A grayscale background image showing various computer hardware components like a keyboard, mouse, and monitor.

Unit - 1  
COMPUTER FUNDAMENTALS



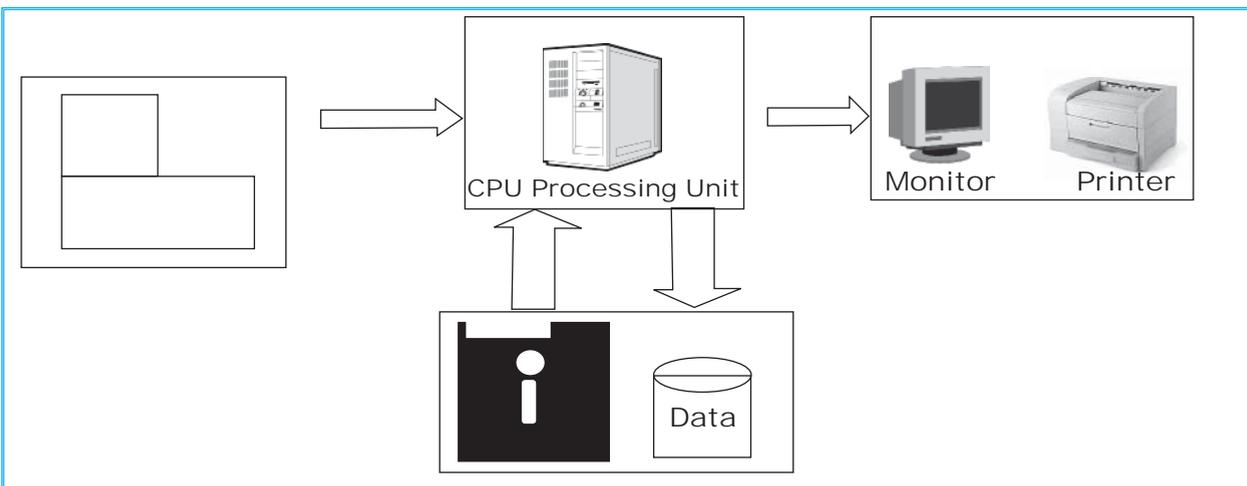
## LEARNING OBJECTIVES

- To understand the basic concepts of computer system
- To know the uses of computers in various fields
- To understand the computing process
- To understand the characteristics of computers
- To do the classification of computers
- To discuss various generations of computers
- To understand the various functions of CPU
- To know the concept of Virtual Memory

## 1.1 COMPUTER

In the simplest definition, a **computer** is an electronic device - a flexible machine that can manipulate data. Computer is being used for tasks as adding up the supermarket bill, getting cash at an ATM, computers are also used by writers, television producers, musicians, poets, graphics illustrators and scholars of medieval history. A computer is **programmable** i.e. the computer depends totally on the program, which the computer is using. (A **program** is a list of instructions, telling the computer 'what to do.')

A computer's hardware (the machine and its components) is designed to be as flexible as possible. By using computer programs, called software, one transforms this flexible hardware into a tool for a specific purpose. No matter which program a computer is using, the machine itself performs only four basic operations, as shown in Fig. 1.1.1. The most widely accepted definition of the computer includes the following operations :



*Fig. 1.1.1: Different Computer Operations*

- **Input:** A computer accepts data that is provided by means of an input device, such as a keyboard.
- **Processing:** A computer performs operations on the data to transform it in some way.
- **Output:** A computer produces output on a device, such as a printer or a monitor, that shows the results of processing operations.
- **Storage:** A computer stores the results of processing operations for future use.

This definition is often referred to as the **IPOS cycle**. The four steps of the IPOS cycle—input, processing, output, storage—do not have to occur in a rigid IPOS sequence. Under the direction of a program, a computer uses the steps of this process when needed and as often as needed. The use of a personal computer, a computer designed to meet an individual's computing needs, illustrates these four basic computer operations. We use the keyboard for taking the input data. The computer's internal circuitry processes the data. We see the results (output) on the computer's **monitor** (the TV-like display) and we can print these results on the printer. We can also store the results on the computer's internal disk or on a removable disk. Fig. 1.1.2 depicts this relationship.



*Fig. 1.1.2: Relationship between different parts of a Computer*

The system unit contains the components with which the computer processes and stores data. The keyboard and the mouse are input devices. The monitor displays the output. The printer prints the output.



### 1.2 USES OF COMPUTER

The purpose of the computer is to transform data into information. In this context, **data** means some kind of unorganized material that can be entered into the computer - a rough sketch that needs work, a first draft of an essay that needs revision or polishing, figures from a company's books, a list of names and addresses. What results from processing operations is **information**, i.e. data that has been made meaningful and useful. This capability to process data can be used in a variety of ways. People have come up with some very interesting uses.

A psychologist keeps a computer in the counselling room. At the touch of a key, the psychologist can search through references on a computer disk for information relating to topics that come up during counselling sessions.

### 1.3 ELEMENTS OF THE COMPUTING PROCESS

Computers consist of hardware, the physical parts of the computer and software, the programs that tell the computer 'what to do.' Processing data into information (the computing process) involves more elements than just hardware and software. All these elements must be organized so that each works smoothly and efficiently with the others. In the **computing process**, computers integrate the use of five key elements which are given as follows:

- Hardware
- Software
- Data
- People
- Procedures

The computing process, in short, includes everything and everyone necessary for the computer to perform a useful task. The following sections show that 'how each of these elements works in the process'.

#### 1.3.1 Hardware

The term hardware refers to the physical parts of the computer. Computer hardware is versatile-but it does depend on the computer program, we use. The key to the computer's versatility is memory. One can think of memory as a temporary workspace. The computer's processor uses this workspace as a scratch pad during processing. Many people confuse memory with storage. Memory is temporary. When we turn off the computer, everything in the memory is lost. Storage is usually permanent. On most computers, storage also has far greater capacity than memory.

Understanding the distinction between memory and storage is essential. Some programs keep their output in memory. One must transfer this information to a storage device, such as a disk drive, if one wants to keep the information permanently. If we switch off the computer without saving this information (transferring it to storage), the information is lost.

The key to the computer's precision is the fact that it represents data digitally. Computers use binary digits, using a base 2 number system rather than a decimal (or base 10) number system. A binary digit, commonly called a bit, has a value of either 0 (zero) or 1 (one). Eight bits are grouped together to represent a **character** - a letter, number or special character. This group is called a **byte**. Many people use the terms character and byte to mean the same thing.

People talk about bytes when they talk about the capacity of computer memories and storage devices. Because one byte can store only one character, these devices must be capable of storing thousands, millions or even billions of bytes. To describe these large capacities, the terms **kilobyte**



**(KB), megabyte (MB) and gigabyte (GB)** are used. A kilobyte equals approximately one thousand bytes, a megabyte equals approximately one million bytes and a gigabyte equals approximately one billion bytes. (The actual number of bytes in a megabyte is slightly higher because computer storage amounts are actually measured in base 2 numbers.)

### 1.3.2 Software

Software is the set of instructions (also called a program) that guides the hardware through its job. The following sections explore additional aspects of software.

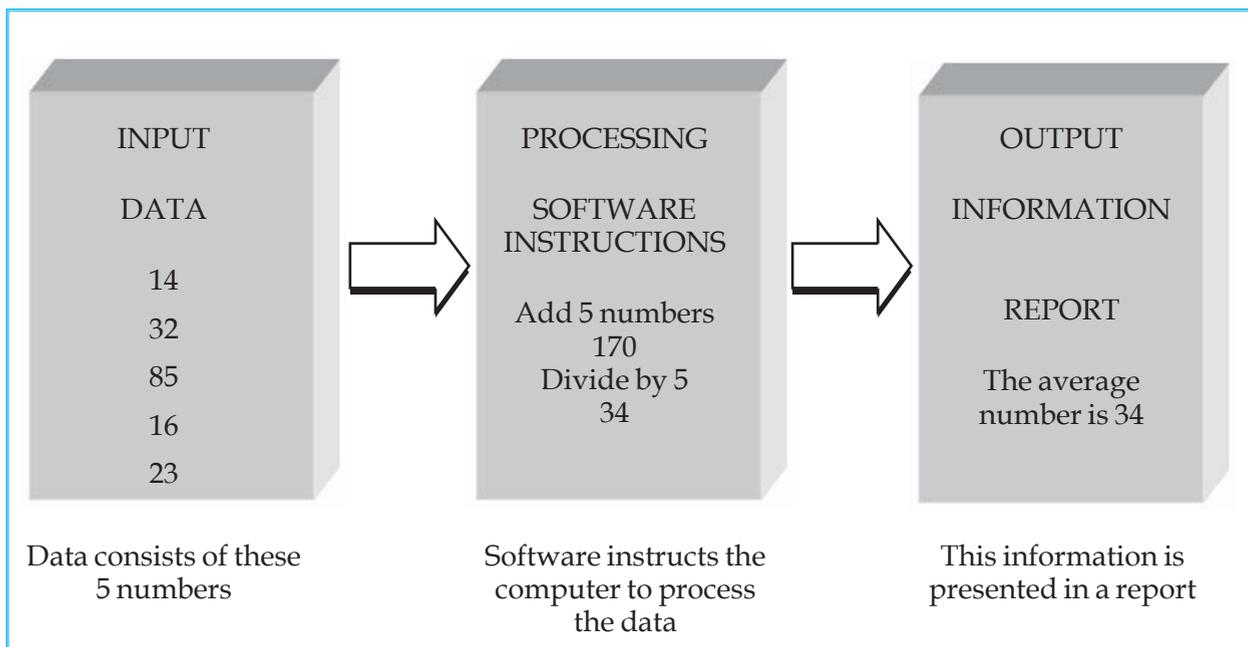
- (a) **Programming Languages:** Software programs must be written in **programming languages**. Programmers i.e. people trained in the use of a programming language, write programs.
- (b) **System and Application Software Packages:** Today's complex computer programs, such as Microsoft Word (a word processing program), consist of many separate programs that are designed to run together. In recognition of this fact, people sometimes speak of **software packages**. When we buy Microsoft Word, we are actually buying a software package rather than a single program. Based on the function of the package, software packages are divided into two categories: system software and application software. Computer literacy involves; learning that 'how to use both system software and one or more application programs'. Computers need system software to function. System software integrates the computer's hardware components and provides tools for day-to-day maintenance tasks, such as displaying a list of the files contained on a disk. MS-DOS, UNIX, Microsoft Windows 98 and System 7 are well-known examples of system software.
- (c) **Application software:** It turns the computer into a tool for a specific task, such as writing. Not all application programs will be useful to us. Some application programs are **special-purpose programs**, which perform a specific task for a single profession. For example, safety managers use a program that prints records of occupation-related injuries and illnesses in a format required by a government health bureau. If we aren't a safety manager, we would not find this application program interesting or useful. Other application programs are called **general-purpose programs**. People use these programs for a variety of tasks. Commonly used general-purpose programs include the following:
  - **Word processing:** More than 85 per cent of the personal computers are equipped with a word processing program, which transforms the computer into a tool for creating, editing, proofing, printing and storing text. Many of today's books originated in text typed into computers-including this one also.
  - **Desktop publishing:** In the past, newsletters and magazines were created through an expensive, tedious process called layout, in which someone does the job of cut and pasting photographs, borders and text to create a pleasing design. With the help of the desktop publishing software in the computer, we can produce attractive results with a little special training.
  - **Electronic spreadsheet:** Businesses previously worked out budgets and made forecasts using accountant's paper and a calculator. Electronic spreadsheet programs enable us to type the headings and numbers into a computerized version of accountant's paper, but with a twist. We can hide formulae within the on-screen 'paper.' These formulae perform computations on the data. The payoff is that one can change any number and immediately see the effect of the change. People use electronic spreadsheets for many purposes, not just business-related ones. For example, a forest ranger uses an electronic spreadsheet to analyse data concerning endangered animal populations.



- **Database:** A database program creates an electronic version of a card file-and the program gives us the tools, needed to organize this file (for example, by alphabetizing it) and to retrieve information. An eighth-grade English teacher, for instance, could create a database of interesting uses of language - and retrieve examples for use in class discussions.
- **Telecommunications software:** These software transforms a computer into a terminal, which can connect to a multiuser computer system by means of the telephone. Commercial multiuser systems enable us to join discussion groups, exchange mail with other users, make plane and hotel reservations and obtain free software for our computer.
- **Graphics software:** Are we going to give a public presentation in our future? If so, we need to learn 'how to use presentation of Graphics programs to create attractive charts and graphs that you can share with the audience.'

### 1.3.3 Data

Computers transform data into information. Data is the raw material; information is processed data. Data is the input to the processing; information is the output. A useful model to describe the relationship between data and information is called the systems model. It shows that data goes into a process and information is then output. Fig. 1.3.1 describes this model.



*Fig. 1.3.1: A System Model*

Several characteristics distinguish useful information from data. The purpose of information is to help people for making well-informed decisions, but what makes information useful? Information must be relevant, timely, accurate, concise and complete in order to be useful. Data must be accurate but doesn't need to be relevant, timely or concise. Table 1.3.1 describes these characteristics.



