. The number of tracks on a diskette is calculated as *tracts per inch* and usually referred to as *tpi.* The higher the tpi, the more data the diskette can hold.

  Each track is divided into sectors. Sectors, like tracks are invisible and are wedge-shaped used by the computer for storage reference purposes. Each sector typically holds 512 bytes of data. However, the number of sectors per tract varies according to the recording density – number of bits per inch. Data saved on diskette are distributed by tracks and sectors on the disk. The operating system then uses the intersection point of

tracks and sectors to reference the location at which a data is stored to spin the disk and position the read-write head for a read or write operation to be performed.

- ***Unformatted vrs Formatted diskette***: Most diskettes today come of the factory formatted. For a diskette to be ready for use, it has to be formatted. If not, it means you have the task to perform before you use your diskette with your computer and disk drive. Formatting – or initializing as it known in Macintosh environment – means that you must prepare the disk for use so that the computer operating system can write information on it.

  Unformatted diskettes are without tracks and sectors on it. By formatting the diskette you define the tracks and sectors on it as well as setting up the file allocation table (FAT) for the diskette. To understand this better, think about a notebook of plain white pages without any ruled lines, margins, nor page numbers. Formatting a diskette is like ruling lines and setting the left and right margin and page number for each page.

Optical Disks

Optical disks are removable disks on which data is written and read using laser technology – there is no mechanical arm, as it is the case with floppy disk drives and hard disks. These disks store much more data than floppies. A single optical disk of type called CD-ROM can hold up to 700 MB of data. This works out to 250,000 pages of text, or more than 7000 photographs or graphic objects or 19 hours of speech, or 74 minutes of video. The greatest advantage to optical disk is its great capacity as result of the precision of laser technology. Recently, some manufacturers have even developed CDs that can hold as much as 6 GB. The most notable drawback to most types of optical disks is that information cannot be changed once stored or written to the optical disk medium. Although some disks are strictly used for digital data storage, many are used to distribute multimedia programs that combine text, visuals, and sound.

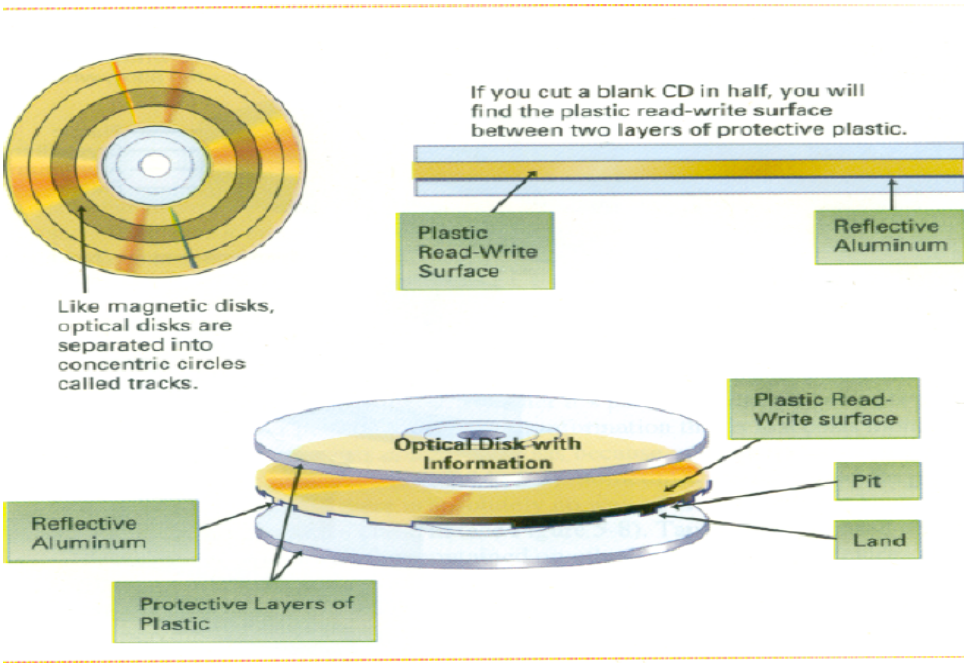


Figure 4.4 Cross-section of compact disk structure

The structure of an optical disk is sandwich of protective plastic layers and plastic read-write surface with reflective aluminum (Figure 4.4). The two outer layers are protective plastic, and the two middle layers are a plastic read-write surface and a layer of reflective aluminum thus making four layers.

With the principal types of optical disk technology, a high power laser beam is used to represent data by burning tiny pits into the bottom of the plastic read-write surface. Low-power laser light scans the disk surface to read data. Pitted areas are not reflected in the process and thus interpreted as 0 bits while smooth areas that reflect are interpreted as 1 bits. Because the pits are so tiny, a great amount of data can be represented more than it is possible on the same amount of space on a diskette and many hard disks.

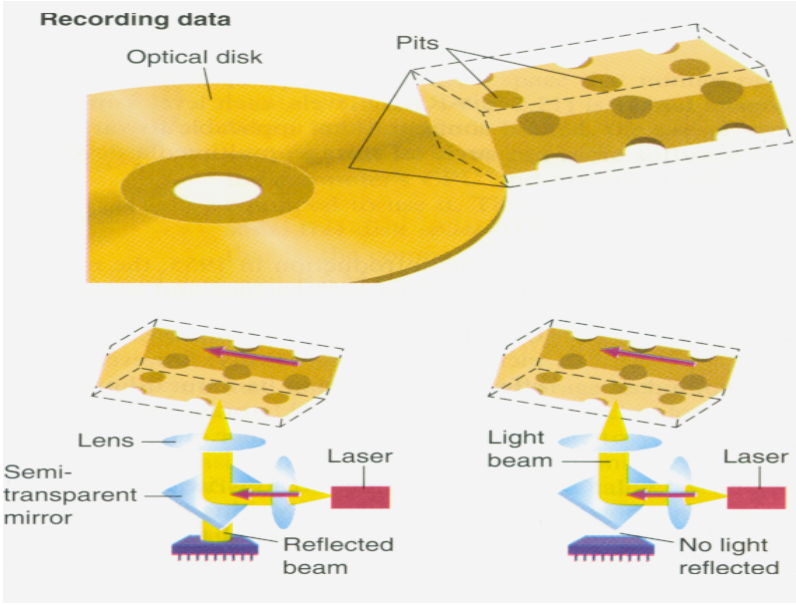


Figure 4.5High power laser beam burns pits or write on optical disk (Top) and a low-powered beam read data by reflecting smooth areas (Below)

The main types of optical technology used with computers are:

- CD-ROM disks
- CD-R disks
- CD-RW disks
- DVD/DVD-ROM

CD-ROM Disks

One of the most popular of optical disks is the CD-ROM – ***compact disk-read-only*** memory. This type is used only to hold software programs and data. CD-ROM is much like the music CD; it is a read-only storage medium. Read-only means once data or information – which may include visuals and sound – is written on the disk from the factory, it cannot be overwritten or erased by the user.

Most microcomputers have built-in CD-ROM drives. Often times the drives are labeled with their speed; written as 10x, 20x, or higher. A 10x drive can access data at 1.5 megabytes per second – the equivalent of 500 typed pages of text. The faster the drive spins, the more quickly it can deliver data to the processor. Typical PC CD-ROM drive is used with only one disk; however, there are multi-disk drives that can handle up to 100 disks. Such drives are called jukeboxes, or CD changers.

CD-R Disks

CD-R, which stands for ***compact disk-recordable***, is a CD format that allows users with CD-R drives to write data, only once, onto a specially manufactured disk that can then be read by a standard CD-ROM drive. Typical example is the Photo CD system developed by Kodak. Photo CD technology allows photographs taken with ordinary 35 millimeter camera to be stored digitally on an optical disk. CD-R are now becoming the industry standard for backing up files on the hard disk and for coping large volume of software programs and data including audio visuals. A typical CD-R has a capacity 700 megabytes

CD-RW Disks

CD-RW stands for ***compact disk rewritable***. It is sometime referred to as ***erasable*** CD. CD-RW allows users to erase data so that the disk can be used over and over again just like the pen drive. The most common type is the magneto-optical disk which used aspects of both magnetic and optical disk technologies.

