

Fundamentals of Computers

SECOND EDITION

REEMA THAREJA

*Assistant Professor
Department of Computer Science
Shyama Prasad Mukherji College for Women
University of Delhi*

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Preface

Today computers are used in almost every field, starting from education, health care, banking, construction, communication, to defence, transportation, sports, manufacturing, marketing, etc. The list is literally unending. In a world driven by Information Technology (IT), it is difficult to fathom a field that does not make use of computers! The use of computers has become so widespread that almost every electrical and electronic device (such as a washing machine or an air conditioner) has a small embedded computer within it. In India, computers are now a part of millions of households. Even the mobile phones that we use are smartphones (phones with computing technology) that are connected to the Internet. Information technology has revolutionized our lifestyle. Online banking and shopping are being preferred. Employees can work from home to save time commuting to their offices. Therefore, in today's scenario learning computers is not just a requirement for students pursuing a career in engineering and technology; it is a must for everyone. Computing skills help one to be more productive and efficient. Therefore, a basic knowledge of computers and its technology will definitely pay rich dividends in the future.

About the Book


Fundamentals of Computers is an ideal textbook for learning computers on one's own. The book covers both the basic concepts of computers such as organization, architecture, input and output devices, and primary and secondary memory as well as advanced topics including operating systems, databases, and computer networks. The book also offers step-by-step tutorials to learn applications such as MS Word, MS Excel, and MS PowerPoint. The book can be used by a broad spectrum of students, ranging from students enrolled in elementary courses on Information Technology and Computer Sciences to those pursuing courses such as BSc (Computer Science), BA/BCom (Computer Applications), BSc (Hospitality & Hotel Administration), BCA, and MCA. It would also be a valuable reference for diploma courses and courses taught at the polytechnic level.

New to the Second Edition

Some of the prominent changes in this edition are as follows:

- **Updated content:** outdated devices and technologies have been replaced with current/emerging devices and technologies. New sections have been included on Blu-ray disks, wireless routers, tablets, digitizers, voice response

systems, mobile operating systems, macOS, Python, and Windows 10

- **Lab activities:** relevant chapters are followed by lab activities which provide practical implementation of the concepts covered in the respective chapter
- **MS Office 2013:** chapters 12-14 provide detailed step-by-step tutorials on how to learn MS Word, MS Excel, and MS PowerPoint applications
- **Digital support:** Assessment questions and supplementary content have been made available on Oxford Areal – a smartphone application that can be downloaded from App Store (iOS) / Play Store (Android). The content can be accessed through the  icon marked on the relevant pages
- **Improved pedagogy:** Numerous new real-life illustrations as well as examples have been included in this edition

Organization of the Book

The book is organized into 14 chapters.

Chapter 1 provides an introduction to computers. The chapter explains the characteristics, history, classifications, and applications of computers, as well as the basic organization of a computer system. The chapter is followed by lab activities on different parts of a computer system and the components integrated into a computer's motherboard.

Chapter 2 gives a detailed description of the different types of input and output devices. Lab activities on how to install a printer and how to customize mouse settings are given at the end of this chapter.

Chapter 3 explains the significance of memory hierarchy and discusses the different types of primary, secondary, and tertiary memory that are widely used to store data. It also discusses the basic processor architecture, instruction set, and types of processors. The discussion is then followed by lab activities on how to transfer files to a computer using a USB drive and how to optimize a local hard drive.

Chapter 4 introduces the binary, octal, and hexadecimal number systems. The chapter also explains arithmetic operations such as addition, subtraction, multiplication, and division on binary numbers. Important binary codes such as ASCII, EBCDIC, Excess 3, Gray, and Unicode are also discussed in the chapter.

Chapter 5 discusses the concepts of digital computing systems such as Boolean expressions, Boolean algebra, and logic gates.

Chapter 6 provides a thorough overview of computer software. It discusses the different types of system software and application software packages that are widely used. It also details the differences between open source and proprietary software.

Chapter 7 details the different steps in software development process, which are performed for creating efficient and maintainable programs. It also explains different tools—algorithms, pseudocodes, and flowcharts—which are used to obtain solution(s) of a given problem at hand. It also introduces the concept of programming languages and their evolution through years. The chapter also discusses different paradigms of programming and some popular programming languages. It is followed by a lab activity on how to create an HTML page.

Chapter 8 discusses operating systems and their evolution. It also explains the different jobs that an operating system performs and discusses some commonly used operating systems such as Windows, Unix, and Linux, as well as mobile operating systems. Lab activities on managing user accounts in Windows 10 are included at the end of the chapter.

Chapter 9 gives a description of traditional file-oriented approach of data management and introduces the concept of databases, their architecture, models, and components.

Chapter 10 discusses data transmission mode and computer networks, their applications, the connecting media, network topologies, area networks, and the devices used to form a network. The chapter is followed by lab activities on finding the IP addresses of different devices.

Chapter 11 introduces the concept and evolution of the Internet. It discusses different services provided by the

Internet, threats to security, and counter measures to be adopted for ensuring privacy and security over the Internet. Lab activities on popular web browsers such as Google Chrome and Microsoft Edge follow this chapter.

Chapters 12-14 provide detailed step-by-step tutorials on MS Word, MS Excel, MS PowerPoint, respectively.

Acknowledgements

The mammoth task of writing this book required the help and support of many individuals. Fortunately, I have had the wholehearted support of my family and friends. I would like to specially thank my father Mr Janak Raj Thareja and mother Mrs Usha Thareja, my brother Pallav, and sisters Kimi and Rashi who are a source of abiding inspiration and divine blessings for me. I am especially thankful to my son Goransh who has been very patient and cooperative in letting me realize my dreams. My sincere thanks go to my uncle Mr B.L. Theraja for his inspiration and guidance in writing this book. Finally, I would like to thank the editorial team at Oxford University Press India for their help and support.

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1

Introduction to Computers

TAKEAWAYS

- Characteristics of computers
- Generations of computers
- Applications of computers
- Stored program concept
- Types of computers
- Basic organization of a computer

1.1 DEFINITION

We all have seen computers in our homes, schools, and colleges. In fact, in today's world, we find computers in most aspects of our daily lives. For some of us, it is hard to even imagine a world without them. A computer, in simple terms, can be defined as an electronic device that is designed to accept data, perform the required mathematical and logical operations at high speed, and output the result.

Nowadays, computers come in different sizes. Their size may vary from very small to very large. In the past, computers were extremely large in size and often required an entire room for installation. These computers consumed enormous amounts of power and were too expensive to be used for commercial applications. Therefore, they were used only for limited tasks, such as computing trajectories for astronomical and military applications. However, with technological advancements, the size of computers became smaller and their energy requirements reduced immensely. This opened the way for adoption of computers for commercial purposes.

These days, computers have become so prevalent that interactive devices such as cellular phones, global positioning system (GPS) units, portable organizers, automated teller machines (ATMs), and gas pumps, all work with computers. Computers are basically meant to solve problems quickly and accurately.

1.2 CHARACTERISTICS OF COMPUTERS

A computer is an electronic device that performs mathematical and logical operations based on a given set of instructions known as a *program*. A computer accepts data, processes it, and produces information. Here, data refers to some raw fact or figure, and information implies the processed data. For example, if 12-12-95 is the date of birth of a student, then it is data (a raw fact/figure).

However, when we process this data (subtract it from the present-date) and say that the age of the student is 23 years, then the outcome is information.

Before going into details, let us learn some key terms that are frequently used in association with computers.

Data is a collection of raw facts or figures.

Information comprises processed data to provide answers to 'who', 'what', 'where', and 'when' type of questions.

Knowledge is the application of data and information to answer the 'how' part of the question (refer Figure 1.1).

Instructions are the commands given to the computer which tell it what to do.

Program is a set of instructions in a language understood by computers.

Software is a set of programs.

Hardware refers to computer and all its physical parts.

The important characteristics of a computer (refer to Figure 1.2) are:

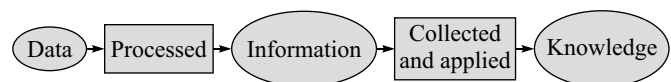


Figure 1.1 Data, information, and knowledge

Speed Computers can perform millions of operations per second, which means that data that may otherwise take many hours to process is output as information in the fraction of a second. The speed of computers is usually given in nanoseconds and picoseconds, where 1 nanosecond = 1×10^{-9} seconds and 1 picosecond = 1×10^{-12} seconds.

