A Brief History of the Computer

The history of computers starts out about 2000 years ago in Babylonia (Mesopotamia), at the birth of the abacus, a wooden rack holding two horizontal wires with beads strung on them.

Blaise Pascal is usually credited for building the first digital computer in 1642. It added numbers entered with dials and was made to help his father, a tax collector.
The basic principle of his calculator is still used today in water meters and modern-day odometers. Instead of having a carriage wheel turn the gear, he made each ten-teeth wheel accessible to be turned directly by a person's hand (later inventors added keys and a crank), with the result that when the wheels were turned in the proper sequences, a series of numbers was entered and a cumulative sum was obtained. The gear train supplied a mechanical answer equal to the answer that is obtained by using arithmetic.
This first mechanical calculator, called the Pascaline, had several disadvantages. Although it did offer a substantial improvement over manual calculations, only Pascal himself could repair the device and it cost more than the people it replaced! In addition, the first signs of technophobia emerged with mathematicians fearing the loss of their jobs due to progress.

Contrary to Pascal, Leibniz (1646-1716) successfully introduced a calculator onto the market. It is designed in 1673 but it takes until 1694 to complete. The calculator can add, subtract, multiply, and divide. Wheels are placed at right angles which could be displaced by a special stepping mechanism.

The speed of calculation for multiplication or division was acceptable. But like the Pascaline, this calculator required that the operator using the device had to understand how to turn the wheels and know the way of performing calculations with the calculator.

Charles Babbage, an English mechanical engineer and polymath, originated the concept of a programmable computer. Considered the "father of the computer",he conceptualized and invented the first mechanical computer in the early 19th century. After working on his revolutionary difference engine, designed to aid in navigational calculations, in 1833 he realized that a much more general design, an Analytical Engine, was possible.

A step towards automated computing was the development of punched cards, which were first successfully used with computers in 1890 by Herman Hollerith and James Powers, who worked for the US. Census Bureau. They developed devices that could read the information that had been punched into the cards automatically, without human help. Because of this, reading errors were reduced dramatically, work flow increased, and, most importantly, stacks of punched cards could be used as easily accessible memory of almost unlimited size. Furthermore, different problems could be stored on different stacks of cards and accessed when needed.

These advantages were seen by commercial companies and soon led to the development of improved punch-card using computers created by International Business Machines (IBM), Remington (yes, the same people that make shavers), Burroughs, and other corporations. These computers used electromechanical devices in which electrical power provided mechanical motion -- like turning the wheels of an adding machine. Such systems included features to:

- feed in a specified number of cards automatically
- add, multiply, and sort
- feed out cards with punched results

The start of World War II produced a large need for computer capacity, especially for the military. New weapons were made for which trajectory tables and other essential data were needed. In 1942, John P. Eckert, John W. Mauchly, and their associates at the Moore school of Electrical Engineering of University of Pennsylvania decided to build a high - speed electronic computer to do the job. This machine became known as ENIAC (Electrical Numerical Integrator And Calculator)

The size of ENIAC's numerical "word" was 10 decimal digits, and it could multiply two of these numbers at a rate of 300 per second, by finding the value of each product from a multiplication table stored in its memory. ENIAC was therefore about 1,000 times faster then the previous generation of relay computers. ENIAC used **18,000 vacuum tubes**, about 1,800 square feet of floor space, and consumed about 180,000 watts of electrical power. It had punched card I/O, 1 multiplier, 1 divider/square rooter, and 20 adders using decimal ring counters, which served as adders and also as quick-access (.0002 seconds) read-write register storage. The executable instructions making up a program were embodied in the separate "units" of ENIAC, which were plugged together to form a "route" for the flow of information.

Early in the 50's two important engineering discoveries changed the image of the electronic - computer field, from one of fast but unreliable hardware to an image of relatively high reliability and even more capability. These discoveries were the magnetic core memory and the Transistor - Circuit Element.
These technical discoveries quickly found their way into new models of digital computers. RAM capacities increased from 8,000 to 64,000 words in commercially available machines by the 1960's, with access times of 2 to 3 MS (Milliseconds). These machines were very expensive to purchase or even to rent and were particularly expensive to operate because of the cost of expanding programming. Such computers were mostly found in large computer centers operated by industry, government, and private laboratories - staffed with many programmers and support personnel. This situation led to modes of operation enabling the sharing of the high potential available.

Many companies, such as Apple Computer and Radio Shack, introduced very successful PC's in the 1970's, encouraged in part by a fad in computer (video) games. In the 1980's some friction occurred in the crowded PC field, with Apple and IBM keeping strong. In the manufacturing of semiconductor chips, the Intel and Motorola Corporations were very competitive into the 1980s, although Japanese firms were making strong economic advances, especially in the area of memory chips. By the late 1980s, some personal computers were run by microprocessors that, handling 32 bits of data at a time, could process about 4,000,000 instructions per second.

What are computers?

The term computer has been borrowed from compute that means to calculate. Computer is an electronic device which is capable of receiving information (data) in a particular form and of performing a sequence of operations in accordance with a predetermined but variable set of procedural instructions (program) to produce a result in the form of information or signals. Whereas initially computers were used to perform arithmetic calculations at fast speed, now they are used in nearly every field.

Characteristics of a Computer:

The following are the characteristics of a typical computer:

Speed:

Present day computer operate at very high speed. A computer can perform several million instruction (calculations) in one second. For example, it can add or multiply 2 lakh number in a second. There are several different types of computers and they all have different speeds running from high to very-very high.

However, even the speed of the slowest personal computer (PC) is very high compare to that of a human being, as far as arithmetic operations are concerned. Typically, the speed of computers is specified in MIP(Million Instructions per Seconds) or MLFOPS(Million Floating-Point Operation Per Seconds).

Accuracy

Computers perform with a very high degree of consistent accuracy. Now a days computer technology stabilized, and the chances of a computer giving in accurate results are very rare. If you ask a computer to perform a particular calculation, say, division of Two numbers a thousand times, it will perform each division operation with the same accuracy.

Sometimes computers do make mistakes. This may happens if there is an undedicated flaw in the design of the computer (That is very rare now a days). Most of the times, computers make mistakes if they are not programmed correctly. That is, if the programmer who has written the program to do same calculations did not consider all excepts of the data that will be fade into the computer, it can give in accurate results. Computers can give accurate results if the input data is in accurate, e.g. if you try to divide a number by zero (0).

Diligence

When human beings are required to work continuously for a few hours, they become try and start losing concentration. On the other hand, a computer can continue a work for hour (or even days) at the same speed and accuracy. It does not show signs of tiredness or lake of concentration when may to work continuously. Unlike human beings, it does not complain or show lethargy or laziness when made to do the same task repeated. Because of this property, computers are generally used in all such situation where the same or similar task has to be repeated a numbers of times, e.g. preparing the salary slip for 10 thousand employs of a company, or printing divide end checks for ten lakh share holders of a large company.

Versatility

Computers are very versatile. The same computer can be used for various applications. For instance, you can use a Personal Computer (PC) to prepare a latter, prepare the balance sheet of a company, store a database of employees, produce a professional-looking advertisement, send or receive fax messages, etc. for a computer to perform a new job, all it needs is a program. (A program is a set of instructions that enables a computer to do a particular task.) Thus, if you want a computer to do perform a new task, all you need to write a new program for that task.

It can store Data

A computer can store a huge amount of data in its memory. You can store almost any type of data, such as a letter, Picture, Sound, etc. in a computer. You can recall the stored from the computer whenever you need it. For instance, if you type a letter you can save it. Then, if you want to send a single letter to another person, you can recall that letter from the computers memory, modify it and then print a new letter.

It is Dumb

A computer is dumb. It has no intelligence of its own. It cannot think or apply its judgment. It gets its power from the program that it runes. It will do only what it is asked to do. It has to be hold what to do, and in what sequence. Therefore, the program that the computer runs determines what task it will perform. Those, if you run a word processor program on a computer, it becomes a word processor and if you run a Desktop Publishing (DTP) program. It becomes a Desktop publisher. So, a computer does not take its own decisions—it simply follows the programmer or the user.

It has No Emotions

Computers are not living beings. Hence, they do not have any emotions. They do not have any heart or soul. Human Beings often take some decisions based on emotions, taste, feelings, etc. in their daily life. On the other hand, computers always take decisions based on a program that they run.

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<u>Applications on Computers:</u>

The use of computers is increasing at such a rate that there is hardly any field where computers are not used. The following list describes some of the applications of computers:

1. In offices and homes for preparing documents and to perform other data processing jobs.
2. To prepare salary slips and salary cheques in office and factories.
3. To maintain accounts and transfer funds in banks.
4. To store and retrieve large amount of information in offices.
5. To send and receive electronic mail / fax.
6. To search and retrieve information from other computers.
7. To reserve tickets in the transportation sectors, eg Railways, Air Lines, etc.
8. To regulate traffic lights on roads and to control machines and robots in factories.
9. To design automobiles, buildings and dams and to forecast weather.
10. To create animation / cartoon movies and compose music.

11. To control modern automobiles, trains, airplanes etc.
12. To control electronic appliances, such as air-conditioner, TVs, VCRs etc.
13. To On-line banking, buy and sell merchandise, shares, bonds, etc.
14. To control and simulate defense equipments.

For scientific and industrial research.

Data vs. Information

Data is a collection of facts and figures. Information is defined as processed data. There is a subtle difference between data and information. **Data** are the details from which **information** is derived. Individual pieces of data are rarely useful alone. For data to become information, data needs to be put into context. Data can be any character, text, words, number, pictures, sound, or video and, if not put into context, means little or nothing to a human. However, information is useful and usually formatted in a manner that allows it to be understood by a human . What may be information for one person may be data for another person. this is true when we see information flows in managerial hierarchy. For information to be useful to the decision maker, it must have certain characteristics and meet certain criteria.

Some of the characteristics of good information are discussed as follows

i. Understandable:

Since information is already in a summarized form, it must be understood by the receiver so that he will interpret it correctly. He must be able to decode any abbreviations, shorthand notations or any other acronyms contained in the information.

ii. Relevant:

Information is good only if it is relevant. This means that it should be pertinent and meaningful to the decision maker and should be in his area of responsibility.

iii. Complete:

It should contain all the facts that are necessary for the decision maker to satisfactorily solve the problem at hand using such information. Nothing important should be left out. Although information cannot always be complete, every reasonable effort should be made to obtain it.

iv. Available:

Information may be useless if it is not readily accessible ‘ in the desired form, when it is needed. Advances in technology have made information more accessible today than ever before.

v. Reliable:

The information should be counted on to be trustworthy. It should be accurate, consistent with facts and verifiable. Inadequate or incorrect information generally leads to decisions of poor quality. For example, sales figures that have not been adjusted for returns and refunds are not reliable.

vi. Concise:

Too much information is a big burden on management and cannot be processed in time and accurately due to “bounded rationality”. Bounded rationality determines the limits of the thinking process which cannot sort out and process large amounts of information. Accordingly, information should be to the point and just enough – no more, no less.

vii. Timely:

Information must be delivered at the right time and the right place to the right person. Premature information can become obsolete or be forgotten by the time it is actually needed.

Similarly, some crucial decisions can be delayed because proper and necessary information is not available in time, resulting in missed opportunities. Accordingly the time gap between collection of data and the presentation of the proper information to the decision maker must be reduced as much as possible.

viii. Cost-effective:
The information is not desirable if the solution is more costly than the problem. The cost of gathering data and processing it into information must be weighed against the benefits derived from using such information.

Comparison

	Data	Information
Meaning	Data is raw, unorganized facts that need to be processed. Data can be something simple and seemingly random and useless until it is organized.	When data is processed, organized, structured or presented in a given context so as to make it useful, it is called information.
Example	Each student's test score is one piece of data.	The average score of a class or of the entire school is information that can be derived from the given data.
Etymology	"Data" comes from a singular Latin word, datum, which originally meant "something given." Its early usage dates back to the 1600s. Over time "data" has become the plural of datum.	"Information" is an older word that dates back to the 1300s and has Old French and Middle English origins. It has always referred to "the act of informing, " usually in regard to education, instruction, or other knowledge communication

Basic functions of Computer

Input

Computers receive data from outside There are a number of devices that are used to receive data and instructions from the out side world. The keyboard on your PC is one of the most commonly used input devices.

Storage

When you enter data or instruction in computer, these are stored somewhere in the computer system. Because a computer cannot process or analyze all input data instantaneously, it has to store the data. The computer will get the data / instructions from the storage unit when it has to process it. It may also have to store data to do additional processing later.

Processing

Computers process (analyze) the input data available in its storage unit in order to get some useful output.

Outputting

After the computer has processed the input data it provides useful information (result) for the.
Control
All computers have a control unit that controls the manner and sequence of operations.
All computer system perform the above five factions.

Components of Computer system

Input unit

Computer need to receive data and instruction in order to solve any problem. We need to put the data and instruction into the computers. The Input Unit consists of one or more Input devices. There are a number of devices that perform the function of input devices. The keyboard of your computer is one of the most commonly used input devices. Other commonly used input devices are the mouse, floppy disk drive, hard disk drive and magnetic tape. Regardless of the type of input device used in a computer system, all input device perform the following functions.

- Accept data and instruction from the outside word
- Convert it to a from that the computer can understand.
- Supply the converted data to the computer system for further processing.

Storage units

The storage unit of the computer holds the data and instruction that you enter through the input unit before these are processed. It preserves the intermediate and final results before these are sent to the output devices. It is also used to preserve the data for later use: e.g. you may like to save letter you type today for printing after one week. The various storage devices used in computer system are classified into two categories-primary and secondary.

Primary Storage

The primary storage also called the primary memory, store and provides information very fast. This is generally used to hold the program being currently executed in the computer, the data being received from the in put unit and the intermediate and final results of the program. The primary generally loses its content when you switch off the computer. Therefore if you need to preserve the results or the input data, you have to transfer it to the secondary storage. The cost of primary storage is more compare to the secondary storage. Therefore, most computers have limited primary storage. Most of the computers use ‘semiconductor memory’ as primary storage.

Secondary Storage

On the other hand, the secondary storage (Memory) is used
Databases; etc .The program that you want to run on the computer is first Transferred to the primary memory before it can run. Similarly, after running the Program, if you need to save the result, you will transfer them to the secondary Storage. The secondary memory is slower and cheaper than the primary memory. Some of the commonly used secondary memory devices are floppy diskette, zip diskette, hard disk and magnetic tape.

