Digital Computer system

The digital computer is a digital system that performs various computational tasks. The word digital implies that the information in the computer is represented by variables that take a limited number of discrete values. These values are processed internally by components that can maintain a limited number of discrete states. The decimal digits 0, 1, 2,..., 9, for example, provide 10 discrete values. The first electronic digital computers, developed in the late 1940s, were used primarily for numerical computations. In this case the discrete elements are the digits. From this application the term digital computer has emerged. In practice, digital computers function more reliably if only two states are used. Because of the physical restriction of components, and because human logic tends to be binary (i.e., true-or-false, yes-or-no statements), digital components that are constrained to take discrete values are further constrained to take only two values and are said to be binary.

Digital computers use the binary number system, which has two digits: 0 and 1. A binary digit is called a bit. Information is represented in digital computers in groups of bits. By using various coding techniques, groups of bits can be made to represent not only binary numbers but also other discrete symbols, such as decimal digits or letters of the alphabet. By judicious use of binary arrangements and by using various coding techniques, the groups of bits are used to develop complete sets of instructions for performing various types of computations.

In contrast to the common decimal numbers that employ the base 10 system, binary numbers use a base 2 system with two digits: 0 and 1. The decimal equivalent of a binary number can be found by expanding it into a power series with a base of 2. For example, the binary number 1001011 represents a quantity that can be converted to a decimal number by multiplying each bit by the base 2 raised to an integer power as follows:

$$1 \times 2^6 + 0 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 75$$

The seven bits 1001011 represent a binary number whose decimal equivalent is 75.