Accuracy Computers are very fast, reliable, and robust devices. They always give accurate results, provided that correct data and set of instructions are input to them. Hence, in the event of an error, it is the user who has fed the incorrect

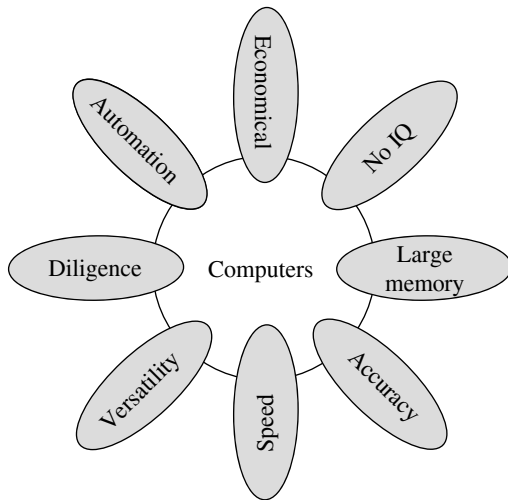


Figure 1.2 Characteristics of computers

data/program is responsible. This clearly means that the output generated by a computer depends on the given instructions and input data. If the input data is wrong, then the output will also be erroneous. In computer terminology, this is known as *garbage-in, garbage-out (GIGO)*.

Automation Besides being very fast and accurate, computers are automatable devices that can perform a task without any user intervention. The user just needs to assign the task to the computer, after which it automatically controls different devices attached to it and executes program instructions.

Diligence Unlike humans, computers never get tired of a repetitive task. They can continually work for hours without generating errors. Even if a large number of executions needs to be executed, each and every execution requires the same duration, and is executed with the same accuracy.

Versatile Versatility is the quality of being flexible. These days, computers are used in our daily life in different fields. For example, they are used as personal computers (PCs) for home use, for business-oriented tasks, weather forecasting, space exploration, teaching, railways, banking, medicine, and so on. On the PC that we use at home, we may play a game, compose and send e-mails, listen to music, etc. Therefore, computers are versatile devices as they can perform multiple tasks of different nature at the same time.

Memory Similar to humans, computers also have memory. Just the way we cannot store everything in our memory and need a secondary medium, such as a notebook, to record certain important things, computers also have internal or primary memory (storage space) as well as external or secondary memory. While the internal memory of computers is very expensive and limited in size, the secondary storage is cheaper and of bigger capacity.

Computers store a large amount of data and programs in the secondary storage space. The stored data and programs

can be retrieved and used whenever required. Some examples of secondary devices include optical disks (CDs and DVDs), hard disk drives, and pen drives.

When data and programs have to be used, they are copied from the secondary memory into the internal memory, often known as random access memory (RAM). The concept of computer memory is discussed in detail in Chapter 3.

No IQ Although the trend these days is to make computers intelligent by inducing artificial intelligence (AI) in them, they still do not have any decision-making abilities of their own. They need guidance to perform various tasks.

Economical Today, computers are considered as short-term investments for achieving long-term gains. Using computers also reduces manpower requirements and leads to an economical and efficient way of performing various tasks. Hence, computers save time, energy, and money. When compared to other systems, computers can do more work in lesser time. For example, using the conventional postal system to send an important document takes at least two to three days, whereas the same information when sent using the Internet (e-mail) will be delivered instantaneously.

1.3 STORED PROGRAM CONCEPT

All digital computers are based on the principle of stored program concept, which was introduced by Sir John von Neumann in the late 1940s. The following are the key characteristic features of this concept:

- Before any data is processed, instructions are read into the memory.
- Instructions are stored in the computer's memory for execution.
- Instructions are stored in binary form (using binary numbers—only 0s and 1s).
- Processing starts with the first instruction in the program, which is copied into the control unit circuit. The control unit executes the instructions.
- Instructions written by users are performed sequentially until there is a break in the current flow.
- Input/Output and processing operations are performed simultaneously. While data is being read/written, the central processing unit (CPU) executes another instruction in the memory that is ready for execution.

Note

A stored program architecture is a fundamental computer architecture wherein the computer executes the instructions that are stored in its memory.

John W. Mauchly, an American physicist, and J. Presper Eckert, an American engineer, further contributed to the stored program concept to make digital computers much

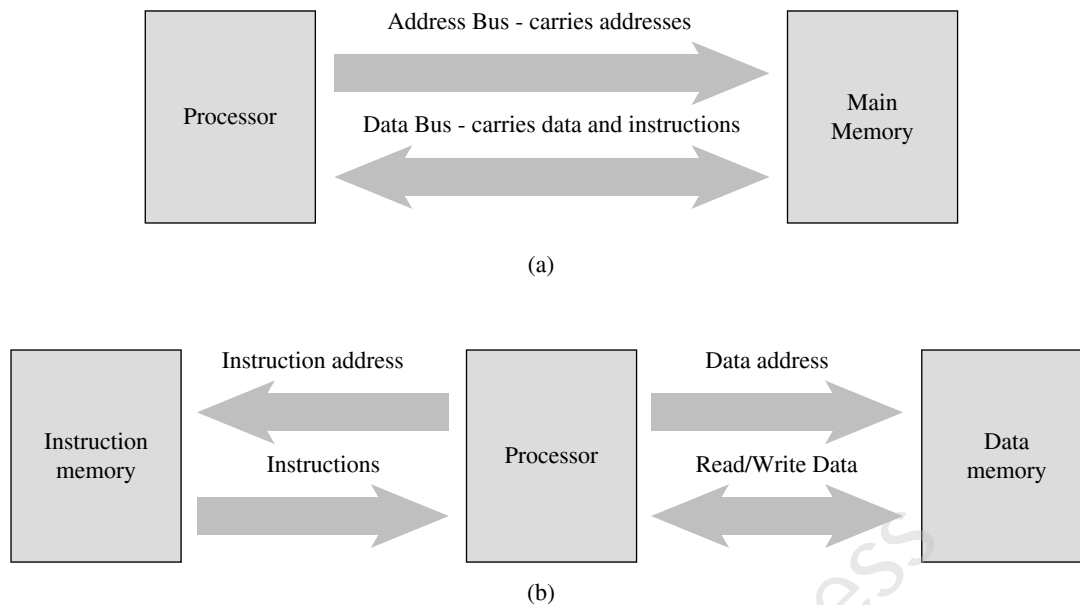


Figure 1.3 Von Neumann architecture: (a) Shared memory for instructions and data; (b) Separate memories for instructions and data

more flexible and powerful. As a result, engineers in England built the first stored program computer, Manchester Mark I, in the year 1949. They were shortly followed by the Americans who designed EDVAC in the very same year.

1.3.1 Types of Stored Program Computers

A computer with a von Neumann architecture stores data and instructions in the same memory (refer Figure 1.3(a)). This is a serial machine in which data and instructions are selected one at a time. Data and instructions are transferred to and from memory through a shared data bus. Since there is a single bus to carry data and instructions, process execution becomes slower.

Later Harvard University proposed a stored program concept in which there is a separate memory to store data and instructions (refer Figure 1.3(b)). Instructions are selected serially from the instruction memory and executed in the processor. When an instruction needs data, it is selected from the data memory. Since there are separate memories, execution becomes faster.

1.4 HISTORY OF COMPUTERS

Early computers were mainly designed for solving number-crunching problems. These computers were punch-card based machines that took up entire rooms. Today, our smartphones have much more computing power than that was available in those early computers.

In this section, we will read about history of computers way back from the invention of abacus and take a look at the remarkable achievements in computing technology till the current time.

Timeline of Developments

300 BC: The abacus was an early aid for mathematical computations and was designed to aid human's memory while performing calculations. A skilled abacus operator can add and subtract with the same speed as that of a person performing the same calculation using a hand calculator. The invention of abacus is often wrongly attributed to China. It was used by the Babylonians even in 300 BC and is still in use today (in the Far East).

1822: English mathematician Charles Babbage designed a steam-driven calculating machine that could compute tables of numbers. Though the project failed as he could not complete the construction of the engine, it laid the foundation for the first computer.

1890: Herman Hollerith, an American inventor, designed a punched card system to calculate the 1880 census. The system completed the task in three years saving the US government \$5 million. Later Herman established a company that we today know as IBM.

1936: British mathematician Alan Turing conceptualized a universal machine called the Turing machine capable of computing anything that is computable. The central concept of the modern computer is based on this machine.

1941: John Vincent Atanasoff, a Bulgarian-American physicist, and his graduate student, Clifford Berry, at Iowa State College designed Atanasoff–Berry computer (ABC) that could solve 29 equations simultaneously. It was the first time a computer could store information in its main memory.

1943–1944: John W. Mauchly and J. Presper Eckert built Electronic Numerical Integrator and Calculator (ENIAC),

which is considered as the grandfather of digital computers. It filled a 20×40 feet room and had 18,000 vacuum tubes.

1946: Mauchly and Presper designed UNIVAC, which was the first commercial computer for business and government applications.

1947: William Shockley, John Bardeen, and Walter Brattain of Bell Laboratories invented the transistor. Soon vacuum tubes in computers were replaced by transistors.

1953: Grace Hopper developed the first computer language—COBOL.

1954: The FORTRAN programming language was developed.

1958: Jack Kilby of Texas Instruments and Robert Noyce at Fairchild Semiconductor Corporation separately invented the integrated circuit, which is commonly known as the computer chip.

