

1 Basic Computing Concepts

1.1 The Computer: A First Look

Probably when we think of a **computer** the first image that comes to mind is one that is similar to the diagram below.

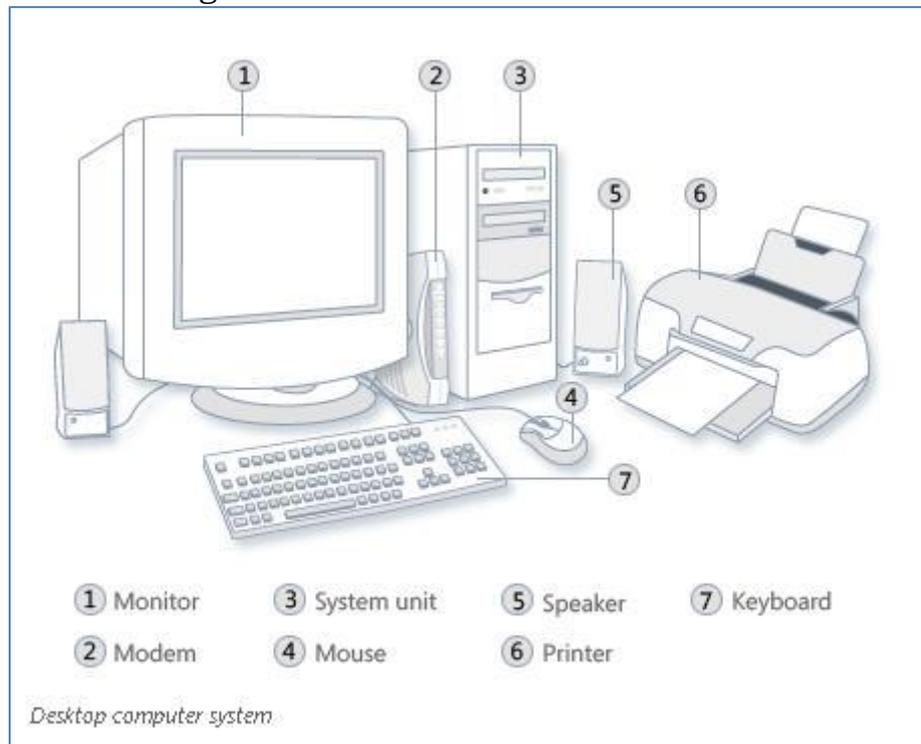


Diagram 1. A desktop computer system

This is called a **desktop computer system**. The computer below is the first **laptop computer**. It was invented by Adam Osborne in 1981. It was called the “Osborne 1” and cost \$1795.



Diagram 2. Osborne 1



Diagram 3. Pleiades: a NASA supercomputer

The computer shown here is called Pleiades, NASA's **supercomputer** in California. Pleiades now boasts 18,432 Intel® Xeon® quad- and hex-core processors that can run at a theoretical peak of approximately 973 trillion (9.73×10^{14}) floating point operations per second.



Diagram 4. An Automatic Washing Machine

Above is a picture of an automatic washing machine that has an **embedded microprocessor**.

1.2 Input and Output

Consider the desktop computer in diagram 1. The labelled parts can be divided into the following groups.

Group 1: Keyboard, mouse and scanner. These are called “**input** devices”. By means of these devices we “talk” to the computer. By means of the keyboard we tell the computer what we want to write in a letter. By means of the mouse we tell the computer which program we want to use. By means of the scanner we “pass on” an image to the computer.

Group 2: Monitor, speakers and printer. These are called “**output** devices”. By means of these devices the computer “talks” to us users. If I want to see a photo the computer shows it to me on the monitor. If I am watching the news (or just hearing) it is the speakers that are passing the words to me.

Group 3: *System unit only*. This is the part that does all the work. We say that this part “**processes**” the information. For example if the user wants to multiply two numbers this is done in the system unit. If the user wants to perform changes on a picture it is the system unit that does the work asked by the user.

Group 4: *Modem only*. The modem is the device that allows our computer system to **communicate** with the Internet.

