12 Computer System Overview

In This Chapter

12.1 INTRODUCTION

Computers are the machines that have revolutionised the world around us. The way we used to live around 25-30 years ago is very different from how we live today. A modern age student cannot even imagine life, without email, Internet, print outs, playing music on computers or smartphones, photos just a click away in the form of smartphones and so on. In short, in every aspect of life around us, we see computers play a role directly or indirectly.

Computers deliver so much, diligently and efficiently, all thanks to the wonderful combination of their **hardware** and **software**.

- **Hardware**. The physical electronic components of a computer are called hardware, *e.g.*, keyboard, CPU, monitor, printer etc.
- **Software**. These are the recorded instructions and programs that govern the working of a computer. Recall that a *program is a set of instructions to carry out a specific task or achieve a special work goal.*

In this chapter, we shall discuss computer's functioning in broad sense by discussing computer system organization and how various types of software aid in computer's overall performance.

12.2 BASIC COMPUTER ORGANIZATION

Computer organization refers to logical structure of a computer describing how its components are connected to one another ; how they affect one another's functioning, and contribute to overall performance of the computer.

Computers, as you must be knowing, follow the 'IPO' principle *i.e.*, Input → Process → Output (a certain input is processed to generate specific output). So, the computer organization is also like this — these are component(s) dedicated to obtain input in different forms, component(s) dedicated to perform processing part and component(s) to produce output in different forms.

Thus basic computer organization is as shown in Figure 12.1.

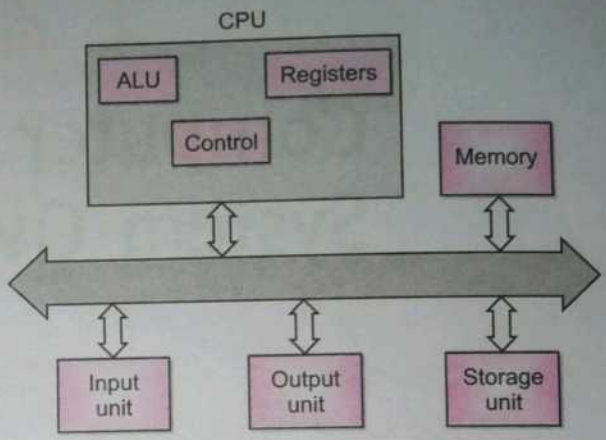

Figure 12.1 Basic Computer Organization.

Let us talk about these functional components of a computer, one by one.

NOTE

A computer runs on electricity power.

12.2.1 Input Unit

The input unit is formed by the input devices attached to the computer. Examples of input devices and media are : keyboard, mouse, magnetic ink character reader (MICR), optical mark reader (OMR), optical character reader (OCR), joystick etc.

The input unit is responsible for taking input and converting it into computer understandable form (the binary code). Since a computer operates on electricity, it can understand only the language of electricity *i.e.*, either ON or OFF or high voltage or low voltage. That means a computer can understand two stages ON/OFF or High/Low voltage or the binary language that uses just two symbols : 1 for ON and 0 for OFF.

NOTE

An input unit takes the input and converts it into binary form so that it can be understood by the computer.

Consider the inputs of the three earlier examples. All the *inputs* consisted of *data* (on which the action was to be performed) *as well as the instruction* (the action to be taken) (see Table 12.1).

On the same lines, the computer input also consists of data and instructions. For example, if the given input to the computer is Add 2 and 3 then *data* consists of 2 and 3 and *instruction* is Add. Similarly, if the given input is Print "Hello World" then *data* consists of "Hello World" and *instruction* is Print.

Table 12.1 *Input Comprises of Data and Instruction*

S.No.	INPUT	DATA	INSTRUCTION
1.	Add 2 and 3	2, 3	Add
2.	Print "Hello World"	"Hello World"	Print

The input unit is comprised of different input devices that take the input in different forms and pass them in digital form to CPU for processing.

Some common input devices are :

(*i*) **Keyboard.** Keyboard is a typewriter like device which is used to type in the letters, digits and commands.

(*ii*) **Mouse.** Mouse is pointing device with either a roller on its base or some laser mechanism. Mouse controls movement of *pointer* (also called ***mouse pointer***) on screen.

(*iii*) **Microphone (Mic).** We can send sound input to computer through a special input device called **microphone** or **mic** in short. A **mic** converts the sound received into computer's format, which is called ***digitized sound*** or ***digital audio.***

A **mic** can work if your computer has a special hardware known as **sound card.**

12.2.2 Output Unit

The output unit is formed by the output devices attached to the computer. The output coming from the CPU is in the form of electronic binary signals which needs conversion in some form which can be easily understood by human beings *i.e.,* characters, graphical or audio visual form. This function of conversion is performed by output units.

Output Unit converts the output in binary form to human readable form.

Some popular output devices are :

(*i*) **Monitors. Monitor** (or "screen") is the most common form of output from a computer. It displays information in a similar way to that shown on a television screen. The picture on a monitor is made up of thousands of tiny coloured dots called **pixels.**

(*ii*) **Printers.** Printers are the devices that deliver information by means of printed characters on paper.

(*iii*) **Speakers.** Speakers receive the sound in form of electric current from the sound card and then convert it to sound format audible to user.