Characteristics	Description
Relevant	Information applies to the current situation.
Timely	Information is up-to-date and available when it is needed.
Accurate	Data given to the computer and the output are correct in every detail.
Concise	Information is condensed into a usable length.
Complete	All important items are included.

*Table 1.3.1: Characteristics of useful information*

### 1.3.4 People

One may be surprised to learn that people are part of the computing process. Some computers, such as the computer chip that controls an automobile engine, function without human intervention. But even these computers were designed by people and occasionally require maintenance by people. Most computers require people, who are called users (or sometimes end users). Some users progress beyond the basics of computer literacy. They learn the advanced features of application programs. With this knowledge, these users can customize an application program for a specific task. These knowledgeable people are called **power users**.

**Computer professionals** have taken intermediate and advanced courses about computers. These people apply their professional training to improve the performance, ease of use and efficiency of computer systems. One kind of computer professional is the programmer, who creates new computer programs. Excellent career opportunities exist for students interested in becoming computer professionals.

### 1.3.5 Procedures

Procedures are the steps that one must follow to accomplish a specific computer-related task. Part of a user's computer literacy is, knowing common procedures. We already know several computer procedures. For example, we have probably used an **Automated Teller Machine (ATM)**. Inside, the ATM is a computer. In response to the on-screen messages, called **prompts**, we insert our card, enter our **Personal Identification Number (PIN)** and tell the machine how much money we want.

## **1.4 CHARACTERISTICS OF COMPUTERS**

No matter where computers are found or how they are applied, they're used for input, processing, output and storage. But computers wouldn't be worth the trouble without the following characteristics:

- Computers are fast. Many of today's computers can perform hundreds of millions of processing operations in one second.
- Computers are **reliable**. Today's computers may run day in and day out for years without failure.
- Computers are **accurate**. The computer's physical processing circuits rarely make errors. Computers make errors, of course, but there are almost always due to faulty programs or incorrect data input.
- Computers can **store massive amount of information**. Today's personal computers can be equipped with disks capable of storing more than forty billion characters (letters or numbers). That capacity is enough to store the complete works of William Shakespeare, an unabridged English dictionary, a 32-volume encyclopaedia, a world atlas and almanac, dozens of computer



## Computer Fundamentals

programs and all our written work from the third grade through graduate school with room for more.

- Computers can move **information** very quickly from one place to another. Using all experimental connection that may soon play a role in the Information Superhighway, one computer can send the entire text of the Encyclopaedia Britannica to another linked computer in less than one second.

A computer-literate person knows that the computer is a tool for creating useful information that can be printed, communicated to others and stored for future use.

### 1.5 CLASSIFICATION OF COMPUTERS

The computer putting on the desk in the classroom is a microcomputer. It is a small, powerful piece of equipment. Even so, the power of the microcomputer is not enough for most large organizations. The computer industry consists of more than just microcomputers. Any classification of computers is somewhat arbitrary. Traditionally, computers have been classified by their size, processing speed and cost. This section explores four commonly used classifications:

#### 1.5.1 Supercomputers

These are the largest, fastest, most powerful and most expensive computers made. Supercomputers can be accessed by many individuals at the same time. Supercomputers are used primarily for scientific applications that are mathematically intensive. The aerospace, automotive, chemical, electronics and petroleum industries use supercomputers extensively. Supercomputers are used in weather forecasting and seismic analysis. These are found in many public and private research centers, such as universities and government laboratories. A supercomputer was used to alert scientists to the impending collision of a comet with Jupiter in 1994, giving them time to prepare to observe and record the event. The United States Department of Energy recently contracted with IBM for an 'ultra-supercomputer,' three hundred times faster than any existing machine. The ultra-supercomputer will simulate nuclear explosions (eliminating the need to detonate any bombs), model global weather trends and design power plants.

Supercomputers derive much of their speed from the use of multiple processors. **Multiprocessing** enables the computers to perform tasks simultaneously-either assigning different tasks to each processing unit or dividing a complex task among several processing units. The first supercomputer had four central processing units; the **massively parallel processors** of today contain hundreds of processors.

The speed of modern supercomputers is measured in nanoseconds and gigaflops. A **nanosecond** is one billionth of a second. A **gigaflop** is one billion floating-point arithmetic operations per second. Supercomputers can perform at upto 128 gigaflops and use bus widths of 32 or 64 bits. This capability makes supercomputers suitable for processor-intensive applications, such as graphics. Supercomputers are rarely used for input/output-intensive processing, such as accounting or record-keeping operations.



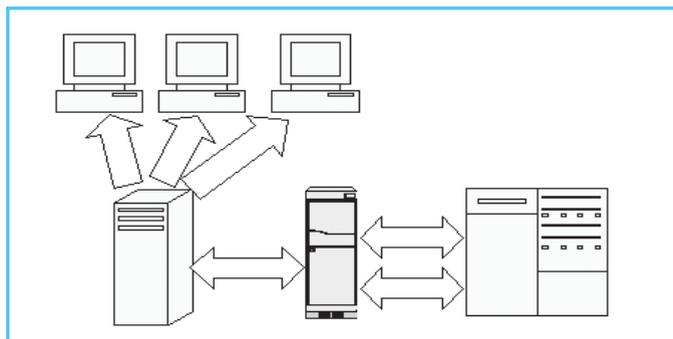
## 1.5.2 Mainframes



*Fig. 1.5.1: Mainframes*

For input/output-intensive operations, mainframe computers are much more suitable than supercomputers. Many modern mainframes have multiprocessing capabilities; however, these are generally limited to eight or fewer processors. The processors in mainframes are slower than those in supercomputers, with speed measured in megaflops (millions of floating-point arithmetic operations per second) rather than gigaflops.

A mainframe computer system is usually composed of several computers in addition to the mainframe or host processor, as shown in Fig. 1.5.1. The **host processor** is responsible for controlling the other processors, all the peripheral devices and the mathematics operations. A **front-end processor** is responsible for handling communications to and from all the remote **terminals** connected to the computer system. Sometimes a **backend processor** is used to handle data retrieval operations. Although the host computer could perform all these operations, it can be used more efficiently if relieved of time-consuming chores that do not require processing speed. Fig. 1.5.2 depicts this relationship.



*Fig. 1.5.2: Relationship between front-end processor, back-end processor and host*

Mainframe computer systems are powerful enough to support several hundred users simultaneously at remote terminals. Terminals can be located near the computer or miles away. Computers can support hundreds of users by keeping numerous programs in primary memory and rapidly switching back and forth between programs. Because computers are so much faster than people, the users never notice that the computer is handling other tasks. This capability to process multiple programs concurrently for multiple users is known as **multiprogramming**.

The introduction of the microcomputer and the increased capabilities of minicomputers have resulted in a decline of sales of mainframe computers. Recently, to booster sales of mainframes, IBM started producing mainframes based on arrays of microprocessor chips and designed to be servers for giant databases used on networks of microcomputers.

## 1.5.3 Minicomputers

The major difference between mainframes and minicomputers is in scale. Minicomputers can perform the same types of tasks as mainframes, but minicomputers are a little slower. Like mainframes, minicomputers can accommodate remote users, but not as many. Minicomputers' input, output and



storage devices look like those on mainframes; but minicomputers have slightly less storage and the printers are slightly slower. The distinctions between these categories of computers are blurring as time passes. Minicomputers are frequently referred to as mid-range computers.

### 1.5.4 Workstations and Microcomputers

When we are working on a multi-user computer, such as a mainframe or a minicomputer, we can control the input and see the output on the display, but we control nothing else. A single-user computer gives us control over all the phases of computer processing: input, processing, output and storage. We can select the programs we want to use and we don't have to compete with other users to gain access to the system. A single-user system is designed to meet the computing needs of an individual. Single-user computers fall into two categories: workstations and microcomputers.

- (a) **Workstations:** This is a powerful desktop computer designed to meet the computing needs of engineers, architects and other professionals who need detailed graphics displays. For example, workstations are commonly used for **Computer-Aided Design (CAD)**, in which industrial designers create pictures of technical parts or assemblies. To process these complex and detailed diagrams, the computer needs much processing power and storage. Workstations are also frequently used as servers for local area networks.

The workstation has sometimes been called a '**supermicro.**' The workstation looks very much like a desktop microcomputer, but the chips inside make the difference. Most workstations use **Reduced Instruction Set Computer (RISC)** microprocessors. Computer designers have discovered that by eliminating infrequently used pre-programmed instructions, the speed of the processor can be increased. Many new processor chips, including the DEC Alpha and the PowerPC, are RISC chips. RISC processors are particularly useful in special-purpose applications, such as graphics, in which speed is critical. The DEC Alpha chip was the first microprocessor designed to work with a 64-bit bus.

- (b) **Microcomputers:** The boundary between workstations and personal computers is becoming less distinct. Today's best personal computers are more powerful and offer more precise displays than the workstations of the recent past. The new Pentium Pro microcomputers have multiprocessing capabilities. In addition, the distinction between workstations and minicomputers is becoming blurred because of the most powerful workstations. These workstations can be equipped so that more than one person can use the workstation at once, in effect making the workstation a minicomputer.

Most microcomputers enable the user to switch between tasks. This capability is known as **multitasking** - a single user variation on multiprogramming. Multitasking can be a great timesaver. Suppose that we are using a word processor to write a test paper and we need to do some computations on the computer and use the results in the paper. Without multitasking, we would have to close the test paper file and the word processing application, open the calculator application, make the computations, write down the results, close the calculator application and reopen the word processing application and the test paper file. With multitasking, we simply open the calculator application, make the calculations and switch back to the test paper file. This capability to task-swap between the paper and the calculator saves time.

People frequently refer to a personal computer as a **microcomputer**, a computer that uses a microprocessor for its processing circuitry. The term microcomputer originated in the late 1970s, when the only computers that used microprocessors were PCs. But today all kinds of computers use microprocessors. By this definition, most of today's computers, including some supercomputers, are microcomputers. But people usually mean PC when they use the term microcomputer.



### 1.5.5 Portable Computers

The first portable computers were dubbed 'luggables' and for good reason. They weighed as much as 28 pounds. Soon, reductions in size created the laptop computer. As many people discovered to their dismay, however, 10 pounds can seem like 20 if one must carry a laptop through a large airport or for any long distance. A picture of Laptop is shown in Fig. 1.5.3.

Portable computing came of age with the creation of notebook computers, portable computers that are small enough to fit into an average-sized briefcase. At first, these computers were underpowered and didn't offer adequate storage. Today, new models offer as much processing power and storage as microcomputers and even some workstations. Notebooks have become very popular. Some people use notebooks instead of desktop computers.

A **docking station** gives us the best of both worlds; we can use the notebook as a portable and then plug it into the docking station to access peripherals, such as printers, as well as full-sized keyboards and monitors. **Subnotebooks** sacrifice some storage and processing capability to bring the total weight down to three or four pounds.

**Palmtop computers**, sometimes called picocomputers, offer reduced size with reduced capabilities. Although some palmtops are general-purpose, many are special-purpose personal information managers or PIMs. Special-purpose palmtops that keep phone directories and calendars and provide calculator capabilities are known as **Personal Digital Assistants (PDAs)**, as shown in Fig. 1.5.4. We can use a PDA to schedule appointments, retrieve frequently used phone numbers and jot down notes. Most PDAs are designed to accept written input by a pen; the PDA decodes what we write.

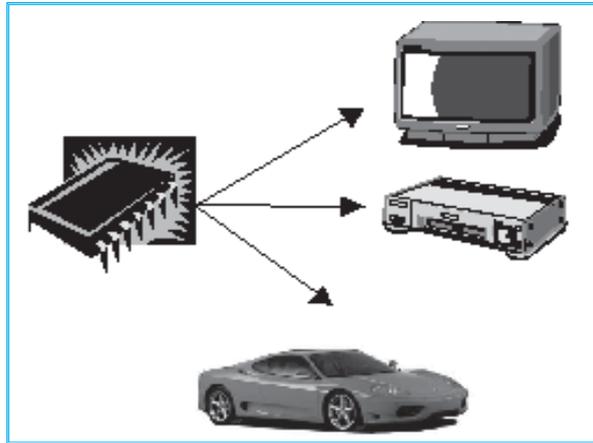
**Smart cards** look like ordinary credit cards but incorporate a microprocessor and memory chips. Smart cards were developed and pioneered in France about twenty years ago and are being used extensively throughout the world. Smart cards are used to pay highway tolls, pay bills and purchase merchandise. In France, the telecarte has virtually replaced paid telephone booths. The telecarte, which costs \$7.50, is inserted into the phone and the charge for the call is automatically deducted from the value stored on the card. Smart cards that hold personal medical history for use in an emergency are currently being tested. A smart card has a microprocessor and a memory chip. In the future, one may use a smart card to record transactions such as purchases and work hours.