1964: Douglas Engelbart developed a prototype of the modern computer, with a mouse and a graphical user interface (GUI). This was a remarkable achievement as this shifted computers from a specialized machine for scientists and mathematicians to a machine that can be used by general public.

1969: Unix operating system was developed at Bell Labs. It was written in the C programming language and was designed to be portable across multiple platforms. Soon it became the operating system of choice among mainframes at large companies and government entities.

1970: DRAM chip was introduced by Intel.

1971: Alan Shugart with his team in IBM invented the floppy disk which allowed data to be shared among computers.

1973: Robert Metcalfe, a research member at Xerox, developed Ethernet for connecting multiple computers and other hardware.

1974–1977: Personal computers started becoming popular.

1975: Paul Allen and Bill Gates started writing software for the Altair 8800 using the new BASIC language. On April 4, they both formed their own software company, Microsoft.

1976: Steve Jobs and Steve Wozniak started Apple Computers and developed Apple I, the first computer with a single-circuit board.

1977: Apple II was launched that offered colour graphics and incorporated an audio cassette drive for storage.

1978: WordStar, a word processor application, was released by MicroPro International.

1979: VisiCalc, the first computerized spreadsheet program for personal computers, was unveiled.

1981: The first IBM personal computer was introduced that used Microsoft's MS-DOS operating system. The term PC was popularized.

1983: The first laptop was introduced. Moreover, Apple introduced Lisa as the first PC with a GUI with drop-down menus and icons.

1985: Microsoft announced Windows as a new operating system.

1986: Compaq introduced Deskpro 386 in the market, which was a 32-bit architecture machine that provided speed comparable to mainframes.

1990: Tim Berners-Lee invented World Wide Web with HTML as its publishing language.

1993: The Pentium microprocessor introduced the use of graphics and music on PCs.

1994: PC games became popular.

1996: Sergey Brin and Larry Page developed the Google search engine at Stanford University.

1999: The term Wi-Fi was introduced when users started connecting to the Internet without wires.

2001: Apple introduced Mac OS X operating system, which had protected memory architecture and pre-emptive multitasking, among other benefits. To stay competitive, Microsoft launched Windows XP.

2003: The first 64-bit processor, AMD's Athlon 64, was brought into the consumer market.

2004: Mozilla released Firefox 1.0 and in the same year Facebook, a social networking site, was launched.

2005: YouTube, a video sharing service, was launched. In the same year, Google acquired Android, a Linux-based mobile phone operating system.

2006: Apple introduced MacBook Pro, its first Intel-based, dual-core mobile computer.

2007: Apple released iPhone, which brought many computer functions in the smartphone.

2009: Microsoft launched Windows 7 in which users could pin applications to the taskbar.

2010: Apple launched iPad, which revived the tablet computer segment.

2011: Google introduced Chromebook, a laptop that runs on the Google Chrome operating system.

2015: Apple released the Apple Watch. In the same year, Microsoft launched Windows 10.

2016: First reprogrammable quantum computer was created.

2017: The Defense Advanced Research Projects Agency (DARPA), U.S. Department of Defense, started a project to develop "Molecular Informatics" programme that uses molecules as computers. This is based on the idea that millions of molecules exist, and each molecule has a unique 3D structure and properties such as shape, size, and colour. This can be used to encode and process data

beyond the 0s and 1s of current binary-based, digital architectures. If the project is successful, future computers may be minuscule molecular machines.

After reading these interesting developments in computing technology, let us also understand the evolution of computers through different generations.

First Generation (1942–1955)

Hardware technology First generation computers were manufactured using thousands of vacuum tubes (see Figure 1.4); a vacuum tube is a device made of fragile glass.

Memory Electromagnetic relay was used as primary memory and punched cards were used to store data and instructions.

Software technology Programming was done in machine or assembly language.

Used for Scientific applications

Examples ENIAC, EDVAC, EDSAC, UNIVAC I, IBM 701

Highlights

- Fastest calculating device of those times
- Too bulky and required a complete room for storage
- Highly unreliable as vacuum tubes emitted a large amount of heat and burnt frequently
- Required air-conditioned rooms for installation
- Costly
- Difficult to use
- Required constant maintenance because vacuum tubes used filaments that had limited lifetime. Therefore, these computers were prone to frequent hardware failures



Figure 1.4 Vacuum tube
© Vladyslav Danilin/Shutterstock

Second Generation (1955–1964)

Hardware technology Second generation computers were manufactured using transistors (see Figure 1.5). Transistors were reliable, powerful, cheaper, smaller, and cooler than vacuum tubes.

Memory Magnetic core memory was used as primary memory; magnetic tapes and magnetic disks were used to store data and instructions. These computers had faster and larger memory than the first generation computers.

Software technology Programming was done in high-level programming languages. Batch operating system was used.

Used for Scientific and commercial applications

Examples Honeywell 400, IBM 7030, CDC 1604, UNIVAC LARC

Highlights

- Faster, smaller, cheaper, reliable, and easier to use than the first generation computers
- Consumed 1/10th the power consumed by the first generation computers
- Bulky in size and required a complete room for installation
- Dissipated less heat than the first generation computers but still required air-conditioned rooms
- Costly
- Difficult to use

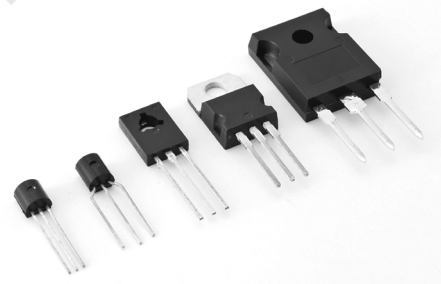


Figure 1.5 Transistors
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Third Generation (1964–1975)

Hardware technology Third generation computers were manufactured using integrated chips (ICs) (shown in Figure 1.6). ICs consist of several components such as transistors, capacitors, and resistors on a single chip to avoid wired interconnections between components. These computers used *SSI* and *MSI* technology. Minicomputers came into existence.

Note

Initially, ICs contained 10–20 components. This technology was called Small Scale Integration (SSI). Later, it was enhanced to contain about 100 components. This was called MSI (Medium Scale Integration).

Memory Larger magnetic core memory was used as primary memory; larger capacity magnetic tapes and magnetic disks were used to store data and instructions.

Software technology Programming was done in high-level programming languages such as FORTRAN, COBOL, Pascal, and BASIC. Time sharing operating system was used. Software was separated from the hardware. This allowed users to invest only in the software they need.

Used for Scientific, commercial, and interactive online applications

Examples IBM 360/370, PDP-8, PADP-11, CDC6600

Highlights

- Faster, smaller, cheaper, reliable, and easier to use than the second generation computers
- Consumed less power than the second generation computers
- Bulky in size and required a complete room for installation
- Dissipated less heat than the second generation computers but still required air-conditioned rooms
- Costly
- Easier to use and upgrade

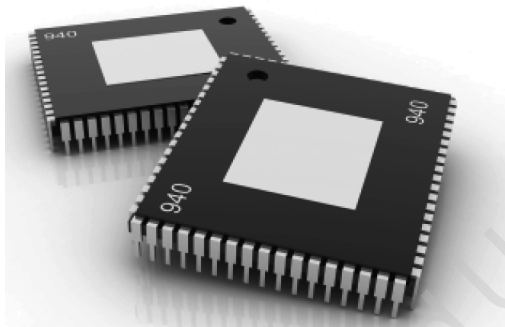


Figure 1.6 Integrated circuits

Fourth Generation (1975–1989)

Hardware technology Fourth generation computers were manufactured using ICs with LSI (Large Scale Integration) and later with VLSI (Very Large Scale Integration) technology (see Figure 1.7). Microcomputers came into existence. Use of PCs became widespread. High-speed computer networks in the form of LANs, WANs, and MANs started growing. Besides mainframes, supercomputers were also used.

Note

LSI circuits contained 30,000 components on a single chip and VLSI circuits have about one million electronic components on a single chip.

Memory Semiconductor memory was used as primary memory, and large capacity magnetic disks were used as built-in secondary memory. Magnetic tapes and floppy disks were used as portable storage devices.

Software technology Programming was done in high-level programming languages such as C and C++. GUI-based operating system (e.g. Windows) was introduced. It had icons and menus among other features to allow computers to be used as a general purpose machine by all users. UNIX was also introduced as an open source operating system. Apple Mac OS and MS-DOS were also released during this period. All these operating systems had multi-processing and multi-programming capabilities.

Used for Scientific, commercial, interactive online, and network applications

Examples IBM PC, Apple II, TRS-80, VAX 9000, CRAY-1, CRAY-2, CRAY-X/MP

Highlights Faster, smaller, cheaper, powerful, reliable, and easier to use than the previous generation computers



Figure 1.7 VLSI chip

Fifth Generation (1989–Present)

Hardware technology Fifth generation computers are manufactured using ICs with ULSI (Ultra Large Scale Integration) technology (see Figure 1.8). The use of Internet became widespread and very powerful mainframes, desktops, portable laptops, and smartphones are being used commonly. Supercomputers use parallel processing techniques.