12.2.3 The CPU (Central Processing Unit)

The CPU or the Central Processing Unit is the main control centre and processing unit. It is also called brain of the computer as it guides, directs, controls and governs the performance of a computer. The CPU has some sub-components that help in carrying out the processing of a task. These are :

(*i*) Arithmetic Logic Unit (ALU) (*ii*) Control Unit (CU) (*iii*) Registers

(i) Arithmetic Logic Unit (ALU)

The ALU performs all the four arithmetic (+, −, *, /) and some logical (<, >, =, < =, >=, !=) operations. When two numbers are required to be added, these numbers are sent from memory to ALU where addition takes place and the result is put back in the memory. In the same way, other arithmetic operations are performed (through ALU only).

For logical operations also, the numbers to be compared are sent from memory to ALU where the comparison takes place and the result is returned to the memory. The result of a logical operation is either TRUE or FALSE. These operations provide the capability of decision-making to the computer.

ALU performs arithmetic (+, −, *, /) and logic operations.

(ii) Control Unit (CU)

The CU **controls and guides** the interpretation, flow and manipulation of all data and information. The CU sends control signals until the required operations are done properly by ALU and memory. Another important function of CU is the **program execution** *i.e.*, carrying out all the instructions stored in the program. The CU gets program instructions from memory and executes them one after the other. After getting the instructions from memory in CU, the instruction is decoded and interpreted *i.e.*, which operation is to be performed. Then the asked operation is carried out. After the work of this instruction is completed, control unit sends signal to memory to send the next instruction in sequence to CU.

CU acts as a supervisor by controlling and guiding the operation taking place.

The control unit even controls the flow of data from input devices to memory and from memory to output devices.

(iii) Registers

Registers or processor registers are small units of data holding places. The CPU uses registers to temporarily hold some important processing-information during the time the processing is taking place. CPU may store some part data or some memory address or some instruction in its processor registers.

12.2.4 The Memory [Main Memory/Primary Memory]

Well, if a computer has a brain (CPU), it must also have the faculty which we call memory. Indeed, it does possess a memory, however, the memory of a computer is most unlike human memory. A human being can remember stored information for a long whereas a computer cannot. Its memory is temporary (volatile), it cannot remember anything after it is switched off.

The memory of a computer is more like a predefined working place, where it temporarily keeps information and data to facilitate its performance. Each memory location has a unique memory address. When the task is performed, it clears its memory and memory space is then available for the next task to be performed. When the power is switched off, everything stored in the memory gets erased and cannot be recalled.

The memory of a computer can be thought of as 'cells'. Each of these cells is further broken down into smaller parts known as *bits* (see Fig. 12.2). A bit means a *bi*nary digi*t i.e.*, either 0 or 1. A number of bits together are used to store data instructions by their combination.

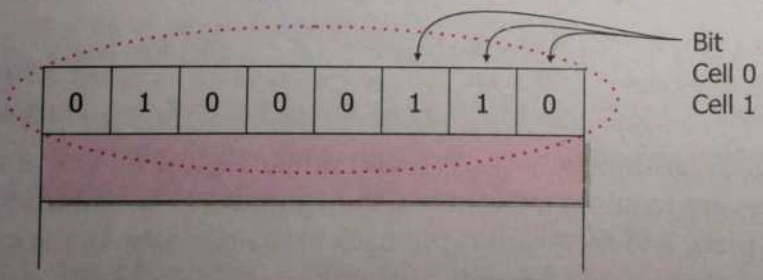

Figure 12.2 Memory cells.

NOTE

The memory of computer is often called main memory or primary memory.

*A **bit** is an elementary unit of the memory.* Eight bits together form a ***byte***.

One byte is the smallest unit which can represent a data item or a character. Other units of memory are KB, MB, GB, TB.

BYTE OR NIBBLE

A group of 8 bits is called a *byte* and a group of 4 bits is called a *nibble*.

Every higher memory unit is equal to 2^{10} of its lower unit. Following Table 12.2 lists various memory units used.

Table 12.2 *Units of Computer Memory Measurements*

Unit	Short Name	Full Name	Unit	Short Name	Full Name
1 Bit	Bit	Binary Digit	2^{10} *i.e.*, 1024 GB	1 TB	Terra Byte
8 Bits	1 Byte	Byte	2^{10} *i.e.*, 1024 TB	1 PB	Peta Byte
2^{10} *i.e.*, 1024 Bytes	1 KB	Kilo Byte	2^{10} *i.e.*, 1024 PB	1 EB	Exa Byte
2^{10} *i.e.*, 1024 KB	1 MB	Mega Byte	2^{10} *i.e.*, 1024 EB	1 ZB	Zetta Byte
2^{10} *i.e.*, 1024 MB	1 GB	Giga Byte			

Since computer's main memory (primary memory) is temporary, secondary memory space is needed to store data and information permanently for later use. Some most common secondary storage media are the hard disk, CD-RWs, pen drive etc. The secondary memory devices are also known as **storage devices.**

MEMORY ACCESS TIME

The amount of time taken to produce data required from memory, from the start of access until the availability of data, is called *Memory Access Time*.

12.2.4A Parts of Main Memory (Primary Memory)

Broadly, the main memory can be divided into *two* parts :

- RAM (Random Access Memory) and
- ROM (Read Only Memory)

Random Access Memory (RAM)

In the random-access memory (RAM), the memory cells can be accessed for information transfer from any desired random location. That is, the process of locating a word in memory is the same and requires an equal amount of memory, thus the name "random access".

Communication between a memory and its environment is achieved through data input and output lines, address selection lines, and control lines that specify the direction of transfer. A block diagram of a RAM unit is shown in Fig. 12.3. The n data input lines provide the information to be stored in memory, and the n data output lines supply the information coming out of memory. The k address lines provide a binary number of k bits that specify the address of a particular word chosen among the 2^k available inside the memory. The two control inputs specify the direction of transfer desired.