Output Unit

The output unit of a computer provides the information and results of a computation to the outside world. As you know, computers do not work in the decimal system, thy work in the binary system. Therefore if required, the output unit also converts the binary data into a form that users can understand. Printer and Video Display Unit (VDU, also called display screen)are commonly used output devices. Other commonly used output devices are floppy disk drive, hard disk drive and magnetic tape drive in the earl ear generation computers, paper tape punch units and card punch units were also used as output devices.

Arithmetic-Logic Unit

All calculations are performed in the Arithmetic Logic Unit (ALU) of the computer. ALU also dose compressions and takes decisions. When ever calculation has to be done, the control unit transfers the required data from the storage unit to ALU. The ALU can perform basic orations such as additions, substrations, multlipactions, division, etc. the ALU can also do logical operations: e.g. it can check if the number a is less than, equal to or grater than the number b. after the ALU has performed the calculation or the logical operation, the result is transfer to the storage unit.

Control Unit

The control unit controls all other units in the computer. The input unit does not know when to receive data and where to put the data in the storage unit after receiving it. It is the control unit that gives the necessary instructions to the input unit. Similarly, the control unit instructs the input unit where to store the data after receiving it from the user. In the same way, it controls the flow of data and instructions from the storage unit to ALU. It also controls the flow of the result from ALU to the storage unit. The control unit also controls what should be sent to the output unit and when. In brief, the control unit is the central nervous system of the computer that controls and synchronizes its working.

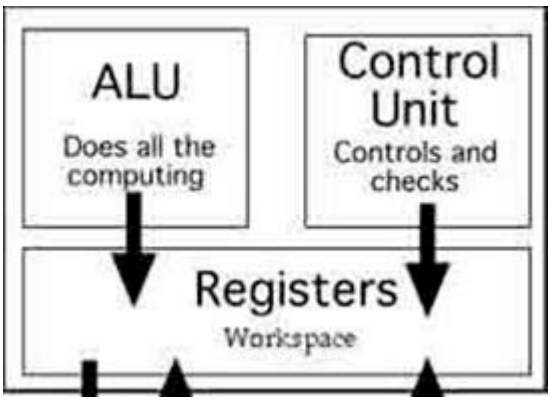
Central Processing Unit

The control unit and ALU of the computer are together known as the central processing unit (CPU). In most modern computers, a single IC does the job of controlling all units of the computer. The same IC also contains the ALU. The CPU is like a computer's brain:
----- It performs all calculations.
----- It takes all Decisions.
---- It controls all units of the computer.
CPU(Central processing Unit .Alternately referred to as a processor, central processor, or microprocessor):is a

- Set of electronic circuitry that executes program instructions
- Converts data into information
- Acts as Control center i.e. it controls all the devices connected to system. because of this function it is called as Brain of Computer System

The three components of the CPU are following,

1. Arithmetic Logic Unit
2. Control Unit
3. Registers



ALU (arithmetic logic unit)

- Performs calculations , logical operations and comparisons (data changed)

Registers

- Small, *permanent* storage locations within the CPU used for a particular purpose
- Manipulated directly by the Control Unit
- Wired for specific function
- Size in bits or bytes (not MB like memory)
- Can hold data, an address or an instruction

Special-Purpose Registers

- *Program Count Register* (PC)
  - Also called instruction pointer. it contains the memory address of instruction that is being executed by CPU ,after execution of instruction it points to address of memory location where next instruction to be executed is stored and these steps are repeated till all the instructions of the program are executed.
- *Instruction Register (IR)*
  - Stores instruction fetched from memory
- *Memory Address Register (MAR)*
- *Memory Data Register (MDR)*
- *Status Registers*
  - Status of CPU and currently executing program
  - *Flags* (one bit Boolean variable) to track condition like arithmetic carry and overflow, power failure, internal computer error

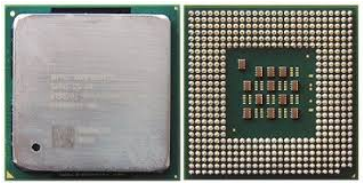
Register Operations

- Stores values from other locations (registers and memory)
- Addition and subtraction
- Shift or rotate data
- Test contents for conditions such as zero or positive

Control unit

- Part of the CPU that generates control signals and controls all operations of computer
- Moves data to and from CPU registers and other hardware components (no change in data)
- Accesses program instructions and issues commands to the ALU
- Directs the computer system to execute program instructions
- Communicates with other parts of the hardware through exchange of control signals

The picture below is an example of what the top and bottom of an Intel Pentium processor may look. The processor is placed and secured into a compatible CPU socket found on the motherboard. Processors produce heat, so they are covered with a heat sink to keep them cool and running smoothly.

- 

As you can see in the above picture, the CPU chip is usually in the shape of a square or rectangle and has one notched corner to help place the chip properly into the CPU socket. On the bottom of the chip are hundreds of connector pins that plug into each of the corresponding holes in the socket. Today, most CPU's resemble the picture shown above. However, Intel and AMD have also experimented with slot processors that were much larger and slid into a slot on the motherboard. Also, over the years, there have been dozens of different types of sockets on motherboards. Each socket only supports specific types of processors and each has its own pin layout.

Bus

- The physical connection that makes it possible to transfer data from one location in the computer system to another
- Group of electrical conductors for carrying signals from one location to another
  - *Line*: each conductor in the bus
- 4 kinds of signals
  - Data (alphanumeric, numerical, instructions)
  - Addresses
  - Control signals
  - Power (sometimes)
- Connect CPU and Memory
- I/O peripherals: on same bus as CPU/memory or separate bus
- Physical packaging commonly called *backplane*
  - Also called *system bus* or *external bus*
  - Example of *broadcast bus*
  - Part of printed circuit board called *motherboard* that holds CPU and related components

Bus Characteristics

- Protocol
  - Documented agreement for communication
  - Specification that spells out the meaning of each line and each signal on each line
- Throughput, i.e., data transfer rate in bits per second
- Data width in bits carried simultaneously

The Five Generations of Computers

First generation computers
(1940-1956)

- The first computers used vacuum tubes for circuitry and magnetic drums for memory.
- They were often enormous and taking up entire room.
- First generation computers relied on machine language.
- They were very expensive to operate and in addition to using a great deal of electricity, generated a lot of heat, which was often the cause of malfunctions.
- The UNIVAC and ENIAC computers are examples of first-generation computing devices.

Second generation computers
(1956-1963)

- Transistors replaced vacuum tubes and ushered in the second generation of computers.
- Second-generation computers moved from cryptic binary machine language to symbolic.
- High-level programming languages were also being developed at this time, such as early versions of COBOL and FORTRAN.
- These were also the first computers that stored their instructions in their memory.

Third generation computers
(1964-1971)

- The development of the integrated circuit was the hallmark of the third generation of computers.
- Transistors were miniaturized and placed on siliconchips, called semiconductors.
- Instead of punched cards and printouts, users interacted with third generation computers through keyboards and monitors and interfaced with an operating system.
- Allowed the device to run many different applications at one time.

Fourth generation computers
(1971-present)

- The microprocessor brought the fourth generation of computers, as thousands of integrated circuits were built onto a single silicon chip.
- The Intel 4004 chip, developed in 1971, located all the components of the computer.
- From the central processing unit and memory to input/output controls—on a single chip.
- . Fourth generation computers also saw the development of GUIs, the mouse and handheld devices.

Fifth generation computers
(present and beyond)

- Fifth generation computing devices, based on artificial intelligence.
- Are still in development, though there are some applications, such as voice recognition.
- The use of parallel processing and superconductors is helping to make artificial intelligence a reality.
- The goal of fifth-generation computing is to develop devices that respond to natural language input and are capable of learning and self-organization.

SOME BASIC CONCEPTS

System Unit

The **system unit** is the main portion of the microcomputer system and is the basis of any PC system arrangement. The components surrounding it vary from system to system depending upon what particular functions the system is supposed to serve.

Internal Components

The components inside the system unit can be divided into four distinct sub-units: a power supply, the disk drives, the system board, and the options adapter cards.

Power Supply Unit

A typical system unit contains a single power supply unit that converts commercial power into the various levels required by the different units in the system.

Drives

The number and types of disk drives in the system vary according to the application for which the system is designed. However, a single floppy-disk drive unit, a single hard-disk drive unit, and a single CD-ROM drive are typically installed to handle the system's mass storage requirements.

System Board

The **system board** is the center of the system. It contains the portions of the system that define its computing power and speed. System boards are also referred to as **motherboards**, or **planar boards**.

Front Panel

The inside face or the plastic front panel is coated with a conductive paint to limit the radio magnetic interference escaping from the case.

Laptops

With advancements in battery design and the advent of usable, large screen liquid crystal display (LCD) panels, the first truly portable PCs, referred to as laptops, were introduced.

What Are Peripherals?

Peripherals are devices and systems that are added to the basic computer system to extend its capabilities. These devices and systems can be divided into three general categories: Input, Output, Memory.

Adapter Boards

Each peripheral device interacts with the basic system through adapter boards that plug into expansion slots inside the system unit.

Input Devices

Input devices enable you to enter commands and data into the computer more easily than is possible with a keyboard. Common input devices include the mouse, joystick, light pen, and trackball. These devices are covered in detail later in this unit.

Classification of Computers

Types of Computers

1. Analog Computers

Analog computers are used to process continuous data. Analog computers represent variables by physical quantities. Thus any computer which solve problem by translating physical conditions such as flow, temperature, pressure, angular position or voltage into related mechanical or electrical related circuits as an analog for the physical phenomenon being investigated in general it is a computer which uses an analog quantity and produces analog values as output. Thus an analog computer measures continuously. Analog computers are very much speedy. They produce their results very fast. But their results are approximately correct. All the analog computers are special purpose computers.

2. Digital Computers

Digital computer represents physical quantities with the help of digits or numbers. These numbers are used to perform Arithmetic calculations and also make logical decision to reach a conclusion, depending on, the data they receive from the user.

3. Hybrid Computers

Various specifically designed computers are with both digital and analog characteristics combining the advantages of analog and digital computers when working as a system. Hybrid computers are being used extensively in process control system where it is necessary to have a close representation with the physical world.
The hybrid system provides the good precision that can be attained with analog computers and the greater control that is possible with digital computers, plus the ability to accept the input data in either form.

Classification of Computers based on size

1. Super Computers
Large scientific and research laboratories as well as the government organizations have extra ordinary demand for processing data which required tremendous processing speed, memory and other services which may not be provided with any other category to meet their needs. Therefore very large computers used are called Super Computers. These computers are extremely expensive and the speed is measured in billions of instructions per seconds.
2) Mainframe Computer
A very large and expensive computer capable of supporting hundreds, or even thousands, of users simultaneously. In the hierarchy that starts with a simple microprocessor (in watches, for example) at the bottom and moves to supercomputers at the top, mainframes are just below supercomputers. In some ways, mainframes are more powerful than supercomputers because they support more simultaneous programs. But supercomputers can execute a single program faster than a mainframe.
3. Mini Computers
Mini computers are smaller than mainframes, both in size and other facilities such as speed, storage capacity and other services. They are versatile that they can be fitted where ever they are needed. Their speeds are rated between one and fifty million instructions per second (MIPS). They have primary storage in hundred to three hundred megabytes range with direct access storage device.
4. Micro Computers
These are the smallest range of computers. They were introduced in the early 70's having less storing space and processing speed. Micro computers of todays are equivalent to the mini computers of yesterday in terms of performing and processing. They are also called "computer of a chip" because its entire circuitry is contained in one tiny chip. The micro computers have a wide range of applications including uses as portable computer that can be plugged into any wall.

Computer software

Computer software is a set of computer programs and program is defined as a set of instructions and data manipulated by those instructions .computer hardware, which is the physical parts of computer system is required to store and execute (or run) the software. In computers, software is loaded into RAM and executed in the central processing unit. At the lowest level, software consists of a machine language specific to an individual processor. Software can be also defined as ordered sequence of instructions for changing the state of the computer hardware in a particular sequence. It is generally written in 'high-level languages' that are easier and more efficient for humans to use (closer to natural language) than machine language. High-level languages are compiled or interpreted into machine language.
Practical computer systems divide software into three major classes:

- system software
- application software

- and programming software, although the distinction is somewhat arbitrary, and often blurred.

System software helps run the computer hardware and computer system. It includes operating systems, device drivers, diagnostic tools, servers, windowing systems, utilities and more.
Programming software usually provides some useful tools to help a programmer to write computer programs and software using different programming languages in a more convenient way. The tools include text editors, compilers, interpreters, linkers, debuggers, and so on. An Integrated development environment (IDE) merges those tools into a software bundle, and a programmer may not need to type multiple commands for compiling, interpreter, debugging, tracing, and etc., because the IDE usually has an advanced graphical user interface, or GUI.
Application software allows humans to accomplish one or more specific tasks. Typical applications include industrial automation, office suites, business software, educational software, databases and computer games. Businesses are probably the biggest users of application software and they use it to automate all sorts of functions.
Three layers of software

People who use general purpose computers usually see three layers of software performing a variety of tasks: platform, application, and user software.

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

Application software
Application software is what most people think of when they think of software. Typical examples include office suites and video games. Application software is often purchased separately from computer hardware.. Applications are independent programs from the operating system, though they are often tailored for specific platforms. Most users think of compilers, databases, and other "system software" as applications.

User-written software or Custom software
User software tailors systems to meet the users specific needs. Depending on how the user-written software has been integrated into purchased application packages, many users may not be aware of the distinction between the purchased packages, and what has been added by fellow co-workers.

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

Software quality and reliability
Software reliability considers the errors, faults, and failures related to the creation and operation of software.
See Software auditing, Software quality, Software testing, and Software reliability.

Software patents
The issue of software patents is very controversial, since while patents protect the ideas of "inventors", they are widely believed to hinder software development.

Firmware:- Firmware is programming that's written to the read-only memory (ROM) of a computing device. Firmware, which is added at the time of manufacturing, is used to run user programs on the device.