DVD-ROM Disks

Originally, DVD was not abbreviation for anything according to the industrial sponsors. The letters used to be interpreted as "*digital video disk*" and later, when its diverse possibilities became obvious, for "*digital versatile disk*".

Figure 4.6 A Notebook computer with CD-ROM / CD-RW / DVD combo drive

DVD is a silvery, 5-inch optically readable digital disk that looks like an audio compact disk but can store up to 40 gigabytes, allowing great data storage, studio-quality video images, and theatre-like surround sound. The home-entertainment version is simply called DVD. The

computer version of DVD is called the DVD-ROM disk. It represents a new generation of high-density CD-ROM disks.

The Read/Write Operations of the Hard Disks

Unlike floppies, hard disks are composed of many layers of thin but rigid metal or glass platters covered with a substance that allows data to be held in the form of magnetized spots. Hard disks are also tightly sealed within an enclosed unit to prevent any foreign matter such as dust or smoke from getting inside. Because hard disks have multiple double-sided platters; they can hold much more data than floppy diskettes. Capacity of hard disks keeps on soaring every year. Today, it is not uncommon to find 160 GB hard disks.

A disk drive is a device that holds, spins, read data from and writes data to the disk. An **internal hard disk** is a single unit that contains both the disk drive and the storage medium (multiple platters). This type looks like part of the front panel of your system.

Reading data from the disk entails the data represented by magnetic spots being converted to electronic signals and transmitted to the primary storage – internal memory or RAM. That is 'read' means data is copied form the disk. 'Write' operation entails the recording of electronic information processed by the computer onto the disk. Data – represented as electronic signals within the computer's memory – is transferred onto the disk and then stored as magnetized spots. Data is read from or written onto a tape in similar fashion.

A **hard disk cartridge** is a disk storage device in which the disk drive is separate from the hard disk storage medium. This type provides increased storage capacity of hard disks and ability to change disk media, as with floppy disks.

Hard card, often referred to as memory cards, this is a type of hard disk that can be added to your system by inserting it into an expansion slot. However, hard cards do not holds as much information as other types of hard disks.

Pen Drives

Pen drive is a portable USB flash memory device that can be used to quickly transfer audio, video and data files from the hard drive of one computer to another. With a construction that

is small enough to fit into a pocket, the pen drive derives its name from the fact that many of these USB drive devices resemble a small pen or pencil in size and shape.

A USB flash drive consists of a NAND-type flash memory data storage device integrated with a USB (Universal Serial Bus) interface. USB flash drives are typically removable and rewritable, much smaller than a floppy disk, and most USB flash drives weigh less than an ounce (30 g).[1] Storage capacities typically range from 64 MB to 128 GB with steady improvements in size and price per capacity. Some allow 1 million write or erase cycles and have 10-year data retention, connected by USB 1.1 or USB 2.0.

A flash drive consists of a small printed circuit board protected inside a plastic, metal, or rubberized case, robust enough for carrying with no additional protection—in a pocket or on a key chain, for example. The USB connector is protected by a removable cap or by retracting into the body of the drive, although it is not likely to be damaged if exposed (but it may damage other items, for example a bag it is placed in). Most flash drives use a standard type-A USB connection allowing plugging into a port on a personal computer, but drives for other interfaces also exist.

Equipped with a large amount of memory capacity, the pen drive is considered to be an improvement on both the older floppy drive disks and the more modern compact disks that are often used to copy data and reload the files on a different hard drive. Even a pen drive with a relatively low storage capacity tends to provide plenty of space for a number of files. The types of files that can be loaded onto a pen drive are all the common types that can be housed on any hard drive. This makes it possible for persons to copy photos, spreadsheets, word processing documents, movie clips, music tracks, and just about any other type of file.

Figure 4.7: Pen or USB flash drive

Figure 4.8: A USB flash drive with a keychain

CHAPTER 5 COMPUTER SOFTWARE

The Three layers of software

Starting in the 1980s, application software has been sold in mass-produced packages through retailers. Users often see things differently than programmers. People who use modern general purpose computers (as opposed to embedded systems, analog computers, supercomputers, etc.) usually see three layers of software performing a variety of tasks: platform, application, and user software.

Platform software

Platform includes the basic input-output system (often described as firmware rather than software), device drivers, an operating system, and typically a graphical user interface which, in total, allow a user to interact with the computer and its peripherals (associated equipment). Platform software often comes bundled with the computer, and users may not realize that it exists or that they have a choice to use different platform software.

Application software

Application software or Applications are what most people think of when they think of software. Typical examples include office suites and video games. Application software is often purchased separately from computer hardware. Sometimes applications are bundled with the computer, but that does not change the fact that they run as independent applications. Applications are almost always independent programs from the operating system, though they are often tailored for specific platforms. Most users think of compilers, databases, and other "system software" as applications.

User-written software

User software tailors systems to meet the users specific needs. User software include spreadsheet templates, word processor macros, scientific simulations, graphics and animation scripts. Even email filters are a kind of user software. Users create this software themselves and often overlook how important it is. Depending on how competently the user-written software has been integrated into purchased application packages, many users may not be aware of the distinction between the purchased packages, and what has been added by fellow co-workers.

Computer software has to be "loaded" into the computer's storage (also known as memory and RAM). Once the software is loaded, the computer is able to operate the software. Computers operate by executing the computer program. This involves passing instructions from the application software, through the system software, to the hardware which ultimately receives the instruction as machine code. Each instruction causes the computer to carry out an operation -- moving data carrying out a computation, or altering the control flow of instructions.

Data movement is typically from one place in memory to another. Sometimes it involves moving data between memory and registers which enable high-speed data access in the CPU. Moving data, especially large amounts of it, can be costly. So, this is sometimes avoided by using "pointers" to data instead. Computations include simple operations such as incrementing the value of a variable data element. More complex computations may involve many operations and data elements together.

Instructions may be performed sequentially, conditionally, or iteratively. Sequential instructions are those operations that are performed one after another. Conditional instructions are performed such that different sets of instructions execute depending on the value(s) of some data. In some languages this is known as an "if" statement. Iterative instructions are performed repetitively and may depend on some data value. This is sometimes called a "loop." Often, one instruction may "call" another set of instructions that are defined in some other program or module. When more than one computer processor is used, instructions may be executed simultaneously. A simple example of the way software operates is what happens when a user selects an entry such as "Copy" from a menu. In this case, a conditional instruction is executed to copy text from data in a document to a clipboard data area. If a different menu entry such as "Paste" is chosen, the software executes the instructions to copy the text in the clipboard data area to a place in the document.

Depending on the application, even the example above could become complicated. The field of software engineering endeavors to manage the complexity of how software operates. This is especially true for software that operates in the context of a large or powerful computer system. Kinds of software by operation: computer program as executable, source code or script, configuration.

System Software

System software is a suite of computer programs that control and manage the basic operations of the computer and also act as interface between the user and the computer. System software is the platform on which applications software are run. Without the system software you won't be able to run any application software. In fact, the user won't be able to communicate with the computer at all.

While you are using the computer or running application software, the system software is in the background making sure that the hardware carries out the tasks you want to perform. Because system software is the closest to the hardware, it must handle a number of difficult and tedious tasks that include:

a) *System Initialization*: Initialization process takes place on switching on the computer system. At this point, the system software stores the hardware configurations, for example type of monitor and amount of internal memory available, and loads the operating system.

b) *Managing System Resources*: This task entails controlling of the execution of the application software and coordinating how the various peripherals work together. This is part of the operating system task and we will discuss it in detail in the next section

c) *Utilities*: These are subprograms that manage the interface to storage devices like the hard disk and the CD-ROM. They also handle such tasks as file storage and retrievals, file copying, and disk formatting. For example, when you save a Word document, the system software utility for file saving takes over and complete the task.

d) *Handling Input / Output*: This entails responsibilities for input and output such as reading characters from the keyboard and displaying them on the screen.