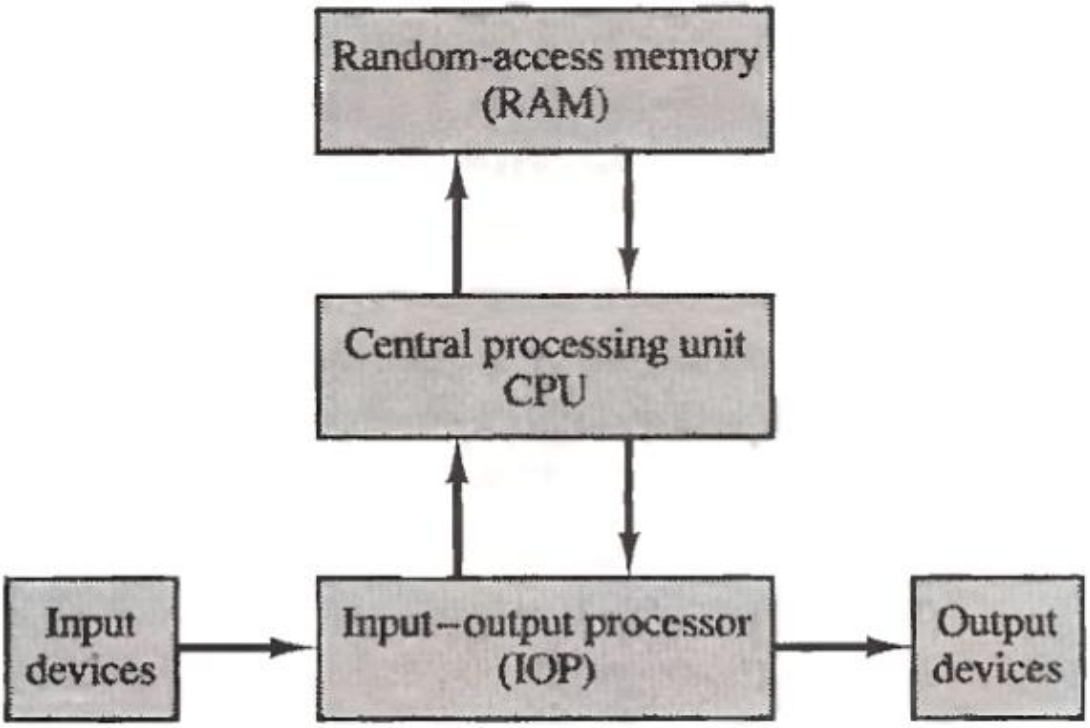
Computer program

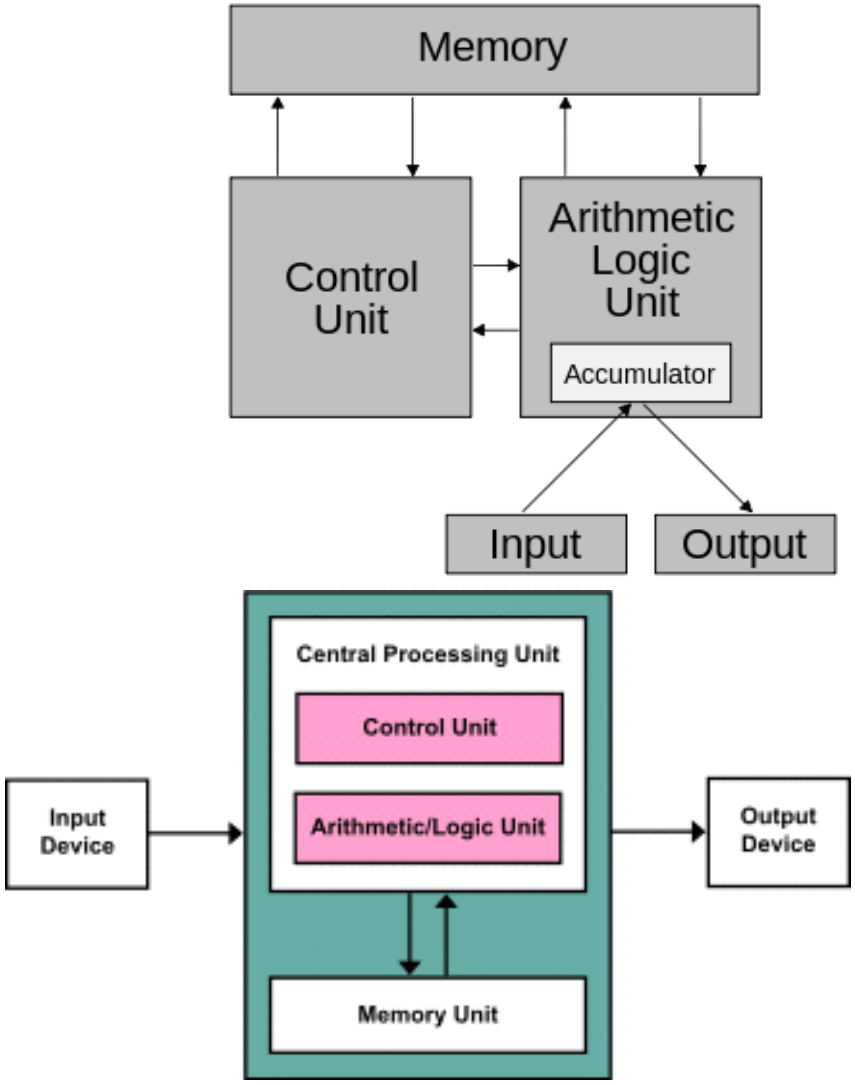
A computer system is sometimes subdivided into two functional entities: hardware and software. The hardware of the computer consists of all the electronic components and electromechanical devices that comprise the physical entity of the device. Computer software consists of the instructions and data that the computer manipulates to perform various data-processing tasks.

A program is a sequence of instructions for the computer is called a program. The data that are manipulated by the program constitute the data base.

A computer system is composed of its hardware and the system software available for its use. The system software of a computer consists of a collection of programs whose purpose is to make more effective use of the computer. The programs included in a systems software package are referred to as the operating system. They are distinguished from application programs written by the user for the purpose of solving particular problems. For example, a high-level language program written by a user to solve particular data-processing needs is an application program, but the compiler that translates the high-level language program to machine language is a system program. The customer who buys a computer system would need, in addition to the hardware, any available software needed for effective operation of the computer. The system software is an indispensable part of a total computer system. Its function is to compensate for the differences that exist between user needs and the capability of the hardware.

The hardware of the computer is usually divided into three major parts ,as shown in Fig. 1-1. The central processing unit (CPU) contains an arithmetic logic unit for manipulating data, a number of registers for storing data, and control circuits for fetching and executing instructions.





Von Neumann architecture

Digital components of computer

Integrated Circuit (IC)

Digital circuits are constructed with integrated circuits. An integrated circuit (abbreviated IC) is a small silicon semiconductor crystal, called a chip, containing the electronic components for the digital gates. The various gates are interconnected inside the chip to form the required circuit. The chip is mounted in a ceramic or plastic container, and connections are welded by thin gold wires to external pins to form the integrated circuit.

As the technology of ICs has improved, the number of gates that can be put in a single chip has increased considerably. The differentiation between those chips that have a few internal gates and those having hundreds or thousands of gates is made by a customary reference to a package as being either a small-, medium-, or large-scale integration device.

Small-scale integration (SSI) - The number of gates is usually less than 10.
Medium-scale integration (MSI) - devices have a complexity of approximately 10 to 200 gates in a single package.
Large-scale integration (LSI) devices contain between 200 and a few thousand gates in a single package.
Very-large-scale integration (VLSI) devices contain thousands of gates within a single package. Examples are large memory arrays and complex microcomputer chips.

Decoder

A decoder is a combinational circuit that converts binary information from the n coded inputs to a maximum of 2" unique outputs. If the n-bit coded information has unused bit combinations, the decoder may have less than 2" outputs.

Multiplexer

A multiplexer is a combinational circuit that receives binary information from one of 2" input data lines and directs it to a single output line. The selection of a particular input data line for the output is determined by a set of selection inputs. A 2"-to-l multiplexer has 2" input data lines and n input selection lines whose bit combinations determine which input data are selected for the

Register

A register is a group of flip-flops with each flip-flop capable of storing one bit of information. An n-bit register has a group of n flip-flops and is capable of storing any binary information of n bits. In addition to the flip-flops, a register may have combinational gates that perform certain data-processing tasks. In

its broadest definition, a register consists of a group of flip-flops and gates that effect their transition. The flip-flops hold the binary information and the gates control when and how new information is transferred into the register.

Shift Registers

A register capable of shifting its binary information in one or both directions is called a shift register. The logical configuration of a shift register consists of a chain of flip-flops in cascade, with the output of one flip-flop connected to the input of the next flip-flop. All flip-flops receive common clock pulses that initiate the shift from one stage to the next.

Binary Counters

A register that goes through a predetermined sequence of states upon the application of input pulses is called a counter. The input pulses may be clock pulses or may originate from an external source. They may occur at uniform intervals of time or at random. Counters are found in almost all equipment containing digital logic. They are used for counting the number of occurrences of an event and are useful for generating riming signals to control the sequence of operations in digital computers.

Memory Unit

A memory unit is a collection of storage cells together with associated circuits needed to transfer information in and out of storage. The memory stores binary information in groups of bits called words. A word in memory is an entity of bits that move in and out of storage as a unit. A memory word is a group of l's and O's and may represent a number, an instruction code, one or more alphanumeric characters, or any other binary-coded information. A group of eight bits is called a byte. Most computer memories use words whose number of bits is a multiple of 8. Thus a 16-bit word contains two bytes, and a 32-bit word is made up of four bytes. Two major types of memories are used in computer systems: random-access memory (RAM) and read-only memory (ROM).