Fig. 1.5.3: Laptop



Fig. 1.5.4: PDA



*Fig. 1.5.5: Embedded Computers*

## 1.5.6 Embedded Computers

We may have as many as a dozen computers in our home, as shown in Fig. 1.5.5. These computers are embedded computers. These are built into special-purpose devices, such as video game players, microwave ovens, 'smart' Video cassette recorders, wrist-watches, programmable furnace thermostats and 'smart' alarm clocks. In these devices, the computer is given just one task, such as getting us out of bed at the right time on Thursday morning. Computers are also embedded in automobiles, CD players, microwave ovens and many other pieces of equipment.

Many people don't realize that today's cars use tiny computers to control the engine. The use of these computers has helped designers create engines that use less fuel and produce less pollution than yesterday's gas guzzlers. The computers described in this unit would be of limited use if we could not transfer data between them. Using networks or telephones to link supercomputers, mainframes and minicomputers is commonplace. New ways to transfer data with portable computers are being developed regularly. Many people think that it is easier to send data around the world using computers than using the mail.

## 1.5.7 Tablet PCs

Tablet PCs are mobile PCs that combine features of laptops and handhelds. Like laptops, they're powerful and have a built-in screen. Like handhelds, they allow you to write notes or draw pictures on the screen, usually with a tablet pen instead of a stylus. They can also convert your handwriting into typed text. Some Tablet PCs are "convertibles" with a screen that swivels and unfolds to reveal a keyboard underneath.



*Fig. 1.5.6: Tablet PC*

## 1.6 HISTORICAL PERSPECTIVE

Various types of computers are developed from time to time.

Based on their characteristics, scientists divided the development of computers into various generations, which are given as follows:

- **The First Generation (1951 to 1959):** The first generation of computers usually dated from 1951 to 1959 - used **vacuum tubes**. Dates for computer generations are not precise, varying from source to source. A change in generation has usually been the result of a major hardware innovation. First generation computers were large and slow and they produced lots of heat. The vacuum tubes failed frequently, so first generation computers were 'down' (not working) much of the



time. But these caught the public's imagination. In newspapers and magazines, journalists wrote of 'electronic brains' that would change the world.

First-generation computers were given instructions in machine language, which is composed entirely of the numbers 0 and 1. Machine language was designed in this manner because electronic computers use the binary number system. Since machine language is very difficult to work with, only a few specialists understood 'how to program these early computers.'

All data and instructions came into the first-generation computers from punched cards. Secondary storage consisted of magnetic drums. It wasn't until 1957 that magnetic tape was introduced as a faster and more convenient secondary storage medium. A single tape could hold the contents of approximately 1,100 punched cards (about 21 pages of information).

- **The Second Generation (1959 to 1963):** First-generation computers were notoriously unreliable, largely because the vacuum tubes kept burning out. Unlike vacuum tubes, transistors are small, require very little power and run cool. And these are much more reliable. Because second-generation computers were created with **transistors** instead of vacuum tubes, these computers were faster, smaller and more reliable than first-generation computers. In the second generation, memory was composed of small magnetic cores strung on wire within the computer. For secondary storage, magnetic disks were developed, although magnetic tape was still commonly used.

Second-generation computers were easier to program than first-generation computers. The reason was the development of high-level languages, which are much easier for people to understand and work with, as compared to assembly languages. Also, unlike assembly language, a high-level language is not machine specific; this makes it possible to use the same program on computers produced by different manufacturers. Second-generation computers could communicate with each other over telephone lines, transmitting data from one location to another. Communication was fairly slow, but a new method of exchanging data and ideas was now available.

These second-generation computers had some problems. The input and output devices were so slow that the computer itself frequently remained idle, waiting for cards to be read or reports to be printed. Two different but equally important solutions solved this problem. Although both projects began during the second generation and used second-generation technology, neither was completed until well into the third generation.

- **The Third Generation (1963 to 1975):** As with the first generation of computers, a device that ended the second generation was invented before the second generation began. **Integrated Circuits (ICs)** incorporate many transistors and electronic circuits on a single wafer or chip of silicon. Integrated circuits are sometimes called chips because of the way they are made. Integrated circuits are also called semiconductors because they are formed by combining layers of materials that have varying capacities to conduct electricity. By etching patterns into these layered materials, the creators can include many transistors and other electronic components on one very small chip.

Integrated circuit technology is responsible for the computer industry's technical progress. By the second generation, scientists knew that more powerful computers could be created by building more complex circuits. But because the circuits had to be wired by hand, these computers were too complex and expensive to build. Integrated circuit technology removed this barrier. The result was a computer that costed no more than first-generation computers but offered more memory and faster processing.

- **The Fourth Generation (1975 to Today):** The significance of the microprocessor cannot be overstated—it has changed the world. The techniques, called **Very Large Scale Integration (VLSI)** used to build microprocessors enable chip companies to mass-produce computer chips that contain hundreds of thousands or even millions, of transistors. Fourth-generation



technology is still going strong. Efforts to pack even more transistors on one chip have led to such developments as Intel's Pentium Pro microprocessor. It contains 5.5 million transistors - a far cry from the 2,250 transistors found in the first Intel chip. Many experts believe that further miniaturization efforts will create billions of transistors on one chip. Although high-level languages are still used extensively, very high-level languages appeared during the fourth generation. A very high-level language is really a way of writing instructions for a complex application program that has a large command set. Most new languages are based on a concept known as **Object-Oriented Programming (OOP)**, which encourages programmers to reuse code by maintaining libraries of code segments. Another fourth-generation development is the spread of high-speed computer networking, which enables computers to communicate and share data. Within organizations, **Local Area Networks (LANs)** connect several dozen or even several hundred computers within a limited geographic area (one building or several buildings near each other). **Wide Area Networks (WANs)** provide global connections for today's computers.

- **The Fifth Generation :** If there is a fifth generation, it's slow in coming; after all, the last one began in 1975. The dates are arbitrary and we may soon learn that the fifth generation began in 1990! Major changes are occurring in software as well as hardware. According to the experts, the trademark of the next generation will be **Artificial Intelligence (AI)**. Computers that use AI will have some attributes associated with human intelligence, such as the capabilities to decode and respond to natural language (a human language such as English), to reason and draw inferences and to recognize patterns in sensory input.

The human drive to learn required innovations in equipments. Past inventions made future innovations possible innovations, from graphics capabilities to parallel processing, have filtered down from the supercomputers to the mainframes. We can foresee the future of small computers by watching the developments in the larger machines. Various renovations along with important points (at a glance) are given in the Table 1.6.1, which is as follows:

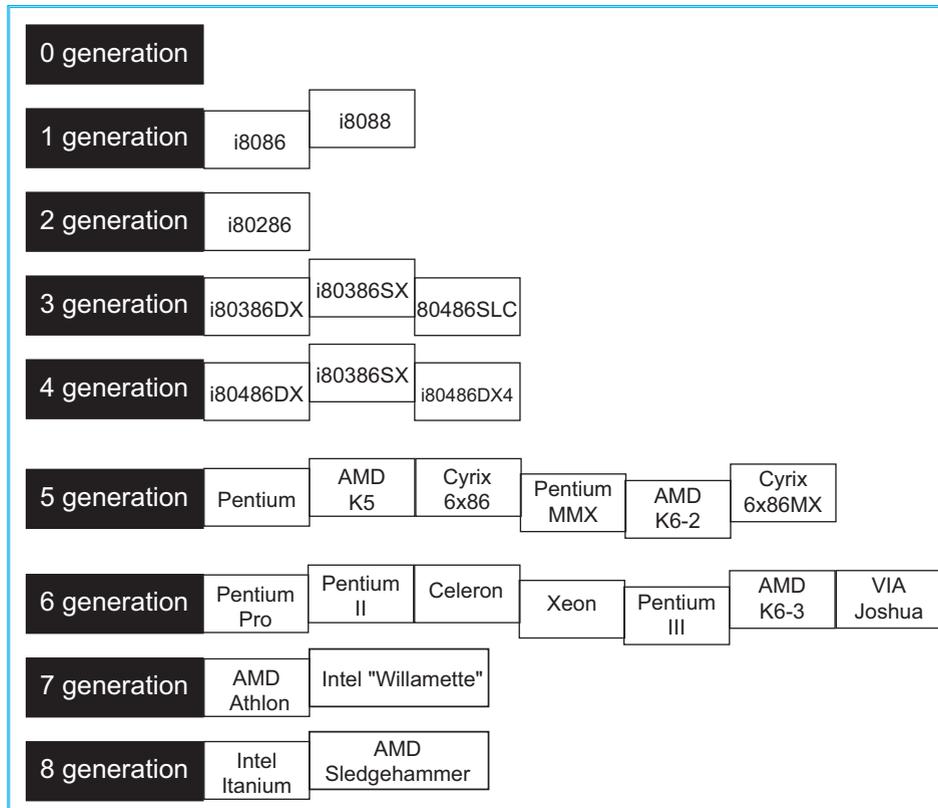
Generation	Years	Circuitry	Characterized by
First	1951 to 1959	Vacuum tubes	Magnetic drum and magnetic tape; difficult to program; used machine language and assembly language
Second	1959 to 1963	Transistors	Magnetic cores and magnetic disk, used high-level languages and were easier to program
Third	1963 to 1975	Integrated circuit	Minicomputer accessible by multiple users from remote terminals
Fourth	1975 to present	VLSI	The Personal computer and user-friendly micro-programs; very fast processor chip high-level language; Object Oriented Programming (OOP)
Fifth Generation	Present to Future	ULSI, Parallel Processing, AI, Quantum Computing, Nanotechnology	Handheld PCs, iPad, Biometric Devices, Note book, Ultra book etc. More userfriendly interface with multimedia features.

*Table 1.6.1: Generations of Computers*



## 1.7 CENTRAL PROCESSING UNIT (CPU)

In order to work, a computer needs some sort of 'brain' or 'calculator'. At the core of every computer, there is a device roughly the size of a large postage stamp. This device is known as the Central Processing Unit (CPU). This is the 'brain' of the computer; it reads and executes program instructions, performs calculations and makes decisions. The CPU is responsible for storing and retrieving information on disks and other media. It also handles information from one part of the computer to another like a central switching station that directs the flow of traffic throughout the computer system.



*Fig. 1.7.1: Generations of CPU*

PC's are designed around different CPU generations. Intel is not the only company manufacturing CPU's, but by far the leading one. Fig 1.7.1 shows the different CPU generations. There are predominantly Intel chips, but in the 5th generation we see alternatives. There are CPU's of many brand names (IBM, Texas, Cyrix, AMD) and often they make models which overlap between two generations. This can make it difficult to keep track of CPU's. Here is an attempt to identify the various CPU's according to generation, as given in Fig. 1.7.1.

The following Table 1.7.1 helps to understand the differences between the different processors that Intel has introduced over the years.

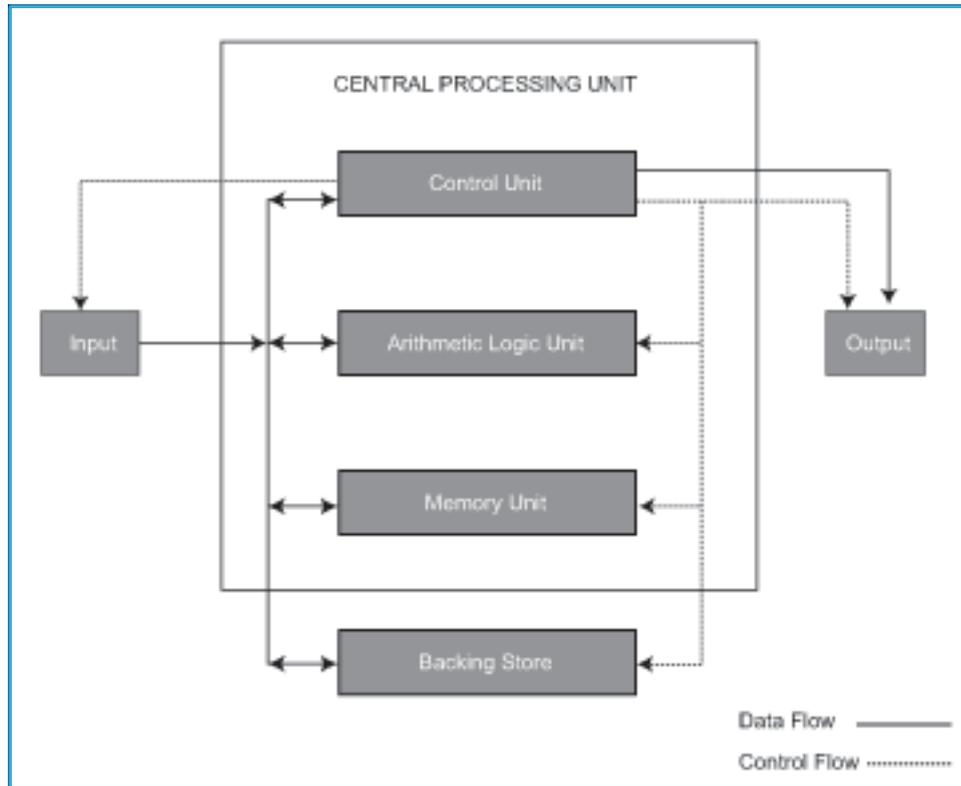


Name	Date	Clock Speed	Data Width
8080	1974	2 MHz	8 Bits
8088	1979	5 MHz	8 Bit Bus, 16 Bits
80286	1982	6 MHz	16 Bits
80386	1985	16 MHz	32 Bits
80486	1989	25 MHz	32 Bits
Pentium	1993	60 MHz	32 Bits, 64 Bit Bus
Pentium II	1997	233 MHz	32 Bits, 64 Bit Bus
Pentium III	1999	450 MHz	32 Bits, 64 Bit Bus
Pentium 4	2000	1.5 GHz	32 Bits, 64 Bit Bus
Pentium M	2003	2.266 GHz	32 Bits, 64 Bit Bus
Intel Core	2006	2.33 GHz	32 Bits, 64 Bit Bus
Intel Pentium Dual-Core	2007	2.93 GHz	64 Bits
Intel Core 2	2008	3.33 GHz	64 Bits
Intel Core i3	2010	3.4 GHz	64 Bits
Intel Core i5	2011	3.46 GHz	64 Bits
Intel Core i7	2012 & upcoming	3.6 GHz	64 Bits

*Table 1.7.1: Different Intel's Processors*

## 1.8 FUNCTIONS OF CPU

The CPU carries out instructions and tells the rest of the computer system 'what to do'. This is done by the Control Unit of the CPU which sends command signals to the other components of the system, as shown in Fig. 1.8.1.