1.3 A Simple Model of a Computer

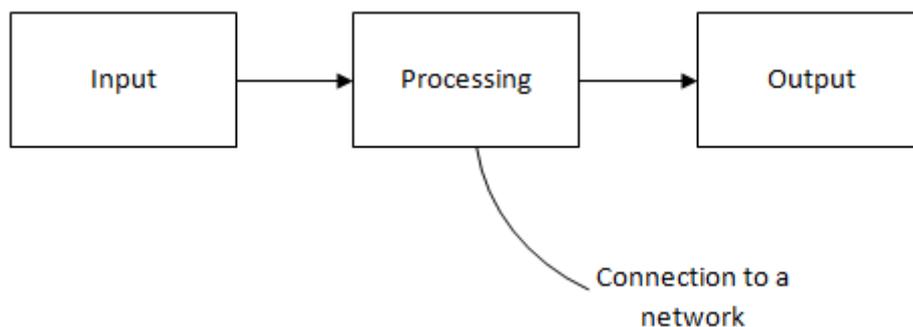


Diagram 5. A Simple Model of a Computer

1.4 Hardware

Hardware refers to objects that you can actually touch, like disks, disk drives, display screens, keyboards, printers, boards, and chips. In contrast, software is untouchable. Software exists as ideas, concepts, and symbols, but it has no substance.



Diagram 6. Computer Hardware

Books provide a useful analogy. The pages and the ink are the hardware, while the words, sentences, paragraphs, and the overall meaning are the software. A

computer without software is like a book full of blank pages - you need software to make the computer useful just as you need words to make a book meaningful.

1.5 Software

1.5.1 Programs

A **program** is a sequence of instructions.

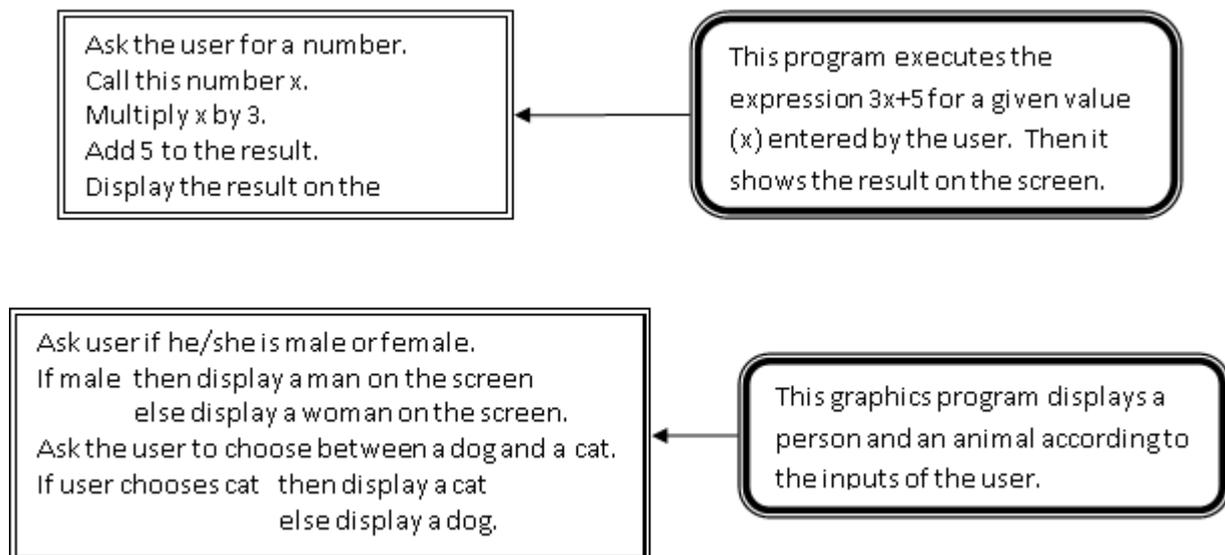


Diagram 7. Two Examples of a Program

1.5.2 Data

Data consists of the values that we enter as input for example if we want to calculate the volume of a cylinder and we enter 4cm (height of cylinder) and 1.5cm (radius of the base) then 4 and 1.5 are the data.

1.5.3 Dual Definition

Software is normally defined as programs. However some computer scientists define software as both programs and data.

Software = Programs (the most common interpretation)

Software = Programs + Data (a different but less common interpretation)

1.5.4 The Two Main Categories of Software

The two major software categories are **system software** and **application software**.

System Software refers to programs required by the computer to function while application software refers to programs required by the users. The **operating system** (the program that acts as manager of the computer system) is system software while a word processor, a spreadsheet or a game are applications software.