Note

ULSI circuits contain about 10 million electronic components on a single chip.

Memory Semiconductor memory is used as primary memory; large capacity magnetic disks are used as built-in secondary memory. Magnetic tapes and floppy disks were used as portable storage devices, which have now been replaced by optical disks and USB flash drives.

Software technology Programming is done in high-level programming languages such as Java, Python, and C#. GUI-based operating systems such as Windows, Unix, Linux, Ubuntu, and Apple macOS are being used. These operating systems are more powerful and user-friendly than the ones available in the previous generations.

Used for Scientific, commercial, interactive online, multimedia (graphics, audio, video), and network applications

Examples IBM notebooks, Pentium PCs, SUM workstations, IBM SP/2, Param supercomputer

Highlights

- Faster, smaller, cheaper, powerful, reliable, and easier to use than the previous generation computers
- Speed of microprocessors and the size of memory are growing rapidly
- High-end features available on mainframe computers in the fourth generation are now available on the microprocessors
- Consume less power than computers of prior generations
- Air-conditioned rooms required for mainframes and supercomputers but not for microprocessors



Figure 1.8 ULSI chip

1.5 CLASSIFICATION OF COMPUTERS

Computers can be broadly classified into four categories based on their speed, amount of data that they can process, and price (refer to Figure 1.9). These categories are as follows:

- Supercomputers
- Mainframe computers
- Minicomputers
- Microcomputers

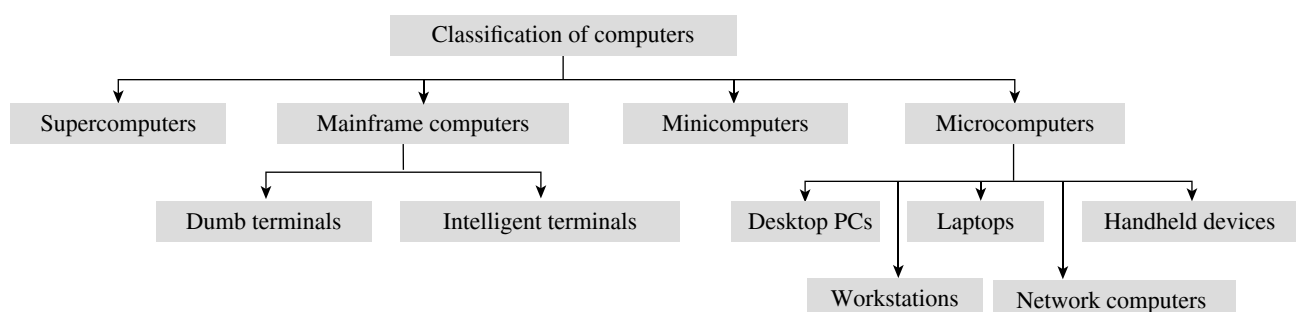


Figure 1.9 Classification of computers

1.5.1 Supercomputers

Among the four categories, the supercomputer is the fastest, most powerful, and most expensive computer (see Figure 1.10). Supercomputers were first developed in the 1980s to process large amounts of data and to solve complex scientific problems. Supercomputers use parallel processing technology and can perform more than one trillion calculations in a second.

A single supercomputer can support thousands of users at the same time. Such computers are mainly used for weather forecasting, nuclear energy research, aircraft design, automotive design, online banking, controlling industrial units, etc. Some examples of supercomputers are CRAY-1, CRAY-2, CYBER 205, and ETA A-10.



Figure 1.10 Supercomputer

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1.5.2 Mainframe Computers

Mainframe computers are large-scale computers which are smaller than supercomputers. These are very expensive and need a very large clean room with air conditioning (see Figure 1.11), thereby making them very costly to deploy. As with supercomputers, mainframes can also support multiple processors. For example, the IBM S/390 mainframe can support 50,000 users at the same time. Users can access mainframes by either using terminals or via PCs. The two types of terminals that can be used with mainframe systems are as follows:

Dumb Terminals

Dumb terminals consist of only a monitor and a keyboard (or mouse). They do not have their own CPU and memory and use the mainframe system's CPU and storage devices.

Intelligent Terminals

In contrast to dumb terminals, intelligent terminals have their own processor and thus can perform some processing operations. However, just like the dumb terminals, they do not have their own storage space. Usually, PCs are used as intelligent terminals to facilitate data access and other services from the mainframe system.

Mainframe computers are typically used as servers on the World Wide Web. They are also used in organizations such as banks, airline companies, and universities, where a large number of users frequently access the data stored in their databases. IBM is the major manufacturer of mainframe computers. Some examples of mainframe computers include IBM S/390, CYBER 176, and Amdahl 580.



Figure 1.11 Mainframe computer
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1.5.3 Minicomputers

As the name suggests, minicomputers are smaller, cheaper, and slower than mainframes. They are called minicomputers because they were the smallest computer of their time. Also known as *midrange computers*, the

capabilities of minicomputers fall between mainframe and personal computers.

Minicomputers are widely used in business, education, hospitals, government organizations, etc. While some minicomputers can be used only by a single user, others are specifically designed to handle multiple users simultaneously. Usually, single-user minicomputers are used for performing complex design tasks.

As with mainframes, minicomputers can also be used as servers in a networked environment, and hundreds of PCs can be connected to it.

The first minicomputer was introduced by Digital Equipment Corporation (DEC) in the mid-1960s. Other manufacturers of minicomputers include IBM Corporation (AS/400 computers), Data General Corporation, and Prime Computer.

1.5.4 Microcomputers

Microcomputers, commonly known as PCs, are very small and inexpensive. The first microcomputer was designed by IBM in 1981 and was named IBM PC. Later on, many computer hardware companies copied this design and termed their microcomputers as *PC-compatible*, which refers to any PC that is based on the original IBM PC design.

Another type of popular PC is designed by Apple. PCs designed by IBM and other PC-compatible computers have a different architecture from that of Apple computers. Moreover, PCs and PC-compatible computers commonly use the Windows operating system, while Apple computers use the Macintosh operating system (macOS). PCs can be classified into the following categories:

Desktop PCs

A desktop PC is the most popular model of PCs. The system unit of the desktop PC can be placed flat on a desk or a table. It is widely used in homes and offices.

Laptops

Laptops (Figure 1.12) are small microcomputers that can easily fit inside a briefcase. They are very handy and can easily be carried from one place to another. They may also be placed on a user's lap (thus the name). Hence, laptops are very useful, especially when going on long journeys. Laptops operate on a battery and do not always have to be plugged in like desktop computers.

The memory and storage capacity of a laptop is almost equivalent to that of a desktop computer. As with desktop computers, laptops also have hard disk drives, USB drives, etc. For input, laptops have a built-in keyboard and a trackball/touchpad, which is used as a pointing device (as a mouse is used for a desktop PC).

Today, laptops have the same features and processing speed as the most powerful PCs. However, a drawback is that laptops are generally more expensive than desktop computers.



Figure 1.12 Laptop

© You can more/Shutterstock

Workstations

Workstations are single-user computers that have the same features as PCs, but their processing speed matches with that of a minicomputer or a mainframe computer. Workstation computers have advanced processors, and more memory and storage capacity than PCs. Therefore, they are more expensive and powerful than a normal desktop computer.

Although workstation computers are widely used as powerful single-user computers by scientists, engineers, architects, and graphics designers, they can also be used as servers in a networked environment.

Network Computers

Network computers are specially designed to be used as terminals in a networked environment. For example, some network computers are specifically designed to access data stored on a network (including the Internet and intranet). They have less processing power, memory, and storage than a desktop computer.

Some network computers do not have any storage space and merely rely on the network's server for data storage and processing tasks. The concept of network computers had become popular in the mid-1990s when several variations of computers such as Windows terminals, NetPCs, and diskless workstations were widely used.

Network computers that are specifically designed to access only the Internet or intranet are often known as Internet PCs or Internet boxes. Some network computers used in homes do not even have a monitor. Such computers may be connected to a television, which serves as the output device. The most common example of a home-based network computer is Web TV, which enables a user to connect a television to the Internet. The Web TV is equipped with a special set-top box that is used to connect to the Internet. The set-top box also provides controls to enable the user to navigate the Internet, send and receive e-mails, and perform other tasks on the network while watching television. The other reason for the popularity of network computers is that they are cheaper to purchase and maintain than PCs.

Handheld Computers

The mid-1990s witnessed a range of small personal computing devices that are commonly known as handheld computers, or mobile computers. These computers are called handheld computers because they can fit in one hand, while users can use the other hand to operate them. Handheld computers are very small in size, and hence they have small-sized screens and keyboards.