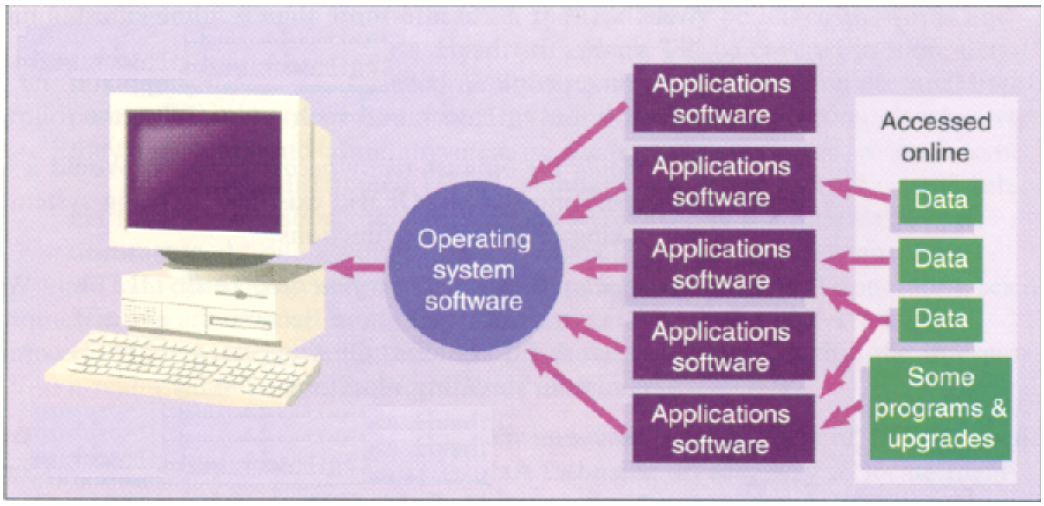
It is the system software that enables communication between the user and the computer and also between the computer and its connecting peripherals. As a computer user, you will have to use system software, it is therefore important to understand the role it plays in the computer

system. System software comprises of a large number of program units that can be grouped into the following categories:

(i) Operating system and BIOS (Basic Input / Output system)
(ii) Device Drivers
(iii) Utility programs
(iv) Language Translators

1. The Operating System

The operating system popularly referred to as OS is the most important of the system software components. The operating system can be described as the *intelligence* of the computer. All the "common sense" that a computer exhibits is due to the operating system that runs it or runs on it. It serves as the interface between the user and the machine and also enables communication between the computer and its connecting peripherals or external devices. It



consists of master programs, called the supervisor, that manage the basic operations of the computer. These programs reside in the RAM while the computer is on and provide resource management services of many kinds, handling such tasks as running and storing programs and processing data. The operating system shields the user from the complexities of managing the computer thus enables the user to concentrate on personal task or applications.

The operating system gets loaded into the RAM – the main memory – upon "booting" the computer. Booting refers to the process of switching on the computer from the main power supply and triggering off the execution of the *bootstrap loader* or *boot routine* – instructions

wired into the ROM which in turn loads the operating system automatically into the RAM or main memory (usually from the hard disk). In the process other programs, diagnostic routines also starts up and test the main memory, the central processing unit, and other parts of the system to make sure they are all running properly. Diagnostic messages that are output of those tests are often displayed on the monitor. Finally other programs known as *device drivers* are stored in the main memory that help the computer interpret, for example, keyboard characters or transmit characters to the display screen.

The operating systems from then on takes over the time to time running of the affairs of the system communicating with the user and performing complex tasks such as file, task, and job management. File management involves storing and keeping track of file locations on disk, loading files from disk into the main memory and deleting files. Task management involves the simultaneously running of more than one program and servicing the need of such programs. Job management entails managing units of work to be processed. Here job means a specified operation such as saving a document or organizing data into a document.

Another important task of the operating system is the basic input /output system (BIOS). This consists of program modules that manage the connecting peripherals or devices such as the keyboard, monitor, disk drives and parallel and serial ports. BIOS also manages some internal settings of the computer such as date and time. Actually, this part of the operating system resides in the ROM and runs the diagnostic test upon booting the computer after which it then loads the rest of the operating system.

Common Operating Systems: Platforms

The operating system a computer is running is often referred to as its platform. However, the operating system that can be run on a computer also depends on the type or brand of its processor. Therefore, a computer platform is defined by its processor model and its operating system. The type of processor used in a computer determines the type of machine language it uses, and the computer's operating system is created to work with that particular type of machine language thereby defining the computer's platform – the type of architecture of the computer or family – such as the IBM PC or Apple Macintosh. Without some form of modification or conversion, software created for one type of platform will not work for or run on another platform. Once you understand the platform, you can begin to understand what

particular computer system is capable of and what type of tasks it can be used for. As a computer user, in addition to learning how to use your application software, you must learn to some degree, the operating system with which they work.

Today, more than half of microcomputers in the world run on Microsoft Windows. However, popular operating systems available include the following:

* DOS
* Windows 3.X/95/NT/98/Me/2000/Xp
* O/S2
* Unix
* Mac OS
* NetWare

Because of the popularity of Windows and for the fact that most microcomputers run on it, we discuss Microsoft Windows exclusively and extensively in Part 2 of this book.

2. Device Drivers

Device drivers can be viewed as "divisional managers". When you buy an external device such as printer to connect to your computer, for the computer to be able to work with the device, there has to be some form of communication between the device and the computer. To enable such communication, the device needs to "introduce itself" to the computer in some way specifying its nature and the "form of language it speaks". Such introduction is done by special software called the device driver. Device drivers comprise software programs that support specific peripheral devices, such as printers, CD-ROM drives, mice, and display adapter cards. The driver contains the detail machine language necessary to control each device. The operating system commands the driver, which in turn commands the peripheral devices.

Most computer systems are configured with a variety of peripheral devices. So that the operating system does not need to load support for all types of existing peripherals every time the computer is switched on, it contains directions for device-specific software drivers.

The trend now is that software companies like Microsoft enter into agreement with device manufacturers and are given the right to include drivers for their products as part of their software so that users of a particular operating system, for example Microsoft Windows, will not have to be installing drivers for some peripherals before they are able to use them. Latest versions of Windows come packaged with hundreds of device drivers from different manufacturers so that if you are running Windows you just connect most devices to your computer and off you go.

3. Utility Programs

Utility programs act like domestic aids. They perform such tasks as setting the dining table, cleaning the kitchen and washing of utensils before and after meals. In computer systems, utility programs are generally used to support, enhance, or expand existing programs built in for common purposes. They perform tasks like: system diagnostics, backup, data recovery.

- *System diagnostics*: In addition to the basic diagnostic routines that are performed by BIOS, more sophisticated diagnostics programs are provided in the form of a utility. A diagnostic program compiles technical information about computer hardware, including peripherals that can be used to diagnose any technical problem.

- *Data Recovery*: In computing there is always the danger of losing data due sudden technical problem. Hence the need for a kind of "disaster management" mechanism. Data recovery utilities provide such services. A data recovery utility program is used to restore data that has been physically damaged or corrupted. This damaged could be as result of hardware failure like the crushing of hard disk, occurrence of power fluctuations during read/write operation or even by virus infection.