There are other groupings for applications software as can be seen in the following list:

- **Process control** deals with the automated control of a process i.e. a system is left under the control of a computer. Examples:
 - Robotics
 - The control of air temperature
- **Office automation** is the use of computer systems to execute a variety of office operations, such as:
 - Word Processing
 - Accounting
 - E-mail
- **Industrial & Commercial.** Examples:
 - CAD (Computer-Aided Design)
 - CAM (Computer-Aided Manufacturing)
 - Architectural (software that enables architects to design, visualize, simulate, document, and build better buildings)
- **Multimedia:**
 - A/V editing (Audio/Video editing)
 - Graphics Design
 - Authoring tools

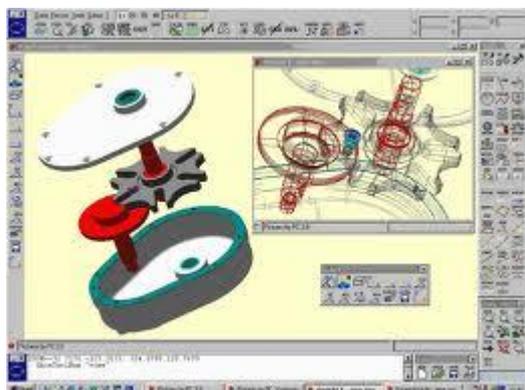
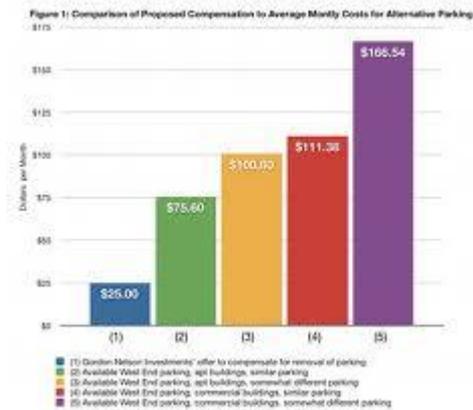


Diagram 8. Examples of the Four Groupings of Application Software Mentioned Above

1.6 Definition of Computer

Our senses pass information to us. There is a similarity between information passed to the brain and information passed to a computer.

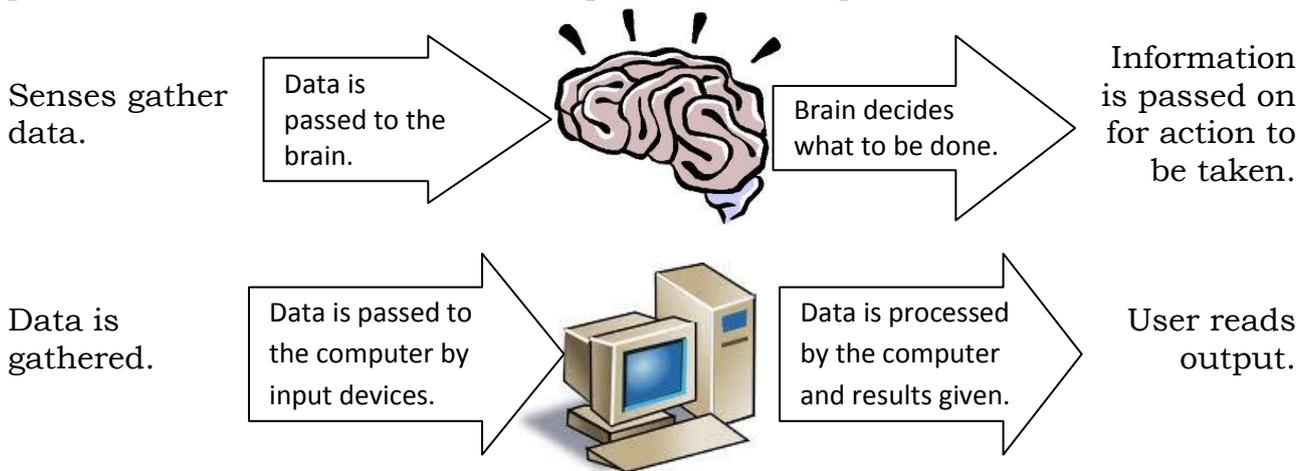


Diagram 9. Comparing the Computer to a Brain

Therefore we can define the computer as a **Processor of Information**.

1.7 Data, Information and Knowledge

Although the terms Data and Information are used interchangeably they theoretically have a different meaning.

Data represents unorganized and unprocessed facts. Example of data: marks of computing of a class (from which the average is required).