Dataflow computers

Dataflow computer architecture directly contrasts the traditional von Neumann architecture or control flow architecture. Dataflow architectures do not have a program counter, or (at least conceptually) the executability and execution of instructions is solely determined based on the availability of input arguments to the instructions, so that the order of instruction execution is unpredictable: i. e. behavior is indeterministic.
Although no commercially successful general-purpose computer hardware has used a dataflow architecture, it has been successfully implemented in specialized hardware such as in digital signal processing, network routing, graphics processing, telemetry, and more recently in data warehousing. It is also very relevant in many software architectures today including database engine designs and parallel computing frameworks.
Synchronous dataflow architectures tune to match the workload presented by real-time data path applications such as wire speed packet forwarding. Dataflow architectures that are deterministic in nature enable programmers to manage complex tasks such as processor load balancing, synchronization and accesses to common resources

Control flow Computers

- Control flow computers deals with orderly processing of individual instructions, these instrucions are linked through precedence constraints. A subsequent instruction does not initiate unless its predecessor has completed.a program is a series of addressable instructions, each of which either specifies an operation along with memory locations of the operands or it specifies (un)conditional transfer of control to some other instruction. Essentially: the next instruction to be executed depends on what happened during the execution of the current instruction. The next instruction to be executed is pointed to and triggered by the PC. The instruction is executed even if some of its operands are not available yet (e.g. uninitialized).

Difference between Control Flow and Data Flow

Control Flow	Data Flow
In Control Flow tasks require completion (Success, fail or completion) before moving to the next task.	In Data Flow one component will not wait for other component to finish, all of them work together for processing data in the streaming way.
There is no proper structure for control flow task as we have for data flow task (Source->transformation->Destination).	It consists of Source, transformation and destination task items.
Precedence constraints are used to connect to the	There is no order for running the different data flow

tasks together and manage the execution order.	tasks. They can run simultaneously.
The data is not transferred between the tasks, if we have to use any data in many tasks; we have to define data in the variables.	Data is being transferred from one task to another. It defines its movement and transformation.
We can add the constraint in the link between the control flow tasks.	We can't add any constraint between the links like Control flow, we only can add the data viewer to watch out the intermediate Data.

Programming languages(basic concepts and Generations)

- A language is a system of communication.
- A **programming language** is a **formal constructed language designed to communicate instructions to a machine, particularly a computer. Programming languages can be used to create programs to control the behaviour of a machine or to express algorithms.**
- A programming language consists of all the symbols, characters, and usage rules that permit people to communicate with computers.
- There are at least several hundred, and possibly several thousand different programming languages. Some of these are created to serve a special purpose (controlling a robot), while others are more flexible general-purpose tools that are suitable for many types of applications.
- Definition of Programming Language
- *"A programming language is a set of written symbols that instructs the computer hardware to perform specific tasks. Typically, a programming language consists of a vocabulary and a set of rules (called syntax) that the programmer must learn"*
- The earliest programming languages preceded the invention of the digital computer and were used to direct the behavior of machines such as Jacquard looms.Thousands of different programming languages have been created, mainly in the computer field, and many more still are being created every year. Many programming languages require computation to be specified in an imperative form (i.e., as a sequence of operations to perform), while other languages use other forms of program specification such as the declarative form (i.e. the desired result is specified, not how to achieve it).
- The description of a programming language is usually split into the two components of syntax (form) and semantics (meaning).
- ***Programming languages have evolved tremendously since early 1950's and this evolution has resulted in over hundreds of different languages being invented and used in the industry. This evolution is needed as we can now instruct computers more easily and faster than ever before due to technological advancement in hardware with fast processors like the 200MHz Pentium Pro developed by Intel. The evolution of computer languages can be better under stood by classifying computer languages into different generations***

Generations of computer languages

- **1GL** or first-generation language was (and still is) *machine language* or the level of instructions and data that the processor is actually given to work on (which in conventional computers is a string of 0s and 1s).
- **2GL** or second-generation language is assembly language. A typical 2GL instruction looks like this:

ADD 12,8

An assembler converts the assembler language statements into machine language.

- **3GL** or third-generation language is a "high-level" programming language, such as PL/I, C, orJava. Java language statements look like this:

public boolean handleEvent (Event evt) { switch (evt.id) { case Event.ACTION_EVENT: { if ("Try me" .equald(evt.arg)) {

A compiler converts the statements of a specific high-level programming language into machine language.A 3GL language requires a considerable amount of programming knowledge.

- **4GL** or fourth-generation language is designed to be closer to natural language than a 3GL language. Languages for accessing databases are often described as 4GLs. A 4GL language statement might look like this:

EXTRACT ALL CUSTOMERS WHERE "PREVIOUS PURCHASES" TOTAL MORE THAN $1000

- **5GL** or fifth-generation language is programming that uses a visual or graphical development interface to create source language that is usually compiled with a 3GL or 4GL language compiler. Microsoft, Borland, IBM, and other companies make 5GL visual programming products for developing applications in Java, for example. Visual programming allows you to easily envision object-oriented programming class hierarchies and drag icons to assemble program components

BOOTING

Booting is the process of loading the operating system

Why is Booting Required?

- Hardware doesn't know where the operating system resides and how to load it.
- Need a special program to do this job – Bootstrap loader.
  - E.g. BIOS – Boot Input Output System.
- Bootstrap loader locates the kernel, loads it into main memory and starts its execution.
- In some systems, a simple bootstrap loader fetches a more complex boot program from disk, which in turn loads the kernel.

How Boot process occurs ?

- Reset event on CPU (power up, reboot) causes instruction register to be loaded with a predefined memory location. It contains a jump instruction that transfers execution to the location of Bootstrap program.
- This program is form of ROM, since RAM is in unknown state at system startup. ROM is convenient as it needs no initialization and can't be affected by virus.

Tasks performed at boot up

- Run diagnostics to determine the state of machine. If diagnostics pass, booting continues.
- Runs a Power-On Self Test (*POST*) to check the devices that the computer will rely on, are functioning.
- BIOS goes through a preconfigured list of devices until it finds one that is bootable. If it finds no such device, an error is given and the boot process stops.
- Initializes CPU registers, device controllers and contents of the main memory. After this, it loads the OS.
- On finding a bootable device, the BIOS loads and executes its boot sector. In the case of a hard drive, this is referred to as the master boot record (*MBR*) and is often not OS specific.
- The MBR code checks the partition table for an active partition. If one is found, the MBR code loads that partition's boot sector and executes it.

- The boot sector is often operating system specific, however in most operating systems its main function is to load and execute a kernel, which continues startup.
- If there is no active partition or the active partition's boot sector is invalid, the MBR may load a secondary boot loader and pass control to it and this secondary boot loader will select a partition (often via user input) and load its boot sector.
- Examples of secondary boot loaders
    - GRUB – GRand Unified Bootloader
    - LILO – LInux LOader
    - NTLDR – NT Loader

Example : DOS

- After identifying the location of boot files, BIOS looks at the first sector (512 bytes) and copies information to specific location in RAM (7C00H) - Boot Record.
- Control passes from BIOS to a program residing in the boot record.
- Boot record loads the initial system file into RAM. For DOS, it is IO.SYS .
- The initial file, IO.SYS includes a file called SYSINIT which loads the remaining OS into the RAM.
- SYSINIT loads a system file MSDOS.SYS that knows how to work with BIOS.
- One of the first OS files that is loaded is the system configuration file, CONFIG.SYS in case of DOS. Information in the configuration file tells loading program which OS files need to be loaded (e.g. drivers)
- Another special file that is loaded is one which tells what specific applications or commands user wants to be performed as part of booting process. In DOS, it is AUTOEXEC.BAT. In Windows, it's WIN.INI .

Questions

- What is the effect on boot sector and boot loader when you install two OS, for e.g. Windows and Linux in two separate partitions ?
- Suppose, you install Windows first. The default boot loader installed in MBR is NTLDR and contains information regarding the active partition of Windows. When you install Linux on this system, the installation prompts to overwrite a new secondary boot loader which identifies both Windows and Linux active partitions and therefore we get a choice of booting the desired OS when the system is started.

In contrast, if Linux is installed first and then Windows, the Windows Installer overwrites the MBR with its own boot loader which doesn't recognize the Linux active partition. This creates a problem. The problem can be corrected by using a LiveCD or any bootable disc which can be used to reinstall a secondary boot loader which identifies both the OS and gives true choice.

Turning the power on is called a "cold boot". A "warm boot" is when you restart the computer (by pressing ctrl + alt + delete). Unlike RAM, ROM circuits retain data and program instructions without requiring power.

Boot Disks

A bootable disk is one that contains "system files". System files are files that your operating system uses to run itself (ex. Command.com). The computer reads these system files and they tell it how to become and act like a computer. Once it read these files, it knows how to run programs. Usually your boot disk is your main hard drive in your computer, however you can also boot from an operating system "boot disk". A boot disk is a specially formatted floppy disk that lets you boot up your computer into a limited text mode in case your hard drive fails.

What is the Internet?

The Internet, sometimes called simply "the Net," is a worldwide system of computer networks - a network of networks in which users at any one computer can, if they have permission, get information from any other computer (and sometimes talk directly to users at other computers). The U.S. Department of Defense laid the foundation of the Internet roughly 30 years ago with a network called ARPANET. But the general public didn't use the Internet much until after the development of the World Wide Web in the early 1990s.

In 1957, the U.S. government formed the Advanced Research Projects Agency (ARPA), a segment of the Department of Defense charged with ensuring U.S. leadership in science and technology with military applications. In 1969, ARPA established ARPANET, the forerunner of the Internet.

ARPANET was a network that connected major computers at the University of California at Los Angeles, the University of California at Santa Barbara, Stanford Research Institute, and the University of Utah. Within a couple of years, several other educational and research institutions joined the network.

In response to the threat of nuclear attack, ARPANET was designed to allow continued communication if one or more sites were destroyed. Unlike today, when millions of people have access to the Internet from home, work, or their public library, ARPANET served only computer professionals, engineers, and scientists who knew their way around its complex workings.

What is the World Wide Web?

The World Wide Web came into being in 1991, thanks to developer Tim Berners-Lee and others at the European Laboratory for Particle Physics, also known as Conseil European pour la Recherche Nucleure (CERN). The CERN team created the protocol based on hypertext that makes it possible to connect content on the Web with hyperlinks. Berners-Lee now directs the World Wide Web Consortium (W3C), a group of industry and university representatives that oversees the standards of Web technology.

Early on, the Internet was limited to noncommercial uses because its backbone was provided largely by the National Science Foundation, the National Aeronautics and Space Administration, and the U.S. Department of Energy, and funding came from the government. But as independent networks began to spring up, users could access commercial Web sites without using the government-funded network. By the end of 1992, the first commercial online service provider, Delphi, offered full Internet access to its subscribers, and several other providers followed.

In June 1993, the Web boasted just 130 sites. By a year later, the number had risen to nearly 3,000. By April 1998, there were more than 2.2 million sites on the Web.

Today, the Internet is a public, cooperative, and self-sustaining facility accessible to hundreds of millions of people worldwide. Physically, the Internet uses a portion of the total resources of the currently existing public telecommunication networks. Technically, what distinguishes the Internet is its use of a set of protocols called TCP/IP (for Transmission Control Protocol/Internet Protocol). Two recent adaptations of Internet technology, the intranet and the extranet, also make use of the TCP/IP protocol.

For many Internet users, electronic mail (e-mail) has practically replaced the Postal Service for short written transactions. Electronic mail is the most widely used application on the Net. You can also carry on live "conversations" with other computer users, using Internet Relay Chat (IRC). More recently, Internet telephony hardware and software allows real-time voice conversations.

The most widely used part of the Internet is the World Wide Web (often abbreviated "WWW" or called "the Web"). Its outstanding feature is hypertext, a method of instant cross-referencing. In most Web sites, certain words or phrases appear in text of a different color than the rest; often this text is also underlined. When you select one of these words or phrases, you will be transferred to the site or page that is relevant to this word or phrase. Sometimes there are buttons, images, or portions of images that are "clickable." If you move the pointer over a spot on a Web site and the pointer changes into a hand, this indicates that you can click and be transferred to another site.

To view files on the Web, you need Web browsing software. You use this software to view different locations on the Web, which are known as Web pages. A group of Web pages is a Web site. The first page of a Web site is often called the home page.
What is a URL?

Every server on the Internet has an IP number, a unique number consisting of 4 parts separated by dots. The IP number is the server's address.
165.113.245.2
128.143.22.55

However, it is harder for people to remember numbers than to remember word combinations. So, addresses are given "word-based" addresses called URLs. The URL and the IP number are one and the same.

The standard way to give the address of any resource on the Internet that is part of the World Wide Web (WWW). A URL looks like this:

http://www.matisse.net/seminars.html
telnet://well.sf.ca.us
gopher://gopher.ed.gov/

The URL is divided into sections:

transfer/transport protocol :// server (or domain). generic top level domain/path/filename

The first part of a URL defines the transport protocol.

http:// (HyperText Transport Protocol) moves graphical, hypertext files
ftp:// (File Transfer Protocol) moves a file between 2 computers
gopher:// (Gopher client) moves text-based files
news: (News group reader) accesses a discussion group
telnet:// (Telnet client) allows remote login to another computer

Here's an example:

http://www.vrml.k12.la.us/tltc/mainmenu.htm

http is the protocol
www.vrml.k12.la.us is the server
tltc/ is the path
mainmenu.htm is the filename of the page on the site

1. You do not have to enter http:// , most browsers will add that information when you press Enter or click the Go button at the end of the Address Bar.

2. To view recently visited Web sites, click the down arrow at the end of the address field.

3. When you start typing a frequently used Web address in the Address bar, a list of similar addresses appears that you can choose from. And if a Web-page address is wrong, Internet Explorer can search for similar addresses to try to find a match.

4. The URL must be typed correctly. If you get a "Server Does Not Have A DNS Entry" message, this message tells you that your browser can't locate the server (i.e. the computer that hosts the Web page). It could mean that the network is busy or that the server has been removed or taken down for maintenance. Check your spelling and try again later.

What are Domains?

Domains divide World Wide Web sites into categories based on the nature of their owner, and they form part of a site's address, or uniform resource locator (URL). Common top-level domains are:

.com—commercial enterprises
.org—organization site (non-profits, etc.)
.net—network
.edu—educational site (universities, schools, etc.)
.gov—government organizations
.mil—military site
.int—organizations established by international treaty
.biz—commercial and personal
.info—commercial and personal
.name—personal sites

Additional three-letter, four-letter, and longer top-level domains are frequently added. Each country linked to the Web has a two-letter top-level domain, for example .fr is France, .ie is Ireland.