- *Virus Protection*: We have come to be living in a dangerous world as a result of our own deeds and misdeeds, and just as human beings, computer programs and data are not left out in susceptibility to virus infections. A virus – in the world of computers – consists of hidden, destructive programming instructions that are buried within a program or data file. Often, they multiply by copying themselves to other programs, causing havoc. Sometimes the virus is merely a simple prank that pops up as a message. Other times too, it can destroy programs and data and wipe out the hard disk clean. Just

as human virus spread when people dine and wine indiscriminately

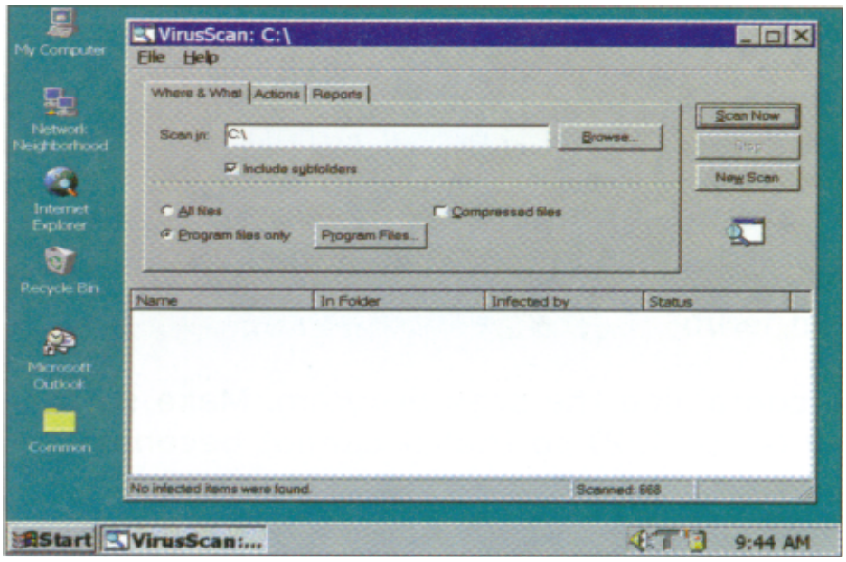


Figure 5.2 An Antivirus program screen

and unprotected, computer virus spread when people exchange storage devices such as pen drives or download (make copies of) files from computer networks or the internet just any how. Antivirus utility program scans hard disks, pen drives, and memory to detect, give information of possible virus behavior, and destroy viruses.

- *Backup*: For fear of ever persisting menace of data loss due unforeseen circumstances such as those mentioned in previous sections, it important to always backup – make duplicate copies of – important programs and files, so that in the event of any loss of data you can fall on the duplicate copies to recover the files. Backup utility programs are meant for such purposes.

- *Defragmentation*: The file management part of the operating systems tries to store the element of data contiguously in memory. However, this is not always possible due to frequent moving of data in and out of memory as a result of processing. After several save and delete operations, there remain many scattered areas of stored data that are too small to be used productively. This is referred to as *fragmentation*. High degree of fragmentation causes the computer to run slower than if all data in a file were stored together in one location. Utility programs known as *defraggers* provide the service of defragmenting the disk, thus rearranging the data so that the data units of each file are repositioned together contiguously in one position on the disk.

There are many other utilities on the market as third party software, such as those for transferring files back and forth between a desktop microcomputer and a laptop, and also Antivirus software like Norton and McAffee Antivirus tool kits.

4. Language Translators

Language translators are generally used by Computer Programmers. These programmers normally write Computer Programs using languages such as COBOL, FORTRAN, C++, Visual Basic, etc in which instructions are written close to mathematical and English-like expressions. These instructions tend to be meaningful to the programmer and not the computer as the computer understands only the machine language. Since the program is not in the language that the Computer has been designed to understand, there is the need to have a program translator. A program translator may be defined as any computer package capable of translating a source program written in either a high level language or an assembly language into a machine language. As mentioned earlier, to date, the Computer only understands instructions written using zeros and ones. Apart from the machine language, the other programming languages do not use only zeros and ones. This means that whenever one writes his or her own Computer programs, there is the need to have the instructions translated into zeros and ones so that the Computer can understand. A translator capable of translating symbols and numbers into zeros and ones are therefore needed. Fortunately, early programmers have designed a number of translators to translate the programs that we write into machine language. Presently, we have Computer programmers who continue to write better translators or improve on the existing translators. Since these translators are computer programs, they are usually referred to as program translators. There are three types of program translators namely Compilers, Interpreters and Assemblers.

INTERPRETER

Most of the early microcomputers were programmed in BASIC language and equipped with an interpreter (BASIC interpreter) stored in a Read Only Memory (ROM) chip. Every program instruction is translated or interpreted on each occasion the program is run (not just once initially as with assemblers and compilers). If any statement does not conform to or violates the rules or grammar (syntax) of the language an error message is displayed on the screen. Until this error is corrected, program execution cannot proceed and this has the disadvantage of slowing down the running of the program. An interpreter, however, allows errors to be

corrected more quickly than a compiler which prints a (long) list of errors which have to be corrected as a whole rather than individually before program execution can continue.

ASSEMBLER

This type of software translates and assembles a program written in assembly code into machine (object) code. The assembler translates the symbolic function codes into the equivalent machine operation code; symbolic addresses are allocated actual internal memory locations. After assembling, the object program is retained on a storage device in machine code. Errors are diagnosed during the assembly process. This is a once only process and does not have to be performed each time a program is run as with an interpreter. Assembly programs tend to run faster than interpreted ones, because assembly language is low level and nearer to machine code and fewer instructions are necessary to accomplish a desired result.

COMPILER

This is another translation program for compiling high level language instructions into machine code. A compiler has more capabilities than an assembler because each source program instruction generates a number of machine code instructions. A compiled program may not be so efficient in the time taken to process a task because of the nature of the high level language used, COBOL for instance. This results in more detailed and less direct instructions than those generated by an assembled program written in assembly code. A compiler is usually used together with a program called the linker, capable of linking together the different translated modules. The use of a linker makes it possible for standard functions (provided by the compiler developers) to be added to one's program to make it a complete working program. The output of the linker is the executable version of the source program.

CHAPTER 6 APPLICATION SOFTWARE

Prospective buyers often agonize over what and what specifications must their computers have for months. However, it is rather your choice of software that really determine the utility or usefulness of your computer. Application software – users' tool – is what makes your computer tick besides system software. Application software is special computer programs that are specifically designed and written to perform specific tasks. These software can be acquired directly form the software manufacturers or companies or even vendors that specialized in the sale and support of microcomputer hardware and software. There are thousands of programs to choose from – games alone numbered over 2500 – and some of them can make life easier and more productive than you can imagine.

Application software are those designed to be used by a user for a specific purpose. For example, if a user wishes to type a document, then he/she would need a Word Processor which is an application software that allows a computer user to use his/her Computer in the same manner as he/she would have done using a typewriter. Below are some of the major application software classes.

Common Features of Application Software

Since the advent of Windows operating systems, all window based application software developed exhibit many similarities and functionalities that are characterized by the underlying operating system's graphical user interface. Some common features of application software are

- Windows
- Menus / Menu bar
- Icons
- Tool Buttons
- Toolbars
- Cursors
- Scroll bar
- Dialog box
- Macros
- OLE
- Clipboard
- tutorial / documentation
- On-line Help Menu/ Screen

Windows

A window is a rectangular screen display of a running program or opened document or file with a title bar on top. Several windows may overlay each other or cascaded alongside one

another depending on the number of executing task. Each window may show a different application display, such as a word processing document and a spreadsheet document.

Menu/Menu bar

A menu bar is a row of menu options displayed across the top or the bottom of the screen. A menu is a list of command options or choices. Various tasks that can be performed in an application are grouped under different names or titles. These names or titles are then used to form the menus. To perform some particular task, click the mouse button on the menu option to open the menu containing the task and then select that particular task.

Icons

An icon is a small on-screen pictorial object that represents a program or a file. Icons serve as short-cut way to access the target programs or files and are therefore referred to as short-cuts.

Tool buttons

These are simulated buttons are provided to serve as quick way of executing commands. They are often small graphic objects arranged on *toolbars*. Tool buttons when clicked with the mouse triggers off execution of the commands associated with them.

Tool bars

A toolbar is arrow of on-screen tool buttons, displayed below the menu bar, and used to activate a variety of functions of the applications program. They can be customized and move around the screen.