*Fig. 1.8.1: Components of CPU*

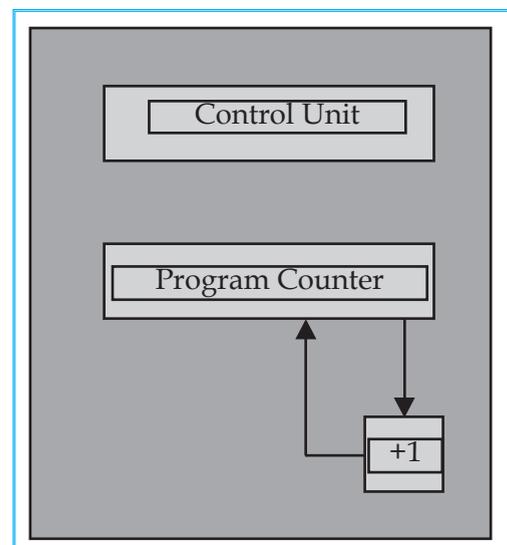
- It also performs arithmetic calculations and data manipulation, eg. comparisons, sorting, combining, etc. This is performed by a part of the CPU known as the **Arithmetic Logic Unit**.
- It holds data and instructions which are in current use. These are kept in the **Main Store or Memory**.

Fig. 1.8.1 shows 'how the whole system works', It shows the basic components of a generalised CPU. An actual CPU may have these components or other with different names that provide the same functions.

### 1.8.1 Control Unit

The control unit directs the entire computer system to carry out stored program instructions. The control unit must communicate with both the arithmetic logic unit and main memory. The control unit uses the instruction contained in the Instruction Register to decide which circuits need to be activated. Fig. 1.8.2 presents an structural view of CU.

The control unit co-ordinates the activities of the other two units as well as all peripheral and auxiliary storage devices linked to the computer. The control unit instructs the arithmetic logic unit which arithmetic operations or logical operation is to be performed.



*Fig. 1.8.2: Control Unit*



Specialised electronic circuitry in the control unit is designed to decode program instructions held in the main memory. Each instruction is read from the memory into the instruction register. The process of reading an instruction, is often referred to as the fetch-execute process.

### 1.8.2 Arithmetic Logic Unit

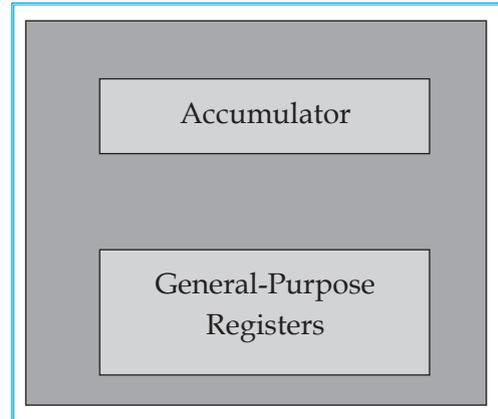
The arithmetic logic unit executes arithmetic and logical operations. Arithmetic operations include addition, subtraction, multiplication and division. Logical operations compare numbers, letters and special characters.

Comparison operations test for three conditions:

- equal-to condition in which two values are the same,
- less-than condition in which one value is smaller than the other, and
- greater-than condition in which one value is larger than the other.

These operations ( $=$ ,  $<$ ,  $>$ ) are used to describe the comparison operations used by the arithmetic logic unit.

On the other hand, ALU also performs logic functions such as AND or and NOT. As shown in Fig. 1.8.3, the accumulator is used to accumulate results. It is the place where the answers from many operations are stored temporarily before being put out to the computer's memory. The other general-purpose registers hold data on which operations are to be performed by the arithmetic logic unit.



*Fig. 1.8.3: ALU*

### 1.8.3 Memory Unit

The Memory Unit is the part of the computer that holds data and instructions for processing. Although it is closely associated with the CPU, but in actual fact, it is separate. Memory associated with the CPU is also called primary storage, primary memory, main storage, internal storage and main memory. When we load software from a floppy disk, hard disk or CD-ROM, it is stored in the Main Memory.

It's amazing 'how many different types of electronic memory encounter in daily life.' Many of them have become an integral part of the vocabulary: RAM, ROM, Cache, Dynamic RAM, Static RAM, Flash memory, Memory sticks, Volatile memory, Virtual memory, Video memory, BIOS.

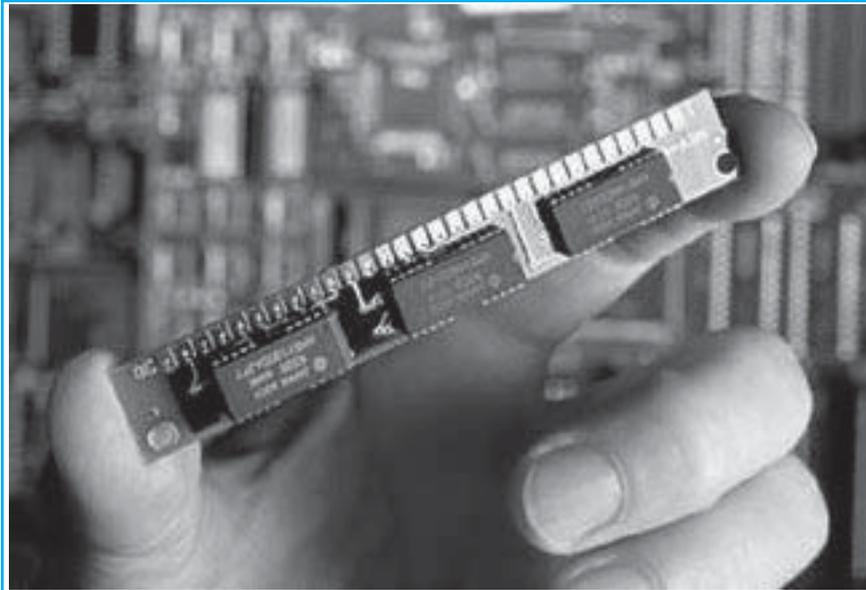
We already know that computer has memory. What we may not know, is that most of the electronic items, we use every day, have some form of memory also. Here are just a few examples of the many items that use memory : Computers, Cell phones, Personal Digital Assistants (PDAs), Game consoles, Car radios, VCRs, TVs.

Each of these devices uses different types of memory in different ways.

There are two basic types of computer memory inside the computer, RAM and ROM.

- (a) **Random Access Memory (RAM):** This is really the main store and is the place where the programs and software we load gets stored. When the Central Processing Unit runs a program, it fetches the program instructions from the RAM and carries them out. If the Central Processing Unit needs to store the results of calculations, it can store them in RAM. A sample picture of the RAM is given in Fig. 1.8.4.

RAM can have instructions READ from it by the CPU and also it can have numbers or other computer data WRITTEN to it by the CPU. When we switch a computer off, whatever is stored in the RAM gets erased.



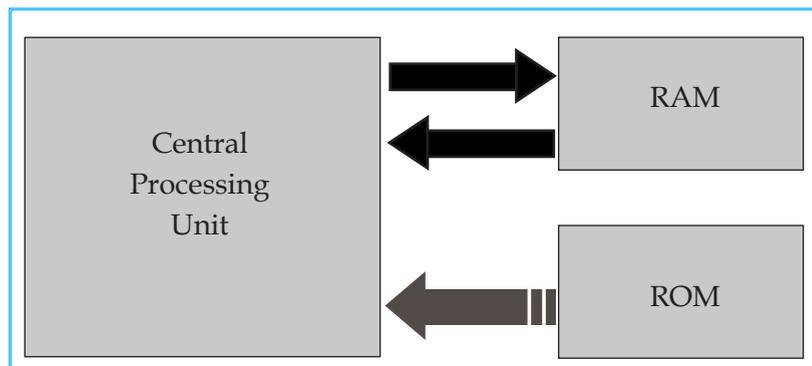
*Fig. 1.8.4: RAM*

RAM is the best known form of computer memory. RAM is considered 'random access' because anyone can access any memory cell directly if we know the row and column that intersect at that cell. The opposite of RAM is **Serial Access Memory (SAM)**. SAM stores data as a series of memory cells that can only be accessed sequentially (like a cassette tape). If the data is not in the current location, each memory cell is checked until the needed data is found. SAM works very well for memory **buffers**, where the data is normally stored in the order in which it will be used (a good example is the texture buffer memory on a video card). RAM data, on the other hand, can be accessed in any order.

**(b) Read Only Memory (ROM):** The CPU can only fetch or read instructions from Read Only Memory (or ROM). ROM comes with instructions permanently stored inside and these instructions cannot be over-written by the computer's CPU. ROM is used for storing special sets of instructions which the computer needs when it starts up.

When we switch the computer off, the contents of the ROM do not get erased but remain stored permanently. Therefore it is non-volatile. Read-only memory (ROM), also known as firmware, is an integrated circuit programmed with specific data when it is manufactured. ROM chips are used not only in computers, but in most other electronic items as well.

Fig. 1.8.5 shows the relationship between the Central Processing Unit and the Main Memory (RAM and ROM).



*Fig. 1.8.5: Relationship between CPU and Main Memory*



- (c) **Cache Memory:** Caching is a technology based on the memory subsystem of the computer. The main purpose of a cache is to accelerate the computer while keeping the price of the computer low. Caching allows to do the computer tasks more rapidly.

Cache technology is the use of a faster but smaller memory type to accelerate a slower but larger memory type. When using a cache, we must check the cache to see if an item is in there. If it is there, it's called a cache hit. If not, it is called a cache miss and the computer must wait for a round trip from the larger, slower memory area. A cache has some maximum size that is much smaller than the larger storage area. It is possible to have multiple layers of cache.