The main drawback of RAM memory is that it is a volatile memory. That is, when the power goes off, the contents of RAM get erased.

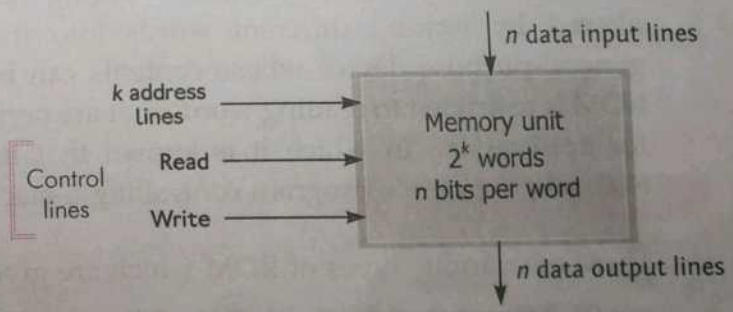

Figure 12.3 Block diagram of random access memory (RAM).

Types of RAM

The RAM chips in a computer can be of *two* basic types :

- Dynamic RAM (DRAM) and
- Static RAM (SRAM)

Dynamic RAM (DRAM)

Dynamic RAM consists of a transistor and capacitor that's capable of storing an electric charge. Depending on the switching action of the transistor, the capacitor either contains no charge (0 bit) or does hold a charge (1 bit). The dynamic RAM provides volatile storage *i.e.*, contents are lost in the event of power failure.

The amount of time taken to produce data required from memory, from the start of access until the availability of data is called *memory access time*. It is sometimes abbreviated as t_{AC}.

Today's DRAM chips have access times ranging from *below 20 to 70 nanoseconds.*

DRAM Storage Density. Since a DRAM cell consists of only one transistor and capacitor per bit, it allows a DRAM chip to pack a large number of cells within the chip compared to SRAM. Generally DRAM chips are available with tens to hundreds Giga bit densities.

DRAM Refreshing. The problem of a capacitor is that it starts loosing the charge over a period of time, and can retain data for barely a thousandth of a second. Even a read-attempt also drains out the charge. Therefore, the memory controller needs to refresh the memory contents as many as thousand times a second, which is called memory refreshing. The refresh operation consumes precious processor time, because each refresh cycle takes several CPU cycles to complete.

Static RAM

Static RAM is also volatile but as long as they are supplied with power, they need no special regenerator circuits to retain the stored data. The static RAM consists eventually of internal flip-flops[1] that store the binary information. The stored information remains valid as long as power is applied to the unit.

Static RAMs take up more space for a given storage capacity than do dynamic RAMs but have faster access times (about 10 nano seconds) than DRAMs. Static RAMs are thus used in specialized applications while dynamic RAMs are used in the primary storage sections of most computers. The static RAM is easier to use and has shorter read and write cycles compared to dynamic RAM.

Read Only Memory (ROM)

As the name implies, a read-only memory (ROM) is a memory unit that performs the read operation only; it does not have a write capability. This implies that the binary information stored in a ROM is made permanent during the hardware production of the unit and cannot be altered by writing different words into it (hence non-volatile). Whereas a RAM is a general-purpose device whose contents can be altered during the computational process, a ROM is restricted to reading words that are permanently stored within the unit. ROMs are used for applications in which it is known that the information never needs to be altered, for example, a monitor program controlling a machine. These, however, are slower than RAM.

There are various types of ROM which are given below :

(*i*) **Programmable Read Only Memory (PROM)** is a ROM that can be programmed to record information using a facility known as PROM-programmer. Once the chip has been programmed, the recorded information cannot be changed *i.e.*, PROM becomes same as ROM.

1. A flip-flop is a binary cell capable of storing one bit of information.

(*ii*) **Erasable Programmable Read Only Memory (EPROM)** is another type of ROM that can be erased and the chip can be reprogrammed to record different information using a special PROM-program facility. Erasure is achieved by exposing the chip to ultraviolet light. When an EPROM is in use, information can only be "read" and the information remains on the chip until it is erased. EPROM are of *two* kinds – UPROM (ultraviolet PROM) and EAPROM (Electrically Alterable PROM).

(*iii*) **Electrically Erasable PROM (EEPROM).** This type of ROM can be programmed and erased by electrical signals. Information loaded in this memory can be retained for many years without any power supplied; one of its new applications is as a back-up to RAM memory whose contents are lost in a power failure. When power is returned, the EEPROM memory can be used to replace the lost contents of the RAM memory and the microcomputer can continue working just as if nothing had happened. Even newer devices are combining RAM and EEPROM memory in a single integrated circuit.

12.2.5 The Storage Unit

Computers need to store and retrieve data for processing. Since primary memory has a limited storage capacity and is not permanent, secondary storage devices are used to store large amount of data permanently. There are various types of secondary devices available these days.

To specify the storage capacity of storage devices, same units of memory are used, which are used for measuring primary memory. That is, we can represent the storage capacity of storage devices in terms of *kilo bytes (KBs), mega bytes (MBs), giga bytes (GBs)* and *tera bytes (TBs)* as we do for main memory.

Let us now talk about some most common storage devices.

Some most common storage devices

- Hard disks — *Magnetic Media*
- CD ROMs, DVDs — *Optical Media*
- Pen drive — *Flash memory*

1. Hard Disks

The hard disk memories store information on one or more circular platters (or disks) which are continually spinning. These rotating disks are coated with a magnetic material and stacked with space between them. Information is recorded on the surface of rotating disks by magnetic heads as tiny magnetic spots. These heads are mounted on *access arms*. Information is recorded in bands. Each band of information on a given disk is called a *track*.