Cursors

The cursor, sometimes referred to as the *insertion point*, is the blinking movable vertical or horizontal line symbol on the screen that indicates where the next data is entered. You can move the cursor around using either the mouse or the directional arrows on the keyboard.

Scrollbars

Scrolling is the way to quickly move through text in a document or the active file upward or downward. Using the directional arrow keys or a mouse, you can scroll through the display

screen and into the text above and below. However, when you have to scroll through a large file that spans many pages, it is easier to using the scrollbars.

There are vertical scrollbars as well as horizontal scrollbars. Vertical scrollbars often appear at the right side of the document screen small triangular arrows pointing up and down. To scroll up (or view the bottom part of document), simply click the left mouse button on the down-pointing small triangular arrow of the scrollbar. To view the top part of document scroll down by clicking the up-pointing small triangular arrow of the scrollbar. Horizontal scrollbars often appear below a document window and are used to scroll the document window right or left.

Dialog box

A dialog box is a window through which the user provides some needed information that the computer or the application program require to perform some task. It also used to display helpful messages at times.

Macros

Series of steps that may be needed to perform a task can be grouped together in a way and the entire routine assigned a keystroke. Pressing the Ctrl key on the keyboard in combination with the assigned key triggers the execution of the programmed routine assigned to the keystroke. These programmed steps are referred to as macros.

OLE (Object Link and Embedding)

This feature enables the user to link and/or embed document of one application program such as a spreadsheet to or in another such a word processor. Changes made to the embedded object affect only the document that contains it. If the object was rather linked, then changes made to the object are automatically made in all the linked documents that contain it. Thus OLE facilitates sharing and manipulating of information. An object may be a document, worksheet, picture or even a sound recording.

Clipboard

During working sessions, it sometimes become necessary to copy an item or part of a document from one document and then paste it into another document or application or even in another part of the same document to save time and labor. The area in the memory where the copied

item is held temporarily before and even after it is pasted to a destination is known as the clipboard.

Tutorial and Documentation

This resembles the on-line Help but rather acts like an electronic instruction book or program that takes you through a prescribed series of steps to help you learn the product. Tutorials are supplemented with documentation. Documentation is a user manual or reference manual that is a narrative and graphical description of a program. It may be instructional but often features and functions are grouped by category for reference purposes. Documentation may come in booklet form or on diskette or CD-ROM; it is sometimes also available on-line from the manufacturer.

On-line Help Menu and Screen

A Help menu offers a choice of help screens – specific display of explanations of how to perform various tasks, such as setting the page lay-out of a document, embedding picture objects and many more. On-line help screens mostly can be displayed by opening the Help menu on the menu bar or clicking on the F1 function key on the keyboard. Help screens serve like electronic reference manual. Sometimes, on-line help may also come in the form of a *wizard* – in-built program that leads the user through a series of questions to determine exactly what the user's problem really is.

Word Processing Software

The traditional machine for typing out documents was the typewriter. However, the machine has long out-lived its usefulness. In fact, if you have a manual typewriter, pray that it never break down – a prayer that may never be granted anyway – for it is becoming as difficult to get it repaired as it is to find a blacksmith. Today word processing is what is in vogue.

Word processing software allows you to use computers to create, edit, store, and print documents. The user can easily insert, delete, and move words, sentences, and paragraphs – without ever using an eraser. Word processing programs also come with several features for "dressing up" documents with variable margins, font types and sizes, and styles. All these can be done by the user on screen in "wysiwyg" – what you see is what you get – fashion, meaning the screen displays documents exactly as it will look when printed.

Word processing offers additional features such as spelling checkers and thesaurus. Among popular word processors are Microsoft Word, Lotus Word Pro, and WordPerfect.

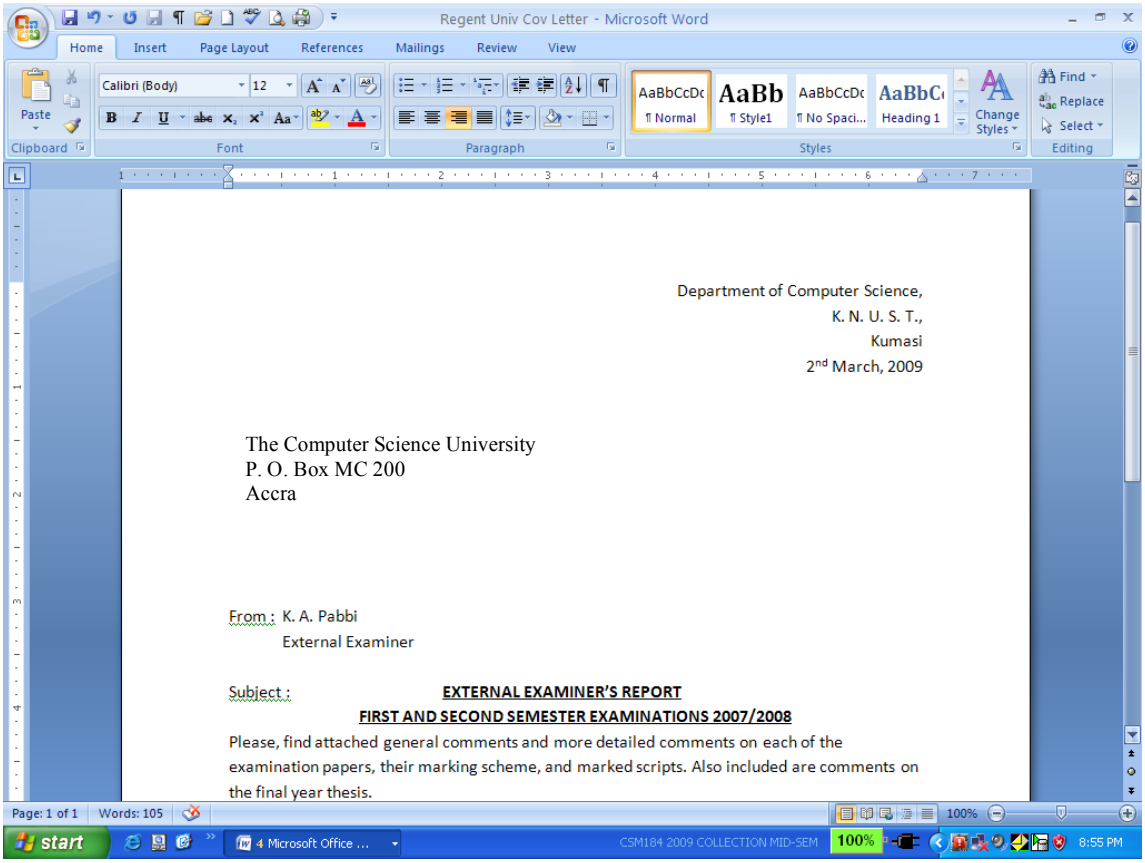


Figure 6.2 A typical word processor, Microsoft Word 2007 screen.

Spreadsheet Software

Traditionally, a spreadsheet was a grid of rows and columns, printed on special green paper, which was used by accountants and others to produce financial projections and reports. Accounting personnel using the spreadsheet often spend long hours and days penciling tiny numbers into countless tiny rectangles. When one figure changed, all the computations on the sheet had to be done all over again.