E-mail electronic mail, e-mail or email is information stored on a computer that is exchanged between two users over telecommunications. More plainly, e-mail is a message that may contain text, files, images, or other attachments sent through a network to a specified individual or group of individuals. The first e-mail was sent by Ray Tomlinson in 1971. By 1996, more electronic mail was being sent than postal mail.
E-mail address breakdown support@computerhope.com
The first portion all e-mail addresses, the part before the @ symbol, contains the alias, user, group, or department of a company. In our above example support is the Technical Support department at Computer Hope.

- Next, the @ (at sign) is used as a divider in the e-mail address; it is required for all SMTP e-mail addresses since the first message was sent by Ray Tomlinson.

- Finally, computerhope.com is the domain name to which the user belongs.

How to send and receive e-mail
E-mail Program

To send and receive e-mail messages, you can use an e-mail program, also known as an e-mail client. When using an e-mail client, you must have a server that stores and delivers your messages, which is provided by your ISP or in some cases, another company. An e-mail client needs to connect to a server to download new e-mail, whereas email stored online updates automatically when you visit the site.

E-mail Online

An alternative way of sending and receiving e-mail (and the more popular solution for most people) is an online e-mail service or webmail. Examples include Hotmail (now Outlook.com), Gmail, and Yahoo Mail. Many of the online e-mail services, including the ones we just mentioned, are free or have a free account option.

Writing an e-mail

When writing an e-mail message, it should look something like the example window below. As you can see, several fields are required when sending an e-mail:

- The To field is where you type the e-mail address of the person who is the recipient of your message.
- The From field should contain your e-mail address.
- If you are replying to a message, the To and From fields are automatically filled out; if it's a new message, you'll need to enter them manually.
- The CC or Carbon Copy field allows you to send a copy of the message to another e-mail address, but is not mandatory.
- The Subject Line, although not required, should consist of a few words describing the e-mail's contents.
- Finally, the Message Body is the location you type your main message. It often contains your signature at the bottom; similar to a hand-written letter.

What makes a valid e-mail address?

There are several rules that an e-mail address must follow to be valid:

- As mentioned earlier, an e-mail must have a username followed by an @ (at sign) which is followed by the domain name with a domain suffix.
- The username cannot be longer than 64 characters long and the domain name cannot be longer than 254 characters.
- There should be only one @ sign in an e-mail address.
- The space and special characters: ( ), : ; < > \ [ ] are allowed. Occasionally, a space, backslash, and quotation mark work but must be preceded with a forward slash. Although valid, some e-mail providers do not allow these characters.
- The username and e-mail addresses as a whole cannot begin or end with a period.
- The e-mail must not have two or more consecutive periods.

Input and Output Devices

Computers do the processing of data .computer can process data when there is some method to input the data into the machine. The device you use will depend on what form this data takes (be it text, sound, artwork, etc.). Computer device that is used for input is called input device. Similarly, after the computer has processed your data, you often need to produce output of the results. This output could be a display on the computer screen, hardcopy on printed pages, or even the audio playback of music you composed on the computer. the device that is used to display result is called output device

The terms “input” and “output” are used both as verbs to describe the process of entering or displaying the data, and as nouns referring to the data itself entered into or displayed by the computer.

List of Input Devices:

a) Graphics Tablets
b) Cameras
c) Video Capture Hardware
d) Trackballs
e) Barcode reader
f) Digital camera
g) Gamepad
h) Joystick
i) Keyboard
j) Microphone
k) MIDI keyboard
l) Mouse (pointing device)
m) Scanner
n) Webcam
o) Touchpads
p) Pen Input
q) Microphone
r) Electronic Whiteboard
s) OMR
t) OCR
u) Punch card reader
v)MICR (Magnetic Ink character reader)
w) Magnetic Tape Drive

OUTPUT DEVICES:

1. Monitor (LED, LCD, CRT etc)
2. Printers (all types)
3. Plotters
4. Projector
5. LCD Projection Panels
6. Computer Output Microfilm (COM)
7. Speaker(s)
8. Head Phone

9. Visual Display Unit
10. Film Recorder
11. Microfiche

Both Input–OutPut Devices:

1. Modems
2. Network cards
3. Touch Screen
4. Headsets (Headset consists of Speakers and Microphone.
5. Speaker act Output Device and Microphone act as Input device)
6. Facsimile (FAX) (It has scanner to scan the document and also
7. have printer to Print the document)
8. Audio Cards / Sound Card
9. Below we discuss the variety of peripheral devices used for computer input and output

Input Devices

1. Keyboard

   the computer keyboard is used to enter text information into the computer, as when you type the contents of a report. The keyboard can also be used to type commands directing the computer to perform certain actions. Commands are typically chosen from an on-screen menu using a mouse, but there are often keyboard shortcuts for giving these same commands.

   In addition to the keys of the main keyboard (used for typing text), keyboards usually also have a numeric keypad (for entering numerical data efficiently), a bank of editing keys (used in text editing operations), and a row of function keys along the top (to easily invoke certain program functions). Laptop computers, which don't have room for large keyboards, often include a "fn" key so that other keys can perform double duty (such as having a numeric keypad function embedded within the main keyboard keys).

   Improper use or positioning of a keyboard can lead to repetitive-stress injuries. Some ergonomic keyboards are designed with angled arrangements of keys and with built-in wrist rests that can minimize your risk of RSIs.

   Most keyboards attach to the PC via a PS/2 connector or USB port (newer). Older Macintosh computers used an ABD connector, but for several years now all Mac keyboards have connected using USB.

   Pointing Devices

   The graphical user interfaces (GUIs) in use today require some kind of device for positioning the on-screen cursor. Typical pointing devices are: mouse, trackball, touch pad, trackpoint, graphics tablet, joystick, and touch screen.

   Pointing devices, such as a mouse, connected to the PC via aserial ports (old), PS/2 mouse port (newer), or USB port (newest). Older Macs used ADB to connect their mice, but all recent Macs use USB (usually to a USB port right on the USB keyboard).

2. Mouse

   The mouse pointing device sits on your work surface and is moved with your hand. In older mice, a ball in the bottom of the mouse rolls on the surface as you move the mouse, and internal rollers sense the ball movement and transmit the information to the computer via the cord of the mouse.

   The newer optical mouse does not use a rolling ball, but instead uses a light and a small optical sensor to detect the motion of the mouse by tracking a tiny image of the desk

surface. Optical mice avoid the problem of a dirty mouse ball, which causes regular mice to roll unsmoothly if the mouse ball and internal rollers are not cleaned frequently.

A cordless or wireless mouse communicates with the computer via radio waves (often using **BlueTooth** hardware and protocol) so that a cord is not needed (but such mice need internal batteries).

A mouse also includes one or more buttons (and possibly a scroll wheel) to allow users to interact with the GUI. The traditional PC mouse has two buttons, while the traditional Macintosh mouse has one button. On either type of computer you can also use mice with three or more buttons and a small scroll wheel (which can also usually be clicked like a button).

3. Touch pad

   Most laptop computers today have a touch pad pointing device. You move the on-screen cursor by sliding your finger along the surface of the touch pad. The buttons are located below the pad, but most touch pads allow you to perform "mouse clicks" by tapping on the pad itself.

   Touch pads have the advantage over mice that they take up much less room to use. They have the advantage over trackballs (which were used on early laptops) that there are no moving parts to get dirty and result in jumpy cursor control.

4. Trackpoint

   Some sub-notebook computers (such as the IBM ThinkPad), which lack room for even a touch pad, incorporate atrackpoint, a small rubber projection embedded between the keys of the keyboard. The trackpoint acts like a little joystick that can be used to control the position of the on-screen cursor.

5. Trackball

   The trackball is sort of like an upside-down mouse, with the ball located on top. You use your fingers to roll the trackball, and internal rollers (similar to what's inside a mouse) sense the motion which is transmitted to the computer. Trackballs have the advantage over mice in that the body of the trackball remains stationary on your desk, so you don't need as much room to use the trackball. Early laptop computers often used trackballs (before superior touch pads came along).

   Trackballs have traditionally had the same problem as mice: dirty rollers can make their cursor control jumpy and unsmooth. But there are modern optical trackballs that don't have this problem because their designs eliminate the rollers.

6. Joysticks

   Joysticks and other game controllers can also be connected to a computer as pointing devices. They are generally used for playing games, and not for controlling the on-screen cursor in productivity software.

7. Touch screen

   Some computers, especially small hand-held PDAs, have touch sensitive display screens. The user can make choices and press button images on the screen. You often use a stylus, which you hold like a pen, to "write" on the surface of a small touch screen.

8. Graphics tablet

   A graphics tablet consists of an electronic writing area and a special "pen" that works with it. Graphics tablets allows artists to create graphical images with motions and actions similar to using more traditional drawing tools. The pen of the graphics tablet is pressure sensitive, so pressing harder or softer can result in brush strokes of different width (in an appropriate graphics program).

9. Scanners

A scanner is a device that images a printed page or graphic by digitizing it, producing an image made of tiny pixels of different brightness and color values which are represented numerically and sent to the computer. Scanners scan graphics, but they can also scan pages of text which are then run through OCR (Optical Character Recognition) software that identifies the individual letter shapes and creates a text file of the page's contents.

10. Microphone
    A microphone can be attached to a computer to record sound (usually through a sound card input or circuitry built into the motherboard). The sound is digitized—turned into numbers that represent the original analog sound waves—and stored in the computer to later processing and playback.
11. MIDI Devices
    MIDI (Musical Instrument Digital Interface) is a system designed to transmit information between electronic musical instruments. A MIDI musical keyboard can be attached to a computer and allow a performer to play music that is captured by the computer system as a sequence of notes with the associated timing (instead of recording digitized sound waves).

Output Devices

1. CRT Monitor
   The traditional output device of a personal computer has been the CRT (Cathode Ray Tube) monitor. Just like a television set (an older one, anyway) the CRT monitor contains a large cathode ray tube that uses an electron beam of varying strength to "paint" a picture onto the color phosphorescent dots on the inside of the screen. CRT monitors are heavy and use more electrical power than flat panel displays, but they are preferred by some graphic artists for their accurate color rendition, and preferred by some gamers for faster response to rapidly changing graphics.
   Monitor screen size is measured diagonally across the screen, in inches. Not all of the screen area may be usable for image display, so the viewable area is also specified. The resolutionof the monitor is the maximum number of pixels it can display horizontally and vertically (such as 800 x 600, or 1024 x 768, or 1600 x 1200). Most monitors can display several resolutions below its maximum setting. Pixels (short for picture elements) are the small dots that make of the image displayed on the screen. The spacing of the screen's tiny phosphor dots is called the dot pitch (dp), typically .28 or .26 (measured in millimeters). A screen with a smaller dot pitch produces sharper images.
   Your computer must produce a video signal that a monitor can display. This may be handled by circuitry on the motherboard, but is usually handled by a video card in one of the computer's expansion slots; often the slot is a special one dedicated to video use, such as an AGP slot (Accelerated Graphics Port). Video cards are also called video display adapters, and graphics cards. Many video cards contain separate processors and dedicated video memory for generating complex graphics quickly without burdening the CPU. These accelerated graphics cards are loved by gamers.
2. Flat Panel Monitor
   A flat panel display usually uses an LCD (Liquid Crystal Display) screen to display output from the computer. The LCD consists of several thin layers that polarize the light passing through them. The polarization of one layer, containing long thin molecules called liquid crystals, can be controlled electronically at each pixel, blocking varying amounts of the light to make a pixel lighter or darker. Other types of flat panel

technology exist (such as **plasma displays**) but LCDs are most commonly used in computers, especially laptops.

Older LCDs had slow response times and low contrast, butactive matrix LCD screens have a transparent thin film transistor (TFT) controlling each pixel, so response, contrast, and viewing angle are much improved.

Flat panel displays are much lighter and less bulky than CRT monitors, and they consume much less power. They have been more expensive than CRTs in the past, but the price gap is narrowing. You will see many more flat panels in the future.

As with CRTs, the display size of a flat panel is expressed in inches, and the resolution is the number of pixels horizontally and vertically on the display.

3. Ink Jet Printer

   For hardcopy (printed) output, you need some kind of printer attached to your computer (or available over a network). The most common type of printer for home systems is the color ink jet printer. These printers form the image on the page by spraying tiny droplets of ink from the print head. The printer needs several colors of ink (cyan, yellow, magenta, and black) to make color images. Some photo-quality ink jet printers have more colors of ink.

   Ink jet printers are inexpensive, but the cost of consumables (ink cartridges and special paper) make them costly to operate in the long run for many purposes.

4. Laser Printer

   A laser printer produces good quality images by the same technology that photocopiers use. A drum coated with photosensitive material is charged, then an image is written onto it by a laser (or LEDs) which makes those areas lose the charge. The drum then rolls through toner (tiny plastic particles of pigment) that are attracted to the charged areas of the drum. The toner is then deposited onto the paper, and then fused into the paper with heat.

   Most laser printers are monochrome (one color only, usually black), but more expensive laser printers with multiple color toner cartridges can produce color output.

   Laser printers are faster than ink jet printers. Their speed is rated in pages per minute (ppm). Laser printers are more expensive than ink jets, but they are cheaper to run in the long term if you just need good quality black & white pages.

5. Other Printers

   Multi-function printers are available that not only operate as a computer printer, but also include the hardware needed to be a scanner, photocopier, and FAX machine as well.

   Dot matrix printers use small electromagnetically activated pins in the print head, and an inked ribbon, to produce images by impact. These printers are slow and noisy, and are not commonly used for personal computers anymore (but they can print multi-layer forms, which neither ink jet or laser printers can).

6. Sound Output

   Computers also produce sound output, ranging from simple beeps alerting the user, to impressive game sound effects, to concert quality music. The circuitry to produce sound may be included on the motherboard, but high quality audio output from a PC usually requires a sound card in one of the expansion slots, connected to a set of good quality external speakers or headphones.

   Multimedia is a term describing computer output that includes sound, text, graphics, movies, and animation. A sound card is an example of a multimedia
   output device

7. projector

   A digital projector is a device which connects to a computer and is used to project the

video output from the computer onto a wall or screen. In classrooms they are often used with electronic whiteboards. The projector can be portable and placed on a stand or it can be permanently fixed to the ceiling.