There are a lot of subsystems in a computer; one can put cache between many of them to improve performance. Here's an example. We have the microprocessor (the fastest thing in the computer). Then there's the L1 cache that caches the L2 cache that caches the main memory which can be used (and is often used) as a cache for even slower peripherals like hard disks and CD-ROMs. The hard disks are also used to cache an even slower medium – Internet connection. A list of different types of cache is given as follows:

- **L1 cache** - Memory accesses at full microprocessor speed (10 nanoseconds, 4 kilobytes to 16 kilobytes in size)
- **L2 cache** - Memory access of type SRAM (around 20 to 30 nanoseconds, 128 kilobytes to 512 kilobytes in size)
- **Main memory** - Memory access of type RAM (around 60 nanoseconds, 32 megabytes to 128 megabytes in size)
- **Hard disk** - Mechanical, slow (around 12 milliseconds, 1 gigabyte to 10 gigabytes in size)

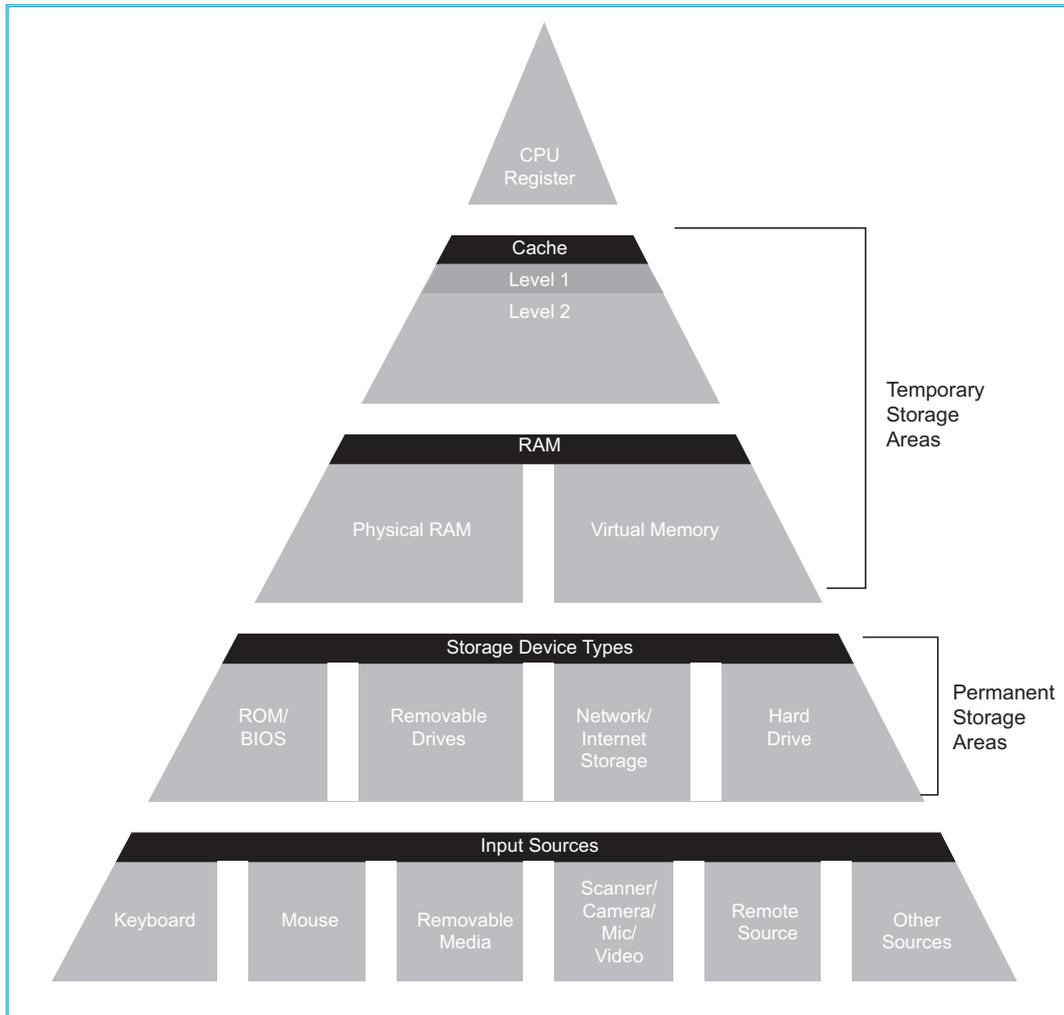
- (d) **Flash Memory:** Electronic memory comes in a variety of forms to serve a variety of purposes. Flash memory is used for easy and fast information storage in such devices as digital cameras and home video game consoles. It is used more as a hard drive than as RAM. In fact, Flash memory is considered a solid state storage device. Solid state means that there are no moving parts – everything is electronic instead of mechanical. Here are a few examples of Flash memory:

- Computer's BIOS chip
- CompactFlash (most often found in digital cameras)
- SmartMedia (most often found in digital cameras)
- Memory Stick (most often found in digital cameras)
- PCMCIA Type I and Type II memory cards (used as solid-state disks in laptops)
- Memory cards for video game consoles

## 1.9 VIRTUAL MEMORY

Most computers today have something like 32 or 64 megabytes of RAM available for the CPU to use. Unfortunately, that amount of RAM is not enough to run all of the programs that most users expect to run at once. For example, if we load the operating system, an e-mail program, a Web browser and word processor into RAM simultaneously, 32 megabytes is not enough to hold it all. If there were no such thing as virtual memory, then once we filled up the available RAM, our computer would have to say, "Sorry, you cannot load any more applications.

Please close another application to load a new one." With virtual memory, what the computer can do is look at RAM for areas that have not been used recently and copy them onto the hard disk. This frees up space in RAM to load the new application. A hierarchy of memories is given in Fig. 1.9.1.



*Fig. 1.9.1: Hierarchy of Memory*

Because this copying happens automatically, we don't even know it is happening and it makes our computer feel like that it has unlimited RAM space even though it only has 32 megabytes installed. Because hard disk space is so much cheaper than RAM chips, it also has a nice economic benefit.

The read/write speed of a hard drive is much slower than RAM and the technology of a hard drive is not geared toward accessing small pieces of data at a time. If our system has to rely too heavily on virtual memory, we will notice a significant performance drop. The key is to have enough RAM to handle everything we tend to work on simultaneously – then, the only time we “feel” the slowness of virtual memory is when there's a slight pause when we are changing tasks. When that's the case, virtual memory is perfect.

When it is not the case, the operating system has to constantly swap information back and forth between RAM and the hard disk. This is called **thrashing** and it can make our computer feel incredibly slow. The area of the hard disk that stores the RAM image is called a page file. It holds pages of RAM on the hard disk and the operating system moves data back and forth between the page file and RAM. On a Windows machine, page files have a SWP extension.

# INPUT/OUTPUT AND AUXILIARY STORAGE DEVICES

## LEARNING OBJECTIVES

- To know about various input devices like keyboard, mouse, trackball etc.
- To discuss about various output devices like monitor, printer etc.
- To understand the classification of monitor, printer etc.
- To discuss various Auxiliary Storage Devices
- To know about Magnetic Tape, Winchester Disk, Floppy Disk etc.
- To understand other storage devices like CD-ROM, CD-R Drive etc.

## 2.1 INPUT DEVICES

An input device is any machine that feeds data into a computer. For example, a keyboard is an input device. Input devices other than the keyboard are sometimes called alternate devices. Trackballs and light pens are all alternate input devices.

### 2.1.1 Keyboard

Keyboard is an input device; consisting of a set of typewriter-like keys that enables to enter data into a computer as shown in Fig. 2.1.1. Computer keyboards are similar to electric-typewriter keyboards but contain additional keys. The keys on computer keyboards are often classified as follows:



*Fig. 2.1.1: Keyboard*

- **Alphanumeric Keys** - letters and numbers
- **Punctuation Keys** - comma, period, semicolon and so on.
- **Special Keys** - function keys, control keys, arrow keys, Caps Lock key and so on.

The standard layout of letters, numbers and punctuation is known as a QWERTY keyboard because the first five keys on the top row of letters spell QWERTY. The QWERTY keyboard was designed in the 1800s for mechanical typewriters and was actually designed to slow typists down to avoid jamming the keys. Another keyboard

design, which has letters positioned for speed typing, is the Dvorak keyboard.

There is no standard computer keyboard, although many manufacturers imitate the standards of

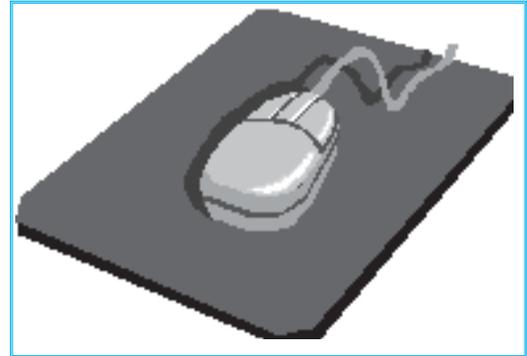


PCs. There are actually three different PC standards: the original PC keyboard, with 84 keys; the AT keyboard, also with 84 keys; and the enhanced keyboard, with 101 keys. The three differ somewhat in placement of function keys, the Control key, the Return key and the Shift keys.

In addition to these keys, IBM keyboards contain the following Keys: Page Up, Page Down, Home, End, Insert, Pause, Num Lock, Scroll Lock, Break, Caps- Lock, Print Screen. Many companies have developed ergonomic keyboards, which reduce the strain while typing with the aim to prevent stress related injuries. Microsoft's natural keyboard is one example.

### 2.1.2 Mouse

Mouse is a device that controls the movement of the cursor or pointer on a display screen, as shown in Fig. 2.1.2. A mouse is a small object that can roll along a hard flat surface. Its name is derived from its shape, which looks a bit like a mouse, its connecting wire that one can imagine to be the mouse's tail and the fact that one must make it scurry along a surface. As we move the mouse, the pointer on the display screen moves in the same direction. Mouse contains at least one button and sometimes as many as three, which have different functions depending on what program is running. Now-a-days, mouse is connected with computer through USB port.

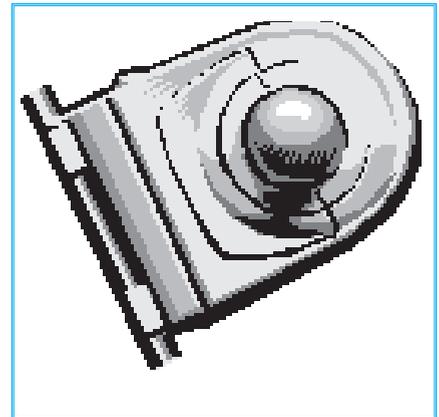


*Fig. 2 .1.2: Mouse*

Invented by Douglas Engelbart of Stanford Research Center in 1963 and pioneered by Xerox in the 1970s, the mouse is one of the great breakthroughs in computer ergonomics because it frees the user to a large extent from using the keyboard. In particular, the mouse is important for graphical user interfaces because one can simply point to options and objects and click a mouse button. Such applications are often called point-and-click programs. T17 mouse is also useful for graphics programs that allows to draw pictures by using the mouse like a pen, pencil or paintbrush.

**Types of Mouse:** There are three basic types of Mouse:

- **Mechanical:** It has a rubber or metal ball on its underside that can roll in all directions. Mechanical sensors within the mouse detect the direction the ball is rolling and move the screen pointer accordingly.
- **Optomechanical:** It is same as a mechanical mouse, but uses optical sensors to detect motion of the ball.
- **Optical:** It does a laser to detect the mouse's movement. One must move the mouse along a special mat with a grid so that the optical mechanism has a frame of reference. Optical mice have no mechanical moving parts. They respond more quickly and precisely than mechanical and optomechanical mice, but they are also more expensive.



*Fig. 2.1.3: Trackball*



### 2.1.4 Trackball

This is another pointing device. Essentially, a trackball is a mouse lying on its back. To move the pointer, we rotate the ball with our thumb, our fingers or the palm of our hand. There are usually one to three buttons next to the ball, which we use just like mouse buttons. The advantage

of trackballs over mice is that the trackball is stationary so it does not require much space to use it. In addition, we can place a trackball on any type of surface, including our lap. For both these reasons, trackballs are popular pointing devices for portable computers.



*Fig. 2.1.4: Joystick*

### 2.1.5 Joystick

With a joystick, the pointer continues moving in the direction the joystick is pointing. To stop the pointer, we must return the joystick to its upright position. Most joysticks include two buttons called triggers. It has a lever that moves in all directions and controls the movement of a pointer or some other display symbols. A joystick is similar to a mouse, except that with a mouse the cursor stops moving as soon as we stop moving the mouse. Joysticks are used mostly for computer games, but they are also used occasionally for CAD/ CAM systems and other applications.

### 2.1.6 Digitizing Tablet

This is an input device that enables to enter drawings and sketches into a computer. A digitizing tablet consists of an electronic tablet and a cursor or pen. A cursor (also called a puck) is similar to a mouse, except that it has a window with cross hairs for pinpoint placement and it can have as many as 16 buttons.



*Fig. 2.1.5: Digitizing Tablet*

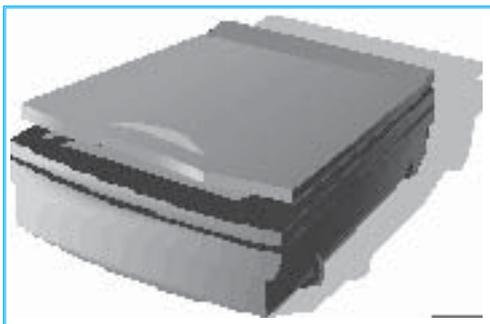
A pen (also called a stylus), which looks like a simple ballpoint pen but uses an electronic head instead of ink. The tablet contains electronics that enable it to detect movement of the cursor or pen and translate the movements into digital signals that it sends to the computer.

For digitizing tablets, each point on the tablet represents a point on the display screen in a fixed manner. This differs from mice, in which all movement is relative to the current cursor position. The static nature of digitizing tablets

makes them particularly effective for tracing drawings. Most modern digitizing tablets also support a mouse emulation mode, in which the pen or cursor acts like a mouse. Digitizing tablets are also called digitizers, graphics tablets, touch tablets or simply tablets.

### 2.1.7 Scanners

Scanner is an input device that can read text or illustrations printed on paper and translate the information into a form that the computer can use. A scanner works by digitizing an image - dividing it into a grid of boxes and representing each box with either a zero or a one, depending on whether



*Fig. 2.1.6: Scanner*



the box is filled in. (For color and gray scaling, the same principle applies, but each box is then represented by up to 24 bits.) The resulting matrix of bits, called a bit map, can then be stored in a file, displayed on a screen and manipulated by programs.

Optical scanners do not distinguish text from illustrations; they represent all images as bit maps. Therefore, we cannot directly edit text that has been scanned. To edit text read by an optical scanner, we need an **Optical Character Recognition (OCR)** system to translate the image into ASCII characters. Most optical scanners sold today come with OCR packages.