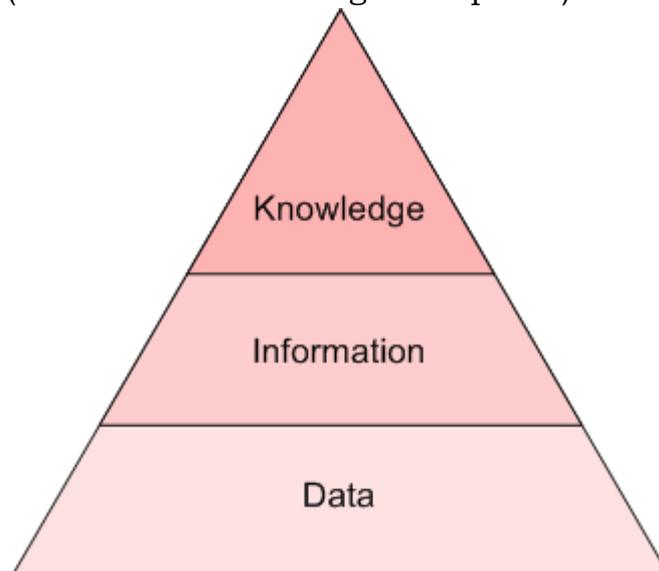


Diagram 10. The Data, Information and Knowledge Pyramid

Information can be considered as processed data (which makes decision-making easier). Information has got meaning and purpose. Example of information: the average mark.

Knowledge is the evaluation of a result vis-à-vis experience. Knowledge is usually based on learning, thinking, and proper understanding of the problem area.

Some computer scientists add **Wisdom** at a level beyond Knowledge. Others go even further by adding **Vision** at a level above Wisdom.

1.8 Classifications of computers

Computers can be classified by size and power as follows, though there is considerable overlap:

- **Embedded computer:** An embedded system is any appliance that contains a microprocessor, which is pre-programmed to perform a dedicated task. Examples of embedded systems are washing machines, rice-cookers, microwave ovens, video recorders, laser printers, and cameras
- **Handheld devices:**
 - **Mobile phones:** These have a limited computer system where the information device responds to input from the user. A smartphone is a high-end mobile phone that combines the functions of a **Personal Digital Assistant (PDA)** and a mobile phone. Today's models typically also serve as portable media players and camera phones with high-resolution touchscreens, web browsers that can access and properly display standard web pages rather than only mobile-optimized sites, GPS navigation, Wi-Fi and mobile broadband access. The term smartphone is usually used to describe phones with more advanced computing ability and connectivity than a contemporary feature phone, although the distinction can be vague.



Diagram 11. A Smartphone and a Palmtop Computer

- **Calculators:** a calculator is an electronic device capable of limited mathematical processing.
- **Palmtop computers:** A small computer that literally fits in your palm. Compared to full-size computers, palmtops are severely limited, but they are practical for certain functions such as phone books and calendars. Palmtops are also called PDAs, hand-held computers and pocket computers.

- **Portable personal computers:**

- **Netbook:** A netbook is a small, light, low-power notebook computer that has less processing power than a full-sized laptop but is still suitable for word processing, running a Web browser and connecting wirelessly to the Internet.



Diagram 12. A Netbook and a Desktop Computer

- **Laptop:** (also called **Notebook**)
- **Tablet PC:** this kind of computer has a touch screen. There are "convertible tablets" with a full keyboard where the screen rotates to be used atop the keyboard.
- **Personal computer (PC):** (desktop, tower model) A small, single-user computer based on a microprocessor. In addition to the microprocessor, a personal computer has a keyboard for entering data, a monitor for displaying information, and a storage device for saving data. This is also called a **microcomputer**.
- **Terminal:** A terminal is a device with a monitor and a keyboard. The term "terminal" can also refer to any device that sends and receives computer data. Different kinds of terminals include:
 - **Dumb terminal:** A dumb terminal has no processing power, cannot act as a stand-alone computer, and must be connected to a server to operate.
 - **Intelligent terminal:** An intelligent terminal has memory and a processor so that it can perform some functions independently of the host computer.
 - **EPOS terminal:** An EPOS (**Electronic Point of Sale**) terminal is used to record purchases at the point where the consumer purchases the product or services.
 - **EFTPOS (Electronic Fund Transfer Point of Sale)** terminals are able to transfer funds from a customer's bank account directly to a retail outlet's account after reading the customer's debit card.
 - **ATM:** An automatic teller machine (ATM) is a self-service banking machine attached to a host computer through a telephone network.
- **Workstation:** A powerful, single-user computer. A workstation is like a personal computer, but it has a more powerful microprocessor and a higher-

quality monitor. Typical users of workstations include architects, engineers, and graphics designers.