Some examples of handheld computers are as follows:

Smartphones These days, cellular phones are web-enabled telephones. Such phones are also known as smartphones because, in addition to basic phone capabilities, they also facilitate users to access the Internet and send e-mails, edit Word documents, create an Excel sheet, prepare a presentation, and lots more.

Smartphones run an advanced mobile operating system that enables them to run various applications. The four major mobile operating systems are iOS, Android, BlackBerryOS, and Windows Mobile. Smartphones also have a processor, more storage space, more memory, and a larger screen than a regular cell phone.

In a nutshell, a smartphone refers to a multi-functional mobile phone handset that has varied functionalities from a camera to a web browser to a high-density display.

Tablet PCs A tablet PC (see Figure 1.13) is a computing device that is smaller than a laptop, but bigger than a smartphone. Features such as user-friendly interface, portability, and touch screen have made them very popular in the recent years. These days, a wide range of high-performance tablets are available in the market. While all of them look similar from outside, they may differ in features such as operating system, speed of data connectivity, camera specifications, size of the screen, processing power, battery life, and storage capability.

Some operating systems that are used in tablets are Android Jellybean (an open-source operating system built by Google), Windows 8, and iOS (developed by Apple). Each operating system has its own advantages and disadvantages and a proprietary app store, from which users can download applications, extending the tablet's functionality. These apps range from games to specialized word processors to e-book readers.

While users can easily type directly on the surface of a tablet, some users prefer a wireless or bluetooth-connected keyboard. These days, tablets also offer an optional docking station with keyboards which transforms the tablet into a full-featured netbook.

Uses The following are the uses of Tablet PCs:

- Video conferencing
- Reading e-books, e-newspaper
- Watching movies
- Playing games
- Sharing pictures, video, songs, documents, etc.
- Browsing the Internet
- Sending e-mails

- Business people use them to perform tasks such as editing a document, exchanging documents, taking notes, and giving presentations
- Tablets are best used in crowded places such as airports and coffee shops, where size and portability become more important



Figure 1.13 Tablet

© ecco/Shutterstock

Note

Tablets are preferably used when one does not have to perform heavy processing tasks and does not require a CD or a DVD player.

1.6 APPLICATIONS OF COMPUTERS

SCAN
THE PAGE
TO KNOW
MORE



When the first computers were developed, they were used only in the fields of mathematics and science. In fact, the first effective utilization of computers was for decoding messages in military applications. Later on, computers were used in real-time control systems, like for landing on the moon. However, with the advancement of technology, the cost of computers and their maintenance declined. This opened the way for computers to be extensively used in the business and commercial sector for information processing. Today, computers are widely used in fields such as engineering, health care, banking, and education. Let us discuss how computers are being effectively utilized to perform important tasks.

Word processing Word processing software enables users to read and write documents. Users can also add images, tables, and graphs for illustrating a concept. The software automatically corrects spelling mistakes and includes copy-paste features (which is very useful where the same text has to be repeated several times).

Internet The Internet is a network of networks that connects computers all over the world. It gives a user

access to a vast amount of information, much more than that available in any library. Using e-mail, the user can communicate in seconds with a person who is located thousands of miles away. Chat software enables users to chat with another person in real time (irrespective of the physical location of that person). Video conferencing tools are becoming popular for conducting meetings with people who are unable to be present at a particular place.

Digital video or audio composition Computers make audio or video composition and editing very simple. This has drastically reduced the cost of equipment to compose music or make a film. Graphics engineers use computers for developing short or full-length films and creating 3D models and special effects in science fiction and action movies.

Desktop publishing Desktop publishing software enables users to create page layouts for entire books.

Let us now have a look at the different areas where computers are being widely utilized.

e-Business

e-Business or electronic business is the process of conducting business via the Internet. This may include buying and selling of goods and services using computers and the Internet. Use of e-mail and video conferencing technology has revolutionized the way business is being conducted these days.

While an e-mail is a service that delivers messages from a sender to one or more receivers via computer, voice mail systems capture, store, and transmit spoken messages. Video conferencing, which is an advanced form of teleconferencing, provides a complete simulation of a normal meeting environment in which all concerned parties can see, hear, and present material, just as if they were in the same room. These meetings not only speed up business process but also save the cost of travel and the cost of time wasted during travel.

Note

Both the terms—e-Commerce and e-Business—are often used interchangeably.

Companies today use e-commerce applications for marketing, transaction, and product and customer services processing. For example, the website of a company can perform activities such as interactive marketing, ordering, payment, and customer support process.

e-commerce used to perform transactions between business partners or customers has several applications such as home banking, electronic shopping, renting a house, finding a job, conducting an auction, marketing and advertising products or services, and providing customer service. e-commerce helps users to conduct business transactions in the following forms:

Business-to-consumer or B2C In this form of electronic commerce, business companies deploy their websites on the Internet to sell their products and services to customers. On their websites, they provide features such as catalogues, interactive order processing system, secure electronic payment system, and online customer support.

Business-to-business or B2B This type of electronic commerce involves business transactions performed between business partners (customers are not involved). For example, companies use computers and networks to order raw materials from their suppliers. Companies can also supply their products to their dealers.

Consumer-to-consumer or C2C This type of electronic commerce enables customers to carry business transactions among themselves. For example, on auction websites, a customer sells his/her product which is purchased by another customer.

Electronic banking Electronic banking, also known as cyberbanking or online banking, supports various banking activities, such as opening accounts and funds transfer, conducted from any place instead of a physical bank location.

Bioinformatics

Bioinformatics is an interdisciplinary field of molecular biology, computer science, statistics, and mathematics. It involves analyses of genomic information to understand human diseases and thus discover new drugs to treat those diseases. Computers are used to collect, store, analyse, and integrate biological and genetic information to facilitate gene-based drug discovery and development.

We know that DNA is made up of smaller pieces of molecules and the sequence of molecules along a string of DNA contains all information about an organism. This information can be used to grow new organisms. For example, scientists are using this information to grow better variety of crops, to generate a genome that will enable cows to yield more milk, so and so forth.

Computers help scientists to store the DNA information in huge databases, retrieve it as and when required, and analyse it to grow and develop new organisms.

Scientists also use bioinformatics to identify diseases and develop drugs for them. This is done by writing special programs that compare the sequence of molecules in the DNA of a healthy person with that of the patient's. These analyses help them to identify what is missing in a patient and to determine drugs that can make the molecules in the DNA of the patient look similar to that of a healthy person. For example, one of the drugs to treat AIDS was designed using bioinformatics techniques.

Health care

Like in our daily lives, computers have also become a necessary device in the healthcare industry. The following

are areas in which computers are extensively used in the healthcare industry:

Storing records To begin with, computers are first and foremost used to store the medical records of patients. Earlier, patient records were kept on paper, with separate records dealing with different medical issues. With time, the number of prescriptions, medical reports, etc., grow in volume making it difficult to maintain and analyse. Use of computers to store patient records has led to great improvement in the efficiency and accuracy of the entire process.

Now, the entire medical history of patients is easily accessible. Since the records are electronically stored, they can be easily shared between different doctors (in same or different healthcare organizations) who are treating the same patient.

Surgical procedures Computers are used for certain surgical procedures. They enable surgeons to use computers to control and move surgical instruments in the patient's body for a variety of surgical procedures. In such surgeries, a small incision is made, and then a small surgical tool with an attached camera is placed inside the patient's body. This reduces the risk of complications from a larger surgical wound, and minimizes damage done to the patient's body. In such a scenario, computers are not only used to drive the tools but also used to relay images from inside the patient's body out to the doctors.

Computers also help to determine the cause of an affliction or illness. For example, computers can combine ultrasonography and imaging in fields like cardiology to check the functionality of the heart. In case of a serious ailment, the causes can be detected in less time and treatment can be started at the earliest, thereby saving a number of lives.

Today, tablets and computers are being used in surgical consultations and video conferencing between doctors.

Better diagnosis and treatment Computers help physicians make better diagnoses and recommend treatments. Moreover, computers can be used to compare expected results with actual results in order to help physicians make better decisions.

Doctors sitting in hospitals can monitor their patients sitting in their homes by using computer-based systems. As soon as warning signs of serious illnesses are spotted, they alert the concerned doctor quickly.

Geographic Information System and Remote Sensing

A geographic information system (GIS) is a computer-based tool for mapping and analysing earth's features. It integrates database operations and statistical analysis to be used with maps. GIS manages location-based information and provides tools for display and analysis of statistics such as population count, types of vegetation, and economic development opportunities. Such type of information helps to predict outcomes and plan strategies.

Remote sensing is the science of taking measurements of the earth's features using sensors on airplanes or

satellites. These sensors collect data in the form of images, which are then analysed to derive useful information.