Scanners differ from one another in the following respects:

- **Scanning Technology:** Most scanners use **Charge-Coupled Device (CCD)** arrays, which consist of tightly packed rows of light receptors that can detect variations in light intensity and frequency. The quality of the CCD array is probably the single most important factor affecting the quality of the scanner. Industry-strength drum scanners use a different technology that relies on a **Photo Multiplier Tube (PMT)**, but this type of scanner is much more expensive than the more common CCD-based scanners.
- **Resolution :** The denser the bit map, the higher the resolution. Typically, scanners support resolutions from 72 to 600 **Dots Per Inch (DPI)**.
- **Bit depth :** The number of bits used to represent each pixel. The greater the bit depth, the more colors or grayscales can be represented. For example, a 24-bit color scanner can represent 2 to the 24th power (16.7 million) colors. However, a large color range is useless if the CCD arrays are capable of detecting only a small number of distinct colors.
- **Size and shape :** Some scanners are small hand-held devices that can be moved across the paper. These hand-held scanners are often called half-page scanners because they can only scan 2 to 5 inches at a time. Hand-held scanners are adequate for small pictures and photos, but they are difficult to use if we need to scan an entire page of text or graphics. Larger scanners include machines into which we can feed sheets of paper. These are called sheet-fed scanners. These are excellent for loose sheets of paper, but they are unable to handle bound documents. A second type of large scanner, called a flatbed scanner, is like a photocopier. It consists of a board on which we lay books, magazines and other documents that we want to scan.



*Fig. 2.1.7: CCD Based Scanner*

### 2.1.8 Digital Camera

Images can be input into a computer using a digital camera. These images can then be manipulated in many ways using the various imaging tools available. The digital camera takes a still photograph, stores it and then sends it as digital input into the computer. The images are then stored as digital files.



*Fig. 2.1.8: Digital Camera*

### 2.1.9 Magnetic Ink Character Recognition (MICR)

This allows the computer to recognize characters printed using magnetic ink. MICR is a direct-entry method used in banks. This technology is used to automatically read those frustrating-looking numbers on the bottom of the cheque. A special-purpose machine known



as a reader/sorter reads characters made of ink containing magnetized particles. A related technology is the magnetic strip, used on the back of credit cards and bank debit cards, that allows readers such as **Automated Teller Machines (ATMs)** to read account information and facilitate monetary transactions. Another example of magnetic strip technology is in ID cards, which can be used for a variety of functions from attendance monitoring to restricting access to specific locations.

### 2.1.10 Optical Character Recognition (OCR)

It refers to the branch of computer science that involves reading text from paper and translating the images into a form that the computer can manipulate (for example, into ASCII codes). An OCR system enables to take a book or a magazine article and feed it directly into an electronic computer file.

All OCR systems include an optical scanner for reading text and a sophisticated software for analyzing images. Most OCR systems use a combination of hardware (specialized circuit boards) and software to recognize characters, although some inexpensive systems do it entirely through software. Advanced OCR systems can read text in a large variety of fonts, but they still have difficulty with handwritten text.

The potential of OCR systems is enormous because they enable users to harness the power of computers to access printed documents. OCR is already being used widely in the legal profession, where searches that once required hours or days can now be accomplished in a few seconds.

### 2.1.11 Optical Mark Recognition (OMR)

OMR also called mark sensing, is a technology where an OMR device senses the presence or absence of a mark, such as a pencil mark. OMR is used in tests such as aptitude tests for different competition/entrance examinations.

### 2.1.12 Bar Code Reader

Most of the persons are probably familiar with the bar code readers in supermarkets, bookshops etc. Bar-code readers are photoelectric scanners that read the bar codes or vertical zebra striped marks, printed on product containers. Supermarkets use a bar code system called the **Universal Product Code (UPC)**.

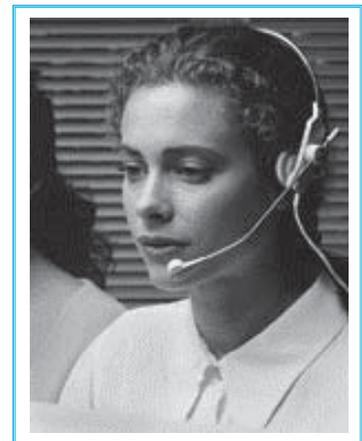
The bar code identifies the product to the supermarket's computer, which has a description and the latest price of the product. The computer automatically tells the **Point of Sales (POS)** terminal what the price is.

### 2.1.13 Speech Input Devices

Speech or voice input devices convert a person's speech into digital form. These input devices, when combined with appropriate software, form voice recognition systems. These systems enable users to operate microcomputers using voice commands.



*Fig. 2.1.9: Bar Code Reader*



*Fig. 2.1.10: Speech Input Device*



Some of these systems must be 'trained' to the particular user's voice. This is done by his/her spoken words to patterns previously stored in the computer. More advanced systems that can recognize the same word spoken by many different people have been developed. However, until recently the list of words has been limited. A newly developed voice recognition system like IBM VoiceType identifies more than 30,000 words and adapts to individual voices. There are even systems that translate from one language to another, such as from English to Japanese. There are two types of voice recognition systems:

- **Continuous speech** : These systems are used to control a microcomputer's operations and to issue commands to special application programs. For example, rather than using the keyword to save a spreadsheet file, the user could simply say 'Save the file'. Two popular systems are Apple Computer's PlainTalk and IBM's continuous speech series.
- **Discrete-Word** : A common activity in business is preparing memos and other written documents. Discrete-word recognition systems allow users to dictate directly into a microcomputer using a microphone. The microcomputer stores the memo in a word processing file where it can be revised later or directly printed out. IBM Voice Type Simply Speaking is an example.

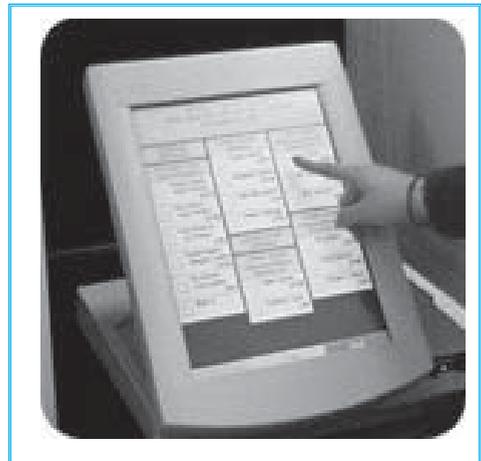
#### 2.1.14 Touch Screen

Touch screen is a type of display screen that has a touch sensitive transparent panel covering the screen. Instead of using a pointing device such as a mouse or light pen, we can use our finger to point directly to objects on the screen.

Although touch screens provide a natural interface for computer novices, they are unsatisfactory for most because the finger is such a relatively large object. It is impossible to point accurately to small areas of the screen. In addition, most users find touch-screens tiring to the arms after long use.

#### 2.1.15 Touch Pad

It is a small, touch-sensitive pad used as a pointing device on some portable computers. By moving a finger or other object along the pad, one can move the pointer on the screen.



*Fig. 2.1.11: Touch Screen*

#### 2.1.16 Light Pen

Light Pen is an input device that utilizes a light-sensitive detector to select objects on a display screen. A light Pen is similar to a mouse, except that with a light pen we can move the pointer and select objects on a display screen by directly pointing to the objects by light pen.

#### 2.1.17 Biometrics

When referring to computers and security, biometrics is the identification of a person by the measurement of their biological features. For example, a user identifying themselves to a computer or building by their finger print or voice is considered biometrics identification. When compared to a password, this type of system is much more difficult to fake since it is unique to the person. Below is a listing of some known biometric devices.



*Fig. 2.1.12: Biometrics*



Other common methods of a biometrics scan are a person's face, hand, iris and retina.

### Types of biometric devices

- **Face scanner** - Biometric face scanners identify a person by taking measurements of a person face. For example, the distance between the persons chin, eyes, nose and mouth. These types of scanners can be very secure assuming they are smart enough to distinguish between a picture of a person and a real person.
- **Hand scanner** - Like your finger print, the palm of your hand is also unique to you. A biometric hand scanner will identify the person by the palm of their hand.
- **Finger scanner** - A biometric finger scanner identifies the person by their finger print. These can be a secure method of identifying a person, however, cheap and less sophisticated finger print scanners can be duped a number of ways. For example, in the show Myth Busters they were able to fake a finger print using a Gummy Bear candy treat.
- **Retina or iris scanner** - A biometric retina or iris scanner identifies a person by scanning the iris or retina of their eyes. These scanners are more secure biometric authentication schemes when compared to the other devices because there is no known way to duplicate the retina or iris.
- **Voice scanner** - Finally, a voice analysis scanner will mathematically break down a person's voice to identify them. These scanners can help improve security but with some less sophisticated scanners can be bypassed using a tape recording.

### 2.1.18 Graphics tablet

Alternatively referred to as a drawing tablet and pen tablet, a graphics tablet is a highly accurate hardware input device that enables an artist to draw or sketch easier than they would be able to do with a standard computer mouse.



*Fig. 2.1.13: Graphics tablet*

### 2.1.19 Light gun

A light gun is a pointing input device that detects light using a photodiode in the gun barrel. When the player of the game pulls the trigger on the gun, the screen is blanked out for a fraction of a second, which allows the photodiode to determine where the gun is pointed. Light guns were most widely used with early console gaming systems such as the NES Zapper light gun, as shown in the picture to the left. Using this gun the player could play games where they were required to point the gun at the screen and shoot targets, such as ducks in the popular Duck Hunt game.



*Fig. 2.1.15: Stylus*



*Fig. 2.1.14: Light gun*

### 2.1.20 Stylus

A pen-shaped instrument used with graphics tablets or touch screen input devices to write or draw on the computer screen, similar to a sheet of paper.



Unlike a pen the Stylus has a simple plastic tip and is often smaller to help fit in a compartment the device is used with. In the picture to the left, is an example of a Stylus, the Palm Z22 Stylus.

Today, the Stylus is not commonly found or used with devices designed as they've been mostly been replaced with touch screens that allow the user to navigate using their finger. A good example of a device using this well is the Apple iPhone.

## 2.2 OUTPUT DEVICES

Output is anything that comes out of a computer. Output can be meaningful information or gibberish and it can appear in a variety of forms - as binary numbers, as characters, as pictures and as printed pages. An output device is any machine capable of representing information from a computer. Output devices include display screens, loudspeakers, printers, plotters etc.

### 2.2.1 Monitor

Monitor is another term for the display screen. The term monitor, however, usually refers to the entire box, whereas display screen can mean just the screen.

In addition, the term monitor often implies graphics capabilities.

(a) **Classification Of Monitors:** Monitors may be classified based on two parameters: Color and signal. Here, a detailed classification is given as follows:

(i) **Based On Color:** There are many ways to classify monitors. The most basic is in terms of color capabilities, which separates monitors into three classes:



Fig. 2.2.1: Color Monitor

- **Monochrome:** Monochrome monitors actually display two colors, one for the background and one for the foreground. The colors can be black and white, green and black or amber and black.
- **Gray-scale:** A gray-scale monitor is a special type of monochrome monitor capable of displaying different shades of gray.
- **Color:** Color monitors can display anywhere from 16 to over 1 million different colors. Color monitors are sometimes called RGB monitors because they accept three separate signals - red, green and blue. This differs from color televisions, for example, which use composite video signals, in which all the colors are mixed together. All color computer monitors are RGB monitors. An RGB

monitor consists of a vacuum tube with three electron guns - one each for red, green and blue at one end and the screen at the other end. The three electron guns fire electrons at the screen, which contains a phosphorous coating. When the electron beams excite the phosphorous, they glow. Depending on which beam excites them, they glow red, green or blue. Ideally, the three beams should converge for each point on the screen so that each pixel is a combination of the three colors.

Color and gray-scaling monitors are often classified by the number of bits they use to represent each pixel. For example, an 8-bit monitor represents each pixel with 8 bits. The more bits per pixel, the more colors and shades of gray the monitor can display.

(ii) **Based on signals :** Another common way of classifying monitors is in terms of the type of signal they accept: analog or digital.



- **Digital Monitor** :A digital monitor accepts digital signals rather than analog signals. All monitors (except flat-panel displays) use CRT technology, which is essentially analog. The term digital, therefore, refers only to the type of input received from the video adapter. A digital monitor then translates the digital signals into analog signals that control the actual display.

Although digital monitors are fast and produce clear images, they cannot display variable colors continuously. Consequently, only low-quality video standards, such as **Monochrome Display Adapter (MDA)**, **Color Graphics Adapter (CGA)** and **Enhanced Graphics Adapter (EGA)**, specify digital signals. **Video Graphics Array (VGA)** and **Super VGA (SVGA)**, on the other hand, require an analog monitor. Some monitors are capable of accepting either analog or digital signals.