Printers and Plotters

Computer printers and plotters output data in printed form. They may be used to produce precision blueprints, graphics, labels, maps, and other images. printers and plotters are used to reproduce visual material, their construction and use differs in significant ways.

Plotter

A plotter is a printer that interprets commands from a computer to make line drawings on paper with one or more automated pens. Unlike a regular printer , the plotter can draw continuous point-to-point lines directly from vector graphics files or commands. Plotters were the first type of printer that could print with colour and render graphics and full-size engineering drawings. As a rule, plotters are much more expensive than printers. They are most frequently used for CAE (computer-aided engineering) applications, such as CAD (computer-aided design) and CAM (computer-aided manufacturing). Hewlett-Packard is the leading vendor of plotters worldwide. In the past, plotters were used in applications such as computer-aided design, though they have generally been replaced with wide-format conventional printers. A plotter gives a hard copy of the output. Plotters are used to print designs of ships and machines, plans for buildings and so on.

Plotters are divided into three types:

1. Drum plotters
2. Flatbed plotters
3. *Pinch-roller plotters* - These are a mixture of the two types above

Drum Plotter

A drum plotter is also known as Roller Plotter. It consists of a drum or roller on which a paper is placed and the drum rotates back and forth to produce the graph on the paper. It also consists of mechanical device known as Robotic Drawing Arm that holds a set of colored ink pens or pencils. The Robotic Drawing Arm moves side to side as the paper are rolled back and forth through the roller. In this way, a perfect graph or map is created on the paper. This work is done under the control of computer. Drum Plotters are used to produce continuous output, such as plotting earthquake activity.

Flatbed Plotter

A flatbed plotter is also known as Table Plotter. It plots on paper that is spread and fixed over a rectangular flatbed table. The flatbed plotter uses two robotic drawing arms, each of which holds a set of colored ink pens or pencils. The drawing arms move over the stationary paper and draw the graph on the paper. Typically, the plot size is equal to the area of a bed. The plot size may be 20- by-50 feet. It is used in the design of cars, ships, aircrafts, buildings, highways etc. Flatbed plotter is very slow in drawing or printing graphs. The large and complicated drawing can take several hours to print. The main reason of the slow printing is due to the movement mechanical devices.

Today, mechanical plotters have been replaced by thermal, electrostatic and ink jet plotters. These systems are faster and cheaper. They also produce large size drawings.

Advantages of plotter

Drawings are of the same quality as if an expert drew them

Larger sizes of paper can be used than most printers can manage

Disadvantages

Plotters are slower than printers because each line is drawn separately
They are often more expensive than printers
They do not produce very high quality text printouts

Printers

"A printer is an external output device that takes data from a computer and generates output in the form of graphics / text on a paper".

There are two types of printers.

Impact printers

An impact printer makes contact with the paper. It usually forms the print image by pressing an inked ribbon against the paper using a hammer or pins. Following are some examples of impact printers.

Dot-Matrix Printers

The dot-matrix printer uses print heads containing from 9 to 24 pins. These pins produce patterns of dots on the paper to form the individual characters. The 24 pin dot-matrix printer produces more dots that a 9 pin dot-matrix printer, which results in much better quality and clearer characters. The general rule is: the more pins, the clearer the letters on the paper. The pins strike the ribbon individually as the print mechanism moves across the entire print line in both directions, i-e, from left to right, then right to left, and so on. The user can produce a color output with a dot-matrix printer (the user will change the black ribbon with a ribbon that has color stripes). Dot-matrix printers are inexpensive and typically print at speeds of 100-600 characters per second.

Daisy-wheel printers

In order to get the quality of type found on typewriters, a daisy-wheel impact printer can be used. It is called daisy-wheel printer because the print mechanism looks like a daisy; at the end of each “Petal” is a fully formed character which produces solid-line print. A hammer strikes a “petal” containing a character against the ribbon, and the character prints on the paper. Its speed is slow typically 25-55 characters per second.

Line printers

In business where enormous amount of material are printed, the character-at-a-time printers are too slow; therefore, these users need line-at-a-time printers. Line printers, or line-at-a-time printers, use special mechanism that can print a whole line at once; they can typically print the range of 1,200 to 6,000 lines per minute. Drum, chain, and band printers are line-at-a-time printers.

Drum printer

A drum printer consists of a solid, cylindrical drum that has raised characters in bands on its surface. The number of print positions across the drum equals the number available on the page. This number typically ranges from 80-132 print positions. The drum rotates at a rapid speed. For each possible print position there is a print hammer located behind the paper. These hammers strike the paper, along the ink ribbon, against the proper character on the drum as it passes. One revolution of the drum is required to print each line. This means that all characters on the line are not printed at exactly the same time, but the time required to print the entire line is fast enough to call them line printers. Typical speeds of drum printers are in the range of 300 to 2000 lines per minute.

Chain printers

A chain printer uses a chain of print characters wrapped around two pulleys. Like the drum printer, there is one hammer for each print position. Circuitry inside the printer detects when the correct character appears at the desired print location on the page. The hammer then strikes the page, pressing the paper against a ribbon and the character located at the desired

print position. An impression of the character is left on the page. The chain keeps rotating until all the required print positions on the line have filled. Then the page moves up to print the next line. Speeds of chain printers range from 400 to 2500 characters per minute.

Band printers

A band printer operates similar to chain printer except it uses a band instead of a chain and has fewer hammers. Band printer has a steel band divided into five sections of 48 characters each. The hammers on a band printer are mounted on a cartridge that moves across the paper to the appropriate positions. Characters are rotated into place and struck by the hammers. Font styles can easily be changed by replacing a band or chain.

Non-impact printers

Non-impact printers do not use a striking device to produce characters on the paper; and because these printers do not hammer against the paper they are much quieter. Following are some non-impacted printers.

Ink-jet printers

Ink-jet printers work in the same fashion as dot-matrix printers in the form images or characters with little dots. However, the dots are formed by tiny droplets of ink. Ink-jet printers form characters on paper by spraying ink from tiny nozzles through an electrical field that arranges the charged ink particles into characters at the rate of approximately 250 characters per second. The ink is absorbed into the paper and dries instantly. Various colors of ink can also be used.

One or more nozzles in the print head emit a steady stream of ink drops. Droplets of ink are electrically charged after leaving the nozzle. The droplets are then guided to the paper by electrically charged deflecting plates [one plate has positive charge (upper plate) and the other has negative charge (lover plate)]. A nozzle for black ink may be all that's needed to print text, but full-color printing is also possible with the addition of needed to print text, but full-color printing is also possible with the addition three extra nozzles for the cyan, magenta, and yellow primary colors. If a droplet isn't needed for the character or image being formed, it is recycled back to its input nozzle.

Several manufacturers produce color ink-jet printer. Some of these printers come with all their color inks in a cartridge; if you want to replace on color, you must replace all the colors. Other color ink-jet printers allow you to replace ink individually. These printers are a better choice if user uses one color more than other colors. These printers produce less noise and print in better quality with greater speed.

Laser printers

A laser printer works like a photocopy machine. Laser printers produce images on paper by directing a laser beam at a mirror which bounces the beam onto a drum. The drum has a special coating on it to which toner (an ink powder) sticks. Using patterns of small dots, a laser beam conveys information from the computer to a positively charged drum to become neutralized. From all those areas of drum which become neutralized, the toner detaches. As the paper rolls by the drum, the toner is transferred to the paper printing the letters or other graphics on the paper. A hot roller bonds the toner to the paper.

Laser printers use buffers that store an entire page at a time. When a whole page is loaded, it will be printed. The speed of laser printers is high and they print quietly without producing much noise. Many home-use laser printers can print eight pages per minute, but faster and print approximately 21,000 lines per minute, or 437 pages per minute if each page contains 48 lines. When high speed laser printers were introduced they were expensive. Developments in the last few years have provided relatively low-cost laser printers for use in small businesses.

Advantages of Laser Printer

- The main advantage of Laser printer is its speed & efficiency at which it prints high-quality quality graphics & text.
- Laser printers produce high-quality output as compared to other printers.
- Laser printers are quite and does not produce disturbing sounds.
- They are also capable to produce color prints.

Disadvantages of Laser Printer

- The main disadvantage of Laser printer is its cost, they are relatively costly as compared to other printers.
- The maintenance, repair & servicing charges are also high of these printers.
- Laser printers emit small amount of ozone and are hazardous to health and the atmosphere.

Printer Characteristics

Printers are also classified by 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 you look closely, you 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 lines per minute). Dot-matrix printers can print up to 500 cps, and laser printers 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.

 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 a 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.

DATA COLLECTION

data collection is the step before computers can process data and generate information

- **starting point for collecting data is a source document.**
- **Two advantages of using manually-prepared source documents is that they are human readable and easily completed on-site.**
- **The main disadvantage of using manually- prepared source documents is that they are usually not machine readable.**

- **Data transcription is inefficient because it is labor-intensive, time-consuming, costly, and nonproductive.**

Point of Sale Devices

- **POS Devices are "smart cash registers" that gather and record pertinent data electronically at the time a sale is made.**
- **Bar Code Readers read universal product codes (UPC), which are vertical bars that identify a manufacturer and the item.**
- **POS systems allow retailers to centralize price information in online computers and update prices when required.**

Advantages of POS Systems

1. **Clerical errors are detectable and may be automatically corrected.**
2. **The register/terminal can perform calculations.**
3. **Processing errors can be reduced.**
4. **Cash register can serve as an inquiry terminal.**
5. **Inventory/disbursement data collected.**
6. **Sales information is automatically collected.**
7. **May reduce personnel because of elimination of many manual procedures.**

Magnetic Ink Character Recognition

- **Magnetic Ink Character Recognition uses magnetically-encoded paper containing standardized fonts to process transactions.**
- **An advantage of MICR coding is that it is both machine readable and human readable.**
- **Another advantage is that MICR coding is quite flexible.**
- **A disadvantage is that the *magnetic strength* of the characters diminishes over time.**

Optical Character Recognition

- **Also referred to as Optical Character Reader**

- **"…a system that provides a full alphanumeric recognition of printed or handwritten characters at electronic speed by simply scanning the form."(UNESCAP, Pop-IT project, 1997-2001)**
- **Intelligent Character Recognition (ICR) is used to describe the process of interpreting image data, in particular alphanumeric text.**
- **Optical Character Recognition (OCR) devices use optical rather than magnetic readers to interpret the data found on source documents.**
- **Mark-sense media use rectangles or ovals as "characters" that a person blackens with a pencil.**
- **Most OCR forms are turnaround documents which are prepared by a company, sent to individuals, and returned to the organization for further data processing.**
- **Main advantage of OCR is that the documents are human-readable and machine-readable.**

Plastic Cards with Magnetic Strips

- **Plastic Cards with magnetic strips store information about the user.**
- **AISs use mag-strip cards to capture data at the time these cards are used.**
- **Automated teller machines (ATM) examine account numbers and passwords encoded on mag-strip cards.**

BAR CODE

A bar code (often seen as a single word, *barcode*) is the small image of lines (bars) and spaces that is affixed to retail store items, identification cards, and postal mail to identify a particular product number, person, or location. The code uses a sequence of vertical bars and spaces to represent numbers and other symbols. A bar code symbol typically consists of five parts: a quiet zone, a start character, data characters (including an optional check character), a stop character, and another quiet zone.

- Barcode reader

A barcode reader (or barcode scanner) is an electronic device that can read and output printed barcodes to a computer. The reader uses a laser beam that is sensitive to the reflections from the line and space thickness and variation. The reader translates the reflected light into digital data that is transferred to a computer for immediate action or storage. Additionally, nearly all barcode readers contain decoder circuitry analyzing the barcode's image data provided by the sensor and sending the barcode's content to the scanner's output port.

Bar codes and readers are most often seen in supermarkets and retail stores, but a large number of different uses have been found for them. They are also used to take inventory in

retail stores; to check out books from a library; to track manufacturing and shipping movement; to sign in on a job; to identify hospital patients; and to tabulate the results of direct mail marketing returns. Very small bar codes have been used to tag honey bees used in research. Readers may be attached to a computer (as they often are in retail store settings) or separate and portable, in which case they store the data they read until it can be fed into a computer.

There is no one standard bar code; instead, there are several different bar code standards called symbologies that serve different uses, industries, or geographic needs. Since 1973, the Uniform Product Code (UPC), regulated by the Uniform Code Council, an industry organization, has provided a standard bar code used by most retail stores. The European Article Numbering system (EAN), developed by Joe Woodland, the inventor of the first bar code system, allows for an extra pair of digits and is becoming widely used. POSTNET is the standard bar code used in the United States for ZIP codes in bulk mailing.

Voice Recognition

also called **speech recognition**, **voice recognition** is a computer software program or hardware device with the ability to decode the human voice. Voice recognition is commonly used to operate a device, perform commands, or write without having to use a keyboard, mouse, or press any buttons. Today, this is done on a computer with **automatic speech recognition** (**ASR**) software programs. Many ASR programs require the user to "train" the ASR program to recognize their voice so that it can more accurately convert the speech to text. For example, you could say "open Internet" and the computer would open the Internet browser.

The first ASR device was used in 1952 and recognized single digits spoken by a user (it was not computer driven). Today, ASR programs are used in many industries, including Healthcare, Military (e.g. F-16 fighter jets), Telecommunications, and personal computing (i.e. hands-free computing).

What does voice recognition require?

For voice recognition to work you must have a computer with a sound card and either a microphone or a headset. Other devices like smart phones have all of the necessary hardware built into the device. Also, the software you use needs voice recognition support or if you want to use voice recognition everywhere you need a program like Nuance Naturally Speaking to be installed.

If you are using Microsoft Windows Vista, 7, 8, or 10 you can also use the included Windows Speech Recognition program.

Tip: Although speech recognition can be done using any microphone, you get much better results if you use a headset.

Examples of where you might have used voice recognition

As voice recognition improves, it is being implemented in more places and it is very likely you have already used it. Below are some good examples of where you might encounter voice recognition.

- **Automated phone systems** - Many companies today use phone systems that help direct the caller to the correct department. If you have ever been asked something like "Say or press number 2 for support" and you say "2," you used voice recognition.
- **Google Voice** - Google voice is a service that allows you to search and ask questions on your computer, tablet, and phone.
- **Siri** - Apple's Siri is another good example of voice recognition that helps answer questions on Apple devices.