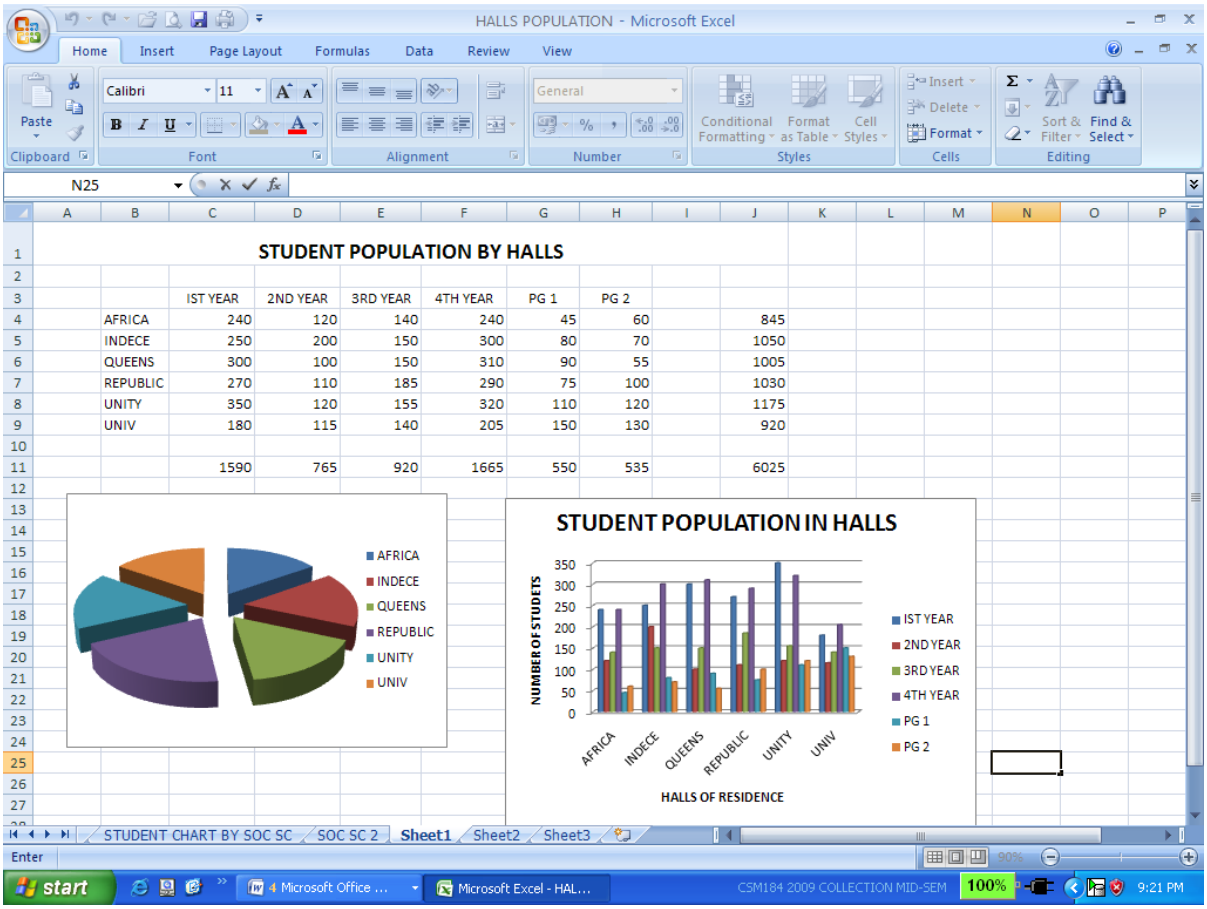


Figure 6.3 A typical spreadsheet, Microsoft Excel 2007 screen

An electronic spreadsheet allows users to create tables and financial schedules by entering data into rows and columns arranged as a grid on a display screen. See Figure 6.3. The electronic spreadsheet is computerized and largely incorporates automation of computations. This software tool quickly became the most popular small-business program, and has been held directly responsible for making the microcomputer a widely used business tool. Today, the principal spreadsheet programs include Microsoft Excel, Lotus 1-2-3, and Quatro Pro.

Presentation Software

Presentation software are software tools designed to use graphics and data/information from other applications or software tools to communicate or make a presentation to audience such as clients, supervisors, directors, or even students in a lecture theatre. Presentations software may make use of some analytical graphics such as charts but they usually look much more sophisticated, using, for instance, different texturing patterns, color, and three-dimensionality (Figure 6.4).

Presentation graphics are output as 35mm slides, which can be projected on a screen or displayed on a large monitor. Presentation software packages often come with slide sorters, which group together a dozen or more slides in miniature. The person making the presentation can use the mouse to click a slide to bring it up for viewing. Some also include clip art (grouped art works) that can be electronically cut and pasted into the graphics. Depending on the system's capability, you can add text, animated sequences, and sound. Examples of well-known presentation software packages are Microsoft PowerPoint, Aldus Persuasion, Lotus Freelance Graphics, and SPC Harvard Graphics.

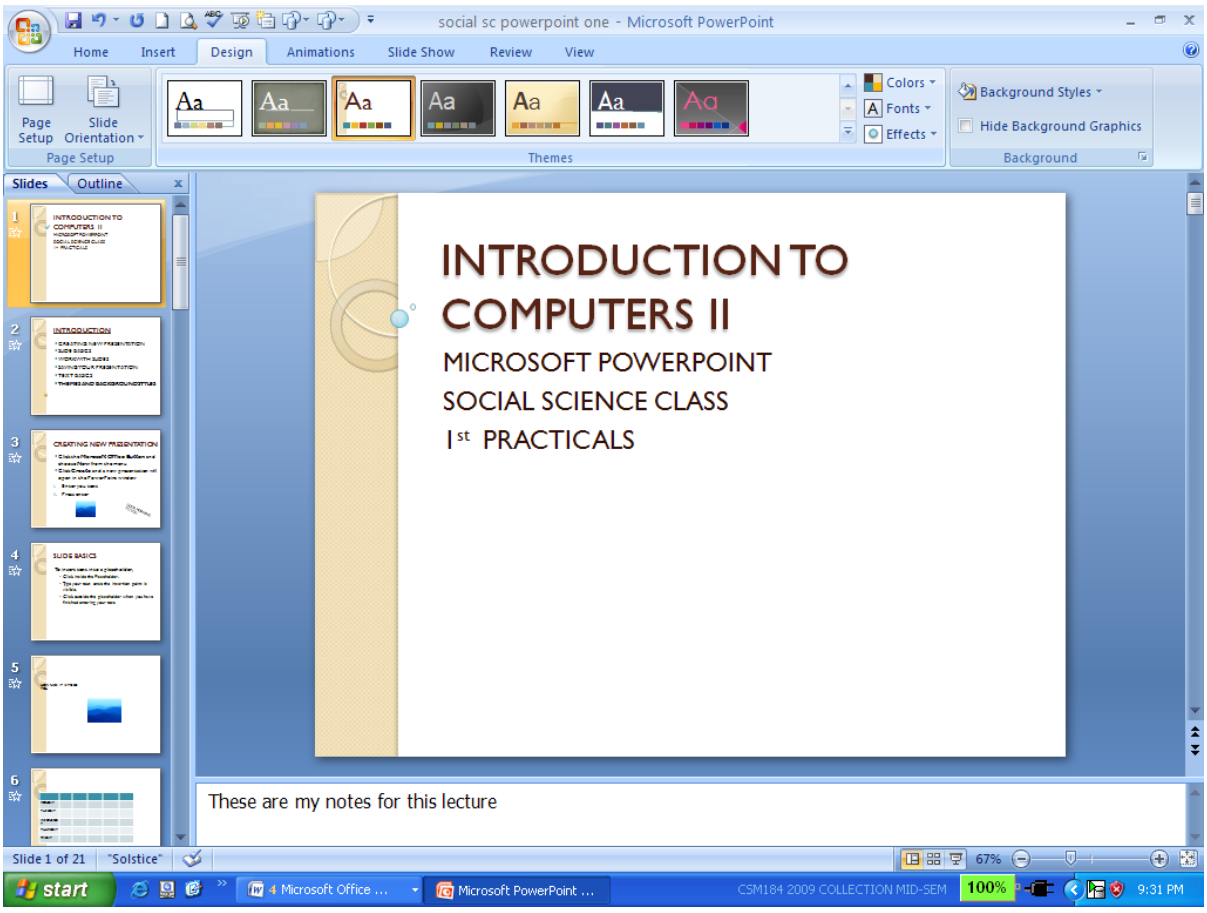


Figure 6.4A typical presentation software, Microsoft PowerPoint 2007 screen

Database Management System Software

Generally speaking, a database is any electronically stored collection of data in a computer system. To be more specific however, a database can be described as a collection of interrelated files in a computer system. These computer-based files are organized according to their common elements or fields, easy retrieval. Database Management System (DBMS) software, therefore, is a program that controls the structure of a database and access to the data (Figure 6.5).