The key feature of remote sensing is that it acquires information about an object without making physical contact with it. Remote sensing is a sub-field of geography, which can be applied in the following areas:

- Monitoring deforestation in areas like the Amazon Basin
- Studying features of glaciers in Arctic and Antarctic regions
- Analysing the depth of coastal and ocean areas
- Studying land usage in agriculture
- Examining the health of indigenous plants and crops
- Determining the prospect for minerals
- Locating and measuring intensity of earthquakes (after they had occurred) by comparing the relative intensity and precise timings of seismograms collected from different locations

Meteorology

Meteorology is the study of the atmosphere. This branch of science observes variables of Earth's atmosphere such as temperature, air pressure, water vapour, and the gradients and interactions of each variable, and how they change over time. Meteorology has applications in many diverse fields such as the military, energy production, transport, agriculture, and construction. Some of the applications include the following:

Weather forecasting It includes application of science and technology to predict the state of the atmosphere (temperature, precipitation, etc.) for a future time and a given location. Weather forecasting is done by collecting quantitative data about the current state of the atmosphere and analysing the atmospheric processes to predict weather patterns.

Weather forecasts are especially made to generate warnings regarding heavy rainfall, snowfall, storms, etc. They are also important to agriculturists and also to commodity traders within stock markets. Temperature forecasts are used by utility companies to estimate demand over coming days.

Aviation meteorology Aviation meteorology studies the impact of weather on air traffic management. It helps cabin crews to understand the implications of weather on their flight plan as well as their aircraft.

Agricultural meteorology Agricultural meteorology deals with the study of effects of weather and climate on plant distribution, crop yield, water-use efficiency, and plant and animal development.

Nuclear meteorology Nuclear meteorology studies the distribution of radioactive aerosols and gases in the atmosphere.

Maritime meteorology Maritime meteorology is the study of air and wave forecasts for ships operating at sea.

Multimedia and Animation

One of the most powerful aspects of computing technology is multimedia and animation which combines still images, moving images, text, and sound in meaningful ways.

Note

Displaying a number of still images within a fraction of a second gives an animation effect. For example, displaying at least 30 still images in a second gives an effect of a moving image.

Using animation software, we can reproduce real-world phenomena such as fire, smoke, fluids, movement of chemicals through the air and ground, and the respiratory system to name a few. Animation is an easy and effective way to show complex interactions or events. Thus, it is an excellent tool for educating an audience.

A dynamic multimedia presentation (created using tools like MS PowerPoint) can make the message not only easily understood but also effective. Multimedia presentation helps corporate people to share information or their ideas and graphically present information in a more understandable and persuasive manner. Multimedia presentations can be recorded and played or displayed dynamically depending on a user's inputs. Multimedia and animation is used to create computer games. A laser show is also an example of a multimedia application. Multimedia and animation is used to add special effects in movies.

In education, multimedia is used to prepare training courses. Students find it difficult to learn complex computer algorithms and data structures by reading only a textual explanation. However, they find it interesting to learn through interacting with an animation of the algorithm.

Note

Edutainment is the combination of education with entertainment.

Legal System

Computers are used by lawyers to search for legal precedent and case research. Lawyers use computers to look through millions of individual cases and find whether similar or parallel cases have been approved, denied, criticized, or overruled in the past. This enables lawyers to formulate strategies based on past case decisions. Moreover, computers are also used to keep track of appointments and prepare legal documents and briefs.

Retail Business

Computers are used in retail shops to enter orders, calculate costs, and print receipts. They are also used to keep an inventory of the products available and their complete description.

Sports

In sports, computers are used to compile statistics, identify weak players and strong players by analysing statistics, sell tickets, create training programmes and diets for athletes,

and suggest game plan strategies based on the competitor's past performance. Computers are also used to generate most of the graphic art displays flashed on scoreboards.

Television networks use computers in the control room to display action replays and insert commercial breaks as per schedule.

In addition, there are simulation software packages available that help sportspersons to practice their skills as well as identify flaws in the technique.

Simulation

Supercomputers that can process enormous amount of data are widely used in simulation tests. Simulation of automobile crashes or airplane emergency landings is done to identify potential weaknesses in designs without risking human lives. Supercomputers also enable engineers to design aircraft models and simulate the effects that winds and other environmental forces have on those designs. Astronauts are trained using computer-simulated problems that could be encountered during launch, in space, or upon return to earth.

Aerospace

Spacecrafts are usually monitored using computers that not only keep a continuous record of the voyage and speed, direction, fuel, and temperature, but also suggest corrective action if the vehicle makes a mistake. The remote stations on earth compare all these quantities with the desired values, and in case these values need to be modified to enhance the performance of the spacecraft, signals are immediately sent that set in motion the mechanics to rectify the situation. With the help of computers, all this is done within a fraction of a second.

Education

A computer is a powerful teaching aid and can act as another teacher in the classroom. Teachers use computers to develop instructional material. Teachers may use pictures, graphs, and graphical presentations to easily illustrate an otherwise difficult concept. Moreover, teachers at all levels can use computers to administer assignments and keep track of grades. Students can also give exams online and get instant results.

Industry and Engineering

Computers are found in all kinds of industries, such as thermal power plants, oil refineries, and chemical industries, for process control, computer-aided designing (CAD), and computer-aided manufacturing (CAM).

Computerized process control (with or without human intervention) is used to enhance efficiency in applications such as production of various chemical products, oil refining, paper manufacturing, and rolling and cutting of steel to customer requirements.

In CAD, computers and graphics-oriented software are integrated for automating the design and drafting process. It helps an engineer to design a 3D machine part, analyse its

characteristics, and then subject it to simulated stresses. In case a part fails the stress test, its specifications can be modified on the computer and retested. The final design specifications are released for production only when the engineer is satisfied that the part meets strength and other quality considerations.

The CAM phase begins when the CAD phase is complete. In this phase, the metal or other materials are manufactured while complying with their specifications. This computer-controlled manufacturing helps to produce high-quality products.

Robotics

Robots are computer-controlled machines mainly used in the manufacturing process in extreme conditions where humans cannot work. For example, in high temperature, high pressure conditions or in processes that demand very high levels of accuracy. The main distinguishing feature between a robot and other automated machines is that a robot can be programmed to carry out a complex task and then reprogrammed to carry out other complex tasks.

Decision Support Systems

Computers help business managers to analyse their organization's data to understand the present scenario of their business, view the trends in the market, and predict the future of their products. Managers also use decision support systems to analyse market research data, to study the competition, and to plan effective strategies for penetrating their markets.

Expert Systems

Expert systems are used to automate the decision-making process in a specific area, such as analysing the credit histories for loan approval and diagnosing a patient's condition for prescribing an appropriate treatment. Expert systems analyse the available data in depth to recommend a course of action. A medical expert system might provide the most likely diagnosis of a patient's condition.

To create an expert system, an extensive amount of human expertise in a specific area is collected and stored in a database, also known as a knowledge base. A software called an interface engine analyses the data available in the knowledge base and selects the most appropriate response.

Publishing

Computers play a very important role in designing and printing books/magazines, journals, brochures, etc. Publishing software, such as Adobe InDesign, CorelDraw, and QuarkXpress, offer predefined templates using which a user can easily add text, images, or other symbols to a document. Documents created using computers are easy to edit. Word-processing software automatically checks and corrects spelling and grammar mistakes. Moreover, publishing by computer takes less time to create and share with others.

It is because of all these reasons that digital books make up about 30% of the book publishing market. Several magazines

for niche markets are especially designed for the online market. It has become very convenient for first-time writers to self-design and publish their works using these tools than approaching traditional publishers to publish their books.

Data Analysis

Researchers and data scientists are increasingly using computers for data analysis for doing market research. Even in the academic world, data analysis is applied in fields such as sociology, psychology, political science, medicine, and educational science. Computers and relevant software enables users to gain a deeper insight into data not only efficiently and effectively but also in very less time. Computers can easily handle very large amounts of data. It can not only store data but also perform repetitive calculations rapidly and accurately. Results of analysis can be presented in the form of charts which are easy to read and interpret.

Note

MATLAB, MS Excel, and SPSS are some commonly used software packages for performing data analysis.

Accounting

Before computers, several books of accounts such as journals, cash books, special purpose books, and ledger were maintained manually. These books helped users to prepare summary of transactions and financial statements. However, with increase in the number and complexity of transactions, computers are now being used to store and process accounting data with greater speed and accuracy.

Preparing financial statements such as balance sheet, income statement, sales ledger, purchases ledger, and stock records requires the processing of innumerable business transactions without any error. A computer can maintain records of all such transactions very effectively and economically. Among other benefits of using computers in accounting are labour saving, time saving, accuracy, minimization of frauds, and better customer relationship.

Note

Computerized accounting system gives businesses greater transparency in day-to-day transactions and provides access to vital information.

Railway and Airline Reservation

In railways and airlines, apart from maintaining train/flight schedules, tracking traffic and monitoring their movements in real time, computers are also used by customers to reserve tickets. Computers along with the power of Internet has made it easy to maintain a record of number of seats booked, passengers' names and other details, number or name of train or flight, number of seats in first, second and general class, number of seats available on a particular date, present status of a ticket using its PNR number, concessions availed, etc.