- **Car Bluetooth** - For cars with Bluetooth or Handsfree phone pairing you can use voice recognition to make commands such as "call my wife" to make calls without taking your eyes off the road.

Types of voice recognition systems

Automatic speech recognition is just one example of voice recognition, below are other examples of voice recognition systems.

- **Speaker dependent system** - The voice recognition requires training before it can be used, which requires you to read a series of words and phrases.
- **Speaker independent system** - The voice recognition software recognizes most users voices with no training.
- **Discrete speech recognition** - The user must pause between each word so that the speech recognition can identify each separate word.
- **Continuous speech recognition** - The voice recognition can understand a normal rate of speaking.
- **Natural language** - The speech recognition not only can understand the voice but also return answers to questions or other queries that are being asked.

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Chapter 6 Secondary Storage

computer memory

Computer memory is any physical device capable of storing data and instructions temporarily or permanently.

Memory is primarily of three types

- Registers
- Cache Memory
- Primary Memory/Main Memory
- Secondary Memory

Cache Memory

Cache memory is a very high speed semiconductor memory which can speed up CPU. It acts as a buffer between the CPU and main memory. It is used to hold those parts of data and program which are most frequently used by CPU. The parts of data and programs are transferred from disk to cache memory by operating system, from where CPU can access them.

- Advantages

The advantages of cache memory are as follows:

- Cache memory is faster than main memory.
- It consumes less access time as compared to main memory.
- It stores the program that can be executed within a short period of time.
- It stores data for temporary use.
- Disadvantages

The disadvantages of cache memory are as follows:

- Cache memory has limited capacity.
- It is very expensive.

Primary Memory (Main Memory)

Primary memory holds only those data and instructions on which computer is currently working. . It is divided into two subcategories RAM and ROM.

It has limited capacity . It is generally made up of semiconductor device. These memories are not as fast as registers. The data and instruction required to be processed reside in main memory

RAM (Random Access Memory) is called **primary storage** since it is used directly by the CPU for processing data and program instructions.

RAM is *volatile* or *temporary storage* (once the power is turned off, the contents are lost).

Characteristics of Main Memory

- These are semiconductor memories
- It is known as main memory.
- Usually volatile memory.
- Data is lost in case power is switched off.
- It is working memory of the computer.
- Faster than secondary memories.
- A computer cannot run without primary memory.

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Chapter 6 Secondary Storage

Types of Primary Memory

1. RAM – Random Access Memory
    a. Static RAM
    b. Dynamic RAM
2. ROM – Read Only Memory
    a. PROM – Programmable Read Only Memory
    b. EPROM – Erasable Programmable Read Only Memory
    c. EEPROM – Electronic Erasable Programmable Read Only Memory

RAM – Random Access Memory

The Read and write (R/W) memory of a computer is called RAM. The User can write information to it and read information from it. With RAM any location can be reached in a fixed (and short) amount of time after specifying its address.The RAM is a volatile memory, it means information written to it can be accessed as long as power is on. As soon as the power is off, it can not be accessed. so this mean RAM computer memory essentially empty.RAM holds data and processing instructions temporarily until the CPU needs it.RAM is considered "random access" because you can access any memory cell directly if you know the row and column that intersect at that cell. RAM is made in electronic chips made of so called semiconductor material, just like processors and many other types of chips. In RAM, transistors make up the individual storage cells which can each "remember" an amount of data, for example, 1 or 4 bits – as long as the PC is switched on. Physically, RAM consists of small electronic chips which are mounted in modules (small printed circuit boards). The modules are installed in the PC's motherboard using sockets – there are typically 2, 3 or 4 of these.

There are two basic types of RAM :

(i) Dynamic Ram

(ii) (ii) Static RAM

Dynamic RAM : loses its stored information in a very short time (for milli sec.) even when power supply is on. D-RAM's are cheaper & lower. Dynamic Memory Cell, represents a single bit of data. The capacitor holds the bit of information – a 0 or a 1. The transistor acts as a switch that lets the control circuitry on the memory chip read the capacitor or change its state. A capacitor is like a small bucket that is able to store electrons. To store a 1 in the memory cell, the bucket is filled with electrons.To store a 0, it is emptied. The problem with the capacitor's bucket is that it has a leak. In a matter of a few milliseconds a full bucket becomes empty. Therefore, for dynamic memory to work, either the CPU or the Memory Controller has to come along and recharge all of the capacitors holding it before they discharge. To do this, the memory controller reads the memory and then writes it right back. This refresh operation happens automatically thousands of times per second.

This refresh operation is where dynamic RAM gets its name. Dynamic RAM has to be dynamically refreshed all of the time or it forgets what it is holding. The downside of all of this refreshing is that it takes time and slows down the memory.

Static RAM uses a completely different technology. S-RAM retains stored information only as long as the power supply is on. Static RAM's are costlier and consume more power. They have higher speed than D-RAMs. They store information in Hip-Hope.In

static RAM, a form of flipflop holds each bit of memory. A flip-flop for a memory cell takes four or six transistors along with some wiring, but never has to be refreshed. This makes static RAM significantly faster than dynamic RAM. However, because it has more parts, a static memory cell takes up a lot more space on a chip than a dynamic memory cell. Therefore, you get less memory per chip, and that makes static RAM a lot more expensive. Static RAM is fast and expensive, and dynamic RAM is less expensive and slower. Static RAM is used to create the CPU's speed sensitive cache, while dynamic RAM forms the larger system RAM space.
Some other RAMS are :
(a) EDO (Extended Data Output) RAM : In an EDO RAMs, any memory location can be accessed. Stores 256 bytes of data information into latches. The latches hold next 256 bytes of information so that in most programs, which are sequentially executed, the data are available without wait states.
(b) SDRAM (Synchronous DRAMS), SGRAMs (Synchronous Graphic RAMs) These RAM chips use the same clock rate as CPUuses. They transfer data when the CPU expects them to be ready.
(c) DDR-SDRAM (Double Data Rate – SDRAM) : This RAM transfers data on both edges of the clock. Therefore the transfer rate of the data becomes doubles.

ROM – Read Only Memory

It is a permanent memory. The instructions can only be read by the computer. The instructions related to system operations are stored here. These instructions are written by the manufacturer and cannot be edited by the user. When the system is turned ON, ROM instructions are instantly executed and used in operation of all I/O devices.

There are 3 types of ROM

a. **PROM** - Programmable Read Only Memory
   It is a non-volatile memory. Instructions can be written once by the programmer and then subsequently read.
b. **EPROM** – Erasable Programmable Read Only Memory
   It is an improvement over the PROM chips. Instructions can be rewritten by the programmer using special techniques. The instructions are erased using UV light and rewritten. To change the instructions the chip has to be removed from the machine and then put back after the changes have been made.
c. **EEPROM** – Electronic Erasable Programmable Read Only Memory
   It is advancement over EPROM, and the chip need not be taken out from the machine. Instead the programming is done using software. These chips are used in Point-of-sale (POS) terminals to record price related information and can be updated as and when needed. However they are expensive compared to the normal ROM chips.

Secondary Memory

This type of memory is also known as external memory or non-volatile. This is also called Mass Storage and Auxiliary Memory.This memory is slower than the Main memory as it involves mechanical motion techniques during storage and retrieval of data. This memory is larger in size than Main memory but the processor is unable to access it directly due to its offline link with the processor. This means that the data from secondary storage must be loaded into RAM before the processor starts processing it. The main memory links the secondary memory to the processor. It is slower than main memory. These are used for storing data/Information permanently. CPU directly does not access these memories instead they are accessed via input-output routines.

Characteristic of Secondary Memory

- These are magnetic and optical memories
- It is known as backup memory.
- It is non-volatile memory.
- Data is permanently stored even if power is switched off.
- It is used for storage of data in a computer.
- Computer may run without secondary memory.
- Slower than primary memories.

Important characteristics of secondary storage include:

- **Media** or *medium*: the actual physical material that holds the data

- **Capacity**: how much the particular storage medium can store, typically measured in MB, GB, and TB
- **Access time**: the amount of time to read and/or write data and programs to the storage medium

Floppy Disks

- **Floppy disks** (aka **floppies**, **diskettes**, **disks** or **flexible disks**) are *portable*, *flexible* and *removable* storage media.
- They use flat circular pieces of Mylar plastic coated with a *magnetic material* that rotate within a jacket.
- Data is stored as *electromagnetic charges* by the presence or absence of these charges, using the ASCII or EBCDIC binary codes.

1. Traditional Floppy Disk

- Traditional disk is the **1.44 MB 3 ½" disk**, labeled as **2HD** meaning "two-sided, high-density".
- They have a thin exterior jacket made of hard plastic to protect the flexible disk inside.
- These disks have a capacity of 1.44 megabytes – equal to 400 typed pages.
- ***Density*** refers to how tightly the bits can be packed on the medium.
- A *Shutter* slides to provide access to the plastic medium that comes under the read/write head of disk drive.
- *Labels* can be applied to the external surface of the disk to identify the contents
- A *Write-Protection Notch* can be moved to protect the disk from accidentally writing over it.
- Data is recorded on a disk in rings called **tracks** – closed concentric circles.
- Each track is divided into invisible wedge-shaped sections known as **sectors**.
- Disks that don't have tracks and sectors must be adapted to the type of microcomputer by a process called **formatting** or **initializing**.

2. High Capacity Floppy Disks

- **High Capacity Floppy Disks** (aka **floppy-disk cartridges**) have capacities of much higher than traditional floppies. Three leading types include:
  - **Zip Disks** (sold by **Iomega**) have **100**-, **250**-, or **750 MB** capacities and external zip drives connect to the PC via parallel or USB ports. The disks are slightly thicker than traditional floppies, so they require special disk drives. Zip disks are widely used to store multimedia, database, large spreadsheet and text files.

- **SuperDisks** (from **Imation**) have a **120 MB** or **240 MB** capacity, and the drives can also read and store data on traditional 1.44 MB floppies. Popular for use with *notebook* computers.
- **HiFD disks** (from **Sony** Corporation) have **200 MB** capacities. The main advantage is the drives can also read traditional 1.44 MB floppies.

Hard Disks

- Hard disks use a thicker, rigid metallic platter for the base medium..
- Hard disks store and retrieve information much *faster* and have a *greater capacity*.
- Read/Write heads are very sensitive and ride a 0.000001 (one 1 millionth) inch cushion of air above the disk.
- A "**head crash**" occurs if the R/W head makes contact with the surface or particles on the surface (human hair, dust, fingerprint) of the disk, and it's a disaster.

3. Internal Hard Disk

- Also known as a **fixed disk**
- Located inside the system unit and used to store the operating system and major applications like *Word* and *Excel*.
- Consists of one or more metallic platters sealed inside a container.
- The container contains a motor for rotating the disks, an access arm and read-write heads for reading and writing data.
- Typically mapped as the "**C:**" drive
- Advantages are *speed* and *capacity*: a 100 GB HD can hold as much as 70,000 traditional 1.44 MB floppies and are also much faster than floppy disks.
- Access speeds are measured in milliseconds (ms) e.g. 10 ms
- Disk rotation speeds are measured in RPM (rotations per minute) e.g. 5,400 RPM
- You should perform routine maintenance on your hard drive using programs such as Microsoft's Disk utility programs.

4. Hard-Disk Cartridges

- Hard disks have *fixed amount* of storage and they cannot be *easily removed*.
- Hard disk cartridges are *easy to remove* and are known as **removable hard disks** and are useful to protect sensitive information.
- Storage amount is limited only by the number of cartridges you use
- *Cartridges* typically hold 2-20 GB of storage.
- Two well-known hard-disk cartridges are *Jaz* and *Peerless* disks from *Iomega*.
- **PC Card Hard disks** are credit card sized hard-disk cartridges with capacities up to 10 GB.

- Examples include IBM's Microdrive and Hitachi's PC Card hard drive.

5. Hard-Disk Packs

- Hard disk packs are removable storage devices used to store massive amounts of information without duplicating the drive mechanism.
- They may have up to 11 large disks with 20 recording surfaces.
- Typical use is in large mainframe shops like banks and insurance companies.

6. Performance Enhancements

- **Disk Caching**: frequently used data is read from hard disk into memory cache. When needed, data is read directly from memory. Transfer rate from memory is much faster than hard disk which improves the transfer rate to the CPU by up to 30%.
- **Redundant Array of Inexpensive Disks** (**RAID**): improves performance by expanding external storage. Groups of inexpensive hard-disk drives are grouped together using networks and special software and is treated as single large-capacity hard disk. While it costs more to have a RAID system, it improves storage reliability. RAID systems are typically used for network servers.
- **File Compression and File Decompression**: increase the amount of storage available on the disks by reducing the amount of space required to store data and programs. File compression programs scans the files for repeating patterns and replace them with a token. Popular programs for compressing files include WinZip and PKZip. The smaller size comes at a price, since it takes a little longer to uncompress the data.

B. Optical Disks

- Optical disks can hold close to **17 GB** of data – enough to store over several million typewritten pages or a medium sized library on a single disk.
- Optical disks use *reflected light* rather than magnetized spots.
- Binary 1s are represented by flat areas called "**lands**" and 0s are represented by bumpy areas called "**pits**" on the disk surface.
- The disk is read by a *laser* that projects a tiny beam of light on these areas. The amount of reflected light determines whether the area represents a 1 or 0.
- Unlike hard disks that have concentric tracks, optical disks have a single spiral track that is divided into equally sized sectors for storing data.
- The most common sized optical disk is 4 ½ inches, and data is stored on these disks in different formats. The two most common are:

1. Compact Disc (CD)

- One of the most widely used optical formats
- Typically store 650 MB to 1 GB (1,000 MB) on one side of a CD
- Rotational speed determines how fast data can be transferred to the CPU
- 24X (24 speed) CD can transfer data at 3.6 MB per second

- 32X (32 speed) CD can transfer data at 4.8 MB per second

a) CD-ROM (Compact Disc – Read Only Memory)

- is similar to a commercial music CD
- RO means *it can not be written* over by the user
- Typically used to deliver large databases, references, or software applications

b) CD-R (Compact Disc – Recordable)

- write once, read many times but cannot be written on or erased
- CD-R drives also known as **CD burners** typically use these to archive data or record music

c) CD-RW (Compact Disc – Rewritable)

- write many times, read many times
- Used to create and edit multimedia presentations
- Typically cost a little more than CD-R

2. Digital Versatile/Video Disc (DVD)

- A newer format similar to CDs except that *more data can be packed* in same space and is replacing CD optical disks
- DVDs can store 4.7 GB to 17 GB on a single disk (17 times the capacity of a single CD)

a) DVD-ROM (Digital Versatile Disc - Read Only Memory)

- Written at manufacturing plant, read many
- Provide over 2 hrs of high-quality video and sound and typically used for video distribution

b) DVD-R (DVD Recordable)

- Write once, read many
- Tend to cost more than CD writable disks
- Used for archiving data and writing video files

c) DVD+RW (DVD Rewriteable) DVD-RAM

- Write many, read many
- Still working on setting a standard format

C. Other Types of Secondary Storage

1. Magnetic Tape

- The two different approaches of external storage are: **sequential access** and **direct access**.
- **Tapes** only provide slower *sequential access*, where **disk** systems provide fast *direct access.*
- With tapes information is stored in sequence, such as alphabetically.
- Magnetic tape is typically ½-inch wide and ½-mile long.
- Advantage with tape is virtually *unlimited storage* (just add another tape), it's *reliable*, and it's *inexpensive* per MB stored.
- Disadvantage is it's somewhat *slow,* and limited to sequential access
- Often used to *back up* disk storage, especially for networked systems
- *Mainframe* systems used **magnetic tape reels**
- Newer tape systems use **tape cartridges** or **magnetic tape streamers** for backing up data.