TRACKS

Concentric circles on the magnetized surface of the magnetic disks are known as *Tracks*.

The tracks are commonly divided into pie-shaped sections called ***sectors***. In most systems, the minimum quantity of information which can be transferred is a sector. You can think of tracks as concentric circles and sectors as segments marked on tracks.

SECTORS

The tracks on the disk surface are divided into invisible segments known as *Sectors*.

A motor rotates the disk at a rapid speed. Data are recorded on the tracks of a spinning disk surface and read from the surface by one or more read/write heads.

The hard disks of today have storage capacity measured in giga bytes upto tera bytes.

2. Compact Disks (CDs)

The compact disks or CDs are optical media. The CDs are relatively cheap and have a storage capacity of upto 700 Mb. There are *three* main types of CDs :

(*i*) **CD-ROM (*Compact Disk-Read Only Memory*).** This is used only to store information and cannot be used to store data. Manufactures use CDROMs to record information including text, graphics or audio on the CD distribution *e.g.*, encyclopedias, software, games, *e*-books etc.

CDROMs come with a reported speed, let us learn what it means. If a CDROM is having a reported speed of 48 ×, it means it can operate at 48 × = 48 × kbps or 7200 kbps. × represents *times* of 150 kbps. Optical disks are available today in speed range of 48 × to 75 ×.

(*ii*) **CD-R (*Compact Disk-Recordable*).** Data can be recorded on these disks only once. The CD-R's allow you to write on one part of the disk one time and another part at a later time. Each part of a CD-R can be written on only once and disk can't be erased.

(*iii*) **CD-RW (*Compact Disk-Rewritable*).** CD-RW is an erasable disk you can write on multiple times. CD-RW overcomes the disadvantage of being able to write on them only once. CD-RW disks are more like floppy's or hard disks *i.e.*, you can write on them many times.

3. DVDs

DVD is an optical storage device that looks the same as a compact disc but is able to hold about 15 times as much information and transfer it to the computer about 20 times as fast as a **CD-ROM**. A DVD, also called a **Super Density disk (SD)**, can hold upto 17 **gigabytes** of data or four hours of movies on a side. DVDs also come in *three* varieties.

(*i*) **DVD-ROM – *Digital Video Disk – Read Only Memory*.** DVD–ROM is high capacity optical disk capable of storing 4.7 GB to 17 GB. The storage capacity of 1 DVD ROM is enough to store a telephone book containing every resident in the U.S. DVD's were originally developed for the movie industry. Huge capacity makes them attractive for storing large amounts of data. DVD-ROM drives can read audio CD's, CD-ROM's, CD-R's and CD-RW's. Look at the storage capacities of todays's DVD ROMs.

DVD-ROM Storage Capacities

Sides	*Layers*	*Storage Capacity*
1	1	4.7 GB
1	2	8.5 GB
2	1	9.4 GB
2	2	17 GB

(*ii*) **DVD-R (DVD-Recordable).** DVD-R similar to CD-R's allow users to write on the disc once but read it many times.

(*iii*) **DVD-RW (DVD-Rewritable).** Most writable DVD drives are DVD–RW You can erase and read many times on them. Because of enormous capacities, they are replacing CD technology. DVD R and RW have two additional formats than CDs, which are + and – (*e.g.*, DVD-R+). DVD technology is coming down in price these days.

4. Pen/Thumb Drives – Flash Memories

Another kind of storage device has recently emerged. It is called 'Flash' memory, USB memory, Key Memory. The Thumb drives/ Pen drives, and cell phones of today use flash memories.

What it does is to combine a well tried memory technology called 'Flash' with the convenience of the USB connector.

Flash is a **'solid state'** memory *i.e.*, it has no moving parts unlike magnetic storage devices, nor does it make use of lasers — unlike optical drives.

Instead, it works in a similar way to RAM. The key difference is that data is retained in Flash memory even when the power is switched off.

They are now fairly inexpensive, costing from ₹ 250/- upwards. Typical sizes range from 256 Mbytes up to 128 GB and beyond

5. Blu Ray Disk

Blu-ray, also known as ***Blu-ray Disc (BD)***, is the name of a next-generation optical disc format jointly developed by the Blu-ray Disc Association (BDA), a group of the world's leading consumer electronics, personal computer and media manufacturers (including Apple, Dell, Hitachi, HP, JVC, LG, Mitsubishi, Panasonic, Philips, etc.). The format was developed to enable recording, rewriting and playback of high-definition video (HD), as well as storing large amounts of data. The format offers more than five times the storage capacity of traditional DVDs and can hold up to 25/50 GB on a single-layer disc and 50/100 GB on a dual-layer disc. This extra capacity combined with the use of advanced video and audio codecs will offer consumers an unprecedented HD experience.

Blu-ray Disc (also known as **Blu-ray** or **BD**) is an optical disc storage media format. Its main uses are high-definition video and data storage. The disc has the same dimensions as a standard DVD or CD. While current optical disc technologies such as DVD, DVD ± R, DVD ± RW, and DVD-RAM rely on a red laser to read and write data, the new format uses a **blue-violet laser** instead, hence the name **Blu-ray**. The benefit of using a *blue-violet laser (405 nm)* is that it has a shorter wavelength than a *red laser (650 nm)*, which makes it possible to focus the laser spot with even greater precision. This allows data to be packed more tightly and stored in less space, so it's possible to fit more data on the disc even though it's the same size as a CD/DVD. This together with the change of numerical aperture to 0.85 is what enables Blu-ray Discs to hold 25 GB/50 GB, almost six times the capacity of a dual layer DVD.