The reservation system also allows customers to do cancellation. The ease of booking and cancellation of tickets has made it very convenient for people, especially in countries such as India, which has the largest railway network in the world since handling all the reservation manually is beyond anyone's imagination.

1.7 BASIC ORGANIZATION OF A COMPUTER

A computer is an electronic device that performs five major operations:

- Accepting data or instructions (input)
- Storing data
- Processing data
- Displaying results (output)
- Controlling and coordinating all operations inside a computer

In this section, we will briefly discuss all these functions and see how one unit of a computer interacts with another to perform these operations. Refer to Figure 1.14, which shows the interaction between the different units of a computer system.

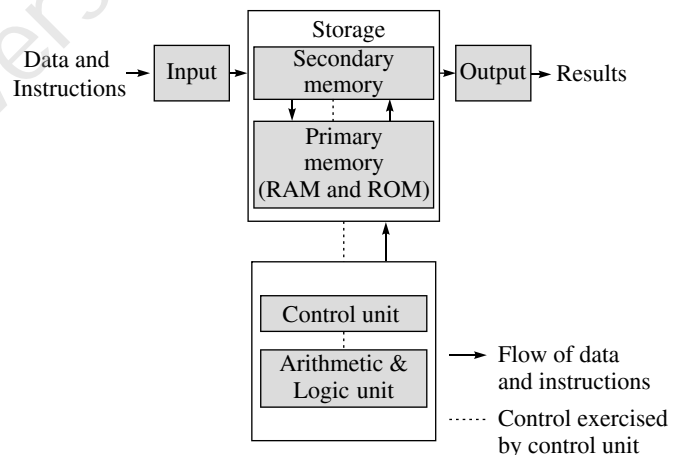


Figure 1.14 Block diagram of a computer

Input This is the process of entering data and instructions (also known as *programs*) into the computer system. The data and instructions can be entered by using different input devices such as keyboard, mouse, scanner, and trackball.

Note

Computers understand binary language, which consists of only two symbols (0 and 1), so it is the responsibility of the input devices to convert the input data into binary codes.

Storage Storage is the process of saving data and instructions permanently in the computer so that they can be used for processing. The computer storage space not only stores data and programs that operate on that data but

also stores the intermediate results and the final results of processing.

A computer has two types of storage areas:

Primary storage Primary storage, also known as *main memory*, is the storage area that is directly accessible by the CPU at very high speeds. It is used to store data and parts of programs, the intermediate results of processing, and the recently generated results of jobs that are currently being worked on by the computer. Primary storage space is very expensive and therefore limited in capacity. Another drawback of main memory is that it is volatile in nature; that is, as soon as the computer is switched off, the information stored gets erased. Hence, it cannot be used as a permanent storage of useful data and programs for future use. Both random access memory (RAM) and read-only memory (ROM) are examples of primary storage.

Secondary storage Also known as *auxiliary memory*, this memory is just the opposite of primary memory. It overcomes all the drawbacks of the primary storage area. It is cheaper, non-volatile, and used to permanently store data and programs of those jobs that are not being currently executed by the CPU. Secondary memory supplements the limited storage capacity of primary memory. An example is the magnetic disk used to store data, such as C and D drives, for future use.

Processing The process of performing operations on the data as per the instructions specified by a user (program) is called processing. Data and instructions are taken from the primary memory and transferred to the arithmetic logic unit (ALU), which performs all sorts of calculation. The intermediate results of processing may be stored

in the main memory, as they might be required again. When the processing completes, the final result is then transferred to the main memory. Hence, the data may move from the main memory to the ALU multiple times before the processing is over.

Output Output is the process of giving the result of data processing to the outside world (external to the computer system). The results are given through output devices such as monitors and printers. Since the computer accepts data only in binary form and the result of processing is also in binary form, the result cannot be directly given to the user. The output devices, therefore, convert the results available in binary codes into a human-readable form before displaying it to the user.

Control The control unit (CU) is the central nervous system of the entire computer system. It manages and controls all the components of the computer system. It is the CU that decides the manner in which instructions will be executed and operations performed. It takes care of the step-by-step processing of all operations that are performed in the computer.

Note that the CPU is a combination of the ALU and the CU. The CPU is better known as the brain of the computer system because the entire processing of data is done in the ALU, and the CU activates and monitors the operations of other units (such as input, output, and storage) of the computer system.

Note

ALU, CU, and CPU are the key functional units of a computer system.

POINTS TO REMEMBER

- A computer is an electronic machine that accepts data and instructions and performs computations on the data based on the instructions.
- Computers are used in all interactive devices, such as cellular telephones, GPS units, portable organizers, ATMs, and gas pumps.
- Modern-day computers are based on the principle of the stored program concept, which was introduced by Sir John von Neumann in the late 1940s.
- The speed of the computer is usually given in nanoseconds and picoseconds.
- The term computer generation refers to the different advancements in computer technology. With each new generation of computers, the circuitry has become smaller and more advanced than that in the previous generation.
- First generation computers used a very large number of vacuum tubes for circuitry and magnetic drums for memory.
- Second generation computers were manufactured using transistors rather than vacuum tubes.
- The development of the integrated circuit was the hallmark of the third generation of computers.
- The microprocessor started the fourth generation of computers, with thousands of integrated circuits built into a single silicon chip.
- Fifth generation computers are manufactured using integrated chips built with ultra-large scale integration (ULSI) technology.
- The CPU is a combination of the ALU and the CU. The CPU is known as the brain of the computer system.
- The CU is the central nervous system of the entire computer system. It manages and controls all the components of the computer system.

Exercises

Fill in the Blanks

1. A program is the _____.
2. Computers operate on _____ based on _____.
3. Computers can perform _____ calculations in a second.
4. The speed of computers is expressed in _____ or _____.
5. Raw facts or figures are called _____.
6. _____ is an example of primary memory.
7. _____ and _____ are examples of first generation computing devices.
8. Second generation computers were first developed for the _____ industry.
9. _____ packages allow easy manipulation and analysis of data organized in rows and columns.
10. CRAY-1, CRAY-2, CYBER 205, and ETA A-10 are _____.
11. _____ concept was introduced by Sir John von Neumann in the late 1940s.
12. Android Jellybean, Windows, and iOS are all examples of popular operating systems used in _____ and _____.
13. First generation computers were manufactured using _____.
14. The intermediate results of processing are stored in _____ memory.
15. _____ is a mathematical model of computation that defines an abstract machine.

Review Questions

1. Define a computer.
2. Differentiate between data and information.
3. Differentiate between primary memory and secondary memory.
4. Write a short note on the characteristics of a computer.
5. Computers work on the garbage-in, garbage-out concept. Comment.
6. Explain the evolution of computers. Further, state how computers in one generation are better than their predecessors.
7. Broadly classify computers based on their speed, the amount of data that they can hold, and price.
8. Discuss the variants of microcomputers that are widely used today.
9. Explain the areas in which computers are being applied to carry out routine and highly specialized tasks.

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LAB ACTIVITY 1: UNDERSTANDING COMPUTER HARDWARE

As part of this activity, the instructor must show the parts of the computer to the students, as illustrated in Figure A.1.



Figure A.1 Computer case and its parts
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Activity I: Parts of a Computer

The following are some of the major parts of the computer:

CPU The CPU is the brain of the computer. It performs all calculations and controls the devices connected to the computer system. The faster the CPU, the quicker programs can process the instructions.

RAM A fast CPU is of no use if the computer does not have sufficient RAM. As discussed earlier, RAM is the computer's memory which stores information used by applications that are currently being executed by the CPU (see Figure A.2). More memory means more applications can be executed at the same time without decreasing the system's performance.

Hard disk drive (HDD) The HDD of the computer is the secondary memory of the computer system where information is stored permanently (see Figure A.3). All types of data, documents, and programs are stored on the HDD. The larger the HDD, the more the amount of data that can be stored on the drive. Though the size of the HDD does not affect the speed of execution of a program, it does affect the speed at which a user can access his/her files.

Video card The video card is a board that plugs into the motherboard of the computer and generates images for display (see Figure A.4). Many video cards these days have their own RAM and processor to enhance the speed of the graphics display. Many computers come with an in-built video chip. In such a computer, a separate video card is used only if the computer has to be used for high-end multimedia work or to play video games.