Fig. 2.2.2: Digital Monitor

- **Analog Monitor** : This is the traditional type of color display screen that has been used for years in televisions. In reality, all monitors based on CRT technology (that is, all monitors except flat-panel displays) are analog. Some monitors, however, are called digital monitors because they accept digital signals from the video adapter. EGA monitors, for example, must be digital because the EGA standard specifies digital signals. Digital monitors must nevertheless translate the signals into an analog form before displaying images.

Some monitors have fixed frequency, which means that they accept input at only one frequency. Another type of monitor, called a multiscanning monitor, automatically adjusts to the frequency of the signals being sent to it. This means that it can accept input from different types of video adapters.

(b) **Characteristics of a Monitor** : A monitor has following major characteristics:

- **Size** :The most important aspect of a monitor is its screen size. Like televisions, screen sizes are measured in diagonal inches, the distance from one corner to the opposite corner diagonally. A typical size for small VGA monitors is 14 inches. Monitors that are 16 or more inches diagonally are often called full-page monitors. In addition to their size, monitors can be either portrait (height greater than width) or landscape (width greater than height). Larger landscape monitors can display two full pages, side by side. The screen size is sometimes misleading because there is always an area around the edge of the screen that can't be used. Therefore, monitor manufacturers must now also state the viewable area, that is, the area of screen that is actually used.
- **Resolution** : The resolution of a monitor indicates how densely the pixels are packed. Pixel is short for Picture Element. A pixel is a single point in a graphic image. Graphics monitors display pictures by dividing the display screen into thousands (or millions) of pixels, arranged in rows and columns. The pixels are so close together that they appear connected. The number of bits used to represent each pixel determines how many colors or shades of gray can be displayed. For example, an 8-bit color monitor uses 8 bits for each pixel, making it possible to display 2 to the 8th power (256) different colors or shades of gray.

The quality of a display monitor largely depends on its resolution, how many pixels it can display and how many bits are used to represent each pixel. VGA monitors display 640 by 480 or about 300,000 pixels. In contrast, SVGA monitors display 1,024 by 768 or nearly 800,000 pixels. True color monitors use 24 bits per pixel, allowing them to display more than 16 million different colors.



In general, the more number of pixels (often expressed in dots per inch), the sharper the image. Most modern monitors can display 1024 by 768 pixels, the SVGA standard. Some high-end models can display 1280 by 1024 or even 1600 by 1200.

- **Bandwidth:** It is the amount of data that can be transmitted in a fixed amount of time. For digital devices, the bandwidth is usually expressed in bits or **Bytes Per Second (BPS)**. For analog devices, the bandwidth is expressed in cycles per second or Hertz (Hz).
- **Refresh Rate :** Display monitors must be refreshed many times per second. The refresh rate determines how many times per second the screen is to be refreshed (redrawn). The refresh rate for a monitor is measured in hertz (Hz) and is also called the vertical frequency or vertical refresh rate. The old standard for monitor refresh rates was 60Hz, but a new standard developed by VESA sets the refresh rate at 75Hz for VGA and SVGA monitors. The faster the refresh rate, the less the monitor flickers.
- **Dot-pitch :** A measurement that indicates the vertical distance between each pixel on a display screen. Measured in millimeters, the dot pitch is one of the principal characteristics that determine the quality of display monitors. The lower the number, the crisper the image. The dot pitch of color monitors for personal computers ranges from about 0.15 mm to 0.30 mm. Another term for dot pitch is phosphor pitch.
- **Convergence :** Convergence refers to 'how sharply an individual color pixel on a monitor appears'. If the dots are badly misconverged, the pixel will appear blurry. All monitors have some convergence errors, but they differ in degree.

### 2.2.2 Printer

Printer is a device that prints text or illustrations on paper and in many cases on transparencies and other media. There are many different types of printers. In terms of the technology utilized, printers fall into the following categories:

(a) *Categories of Printers:* Printers may be classified as follows:

- (i) **Daisy-wheel Printer:** Daisy-wheel printers are a type of printer that produces letter-quality type. A daisywheel printer works on the same principle as a ball-head typewriter. The daisy wheel is a disk made of plastic or metal on which characters stand out in relief along the outer edge. To print a character, the printer rotates the disk until the desired letter is facing the paper. Then a hammer strikes the disk, forcing the character to hit an ink ribbon, leaving an impression of the character on the paper. One can change the daisy wheel to print different fonts.



*Fig. 2.2.3: Daisy-Wheel Printer*

Daisy-wheel printers cannot print graphics and in general they are noisy and slow, printing from 10 to about 75 characters per second. As the price of laser and ink-jet printers has declined and the quality of dot-matrix printers has improved, daisy-wheel printers have become almost obsolete.



(ii) **Dot-matrix Printer:** Dot-matrix printers create characters by striking pins against an ink ribbon. Each pin makes a dot and combinations of dots form characters and illustrations.

These printers are inexpensive and relatively fast, but they do not produce high-quality output. Dot-matrix printers vary in two important characteristics :

- **Speed :** Measured in characters per second (cps), the speed can vary from about 50 to over 500 cps. Most dot-matrix printers offer different speeds depending on the quality of print desired.
- **Print quality :** Determined by the number of pins (the mechanisms that print the dots), it can vary from 9 to 24. The best dot-matrix printers (24 pins) can produce near letter-quality type, although we can still see a difference if we look closely.

In addition to these characteristics, one should also consider the noise factor. Compared to laser and ink-jet printers, dot-matrix printers make lot of noise. Although the prices of laser and ink-jet printers are dropping rapidly, dotmatrix printers are still cheaper to operate. In addition, since they are impact printers, the dot-matrix printers can print to multi-page forms (that is, carbon copies), something laser and ink-jet printers cannot do.



*Fig. 2.2.4: Dot-matrix Printer*

(iii) **Ink-jet Printer:** Ink-jet printers work by spraying ionized ink at a sheet of paper. This is also shown in Fig. 2.2.5. Magnetized plates in the ink's path direct the ink onto the paper in the desired shapes. Ink-jet printers are capable of producing high quality print approaching to that produced by laser printers. A typical ink-jet printer provides a resolution of 300 dots per inch, although some newer models offer higher resolutions.

In general, the price of ink-jet printers is lower than that of laser printers. However, they are also considerably slower. Another drawback of ink-jet printers is that they require a special type of ink that is apt to smudge on inexpensive copier paper.



*Fig. 2.2.5: Ink-Jet Printer*

Because ink-jet printers require smaller mechanical parts than laser printers, they are especially popular as portable printers. In addition, color ink-jet printers provide an inexpensive way to print full-color documents.

(iv) **Laser Printer:** Laser printer utilizes a laser beam to produce an image on a drum, as shown Fig. 2.2.6. The light of the laser alters the electrical charge on the drum wherever it hits. The drum is then rolled through a reservoir of toner, which is picked up by the charged portions of the drum. Finally, the toner is transferred to the paper through a combination of heat and pressure. This is also the way copy machines work.

Because an entire page is transmitted to a drum before the toner is applied, laser printers are sometimes called page printers. There are two other types of page printers that fall under the category of laser printers even though they do not



*Fig. 2.2.6: Laser Printer*



use lasers at all. One uses an array of LEDs to expose the drum and the other uses LCDs. Once the drum is charged, however, they both operate like a real laser printer.

One of the chief characteristics of laser printers is their resolution – how many dots per inch (dpi) they lay down. The available resolutions range from 300 dpi at the low end to 1,200 dpi at the high end. By comparison, offset printing usually prints at 1,200 or 2,400 dpi. Some laser printers achieve higher resolutions with special techniques known generally as resolution enhancement.

In addition to the standard monochrome laser printer, which uses a single toner, there also exist color laser printers that use four toners to print in full color. Color laser printers tend to be about five to ten times as expensive as their monochrome siblings.

- (v) **WD & LED Printers:** These are similar to a laser printer but uses liquid crystals or light-emitting diodes rather than a laser to produce an image on the drum.
- (vi) **Line Printer:** Line printers are high-speed printers capable of printing an entire line at one time. A fast line printer can print as many as 3,000 lines per minute. The disadvantages of line printers are that they can print only one font, they cannot print graphics, the print quality is low and they are very noisy.
- (vii) **Thermal Printer:** Thermal printers are printers that produce images by pushing electrically heated pins against special heat-sensitive paper. Thermal printers are inexpensive and are used in most calculators and many fax machines. They produce low-quality print and the paper tends to curl and fade after a few weeks or months.

#### (b) *Characteristics of Printers*

Printers are also classified according to the following characteristics:

- **Quality of type** - The output produced by printers is said to be either letter quality (as good as a typewriter), near letter quality or draft quality. Only daisy-wheel, ink-jet and laser printers produce letter-quality type. Some dot-matrix printers claim letter-quality print, but if we look closely, we can see the difference.
- **Speed** - Measured in characters per second (cps) or pages per minute (ppm) the speed of printers varies widely. Daisy-wheel printers tend to be the slowest, printing about 30 cps. Line printers are fastest (up to 3,000 line per minute). Dot-matrix printers can print up to 500 cps and laser printer range from about 4 to 20 text pages per minute.
- **Impact or Non-impact** - Impact printers include all printers that work by striking an ink ribbon. Daisy-wheel, dot-matrix and line printers are impact printers. Non-impact printers include laser printers and ink-jet printers. The important difference between impact and non-impact printers is that impact printers are much noisier but are useful for making multiple copies like carbon copies.
- **Graphics** - Some printers (daisy-wheel and line printers) can print only text Other printers can print both text and graphics.
- **Fonts** - Some printers, notably dot-matrix printers, are limited to one or few fonts. In contrast, laser and ink-jet printers are capable of printing an almost unlimited variety of fonts. Daisy-wheel printers can also print different fonts, but you need to change the daisy wheel, making it difficult to mix fonts in the same document.



## 2.2.3 Plotter



Fig. 2.2.7: Plotter

Plotter is a device that draws pictures on paper based on commands from a computer. Plotters differ from printers as they draw lines using a pen. As a result, they can produce continuous lines, whereas printers can only simulate lines by printing a closely spaced series of dots. Multicolor plotters use different-colored pens to draw different colors. In general, plotters are considerably more expensive than printers. They are used in engineering applications where precision is mandatory.

## 2.2.4 Sound Cards & Speakers



Fig. 2.2.8: Speakers

Sound card is an expansion board that enables a computer to manipulate and output sounds. Sound cards are necessary for nearly all CD-ROMs and have become commonplace on modern personal computers. Sound cards enable the computer to output sound through speakers connected to the board, to record sound input from a microphone connected to the computer and manipulate sound stored on a disk. Nearly all sound cards support MIDI, a standard for representing music electronically. In addition, most sound cards are Sound Blaster-compatible, which means that they can process commands written for a Sound Blaster card, the defacto standard for PC sound. Sound cards use two basic methods to translate digital data into analog sounds:

- **Frequency Modulation (FM) Synthesis** mimics different musical instruments according to built-in formulae, and
- **Wavetable Synthesis** relies on recordings of actual instruments to produce sound. Wavetable synthesis produces more accurate sound, but is also more expensive.

## 2.2.5 3D-Audio

3D audio is a technique for giving more depth to traditional stereo sound. Typically, 3D sound or 3D audio, is produced by placing a device in a room with stereo speakers. The device dynamically analyzes the sound coming from the speakers and sends feedback to the sound system so that it can readjust the sound to give the impression that the speakers are further apart. 3D audio devices are particularly popular for improving computer audio where the speakers tend to be small and close together. There are a number of 3D audio devices that attach to a computer's sound card.

## 2.2.6 GPS

Short for Global Positioning System, GPS is a network of satellites that helps users determines a location on Earth. The thought of GPS was conceived after the launch of Sputnik in 1957. In 1964, the TRANSIT system became operational on U.S. Polaris submarines and allowed for accurate positioning updates. Later this became available for commercial use in 1967. In the picture, is an example of the GARMIN nuvi 350, a GPS used to find locations while driving.

Today, with the right equipment or software, anyone can establish a connection to these satellites to establish his or her location within 50 to 100 feet.



Fig. 2.2.9: GPS



### **2.2.7 Projector**

An output device that can take the display of a computer screen and project a large version of it onto a flat surface. Projectors are often used in meetings and presentations to help make sure everyone in the room can view the presentation. In the picture, is a ViewSonic projector and an example of what a projector may look like.



*Fig.2.2.10: Projector*

## **2.3 AUXILIARY STORAGE DEVICES**

Auxiliary storage also known as auxiliary memory or secondary storage, is the memory that supplements the main storage. This is a long-term, non-volatile memory. The term non-volatile means that stores and retains the programs and data even after the computer is switched off. Unlike RAM which loses the contents when the computer is turned off and ROM, to which it is not possible to add anything new, auxiliary storage devices allow the computer to record information semi-permanently, so it can be read later by the same computer or by another computer. Auxiliary storage devices are also useful in transferring data or programs from one computer to another. They also function as back-up devices which allow to back-up the valuable information. So even if by some accident the computer crashes and the stored data is unrecoverable, we can restore it from the back-ups. The most common types of auxiliary storage devices are magnetic tapes, magnetic disks, floppy disks, hard disks etc.