2. Internet Hard Drives

- Special web sites that provide users with free or low-cost storage
- Also called **i-drive** or **online storage**
- Advantage is low(or no) cost and the flexibility to access information from any location using any computer as long as you have an Internet connection
- Disadvantage is access time is often more, and there is some hesitation about storing sensitive data on these sites.

3. Solid-state storage

- These devices have *no moving parts*, so they are *fast*, require *less power* and *reliable*
- Tends to have less capacity, and *costs more* per byte
- **Flash memory cards** are used in *notebook* computers and digital camera

Main Memory Storage Units:

Sr.No.	Unit	Description
1	Bit (Binary Digit)	A binary digit is logical 0 and 1 representing a passive or an active state of a component in an electric circuit.
2	Nibble	A group of 4 bits is called nibble.

3	Byte	A group of 8 bits is called byte. A byte is the smallest unit which can represent a data item or a character.
4	Word	A computer word, like a byte, is a group of fixed number of bits processed as a unit which varies from computer to computer but is fixed for each computer. The length of a computer word is called word-size or word length and it may be as small as 8 bits or may be as long as 96 bits. A computer stores the information in the form of computer words.

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Memory hierarchy

The hierarchical arrangement of storage in current computer architectures is called the memory hierarchy. It is designed to take advantage of memory locality in computer programs. Each level of the hierarchy is of higher speed and lower latency, and is of smaller size, than lower levels.

Most modern CPUs are so fast that for most program workloads the locality of reference of memory accesses, and the efficiency of the caching and memory transfer between different levels of the hierarchy, is the practical limitation on processing speed. As a result, the CPU spends much of its time idling, waiting for memory I/O to complete.

Memory Hierarchy

The memory hierarchy in most computers is as follows:

* Processor registers – fastest possible access (usually 1 CPU cycle), only hundreds of bytes in size

* Level 1 (L1) cache – often accessed in just a few cycles, usually tens of

kilobytes

* Level 2 (L2) cache – higher latency than L1 by 2× to 10×, often 512KB or more

* Level 3 (L3) cache – (optional) higher latency than L2, often multiple MB's

* Main memory (DRAM) – may take hundreds of cycles, but can be multiple gigabytes

*On-line mass storage – Secondary storage.
*Off-line bulk storage – Tertiary and Off-line storage.
This is a general memory hierarchy structuring. Many other structures are useful. For example, a paging algorithm may be considered as a level for virtual memory when designing a computer architecture, and one can include a level of nearline storage between online and offline storage.

At the top level of the memory hierarchy are the CPU's general purpose registers. The registers provide the fastest access to data possible on. The register file is also the smallest memory object in the memory hierarchy (with just eight general purpose registers available). By virtue of the fact that it is virtually impossible to add more registers .registers are also the most expensive memory locations.

Working our way down, the Level One Cache system is the next highest performance subsystem in the memory hierarchy. Although the Level One Cache size is fixed on the CPU and you cannot expand it, the cost per byte of cache memory is much lower than that of the registers because the cache contains far more storage than is available in all the combined registers.

The Level Two Cache is present on some CPUs, on other CPUs it is the system designer's task to incorporate this cache (if it is present at all). For example, most Pentium II, III, and IV CPUs have a level two cache as part of the CPU package, but many of Intel's Celeron chips do not 1. The Level Two Cache is generally much larger than the level one cache On CPUs where Intel includes the Level Two Cache as part of the CPU package, the cache is not expandable. It is still lower cost than the Level One Cache because we amortize the cost of the CPU across all the bytes in the Level Two Cache. On systems where the Level Two Cache is external, many system designers let the end user select the cache size and upgrade the size. For economic reasons, external caches are

actually more expensive than caches that are part of the CPU package, but the cost per bit at the transistor level is still equivalent to the in-package caches.

Below the Level Two Cache system in the memory hierarchy falls the main memory subsystem. This is the general-purpose, relatively low-cost memory found in most computer systems. Typically, this is DRAM or some similar inexpensive memory technology.

Below main memory is the NUMA category. NUMA, which stands for Non Uniform Memory Access is a bit of a misnomer here. NUMA means that different types of memory have different access times. NUMA are blocks of memory that are electronically similar to main memory but for one reason or another operate significantly slower than main memory. A good example is the memory on a video display card. Access to memory on video display cards is often much slower than access to main memory. Other peripheral devices that provide a block of shared memory between the CPU and the peripheral probably have similar access times as this video card example. Another example of NUMA includes certain slower memory technologies like Flash Memory that have significant slower access and transfers times than standard semiconductor RAM

Most modern computer systems implement a Virtual Memory scheme that lets them simulate main memory using storage on a disk drive. While disks are significantly slower than main memory, the cost per bit is also significantly lower. Therefore, it is far less expensive (by three orders of magnitude) to keep some data on magnetic storage rather than in main memory. A Virtual Memory subsystem is responsible for transparently copying data between the disk and main memory as needed by a program.

File Storage also uses disk media to store program data. However, it is the program's responsibility to store and retrieve file data. In many instances, this is a bit slower than using Virtual Memory, hence the lower position in the memory hierarchy 2.

Chapter 6 Secondary Storage

Below File Storage in the memory hierarchy comes Network Storage. At this level a program is keeping data on a different system that connects the program's system via a network. With Network Storage you can implement Virtual Memory, File Storage, and a system known as Distributed Shared Memory (where processes running on different computer systems share data in a common block of memory and communicate changes to that block across the network).

Virtual Memory, File Storage, and Network Storage are examples of so-called on-line memory subsystems. Memory access via these mechanism is slower than main memory access, but when a program requests data from one of these memory devices, the device is ready and able to respond to the request as quickly as is physically possible. This is not true for the remaining levels in the memory hierarchy.

The Near-Line and Off-Line Storage subsystems are not immediately ready to respond to a program's request for data. An Off-Line Storage system keeps its data in electronic form (usually magnetic or optical) but on media that is not (necessarily) connected to the computer system while the program that needs the data is running. Examples of Off-Line Storage include magnetic tapes, disk cartridges, optical disks, and floppy diskettes. When a program needs data from an off-line medium, the program must stop and wait for a someone or something to mount the appropriate media on the computer system. This delay can be quite long (perhaps the computer operator decided to take a coffee break?). Near-Line Storage uses the same media as Off-Line Storage, the difference is that the system holds the media in a special robotic jukebox device that can automatically mount the desired media when some program requests it. Tapes and removable media are among the most inexpensive electronic data storage formats available. Hence, these media are great for storing large amounts of data for long time periods.

Hard Copy storage is a print-out (in one form or another) of some data. If a program requests some data and that data is present only in hard copy form, someone will have to manually enter the data into the computer. Paper (or other hard copy media) is probably the least expensive form of memory, at least for certain data types.

> In computer architecture the memory hierarchy is a concept used to discuss performance issues in computer architectural design, algorithm predictions, and lower level programming constructs involving locality of reference. The memory hierarchy in computer storage separates each

of its levels based on response time. Since response time, complexity, and capacity are related, the levels may also be distinguished by their performance and controlling technologies. Memory Hierarchy lets us have the best of both worlds - speed and size. You have a small amount of ultra-fast memory, a larger amount of slower memory, and a huge amount of very slow memory. By cleverly choosing what data to store in which type of memory, we can appear to have an a huge amount of very fast memory.
Designing for high performance requires considering the restrictions of the memory hierarchy, i.e. the size and capabilities of each component. Each of the various components can be viewed as part of a hierarchy of memories (m1,m2,...,mn) in which each member mi is typically smaller and faster than the next highest member mi+1 of the hierarchy. To limit waiting by higher levels, a lower level will respond by filling a buffer and then signaling to activate the transfer

STRUCTURE OF HARD DISK

hard disk is part of a unit, often called a "disk drive," "hard drive," or "hard disk drive," that stores and provides relatively quick access to large amounts of data on an electromagnetically charged surface or set of surfaces(platters) coated with magnetic material. The platters are paired with magnetic heads arranged on a moving actuator arm, which read and write data to the platter surfaces. Data in hard is accessed in a random-access manner, meaning that individual blocks of data can be stored or retrieved in any order and not only sequentially. HDDs are a type of non-volatile memory, retaining stored data even when powered off. The term ***hard*** *is used to distinguish it from a soft, or floppy, disk. Each platter is divided into thin concentric bands known as* ***tracks.*** *There can be more than a thousand tracks on a 3.5 inch hard disk. The tracks are further subdivided into sectors. These are the smallest physical storage unit on a disk and they are almost always 512 bytes long.*

A group of tracks which have the same track number, but are on different platters, is sometimes referred to as a **cylinder**, but this term is no longer widely used.

Tracks are created when the disk is initially formatted. There are normally 1024 tracks on a hard disk, numbered from 0 (at the edge of the disk) to 1023 (near the centre).

One obvious problem with this structure is that the tracks near the centre are shorter than those near the edge of the disk. To compensate for this, they are more densely populated with data, meaning that the same amount of data can be written or read over the same period of time, irrespective of the drive head position.

One side of the first platter has space reserved for hardware-based track-positioning information which is not available to the operating system. This data is written to the disk during assembly and is used by the **disk controller** to position the drive heads correctly. sector is the smallest physical storage unit on the disk and is usually 512 bytes long. Files should ideally be stored in a single contiguous area of disk space. Since most files are longer than 512 bytes, the file system must allocate the number of sectors required to store the file, eg: a 640 byte file would require two sectors. If additional data is appended to the file later, further sectors can be allocated . In practice, operating systems typically operate on blocks of data, which may span multiple sectors.

In disk drives, each physical sector is made up of three basic parts, the sector header, the data area and the error-correcting code (ECC). The sector header contains information used by the drive and controller; this information includes sync bytes, address identification, flaw flag and header parity bytes. The header may also include an alternate address to be used if the data area is undependable. The address identification is used to ensure that the mechanics of the drive have positioned the read/write head over the correct location. The data area contains the recorded user data, while the ECC field contains codes based on the data field, which are used to check and possibly correct errors that may have been introduced into the data.

Clusters are allocation units for data on various file systems (FAT, NTFS, etc.), where data mainly consists of files.

Disk Formatting

Disk formatting contains low-level formatting and high-level formatting. The former is often performed by hard disk manufacturers while the latter is made by users themselves.

What Is Low-level Disk Formatting

Low-level formatting is the process of marking out cylinders and tracks for a blank hard disk, and then dividing tracks into multiple sectors. This process is often called the "*real*" formatting since it creates physical format which defines where the data is saved. If users perform low-level formatting when data have been installed, all existing files will be erased, and it is almost impossible to recover them. Therefore, some users make such a format to avoid privacy leakage. Nevertheless, performing low-level formatting will bring great influence on hard disk, thus shortening hard disk service time. Therefore, it is not suggested.

To low level format a hard disk, users can make use of specific tools as well as Debug assembler languages. That's relatively complicated.

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What Is High-level Disk Formatting

After a low-level formatting has been completed, users need to make high-level formatting which makes it possible to save data and should be done on a partition. It is the process of writing a file system, cluster size, partition label, and so on for a newly created partition or volume. And we can also say high-level formatting just clears data on hard disk, generates boot information, initializes FAT, and labels logical bad sectors when the partition has existed. This process does no harm to hard disk in general situations, so we suggest taking such a format to fix a logically damaged partition or device, for example, Windows asks to format a SD card.

It can be every easy to high level format a drive, and users can complete this operation in Windows snap-in Disk Management tool, diskpart, cmd, etc. Nevertheless, if users perform such a format on partitions with data saved, all these data will be lost. Nowadays, many users hope to reformat an existing partition like convert file system, change drive letter, and change cluster size without data loss. Aiming at this situation, we will give a good solution

What is an Operating System?

- Operating System is a Resource Manager.
  - Handles multiple computer resources: CPU, Internal/External memory, Processes, Tasks, Applications, Users, etc…
  - Manages and allocates resources to multiple users or multiple jobs running at the same time (e.g., processor time, memory space, I/O devices)
  - Arranges to use the computer hardware in an efficient manner (maximize throughput, minimize response time) and in a fair manner.

- It is a Control Program.
  - Manages all the components of a complex computer system in an integrated manner.
  - Controls the execution of user programs and I/O devices to prevent errors and improper use of the computer resources.
  - Looks over and protects the computer.

- It is an extended/virtual machine
  - An interface between the user and hardware that hides the details of the hardware (e.g., I/O).
  - Constructs higher-level (virtual) resources out of lower-level (physical) resources (e.g., files).
  - Definition: Is a collection of software enhancements, executed on the bare hardware, culminating in a high-level virtual machine that serves as an advanced programming environment

Why Operating System needed?

- Computer hardware is developed to execute user programs and make solving user problems easier.

- An operating system makes a computer more convenient to use.
  - It acts as an interface between user and computer hardware. Therefore, the end-users are not particularly concerned with the computer's architecture, and they view the computer system in terms of an application.
  - To programmers, it provides some basic utilities to assist him in creating programs, the management of files, and the control of I/O devices.