- **Client computer:** A client computer is a computer that can access the resources on a network. It is a network computer.
- **Server:** A server is the host or central computer that manages the resources on a network. A server provides a centralized storage area for programs, data, and information. A dedicated server is a server that performs a specific task for example:
 - A **file server** stores and manages files.
 - A **print server** manages printers and print jobs.
 - A **database server** stores and provides access to a database.
 - A **network server** manages network traffic.

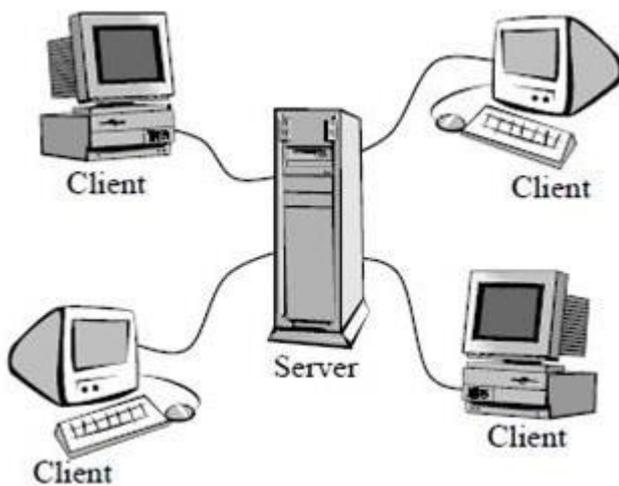


Diagram 13. The Architecture of a Client-Server System and a Server Technician

- **Midrange Computer:** (previously known as **minicomputer**) This is a multi-user computer capable of supporting from 10 to hundreds of users simultaneously. A minicomputer is often used in situations where a microcomputer is not powerful enough but a mainframe is too expensive. Minicomputers are also known as mid-range servers, which can normally support up to several thousand users at the same time. Users typically access a minicomputer via a personal computer or a terminal.
- **Mainframe:** A powerful multi-user computer capable of supporting many hundreds or thousands of users simultaneously. A mainframe is a large, expensive, but powerful computer that can handle thousands of connected users at the same time. Users typically access a mainframe via a personal computer or a terminal. Typical users of mainframes include banks, insurance companies, and airlines with sophisticated reservation systems.
- **Supercomputer:** An extremely fast computer that can perform hundreds of millions of instructions per second. A supercomputer is the fastest, most powerful, and most expensive computer used for applications that require complex and sophisticated mathematical calculations.

