

1.4 GENERATIONS OF COMPUTERS

The history of computer development is often discussed with reference to the different generations of computing devices. In computer terminology, the word **generation** is described as a stage of technological development or innovation. A major technological development that fundamentally changed the way computers operate, resulting in increasingly smaller, cheaper, and more powerful and more efficient and reliable devices, characterizes each generation of computer. According to the technology used, there are five generations of computers, which are discussed in the following sections.

1.4.1 FIRST GENERATION (1940–56): VACUUM TUBES

First generation computers were vacuum tubes/thermionic valve based machines. These computers used vacuum tubes for circuitry and magnetic drums for memory. A magnetic drum is a metal cylinder coated with magnetic iron-oxide material on which data and programs can be stored. Input was based on punched cards and paper tape and output was displayed in the form of printouts.

First generation computers relied on binary-coded language (language of 0s and 1s) to perform operations and were able to solve only one problem at a time. Each machine was fed with different binary codes and hence were difficult to program. This resulted in lack of versatility and speed. In addition, to run on different types of computers, instructions must be rewritten or recompiled.

Characteristics of First Generation Computers

- These computers were based on vacuum tube technology.
- These were the fastest computing devices of their times (computation time was in milliseconds).
- These computers were very large, and required a lot of space for installation.
- Since thousands of vacuum tubes were used, they generated a large amount of heat. Therefore, air conditioning was essential.
- These were non-portable and very slow equipments.
- They lacked in versatility and speed.
- They were very expensive to operate and used a large amount of electricity.

- These machines were unreliable and prone to frequent hardware failures. Hence, constant maintenance was required.
- Since machine language was used, these computers were difficult to program and use.
- Each individual component had to be assembled manually. Hence, commercial appeal of these computers was poor.

1.4.2 SECOND GENERATION (1956–63): TRANSISTORS

Second generation computers used transistors, which were superior to vacuum tubes. Since transistor is a small device, the physical size of computers was greatly reduced. Computers became smaller, faster, cheaper, energy-efficient and more reliable than their predecessors. In second generation computers, magnetic cores were used as primary memory and magnetic disks as secondary storage devices. However, they still relied on punched cards for input and printouts for output.

One of the major developments of this generation includes the progress from machine language to assembly language.

Characteristics of Second Generation Computers

- These machines were based on transistor technology.
- These were smaller as compared to the first generation computers.
- The computational time of these computers was reduced to microseconds from milliseconds.
- These were more reliable and less prone to hardware failure. Hence, such computers required less frequent maintenance.
- These were more portable and generated less amount of heat.
- Assembly language was used to program computers. Hence, programming became more time-efficient and less cumbersome.
- Second generation computers still required air conditioning.
- Manual assembly of individual components into a functioning unit was still required.

1.4.3 THIRD GENERATION (1964–EARLY 1970S): INTEGRATED CIRCUITS

The development of the integrated circuit was the trait of the third generation computers. Also called an **IC**, an integrated circuit consists of a single chip (usually silicon) with many components such as transistors and resistors fabricated on it. Integrated circuits replaced several individually wired transistors. This development made computers smaller in size, reliable, and efficient.

Instead of punched cards and printouts, users interacted with third generation computers through keyboards and monitors and interfaced with operating system. This allowed the device to run many different applications at one time with a central program that monitored the memory. For the first time, computers became accessible to mass audience because they were smaller and cheaper than their predecessors.

Characteristics of Third Generation Computers

- These computers were based on integrated circuit (IC) technology.
- They were able to reduce computational time from microseconds to nanoseconds.
- They were easily portable and more reliable than the second generation.
- These devices consumed less power and generated less heat. In some cases, air conditioning was still required.
- The size of these computers was smaller as compared to previous computers.
- Since hardware rarely failed, the maintenance cost was quite low.
- Extensive use of high-level languages became possible.
- Manual assembling of individual components was not required, so it reduced the large requirement of labour and cost. However, highly sophisticated technologies were required for the manufacture of IC chips.
- Commercial production became easier and cheaper.

1.4.4 FOURTH GENERATION (EARLY 1970S–TILL DATE): MICROPROCESSORS

The fourth generation is an extension of third generation technology. Although, the technology of this generation was still based on the integrated circuit, these have been made readily available to us because of the development of the microprocessor (circuits containing millions of transistors).

The fourth generation computers became more powerful, compact, reliable, and affordable. As a result, it gave rise to the personal computer (PC) revolution. This generation also saw the development of the GUIs (Graphical User Interfaces), mouse, and handheld devices. Despite many advantages, this generation required complex and sophisticated technology for the manufacturing of CPU and other components.

Characteristics of Fourth Generation Computers

- Fourth generation computers are microprocessor-based systems.
- These computers are very small.
- Fourth generation computers are the cheapest among all the other generations.
- They are portable and quite reliable.
- These machines generate negligible amount of heat, hence they do not require air conditioning.
- Hardware failure is negligible, so minimum maintenance is required.
- The production cost is very low.
- GUI and pointing devices enable users to learn to use the computer quickly.
- Interconnection of computers leads to better communication and resource sharing.

1.4.5 FIFTH GENERATION (PRESENT AND BEYOND): ARTIFICIAL INTELLIGENCE

The dream of creating a human-like computer that would be capable of reasoning and reaching a decision through a series of “what-if-then” analyses has existed since the beginning of computer technology. Such a computer would learn from its mistakes and possess the skill of experts. These are the objectives for creating the fifth generation of computers. The starting point for the fifth generation of computers has been set in the early 1990s. The process of developing fifth generation of computers is still in the development stage. However, the expert system concept is already in use. The **expert system** is defined as a computer information system that attempts to mimic the thought process and reasoning of experts in specific areas. Three characteristics can be identified with the fifth generation computers, which are:

- **Mega Chips:** Fifth generation computers will use *Super Large Scale Integrated (SLSI)* chips, which will result in the production of microprocessor having millions of electronic components on a single chip. In order to store instructions and information, fifth generation computers require a great amount of storage capacity. Mega chips may enable the computer to approximate the memory capacity of the human mind.
- **Parallel Processing:** Most computers today access and execute only one instruction at a time. This is called **serial processing**. However, a computer using parallel processing accesses several instructions at once and works on them at the same time through the use of multiple central processing units.
- **Artificial Intelligence (AI):** It refers to a series of related technologies that tries to simulate and reproduce human behaviour, including thinking, speaking and reasoning. AI comprises a group of related technologies: expert systems (ES), natural language processing (NLP), speech recognition, vision recognition, and robotics.