Operating System Objectives

- Convenience
  - Makes the computer more convenient to use
- Efficiency
  - Allows computer system resources to be used in an efficient manner
- Ability to evolve
  - Permit effective development, testing, and introduction of new system functions without interfering with service

Services Provided by Operating Systems

- Facilities for program creation
  - Editors, compilers, linkers, debuggers, etc.
- Program execution
  - Loading in memory, I/O and file initialization.
- Access to I/O and files
  - Deals with the specifics of I/O and file formats.
- System access
  - Resolves conflicts for resource contention.
  - Protection in access to resources and data.
- Error detection and response
  - internal and external hardware errors
    - memory error

        - device failure
    - software errors
        - arithmetic overflow
        - access forbidden memory locations
    - operating system cannot grant request of application

- Accounting
    - collect statistics
    - monitor performance
    - used to anticipate future enhancements
    - used for billing users

Computer System Components

- A computer system can be divided in to four components.
    - The Hardware: Provides basic computing resources (CPU, memory, I/O devices).
    - The Operating System: Controls and coordinates the use of the hardware among the various application programs for the various users.
    - The Application Programs: Define the ways in which the system resources are used to solve the computing problems of the users (compilers, database systems, video games, business programs).
    - The Users: Users (people, machines, other computers).
- These components can be viewed as layers, where each layer uses the services provided by the layer beneath it.

DOS

DOS (Disk Operating System) is an operating system that runs from a hard disk drive. The term can also refer to a particular family of disk operating systems, most commonly MS-DOS (Microsoft Disk Operating System).PCDOS (Personal Computer Disk Operating System) was the first widely-installed disk operating system used in personal computers running on Intel 808616-bit processors. It was developed for IBM by Microsoft Corporation, which also produced its own almost identical version called MS-DOS.

Microsoft Disk operating system, **MS-DOS** is a non-graphical command line operating system. MS-DOS allows the user to navigate, open, and otherwise manipulate files on their computer from a command line instead of a GUI like Windows.

Today, MS-DOS is no longer used; however, the command shell, more commonly known as the **Windows command line** is still used by many users. The picture to the right is an example of what an MS-DOS window more appropriately referred to as the Windows command line looks like running under Microsoft Windows.

DOS is an interpreter which creates an interface between hardware and software. The keyboard, mouse, monitor, printer and processor are hardware and programs. DOS is a program loaded into the memory (RAM) of user's personal computer before execution of any application. It creates an environment for managing the resources and execution of any program having extension .Exe, .Com, .Bat. Dos are a single user operating system. A single user operating system caters to a single user and all the resources are available to this user. DOS works mostly on Micro Computers. The DOS software is divided into three parts stored in three different files on a disk (Floppy or Hard disk). The disk that contains all the three files is called a Bootable disk or System disk. These three files are:

1. **IO.SYS:** These files have two main parts. In one part device drivers for device like Printer, VDU, Keyboard, and Mouse are configured by the file. It verifies some more input output devices and its drivers. Second part of the IO.SYS file is SYS.INI which loads the file MSDOS.SYS from hard disk into memory.
2. **MSDOS.SYS:** This file is also called DOS Kernel. It is a link between the BIOS (basic input output services) and user application programs which provides the logical interface for the application program. The MS-DOS Kernel has four important functions are:
    A. Process Control
    B. Memory Management
    C. Application Program Interface
    D. File Management System

3. **COMMAND.COM**: This file contains command processor or command executor and has all memory resident programs that is it has all internal commands in it. It is the user's interface to the operating system. This command loads and executes application programs.

DOS Internal Commands

The DOS (Windows 9x) *internal commands* are so-called because their instructions are a part of COMMAND.COM, the DOS (Windows 9x) command processor.

Recall that COMMAND.COM is placed into memory each time the DOS or Windows 9x OS is booted. Therefore, the internal commands are always in memory and can always be executed from any command line prompt.

This is in contrast to the disk-bound external commands, which reside in secondary memory up until the moment they are needed, at which time the OS must find them and load them into primary memory.

The syntax for some frequently used internal commands follows.

TIME
Displays current time and allows it to be changed.
Syntax:

TIME

DATE
Displays current date and allows it to be changed.
Syntax:

DATE

CLS
Clears the screen.
Syntax:

CLS

DIR
Shows directory information of a diskette: name, size, and the date and time stamp of files.
Syntax:

DIR [d:][path]
Optional switches:
/p Display dir info and pauses display when the screen is full
/w Display names and extensions only in five columns

To display a file directory listing for D:\DATA\LETTER\ANNUAL from different current directories:

D:\DATA\LETTER\ANNUAL> DIR
D:\DATA> DIR LETTER\ANNUAL
C:\WINDOWS> DIR D:\DATA\LETTER\ANNUAL

DEL
Deletes a file from disk.
Syntax:

DEL [d:][path][name.ext]

To delete one file:

A:\> DEL A:\MY.LET

To del all files in current directory

A:\> DEL *.*

REN
Renames a file.
Syntax:

REN [d:][path][name.ext] [d:][path][newname.ext]

To change the name of the file D:\LET\ANNUAL\99.DOC to 1999.DOC

D:\LET> REN ANNUAL\99.DOC 1999.DOC (from D:\LET)
D:\DATA> REN \LET\ANNUAL\99.DOC 1999.DOC (from D:\DATA)
C:\WINDOWS> REN D:\LET\ANNUAL\99.DOC 1999.DOC (from C:\WINDOWS)

MD
Makes (creates) a new directory.
Syntax:

MD [d:][path][dirname]

To create a directory named HERMIT in the root of D: drive

D:\> MD HERMIT (from D:\)
C:\> MD D:\HERMIT (from C:\)

RD
Removes an existing directory (directory must be empty).
Syntax:

RD [d:][path][dirname]

To remove the HERMIT sub-directory:

D:\> RD HERMIT (from D:\)
C:\> RD D:\HERMIT (from C:\)

CD
Changes the current directory.
Syntax:

CD [path][dirname]

To make D:\HERMIT the current directory

D:\> CD HERMIT (from D:\)
D:\DATA> CD \HERMIT (from D:\DATA)
D:\DATA\SOURCE> CD \HERMIT (from D:\DATA\SOURCE)
D:\DATA\SOURCE> CD .. (from D:\DATA\SOURCE)

PATH
The PATH command is used to help the command interpreter find external commands which are not in the current directory. The command interpreter looks into the *DOS environment* for "PATH=" and then searches the paths (each separated from the next by a semicolon) that follow.
Syntax:

PATH=[path;path;...]

To set the DOS PATH:

PATH=C:\DOS;C:\PCW;\C:\BIN

To display the current path:

PATH

SET PROMPT
Used to specify the appearance of the DOS prompt.
Syntax:

SET PROMPT= (from the command line)

PROMPT= (in a batch file)

DOS PROMPT Characters

$b | $d system date

$e esc char $g >

$h destructive bk space $i <

$n default drive $p full path description

$q = $t system time

$v DOS version no $_ CR and LF

$$ the $ sign

To display current drive & current path followed by ">" as prompt

SET PROMPT=PG

To display the current date, time, and drive on separate lines

SET PROMPT D_T_NG

To redefine F9 to CD\Windows\Start Menu\Programs\Startup

SET PROMPT $e[0,67;"'CD\Windows\Start Menu\Programs\Startup'";13p

DOS External Commands

Unlike the DOS internal commands, which are loaded into random access memory as part of COMMAND.COM each time a computer is booted, the DOS external commands are disk-bound. That means they must be fetched from disk and loaded into RAM each time they are used.

FORMAT.EXE, CHKDSK.COM, and DISKCOPY.EXE are three examples of external commands. Their syntax follows.

FORMAT
Prepares a diskette for use by DOS.

Syntax: FORMAT [d:]

Parameters: [d:] = Drive which is to receive the format.

Optional switches:

- /s Include all system files necessary to make disk "bootable"

- /b Reserve space for system files on diskette. (Formats 320k instead of 360k).
- /v Volume label of 11 characters

Some examples:

- To format a diskette in drive B: without system files:

FORMAT B:

- To format a diskette in drive A: with system files:

FORMAT A: /s

- To give the formatted diskette a volume name, include the /v switch:

FORMAT A: /V

- Combine switches to format a boot diskette with a volume label:

FORMAT A: /S /V

CHKDSK
Analyzes disk or diskette (first and only parameter) and displays disk and memory status report.

Syntax: CHKDSK [d:] [/f] [/v]

Parameters: [d:] = Drive upon which to perform CHKDSK.

Optional switches:

- /f Fix. Writes lost clusters to a disk file and corrects file allocation table.
- /v Verbose. Lists all files on a disk.

Example:

- To display statistics about the diskette in drive A:

CHKDSK A:

- To display statistics about the first hard disk and fix any lost clusters:

CHKDSK A: /f

DISKCOPY
Makes an exact copy of a diskette, including hidden system files if they are present.

Syntax: DISKCOPY [d1:] [d2:]

Parameters:[d1:] = Drive for source diskette, [d2:] = Drive for target diskette.

Example:

- To make an exact copy of a diskette in drive A: to a diskette in B:

DISKCOPY A: B:

- To make an exact copy of a diskette using only drive A:

DISKCOPY A: A:

(Change source and target diskettes as requested).
DISKCOPY asks for a SOURCE diskette (the diskette being copied) and a TARGET diskette (the diskette being copied to). The TARGET diskette need not be formatted, DOS will format it while doing the DISKCOPY. If the SOURCE diskette is bootable, the system will be transferred to the TARGET as well. The two disk drives must always use the same media.

What's a batch file?

- A batch file is simply a text file that you can create by using unformatting text editor tools, e.g. the EDIT command in MS-DOS. (some other methods will be discussed later)
- A batch file must be named with an extension BAT, e.g. autoexec.bat, menu.bat
- A batch file is a program which contains MS-DOS commands. Each command used in the batch file must be started from a new line and written in a correct syntax. The syntax of a command is just the same as that you use it at the DOS prompt.

Now, consider the following instructions

```
md \newdir
copy \dos\*.exe \newdir
cd \newdir
dir
cd \
```

- Executing commands at DOS prompt:

Normally, you can execute only one MS-DOS command at one time If you manually instruct DOS to execute the above commands, you have to type each command at the DOS prompt one after another.

- Executing commands in a batch file:

However, if you put all of the commands in a text file in the same manner as in the above box, it becomes an executable program. name it as anyname.bat Similar to a COM or EXE command, you can simply type the name of this batch file at the DOS prompt to start your instructions. i.e. C:\>anyname or C:\>anyname.bat (note: the extension bat is optional here. It makes no difference, no matter you put it or not.)

DOS will then execute the commands automatically in the same order as written in the anyname.bat The followings are details of what DOS will do for you:-

1. Creates a new directory under the root called newdir
2. Copies all files under the DOS directory with an extension of EXE to the newly created newdir directory.
3. Changes the current directory to newdir directory
4. Display the directory listing of newdir directory
5. Changes the current directory to root directory

- Under DOS, a filename consists of

- Up to 8 characters for the name, plus an optional 3 character for the extension. The name and the extension are separated by a period. - Any combination of letters (A-Z) and numbers (0-9) can be used.
- "Character": A letter, number or other symbol such as may be typed on the computer keyboard and appear on the computer screen. The characters you should use are: abcdefghijklmnopqrstuvwxyz1234567890
- Sometimes other characters used in filenames, such as: ( ) { } @ # $ % ^ & ! ' / ~ but these have special meaning and should not be used.
- Spaces, punctuation and non-letter characters are generally not allowed.
- Spaces are not allowed
  Bad example: "my file.htm"
  The underscore (_) or the dash (-) may be used instead of a space. examples: "myfile.htm" or my-file.htm" or "my_file.htm"
- Exceptions: a period (also called a Dot) is used to separate the filename from the extension. It cannot be used in a DOS or Web filename at any other spot.
- For example:
  jimmy.txt
  resume.wpd
- The three-character extension is sometimes optional, An extension usually tells what kind of file the filename represents, thus which program(s) can use that file.

Pipes and Redirection

A number of Dos commands send output to the screen and/or require input from the user. Redirection is a mechanism whereby the output of a command can be fed either to some other device (eg a printer or file) or to another program or command.

There are four redirection functions:

>	Redirect output
>>	Append
<	Redirect Input
|	Pipe

>

Redirects a command's output from the "standard output device" (usually the monitor) to another device (eg printer) or a file.

Syntax:

To redirect output to a device:
Command **>** ***Device***

To redirect output to a file:
Command **>** ***Filename***

Notes:

1. Acceptable ***Device*** names are: **CON** (Monitor); **PRN** (LPT1 - assumed to be the printer); **LPT1 - 3** (Parallel Ports - usually connected to a printer); **COM 1 - 4** (Serial Ports); and **NUL** (an electronic void). If anything other than a recognised device is specified, it is assumed to be the name of a file.
2. If a file already exists with the specified ***Filename***, it is overwritten without any warnings.

Examples:

Probably the most common uses of this redirection function is to send directory listings to the printer or to save them as a file. (One of Windows Explorer's biggest weaknesses is that it does not enable either of these operations).

1. To print out a sorted directory listing of all files in the Windows directory:
   DIR c:\windows /o/a > PRN
2. To create a file containing the directory listing of the same directory:
   DIR c:\windows /o/a > c:\data\directories\windows.txt

>>

Appends the output from a command to the specified file.

Syntax:

Command >> Filename

Note:

If ***Filename*** does not exist, it is created. If ***Filename*** does exist, the output from the command is added to it (unlike the > function where the original contents are overwritten).

Example:

To add the directory listing of the files in the c:\windows\system directory to that created above:

DIR c:\windows\system /o/a >> c:\data\directories\windows.txt

<

Directs input to a command from a source other than the default (the default source usually being the keyboard).

Syntax:

Command* < *Datasource

Example:

To sort the lines in a text file (c:\data\address list.txt) on the 12th character, the SORT command is fed input from the file:
SORT /+12 < c:\data\address list.txt

|

The "pipe" redirects the output of a program or command to a second program or command.

Syntax:

Command1* | *Command2

Example:

To sort a directory listing based on the time the files were last modified, the output of a directory listing is piped to the SORT filter which sorts on the 39th character of each line:
DIR c:\data\docs | SORT /+39

Note that if the output of the DIR command had been redirected to SORT /+39 using >, Dos would return an "invalid switch" error after attempting to create a file called Sort.