Sound card Like video cards, sound cards are expansion boards that are used to enable a computer to manipulate sound (see Figure A.5). For example, sound cards allow

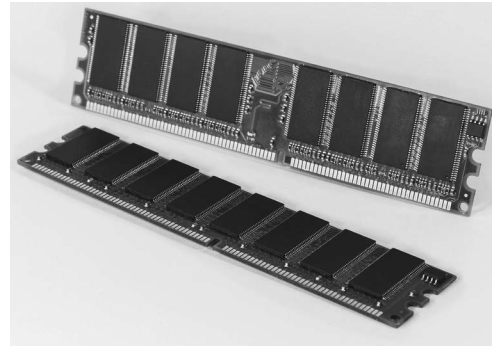


Figure A.2 RAM memory
© Chutchawarn/Shutterstock



Figure A.3 Hard disk drive
© Vladimir Arndt/Shutterstock



Figure A.4 Video card
© Leo Shoot/Shutterstock



Figure A.5 Sound card
© bogdandimages/Shutterstock

users to plug in speakers and a microphone. Some sound cards also provide jacks for connecting the computer to a common stereo. These days, many computers come with a built-in sound chip, which makes it unnecessary to buy a separate card unless a higher quality of sound is needed.

Network card A network card is used to connect the computer either to other computers or to the Internet (in case we are using a fast Internet connection such as cable or DSL).

Fans There are one or more fans inside the computer to keep the air moving and the computer cool.

Cables There are multiple wires inside the computer that are flat, ribbon-like cables. They are used to provide power and communication to the various parts inside the computer.

Activity II: Motherboard

The motherboard, also known as the mainboard or the parent board (refer Figure A.6), is the primary component of a computer. It is used to connect all the components of the computer. The motherboard is a printed circuit that has connectors for expansion cards, memory modules, the processor, etc.

Characteristics of a Motherboard

A motherboard can be classified depending on the following characteristics:

- Form factor
- Chipset
- Type of processor socket used
- Input–Output connectors

Form factor Form factor refers to the motherboard's geometry, dimensions, arrangement, and electrical requirements. The industry has defined a few standards for form factors, so that they can be used in different brands of cases.

Integrated components Some of the motherboard's components are integrated into its printed circuitry. These include the following:

- Chipset
- CMOS clock and battery
- BIOS
- System bus and expansion bus

In addition to these, the latest motherboards also have a number of onboard multimedia and networking devices (which can be disabled), such as integrated network card, integrated graphics card, integrated sound card, and upgraded hard drive controllers.

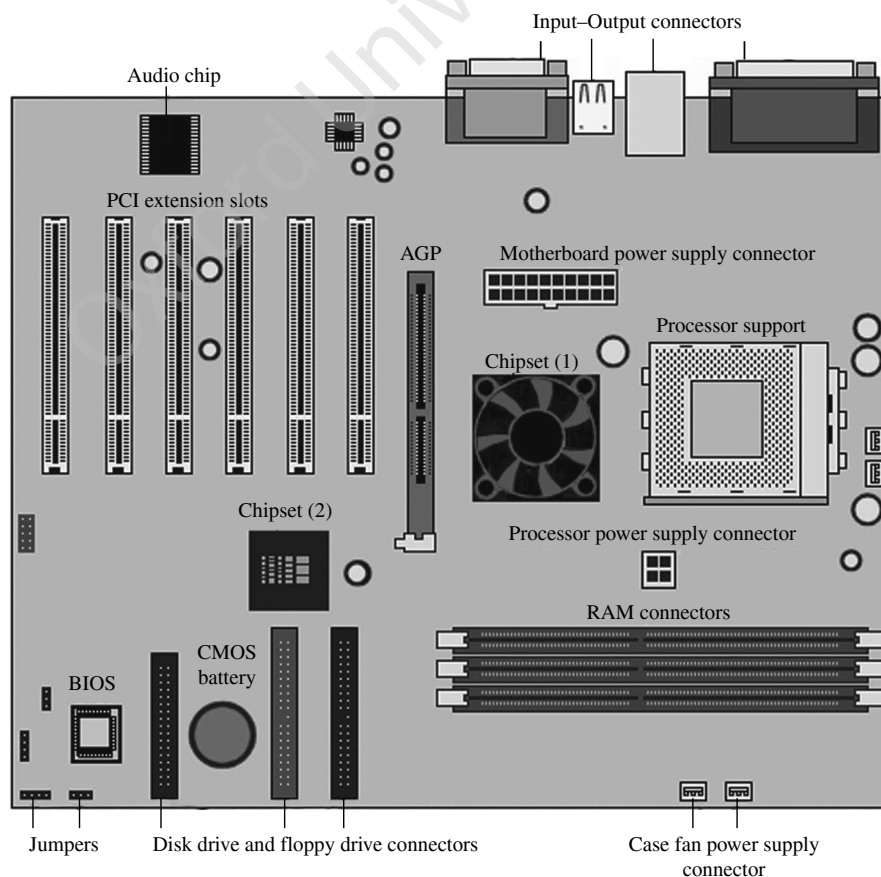


Figure A.6 Computer's motherboard

Chipset It is an electronic circuit that coordinates data transfers between the different components of the computer (such as the processor and memory). In order to enhance the computer's upgradeability, one must choose a motherboard that has the latest chipset integrated in it. Some chipsets may include a graphics or audio chip, which makes it unnecessary to install a separate graphics card or sound card. However, in case we need very high quality of audio and visual capabilities, then we must disable the graphics/audio chip in the BIOS setup and install high-quality expansion cards in the appropriate slots.

CMOS clock and battery The real-time clock (or RTC) is a circuit that is used to synchronize the computer's signals. When the computer is switched off, the power supply stops providing electricity to the motherboard. You must have observed that when we turn on the system, it always displays the correct time. This is because an electronic circuit, called the complementary metal-oxide semiconductor (CMOS) chip, saves some system information, such as time, date, and other essential system settings.

The CMOS chip is powered by a battery located on the motherboard. Information about the hardware installed in the computer (such as the number of tracks or sectors on each hard drive) is stored in the CMOS chip. Since the CMOS chip is quite slow, some systems prefer to copy the CMOS chip's content into RAM, which is a comparatively faster storage. This process of copying data into RAM is known as *memory shadow*.

Have you noticed that, at times, the system time gets reset automatically, or the clock runs late? This indicates that you need to change the battery.

BIOS The basic input/output system (BIOS) is an interface between the operating system and the motherboard. The BIOS is stored in ROM, which cannot be rewritten. The BIOS uses data stored in the CMOS chip to know about the system's hardware configuration.

To configure the BIOS, the user can use an interface known as *BIOS setup*, which can be accessed when the computer is booting. To enter BIOS setup, the user must press the DEL key. F1 and F2 keys can also be used.

Processor socket The processor (also called the *micro-processor*) is the brain of the computer. The processor is characterized by its speed or frequency, which is the rate at which it executes instructions. For example, an 800-MHz processor can perform 800 million operations per second.

The slot on the motherboard into which the processor is inserted is called the *processor socket* or *slot*. Irrespective of whether we use a slot or a socket, we must gently insert the processor, so that none of its pins are bent (it has hundreds of them). Usually, a concept called *zero insertion force* (ZIF) is used. The ZIF sockets allow the processor to be inserted very gently and easily.

When the computer is on, the processor is working and it releases heat, which must be dissipated to keep the circuits from melting. Therefore, the processor is generally mounted on a cooler that is made of metal (such as copper or aluminum), which conducts heat well. In addition to the cooler, there is also a fan to improve air circulation around it and to improve the heat transfer. The fan vents hot air from the case and lets fresh air come in from outside.

RAM connectors RAM is the primary storage area that stores data while the computer is running. However, its contents are erased when the computer is turned off or restarted. While the hard disk can store data permanently, we still need RAM because it is extremely fast when compared to mass storage devices such as hard drives. Therefore, the fast processor accesses data from RAM and not from the hard disk. The data is transferred from the hard disk to the RAM, from where it is used by the processor. RAM is available in the form of modules that plug into motherboard connectors.

Expansion slots Expansion slots are compartments into which expansion cards can be inserted. Such cards render new features or enhance the computer's performance. For example, the AGP slot (also known as Accelerated Graphics Port) is a fast port used for graphics cards.

I/O connectors The motherboard has a number of input–output sockets (Figure A.7) on its rear panel, some of which include:

- A serial port to connect some old peripherals
- A parallel port to connect old printers
- USB ports to connect more recent peripherals such as mouse and pen drive
- RJ45 connector (also known as LAN or Ethernet port) to connect the computer to a network. It corresponds to a network card integrated into the motherboard
- Video graphics array (VGA) connector to connect a monitor. This connector interfaces with the built-in graphics card
- Audio plugs that include the *line in*, *line out*, and *microphone* to connect sound speakers, hi-fi system, or microphone. This connector interfaces with the built-in sound card

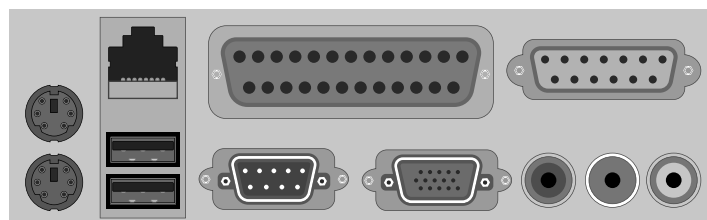


Figure A.7 I/O connectors

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