Blu-ray is currently supported by more than 180 of the world's leading consumer electronics, personal computer, recording media, video game and music companies. The format also has broad support from the major movie studios as a successor to today's DVD format.

Blu Ray disks of today are capable of storing upto 128 GB of data.

Check Point 12.1

1. (*i*) Storage of 1 KB means the following number of bytes :
   (*a*) 1000 (*b*) 964
   (*c*) 1024 (*d*) 1064
   (*ii*) One Megabyte is equivalent to
   (*a*) 210 bytes
   (*b*) 220 bytes
   (*c*) 230 bytes
   (*d*) none of the above
2. What are the functional components of a digital computer ?
3. What are the components of CPU ? What is its role ? What is the function of control unit of CPU ?
4. What role does the input unit play in a computer ?
5. What is the function of ALU ?
6. What role does the output unit play in a computer ?
7. What is the function of main memory ? What are the measuring units of memory ?
8. What are different types of ROM ?
9. Name some fast storage devices.
10. Which storage device is considered a portable device ?

12.2.6 The System Bus

The system bus (or the bus) is an electronic pathway composed of connecting cables and that connects the major components of a computer system. Through system bus, data and instructions are passed among the computer system components.

- The data carrying part of system bus is called **data bus**.
- The control instruction carrying part of system bus is called **control bus**.
- The memory address carrying part of system bus is called **Address bus**.
- A separate type of bus called **I/O Bus** connects the Input, Output and other external devices to the system.

12.3 MOBILE SYSTEM ORGANIZATION

Modern mobile system are tiny computers in your hand. Although they have less computing power compared to their bigger versions, they handle diverse type of applications such as making calls through radio signals, offering camera utilities, handling touch sensitive screen, display audio/video/graphical content but having little battery based power etc.

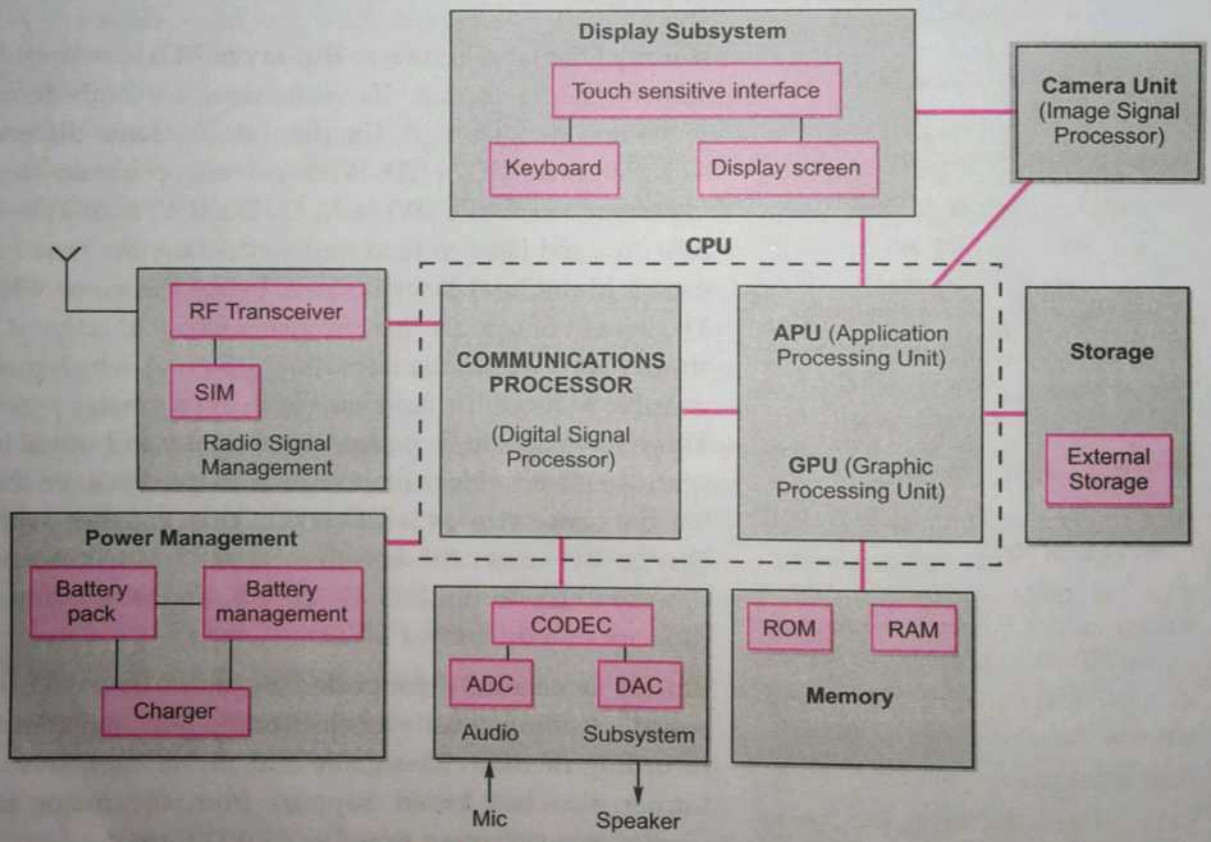

Figure 12.4 Mobile System Organization

Thus, the system organization of a mobile system has components to handle all these. The block diagram of a mobile system is as shown here.

Let us talk about these functional components of a mobile system one by one.