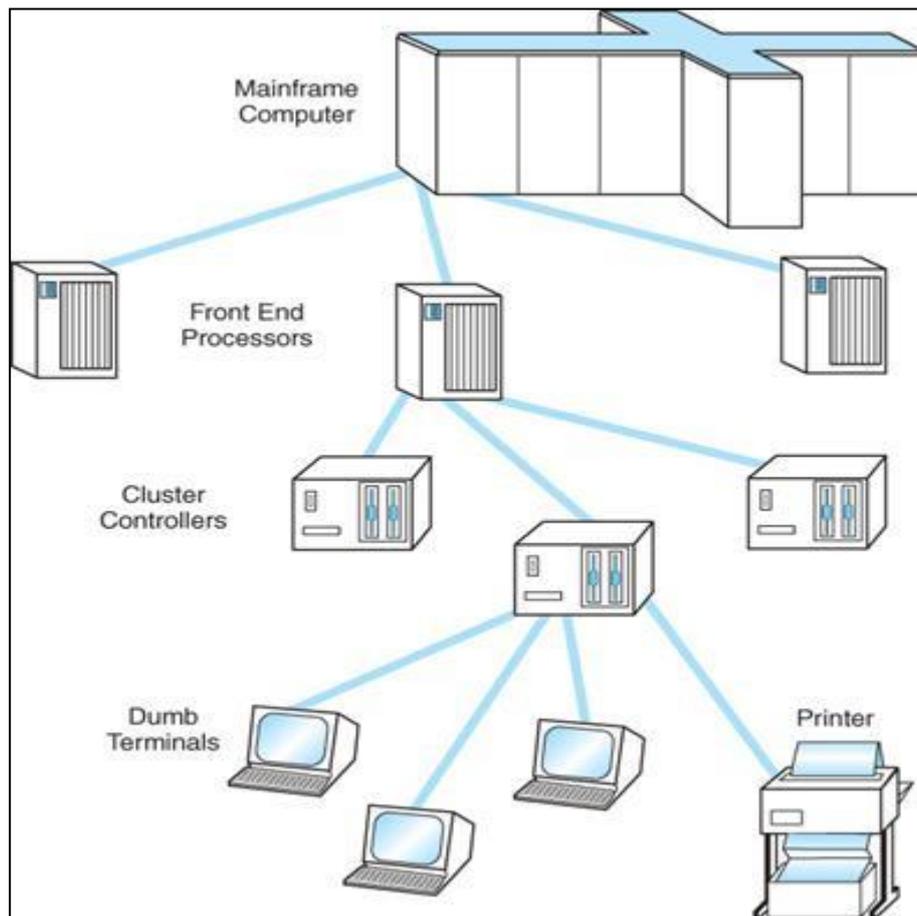


Diagram 14. A Computer System using a Mainframe

1.9 The Five Generations of Computers

Each generation of computer is characterised by a major technological development that fundamentally changed the way computers operate (from the hardware point of view), resulting in increasingly smaller, cheaper, more powerful and more efficient and reliable devices.

1.9.1 First Generation (1940-1956) Vacuum Tubes

The first computers used vacuum tubes for circuitry and magnetic drums for memory, and were often enormous, taking up entire rooms. They were very expensive to operate and in addition to using a great deal of electricity, generated a lot of heat, which was often the cause of malfunctions.

First generation computers relied on machine language, the lowest-level programming language understood by computers, to perform operations, and they could only solve one problem at a time. Input was held on punched cards and paper tape, and output was displayed on printouts.

The UNIVAC and ENIAC computers are examples of first-generation computing devices. The UNIVAC was the first commercial computer delivered to a business client, the U.S. Census Bureau in 1951.

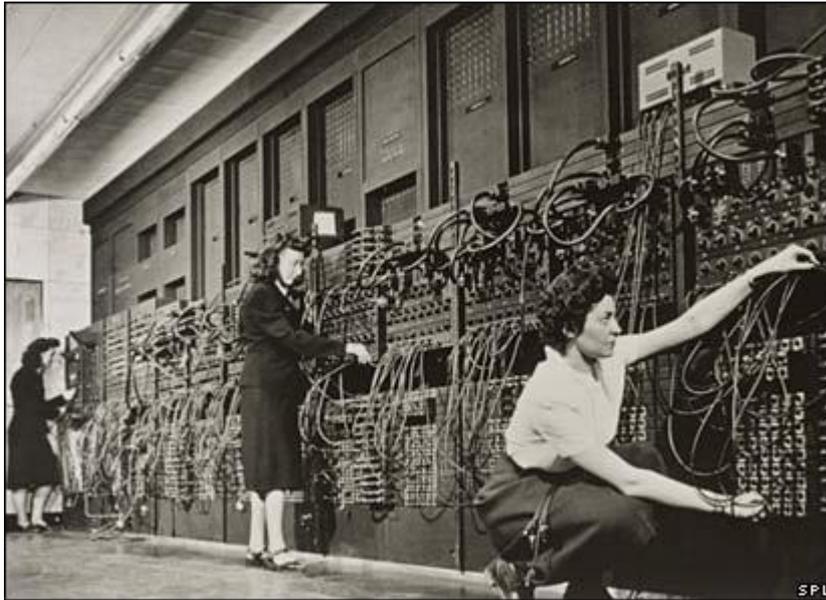


Diagram 15. The ENIAC computer at the University of Pennsylvania is shown on the left and on the right is an image of a vacuum tube.

1.9.2 Second Generation (1956-1963) Transistors

Transistors replaced vacuum tubes and ushered in the second generation of computers. The transistor was invented in 1947 but did not see widespread use in computers until the late 1950s. The transistor was far superior to the vacuum tube, allowing computers to become smaller, faster, cheaper, more energy-efficient and more reliable than their first-generation predecessors. Though the transistor still generated a great deal of heat that subjected the computer to damage, it was a vast improvement over the vacuum tube. Second-generation computers still relied on punched cards for input and printouts for output.