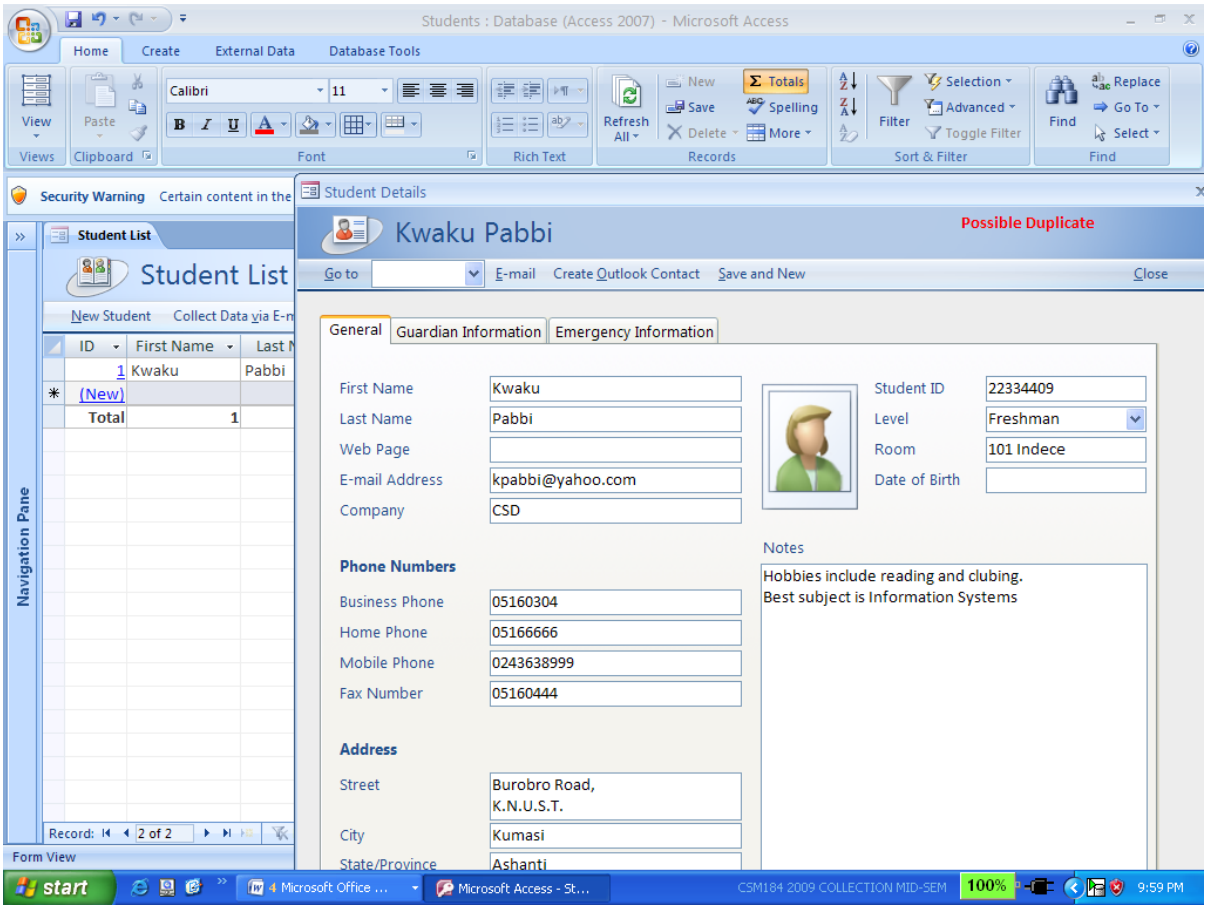


Figure 6.5 A typical Database Management System Software, Microsoft Access 2007 screen

A DBMS has several advantages over the traditional file managers or flat-file management system. A DBMS can access several files at one time as against file manager that can access only one file a time. Also, you cannot extract information across more than one file with the flat-file system while this can be easily accomplished with a DBMS. For example, using a file manager or the flat-file system, you could call up a list of all Faculty of Science students. You could also call the list of all Africa Hall students. But you could not extract all Faculty of Science students resident in Africa Hall. A DBMS allows you to do that and even more.

Databases are getting more and more sophisticated. Some years back, they included only text. Today, they incorporate new data types – not only texts but also pictures and even sound, and animation. Some popular database management software include Microsoft Access, Microsoft Visual FoxPro, Paradox, and Claris Filemaker Pro.

Statistical Packages

These packages are used by Computer users for statistical analysis and also for producing different types of graphs. They can be used for performing regression analysis, computation of statistical parameters such as the mean, median, standard deviation, kurtosis, skewness, etc., They can also be used for solving systems of linear equations, etc. Typical examples of statistical packages are SPSS PC+, MathLab, MINITAB, MATHEMATICA, SAS, etc.

Accounting Packages

These are packages designed to be used by Companies and individuals for accounting purposes. Thus, these packages can be used in preparing documents such as Trial Balance, Balance sheet, Statement of account, Invoices, etc. They can be used by individuals at home in tracking their daily transactions or income and expenditure. Examples of these packages are SAGE Accounting, CA-Simply Accounting, MS Money, Quicken, etc.

Communication Packages

These are software packages that allow two or more Computer users to communicate with one another if the necessary hardware components are in place. Examples of these packages are Derlina WinFax, EUDORA, INTERNET in a Box, etc.

Web Browsers

These are packages that enable one to surf or browse the internet for data, information, chatting, sending and receiving emails, etc. Some of the commonly used web browsers are Yahoo, Netscape, Explorer, Mozilla Firefox, Google, etc.

CHAPTER 7 COMPUTER NETWORKS

A network is basically a combination of hardware and software that send data from one computer to another. It can also be defined as two or more computers that are connected to each other to share and exchange data. The hardware consist of the physical components that carries data or signals from one point to the other while the software are the instructions that make the services expected from a network possible.

A computer network must meet a number of criteria, notable among these are performance, security and reliability.

Performance is normally measured in terms of transit time and response time. The transit time is the time it takes data to travel from one computer to the other while the response time is the time elapse between an enquiry and response. The performance of a network can be affected by the number of people on the network at a time, the transmission medium, etc.

Security basically deals with preventing unauthorized users to access, update or damage data. It also deals with the policies needed for implementation and procedures needed for recovery from breaches and data loses.

Reliability is usually measured by the frequency at which failure occurs, the time it takes the network to recover from a failure and the network's robustness in an emergency or disaster.

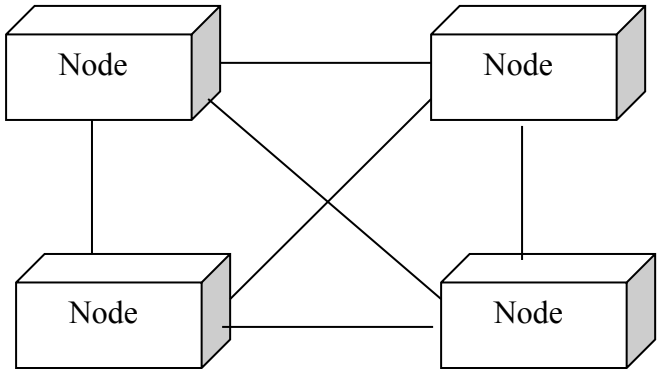
Type of connections: As mentioned earlier, a network consists of two or more devices that have been connected through links to send and receive data. A link is simply a communication pathway for transferring data from one device to another. There are basically two types of connections namely point-to-point and multipoint connections. For a point-to-point connection, there is a dedicated link between two devices and the entire capacity of the link is set aside for transmission between these two devices. A multipoint connection on the other hand is one in which more than two devices share a common link.