A mobile system's CPU handles diverse types of applications but has a little power compared to computers as mobile systems run on battery power.

1. Mobile Processor

This is the **brain** of a smartphone. The CPU receives commands, makes instant calculations, plays audio/video, stores information and sends signals throughout the device.

The CPU of a mobile system has majorly *two* sub-processor[2] types :

(*i*) Communications Processing Unit (*ii*) Applications Processing Unit (APU)

(*i*) **Communications Processing Unit.** This subsystem is responsible for making and receiving phone calls on a mobile handset. It has a digital signal processor that helps it work with **RF Transceiver** and the **Audio subsystem**.

- ***Radio Signal Management Unit*** is responsible for connecting **SIM** (which provides a type of modem) to the base stations through radio signals. (Mobile Telephony works through established connections between mobile stations to base stations and base stations connected to other base stations — Cellular networks *e.g.*, 3G/LTE/4G based cellular networks).
- ***Audio Subsystem*** is responsible for converting the voice signals (analog type) to digital signals and vice-versa. The audio subsystem can receive voice input through in-built mic and can produce audio output and send it to in-built speaker. The audio subsystem has two subparts that convert audio signals to digital signals and vice-versa :
  - **DAC** (*Digital to Analog Converter*) produces digital audio output to analog audio form.
  - **ADC** (*Analog to Digital Converter*) receives audio input (analog form *e.g.*, when you speak) and converts it into digital form so that mobile system can work on it.

(*ii*) **Applications Processing Unit (APU).** This subsystem is responsible for governing, controlling all types of operations taking place on a mobile system.

The **Application Processing Unit** is responsible for carrying out different applications that a mobile system can perform such as making calculations, playing music, browsing net, streaming videos, connecting to other devices, capturing stills or videos, saving data and so on. It has a separate subcomponent available to it which enhances its power and performance. This component is GPU.

Graphics Processing Unit. The GPU assists the CPU by handling the visuals, other graphically-rich applications. In short, GPU handles all graphics-related chores of a mobile CPU.

The application processing unit is connected with all other subsystems of a mobile system such as display subsystem, camera subsystem, memory, storage, connectivity subsystem etc.

SoC (System on a Chip)

These days major components of a mobile system are integrated on a single chip called **System on a Chip (SoC)**. An SoC not only comprises up of the smartphone's CPU, but GPU, modem, display processor, video processor, and other bits of silicon that turn it into a functional 'system' in a phone. The SoC chips consume less power compared to other alternatives.

NOTE

These days major components of a mobile system are integrated on a single chip called **System on a Chip (SoC)**. The SoC chips consume less power compared to other alternatives.

2. In fact, major subsystems are like processors in themselves *e.g.*, Radio Signal Management system can be termed as Radio signal processor.

2. Display Subsystem

This subsystem is responsible for providing display facilities and touch sensitive interface. This is an important subsystem as most mobile systems get instructions through touch based and other sensors. It supports :

- **Display screen**. Mobile display screens such as Amoled based display screens form a major part of this subsystem.
- **Touch sensitive interface** that activates the touch sensors of the mobile system screen and recognizes instructions given through it.
- **Touch sensitive keyboards** allow you to type letters and numbers through touch.

3. Camera Subsystem

This subunit is designed to deliver a tightly bound image processing package and enable an improved overall picture and video experience. It has an integrated Image Signal Processor ensures things like *instant image capture, high-resolution support, image stabilization,* and other *image enhancements.*

4. Mobile System Memory

Like its other counterparts, a mobile system also needs memory to work. A mobile system's memory is comprised of following *two* types of memories :

(*i*) RAM (Random Access Memory)

(*ii*) ROM (Read Only Memory)

(*i*) **RAM (Random Access Memory).** It is the work memory of your mobile system. The installed mobile apps, when run, are first loaded in the RAM and then executed. These apps remain in the RAM after you are no longer using them and then they are shifted to background.

The more RAM you have on a smartphone, the better the performance and faster the phone will generally be. Please remember that the RAM can only work when the mobile device is turned on. In other words, this means that RAM does not store information once the device is turned off.

(*ii*) **ROM (Read Only memory).** The ROM or **Read Only Memory** is a part of mobile system's internal storage and it is not accessible for users to write on and is thus referred to as ***Read Only Memory***. The ROM is basically **Flash memory** or technically **EEPROM** (electrically erasable and programmable read only memory).

This ROM part of a mobile system internal storage is where operating system resides. It also has some preinstalled apps in this memory sections which cannot be deleted on users' end either. This is the reason why you don't get full internal memory as advertised on the Box, because a part of it has been used to house operating system and other preinstalled apps.

NOTE

RAM memory is volatile, it loses its contents when you switch off the device.

Check Point 12.2

1. What are major functional components of a mobile system ?
2. What is the role of Communication processor of a mobile system ?
3. How does a mobile system manage and draw power ?
4. What is the role of display management unit of a mobile system ?
5. How does memory of mobile function ?
6. How does the CPU of a mobile system work ?
7. Which unit of a mobile system uses ADC (analog to digital converter) and DAC (digital to analog converter) ?
8. What is the role of a GPU in a mobile system ?

5. Storage

The external storage of a mobile system is also called **expandable storage**. It comes in the form of SD cards, or micro SD cards etc. It is the storage which can be removed easily by you and can be used for storing pictures, music, videos and the likes. You may or may not be able to install applications on it. This is because some manufacturers allow for it while some don't. To an extent, even the cloud storage can also be categorized as external storage.