There are two types of auxiliary storage devices. This classification is based on the type of data access: sequential and random. Based on the type of access, they are called sequential-access media or random-media. In the case of sequential-access media, the data stored in the media can only be read in sequence and to get to a particular point on the media, we have to go through all the preceding points. Magnetic tapes are examples of sequential-access media. In contrast, disks are random-access also called direct-access media because a disk drive can access any point at random without passing through intervening points. Other examples of direct access media are floppy diskettes, optical disks, zip disks etc.

## **2.4 MAGNETIC TAPE**

Magnetic tape is a magnetically coated strip of plastic on which data can be encoded. Tapes for computers are similar to the tapes used to store music. Some computers, in fact, enable us to use normal cassette tapes. Storing data on tapes is considerably cheaper than storing data on disks. Tapes also have large storage capacities, ranging from a few hundred kilobytes to several gigabytes. Accessing data on tapes, however, is much slower than accessing data on disks. Because tapes are so slow, they are generally used only for long-term storage and backup. Data to be used regularly is almost always kept on a disk. Tapes are also used for transporting large amounts of data. Tapes come in a variety of sizes and formats as given in Table 2.4.1. Tapes are sometimes called streamers or streaming tapes.



Type	Capacity	Description
Half Inch	60MB - 400MB	Half-inch tapes come both as 9 track reels and as cartridges. These tapes are relatively cheap, but require expensive tape drives
Quarter Inch	40MB - 5GB	<b>Quarter Inch Cartridges (QIC tapes)</b> are relatively inexpensive and support fast data transfer rates, QIC mini cartridges are even less expensive, but their data capacities are smaller and their transfer rates are lower.
8-mm Helical scan	1 GB - 5 GB	8 min helical-scan cartridges use the same technology as VCR tapes and have the great capacity. But they require expensive tape drives and have relatively slow data transfer rates.
4-mm DAT	2GB - 24GB	<b>DAT (Digital Audio Tape)</b> cartridges have the greatest capacity but they require expensive tape drives and have relatively slow data transfer Rates.

Table 2.4.1: Tapes

### 2.4.1 Helical-scan Cartridge

It's a type of magnetic tape that uses the same technology as VCR tapes. The term helical scan usually refers to 8-mm tapes, although 4-mm tapes (called DAT tapes) use the same technology. The 8-mm helical-scan tapes have data capacities from 2.5GB to 5 GB.

### 2.4.2. DAT Cartridge

This is a type of magnetic tape that uses an ingenious scheme called helical scan to record data, as shown in Fig. 2.4.1. A DAT cartridge is slightly larger than a credit card and contains a magnetic tape that can hold from 2 to 24 gigabytes of data. It can support data transfer rates of about 2 **MBPS (Million Bytes Per Second)**. Like other types of tapes, DATs are sequential-access media. The most common format for DAT cartridges is **DDS (Digital Data Storage)** which is the industry standard for digital audio tape (DAT) formats. The latest format, DDS-3, specifies tapes that can hold 24 GB (the equivalent of over 40 CD ROMs) and support data transfer rates of 2 MBPS.



Fig 2.4.1: DAT Cartridge

## 2.5 WINCHESTER DISK

The term Winchester comes from an early type of disk drive developed by IBM that stored 30MB and had a 30-millisecond access time; so its inventors named it a Winchester in honour of the 30-caliber rifle of the same name. Although modern disk drives are faster and hold more data, the basic technology is the same, so Winchester has become synonymous with hard disk.

### 2.5.1 Hard Disk

Hard disk is a magnetic disk on which we can store computer data. The term hard is used to distinguish it from a soft or floppy, disk. Hard disks hold more data and are faster than floppy disks. A hard disk, for example, can store anywhere from 10 megabytes to several gigabytes, whereas most of the floppies have a maximum storage capacity of 1.4 megabytes.



A single hard disk usually consists of several platters. Each platter requires two read/write heads, one for each side. All the read/write heads are attached to a single access arm so that these cannot move independently. Each platter has the same number of tracks and a track location that cuts across all platters is called a cylinder. For example, a typical 84 megabyte hard disk for a PC might have two platters (four sides) and 1,053 cylinders. Fig. 2.5.1 shows a sample of hard disk.

In general, hard disks are less portable than floppies, although it is possible to buy removable hard disks. There are two types of removable hard disks: disk packs and removable cartridges.



Fig.2.5.1: Hard Disk

## 2.6 FLOPPY DISK

Floppy disk is a soft magnetic disk as shown in Fig 2.6.1 It is called floppy because it flops if we wave it (at least, the 5¼ -inch variety does). Unlike most hard disks, floppy disks (often called floppies or diskettes) are portable, because we can remove them from a disk drive. Disk drives for floppy disks are called floppy drives. Floppy disks are slower to access, than hard disks and have less storage capacity, but these are less expensive and are portable. Floppies come in two basic sizes, given below:

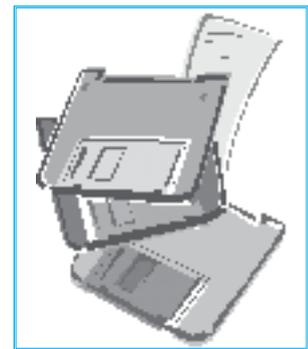


Fig. 2.6.1: Floppy Disk

- **5¼ - inch** - The common size for PCs made before 1987. This type of floppy is generally capable of storing between 100K and 1.2MB (megabytes) of data.
- **3½ - inch** - Floppy is something of a misnomer for these disks, as these are encased in a rigid envelope. Despite their small size, microfloppies have a larger storage capacity than their cousins -from 400K to 1.4MB of data. The most common storage capacity for PCs are 720K (double-density) and 1.44MB (high-density).

## 2.7 ZIP DISK

These are high-capacity floppy disk drives developed by the Iomega Corporation, as shown in Fig. 2.7.1. Zip disks are slightly larger than the conventional floppy disks and are about twice as thick. These disks can hold 100MB of data. Because these are relatively inexpensive and durable, these have become a popular media for backing up hard disks and for transporting large files.



Fig. 2.7.1: Zip Disk

## 2.8 JAZ DISK

These are removable disk drives developed by the Iomega Corporation, as shown in Fig. 2.8.1. The Jaz drive has a 12-ms average seek time and a transfer rate of 5.5Mbps. The removable cartridges hold 1GB of data. The fast data rates and large storage capacity make it a viable alternative for backup storage as well as everyday use.



Fig. 2.8.1: Jaz Disk



## 2.9 SUPERDISK

This is a new disk storage technology developed by the Imation Corporation that supports very high-density diskettes, as shown in Fig. 2.9.1. SuperDisk diskettes are etched with a servo pattern at the factory. This pattern is then read by the SuperDisk drive to precisely align the read/write head. The result is that a SuperDisk diskette can have 2,490 tracks, as opposed to the 135 tracks that conventional 3.5-inch 1.44MB diskettes use. This higher density translates into 120MB capacity per diskette.



Fig. 2.9.1: SuperDisk

Unlike the other removable disk storage solutions, such as the Zip drive, SuperDisk is backward compatible with older diskettes. This means that we can use the same SuperDisk drive to read and write to older 1.44MB diskettes as well as the new 120 MB SuperDisk diskettes. Imation's current SuperDisk drive is called the LS-120.

## 2.10 OPTICAL DISK

Optical Disks are a storage medium from which data is read and to which it is written by lasers. Optical disks can store much more data - up to 6 gigabytes (6 billion bytes) - than magnetic media, such as floppies and hard disks. There are three basic types of optical disks:

- **CD-ROM:** Like audio CDs, CD-ROMs come with data already encoded onto them. The data is permanent and can be read any number of times, but CD-ROMs cannot be modified.
- **WORM:** This term stands for "Write-Once, Read-Many". With a WORM disk drive, we can write data onto a WORM disk, but only once. After that, the WORM disk behaves just like a CD-ROM.
- **Erasable:** Optical disks that can be erased and loaded with new data, just like magnetic disks. These are often referred to as EO (erasable optical) disks.

These three technologies are not compatible with each other; each requires a different type of disk drive and disk. Even within one category, there are many competing formats, although CD-ROMs are relatively standardized.

### 2.10.1 CD-ROM

CD-ROM, which is pronounced as 'see-dee-rom', is the abbreviation of Compact Disc Read-Only Memory, as shown in Fig. 2.10.1. CD-ROM is a type of optical disk capable of storing large amounts of data - up to 1GB, although the most common size is 630MB (megabytes). A single CD-ROM has the storage capacity of 700 floppy disks, enough memory to store about 300,000 text pages. CD-ROMs are recorded by the vendor and once recorded, these cannot be erased and filled with new data. To read a CD, we need a CD-ROM drive. A CD-ROM player is a device that can read information from a CD-ROM. These can be either internal or external.



Fig. 2.10.1: CD-ROM

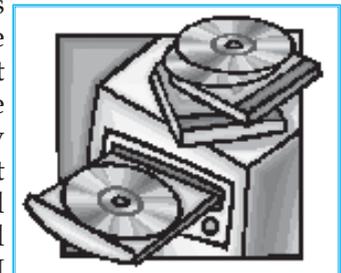


Fig. 2.10.2: CD Drive

### 2.10.2 CD-R Drive

CD-R drive, which stands for Compact Disk-Recordable drive, is a type of disk drive that can create



CD-ROMs and audio CDs. This allows the users to 'master' a CD-ROM or audio CD for publishing. Until recently, CD-R drives were quite expensive, but prices have dropped dramatically.

A feature of many CD-R drives called multisession recording, enables to keep adding data to a CD-ROM over time. This is extremely important if we want to use the CD-R drive to create backup CD-ROMs. To create CD-ROMs and audio CDs, we'll need not only a CD-R drive, but also a CD-R software package. Often, it is the software package, not the drive itself that determines how easy or difficult it is to create CD-ROMs. CD-R drives can also read CD-ROMs and play audio CDs.

### 2.10.3 CD-RW Disks

CD-RW disk is short for CD-ReWritable disk and this is a new type of CD disk that enables to write onto it in multiple sessions. One of the problems with CD-R disks is that we can only write to them once. With CD-RW drives and disks, we can treat, the optical disk just like a floppy or hard disk, writing data onto it multiple times. The first CD-RW drives became available in mid-1997. These can read CD-ROMs and can write onto today's CD-R disks, but these cannot write on CD-ROMs.

## 2.11 MAGNETO-OPTICAL (MO) DRIVES

This is a type of disk drive that combines magnetic disk technologies with CD-ROM technologies. Like magnetic disks, MO disks can be read and written to. And like floppy disks, these are also removable. However, their storage capacity can be more than 200 megabytes, much greater than magnetic floppies. In terms of data access speed, these are faster than floppies and CD-ROMs, but not as fast as hard disk drives.

## 2.12 DVD

DVD also known as **Digital Versatile Disc** or **Digital Video Disc** is a popular optical disc storage media format. Its main uses are video and data storage. Most DVDs are of the same dimensions as compact discs (CDs) but store more than six times as much data. Variations of the term *DVD* often describe the way data is stored on the discs: DVD-ROM has data that can only be read and not written, DVD-R and DVD+R can record data only once and then function as a DVD-ROM. DVD-RW, DVD+RW and DVD-RAM can both record and erase data multiple times. The wavelength used by standard DVD lasers is 650 nm and thus the light has a red color.

DVD-Video and DVD-Audio discs respectively refer to properly formatted and structured video and audio content. Other types of DVDs, including those with video content, may be referred to as DVD-Data discs. As next generation high-definition optical formats also use a disc identical in some aspects yet more advanced than a DVD, such as Blu-ray Disc, the original DVD is occasionally given the retronym SD DVD (for *standard definition*).

## 2.13 USB FLASH DRIVE

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 (1 to 4 inches or 2.5 to 10 cm) and weigh less than 2 ounces (56 g). Storage capacities typically range from 64 MB to 64 GB with steady improvements in size and price per gigabyte.

USB flash drives offer potential advantages over other portable storage devices, particularly the floppy disk. They have a more compact shape, operate faster, hold much more data, have a more durable design and operate more reliably due to their lack of moving parts. Additionally,

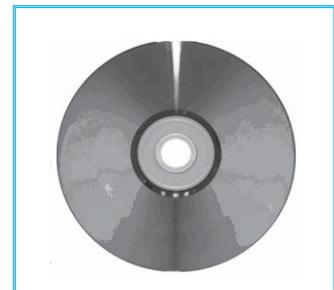


Fig. 2.13.1: DVD



it has become increasingly common for computers to ship without floppy disk drives. USB ports, on the other hand, appear on almost every current[update] mainstream PC and laptop. These types of drives use the USB mass storage standard, supported natively by modern operating systems such as Windows, Mac OS X, Linux and other Unix-like systems. USB drives with USB 2.0 support can also operate faster than an optical disc drive, while storing a larger amount of data in a much smaller space.

A flash drive consists of a small printed circuit board protected inside a plastic, metal or rubberised 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 liable to be damaged if exposed. Most flash drives use a standard type-A USB connection allowing plugging into a port on a personal computer.



*Fig. 2.13.2: USB Flash Drive*