NETWORK TOPOLOGY

A network topology refers to the way in which the network devices are connected to each other. When two or more devices are connected they form a link, and one or more links form a topology. In a network the devices are normally referred to as nodes. There are basically four main types of networking and these are the **mesh**, **star**, **bus** and **ring**.

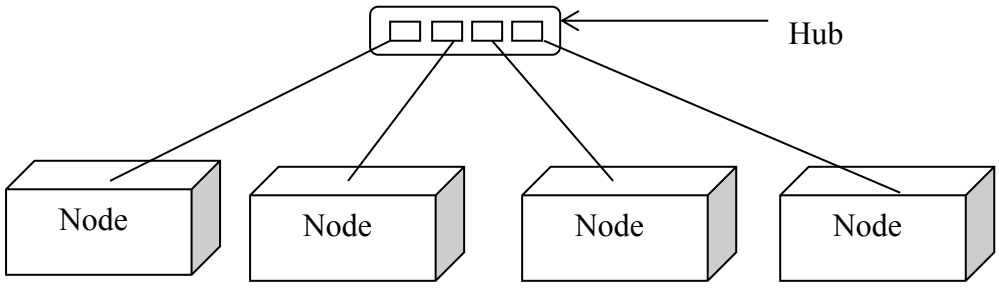
MESH TOPOLOGY

In a mesh topology each device has a dedicated point-to-point link to all other devices in the network. In other words, there is a direct connection between every two devices on the network. A typical mesh topology is as shown below:



STAR TOPOLOGY

In a star topology, each device has a dedicated point-to-point link only to a hub; a central controller. In other words, there is no direct link between any two devices. A typical star topology is as shown below:



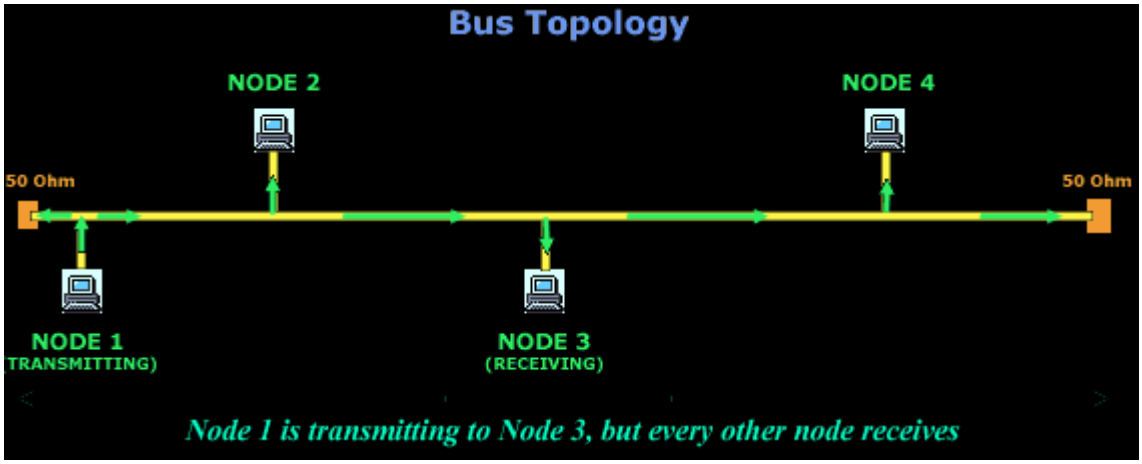
BUS TOPOLOGY

In a bus topology one long cable called the bus cable is used to link all the devices in a link. The bus topology is a multipoint. Each device is connected to the bus cable by drop lines and connectors (taps)

The Physical Bus Topology

Bus topology is fairly old news and you probably won't be seeing much of these around in any modern office or home.

With the Bus topology, all workstations are connected directly to the main backbone that carries the data. Traffic generated by any computer will travel across the backbone and be received by all workstations. This works well in a small network of 2-5 computers, but as the number of computers increases so will the network traffic and this can greatly decrease the performance and available bandwidth of the network.



Bus Topology

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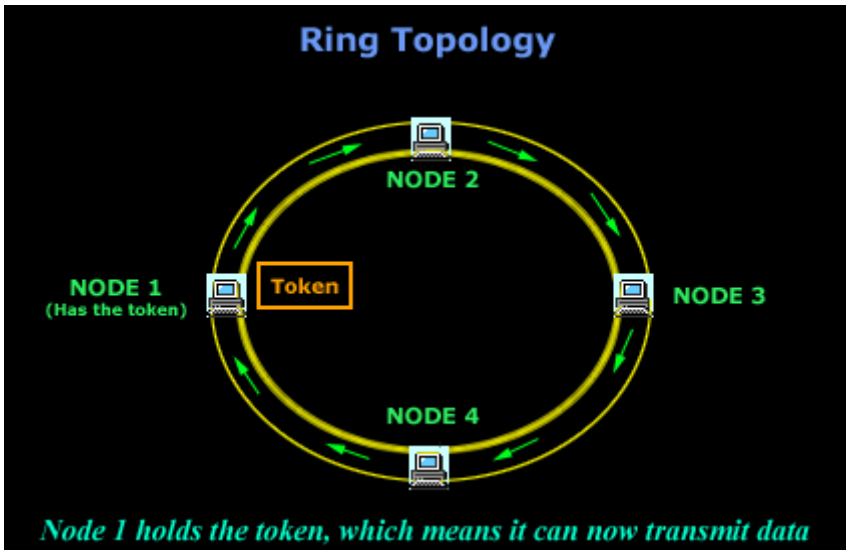
The Physical Ring Topology

In the ring topology, computers are connected on a single circle of cable. Unlike the bus topology, there are no terminated ends. The signals travel around the loop in one direction and pass through each computer, which acts as a repeater to boost the signal and send it to the next

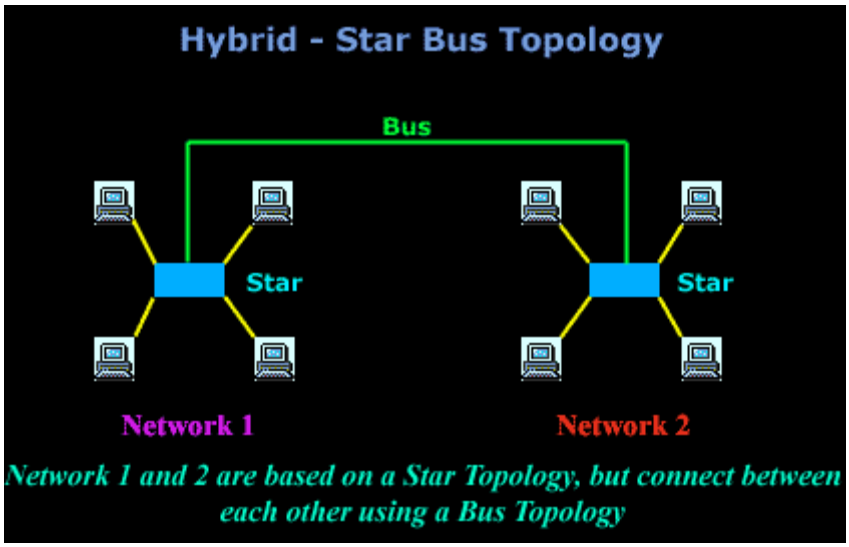
computer. On a larger scale, multiple LANs can be connected to each other in a ring topology by using Thicknet coaxial or fiber-optic cable



Ring Topology

The Physical Hybrid Topology

With the hybrid topology, two or more topologies are combined to form a complete network. For example, a hybrid topology could be the combination of a star and bus topology. These are also the most common in use.



Hybrid-Star Bus Topology