6. Power Management Subsystem

This subsystem is responsible for providing power to a mobile system. The mobile systems work on limited power provided through an attached *battery unit*. This subsystem has a battery management system that works with a battery charger and a battery unit, and provides power to the mobile system in required form.

In other words, it contains a collection of different functions that include battery charging, monitoring and supplying many different voltages these systems require. It also contains software controlled turn-on and turn-off feature to optimize the power consumption and battery life of the whole box.

12.4 TYPES OF SOFTWARE

A computer system consists of hardware and software for its proper functioning.

Hardware represents the physical and tangible components of the computer *i.e.*, the components that can be seen and touched. *Input devices, output devices, CPU, hard disk, printer* etc. are examples of computer hardware.

Software represents the set of programs that govern the operation of a computer system and make the hardware run. Software can be classified broadly into *two* categories.

1. System Software
2. Application Software

Following sections discuss system software and application software in details.

12.4.1 System Software

A computer is mere a machine that knows nothing of itself. Rather it requires instructions for each and everything it performs. These instructions are provided to it through software. The software that controls internal computer operations (*viz.* reading data from input devices, transmitting processed information to the output devices, checking system components, converting data/instructions to computer understandable form etc.) is known as **system software.**

The system software can further be classified into *two* categories :

1. Operating System
2. Language Processor.

Let us discuss each one of these individually.

SYSTEM SOFTWARE

The software that controls internal computer operations is called *System Software*.

12.4.1A Operating System

The primary goal of an operating system is thus to make the computer system convenient to use and secondary goal is to use computer hardware in an efficient manner. An operating system is an important component of a computer system which controls all other components of the computer system.

Major components of a computer system are :

1. The Hardware
2. The Operating System
3. The Application program routines (compiler, linkers, database management systems, utility programs)
4. The Humanware (users)

OPERATING SYSTEM

An *Operating System* is a program which acts as an interface between a user and the hardware (*i.e.*, all computer resources).

where *hardware* provides the basic computing resources, *the application program routines* define the ways in which these resources are used to solve the computing problems of the users and the *Operating System* controls and coordinates the use of the hardware among the various application programs for the various users.

An operating system's major role is to execute a program. How an operating system executes a program, is covered in chapter 15.

There are different types of operating systems available today to cater to varied type of requirements. These are : Single user OS, Multiuser OS, Time sharing OS, Real time OS, Multiprocessing OS, Distributed OS etc.

We are not discussing these operating systems types here as it is beyond the scope of the syllabus.

12.4.1B Language Processors

A language processor is a special type of a computer software that can translate the source code into an object code or machine code. Here you should know the meaning of the terms *source code* or *object code*.

- A **source code** refers to the program-code written by a programmer in a high level programming language (HLL) such as in C, Java, C++ etc.
- An **object code** refers to a code usually in machine language or binary code, a language that computer can understand easily and run on hardware.

So, you can safely say that language processors are software that convert source codes into object codes.

You have read in previous chapter that there are *three* types of language processors : *assembler*, *compiler* and *interpreter*.

(*i*) *Assembler*. This language processor converts the program written in assembly language into machine language.

(*ii*) *Interpreter*. An interpreter is a type of system software that translates and executes instructions written in a computer program line-by-line, unit by unit etc.

(*iii*) *Compiler*. A Compiler is another type of system software that translates and executes instructions written in a computer program in one go.

Chapter 15 (section 15.3) discusses the working of compilers and interpreters in details.

12.4.2 Application Software

This type of software pertains to one specific application. For instance, a software that can perform railway reservation functions cannot prepare result for a school.

APPLICATION SOFTWARE

An *Application Software* is the set of programs necessary to carry out operations for a specified application.

These are the programs written by programmers to enable computer to perform a specific task such as processing words, inventory control, handling calculations and figures, medical accounting, financial accounting, result preparation, railway reservation, billing etc. Application software can further be subdivided into *four* categories :

1. Packages 2. Utilities 3. Customised Software 4. Developer Tools

12.4.2A Packages

Only system software does not suffice for efficient use of computers because the system software exists mostly for the benefit of the computer. Other programs *i.e.*, the application software are required to make the computer useful for people. Application software has been written to do almost every task imaginable, from word processing to selecting a college to attend.

As applications may be numerous (*from thousands to millions of them*), it is not feasible to design software for each one of them. Rather some general software are designed that may be used by individual users in the manner it suits their needs and requirements. Such general-application software are known as packages. Some major and most common categories of general application software (packages) are :

(*i*) Word Processing Software (*ii*) Spreadsheets
(*iii*) Database Management Systems (*iv*) Desktop Publishing Software
(*v*) Graphics, multimedia, and presentation applications.

12.4.2B Utilities

Utilities are those helpful programs that ensure the smooth functioning of the computer. **Utility programs** or simply **Utilities** are meant to assist your computer. Some utilities help you backup data, some help remove outdated files or recover data that has been accidentally erased. Some make it easier to find and arrange the information you need. And some help you avoid virus attacks or clean viruses, if any. In other words, the utility programs perform house-keeping functions.

UTILITIES

Utilities are those application programs that assist the computer by performing housekeeping functions like backing up disk or scanning / cleaning viruses or arranging information etc.

It is an established truth that everything comes with certain pros and cons. Software also are not an exception to it. Utilities bridge the gaps by helping to solve the problems and maximize your computer's potential.

Some important utilities are being discussed below.