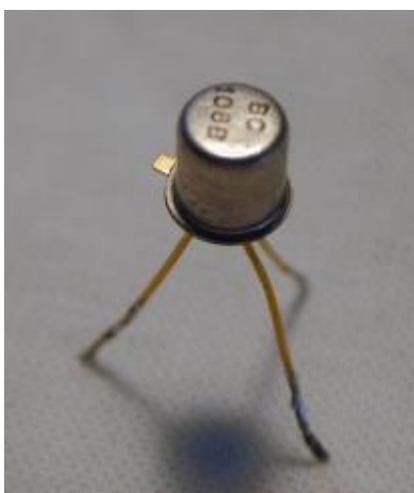


Diagram 16. The picture on the left shows a transistor while the one on the right shows an IBM 2nd Generation computer.

Second-generation computers moved from cryptic binary machine language to symbolic, or assembly, languages, which allowed programmers to specify instructions in words. High-level programming languages were also being developed at this time, such as early versions of COBOL and FORTRAN. These were also the first computers that stored their instructions in their memory, which moved from a magnetic drum to magnetic core technology.

The first computers of this generation were developed for the atomic energy industry.

1.9.3 Third Generation (1964-1971) Integrated Circuits

The development of the integrated circuit was the hallmark of the third generation of computers. Transistors were miniaturized and placed on silicon chips, called semiconductors, which drastically increased the speed and efficiency of computers.



Diagram 17. The picture on the left shows an integrated circuit while the one on the right shows two 3rd Generation computers.

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

1.9.4 Fourth Generation (1971-Present) Microprocessors

The microprocessor brought the fourth generation of computers, as thousands of integrated circuits were built onto a single silicon chip. What in the first generation filled an entire room could now fit in the palm of the hand. The Intel 4004 chip, developed in 1971, located all the components of the computer—from the central processing unit and memory to input/output controls—on a single chip.

In 1981 IBM introduced its first computer for the home user, and in 1984

Apple introduced the Macintosh. Microprocessors also moved out of the realm of desktop computers and into many areas of life as more and more everyday products began to use microprocessors.

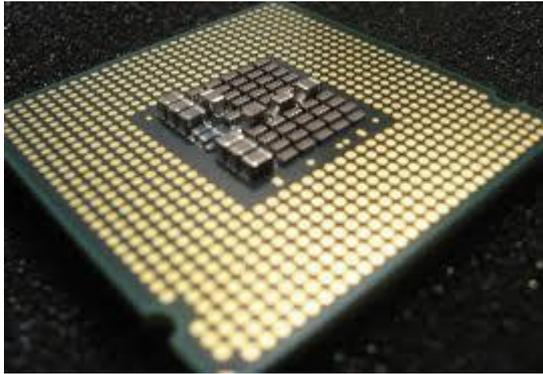


Diagram 18. The picture on the left shows a Quad 4 processor right shows a laptop. Today's PCs and laptops make use of very high-scale integrated circuits.

As these small computers became more powerful, they could be linked together to form networks, which eventually led to the development of the Internet. Fourth generation computers also saw the development of GUIs, the mouse and handheld devices.

1.9.5 Fifth Generation (Present and Beyond) Artificial Intelligence

Fifth generation computing devices, based on artificial intelligence, are still in development, though there are some applications, such as voice recognition, that are being used today. The use of parallel processing and superconductors is helping to make artificial intelligence a reality. Quantum computation and molecular and nanotechnology will radically change the face of computers in years to come. The goal of fifth-generation computing is to develop devices that respond to natural language input and are capable of learning and self-organization.

1.10 Exercise

1. Give a definition of Program and Computer?
2. A computer has a 3.5 GHz processor. How many (small) operations can it perform in one second?
3. A computer has a 16GB internal memory. How many 1.5MB photos can it hold?
4. A computer has a 1TB hard disk. If a 2-minute YouTube video takes approximately 4MB how many such videos can the hard disk hold?
5. Write the most common definition of Software.
6. Software is divided in two main categories. Which are they? Give two examples of each category.
7. Explain the difference between Data, Information and Knowledge.

8. Explain the terms Embedded Computer, Workstation, Dumb Terminal, EPOS, EFTPOS.
9. What is the difference between a Client computer and a Server (computer)? Name four different types of servers.
10. Explain one difference between a Mainframe and a Supercomputer.