1. ***Text Editor.*** This utility program is used for creating, editing text files.
2. ***Backup Utility.*** This utility program facilitates the backing-up of disk. Back-up means duplicating the disk information so that in case of any damage or data-loss, this backed up data may be used.
3. ***Compression Utility.*** This utility program facilitates compression of files. Large files can be compressed so that they take less storage area.
4. ***Disk Defragmentor.*** A file is fragmented when it becomes too large for your computer to store in a single location on a disk. When this happens, your computer splits the file

up and stores it in pieces. You can use fragmented files, but it takes your computer longer to access them.

Disk Defragmentor utility program speeds up disk access by rearranging the files and free space on your computer, so that files are stored in contiguous units and free space is consolidated in one contiguous block.

5. ***Antivirus Software.*** This utility program ensures virus-free work environment. A computer virus is a malicious computer program that disrupts normal functioning of a computer.

   An *antivirus software* scans your disk for viruses and removes them, if any virus is found. Moreover, some antivirus software remains present in memory all the time so that they can detect the viruses (as soon as they occur) and counterattack them.

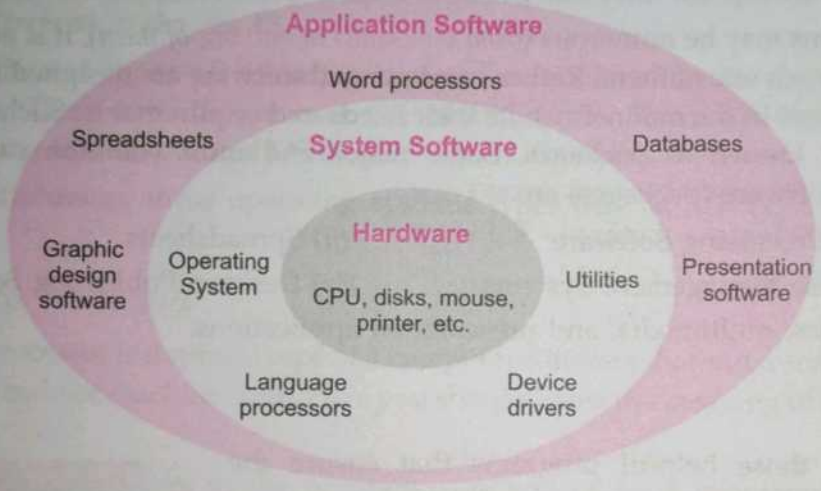

Figure 12.5 Working hierarchy in a computer.

12.4.2C Business Software

This type of software is specifically created software according to a business requirements. This type of software is developed to meet the general requirements of a business. For instance, a company wants to computerize its 'Accounts' department and gets a software that can serve its needs. Such a software is **business software**. There are many readymade business software. These can cater to a variety of business needs. Examples of these software are **Inventory Management System** (for managing inventory details of a company), **Payroll system** (for handling payroll of a company's employees), **Financial Accounting, Hotel Management and Reservation System** etc. Although there are standard business software available in market, yet some companies prefer getting **customized (tailor-made) software** as per their specific requirements. However, such softwares cannot be directly installed at any other user's workplace as the requirements of the second user may differ from the first and the software may not fit in the requirements of the new user.

12.4.3 Software Libraries

When programmers develop software and programs, they have a prewritten set of code/functions, classes, scripts etc. available to do a variety of tasks, which they can use directly in their code. These predefined sets of codes are called software libraries. A **software library** is a

predefined and available to use, suite of data and programming code in the form of prewritten code/ functions/scripts/classes etc. that can be used in the development of new software programs and applications.

SOFTWARE LIBRARIES

A **software library** is a predefined and available to use, suite of data and programming code in the form of prewritten *code / functions / scripts / classes* etc. that can be used in the development of new software programs and applications.

The software libraries combine codes/ functions / scripts / classes etc. on the basis of their common domain. In order to use the rewritten functionality, a programmer needs to add that libraries to its code. For instance, if your software requires some heavy mathematical work then you need not write the functions/code etc. for complex mathematical functions. Rather what you need to do is that to include/import an available math based software library in your program. Then you can use all the available functions and features of this library in your code without having to rewrite them. You can use a software library in a variety of projects.

For example, Python comes equipped with many software libraries. Some of these are :

1. **NumPy (Numerical Python).** It provides an abundance of useful features and functions for operations on numeric arrays and matrices in Python.
2. **SciPy (Scientific Python).** SciPy contains modules for linear algebra, optimization, integration, and statistics.
3. **Panda Library.** Pandas is a Python package designed to do work with "labeled" and "relational" data. It is designed for quick and easy data manipulation, aggregation, and visualization.

With this we have come to the end of this chapter. Let us quickly revise what we have learnt so far.

LET US REVISE

- *Computers can deliver performance because of an efficient combination of hardware and software.*
- *While **hardware** refers to physical electronic components of a computer, **software** represent the recorded instructions/software that govern its operation.*
- *Computer organization refers to logical structure of a computer describing their interconnections and work dependency.*
- *The functional components of a computer include : **input unit, CPU, Memory, Storage Unit, Output Unit.***
- *The Input unit is responsible for obtaining input from user and converting it to digital form.*
- *The CPU (Central Processing Unit) processes the receiver input as per a set of instructions and produces output.*
- *The CPU has these sub-components : ALU, Control Unit and Registers.*
- *The ALU (Arithmetic of Logic Unit) is responsible for carrying out arithmetic operations and logic operations (e.g., comparing two values).*

Check Point **12.3**

1. How can computer software be classified ?
2. What are two categories of system software ?
3. What is an operating system ? What is its role ?
4. What is application software ? What are the three categories of application software ?
5. Differentiate between a compiler and interpreter.
6. What is utility software ?
7. What are software libraries? How are they useful to programmers ?