ECOLE SUPÉRIEURE POLYTECHNIQUE INTERNATIONALE PRIVÉE
DE SFAX

Chapter 1

Introduction to computer architecture

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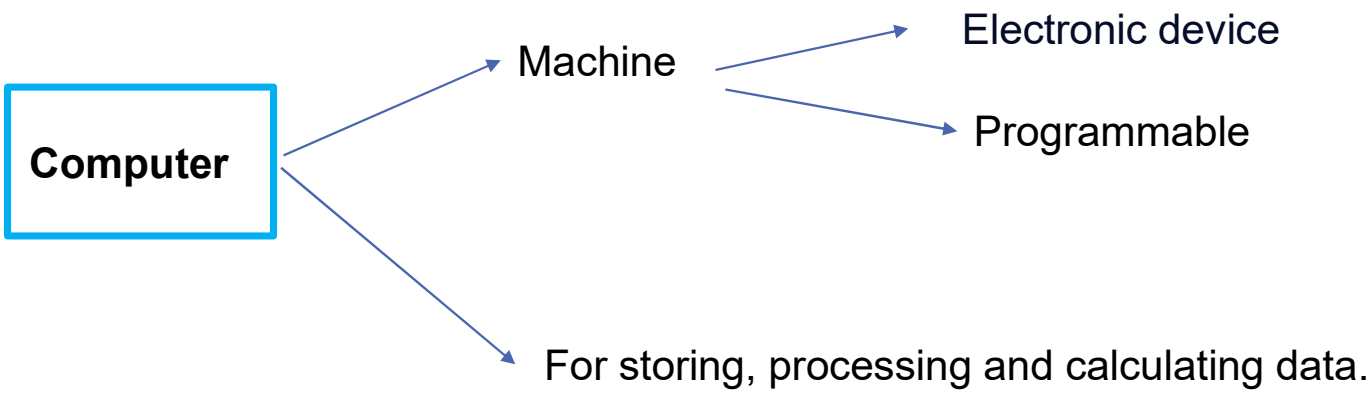
PhD in electrical engineering

Introduction

What is a computer ?

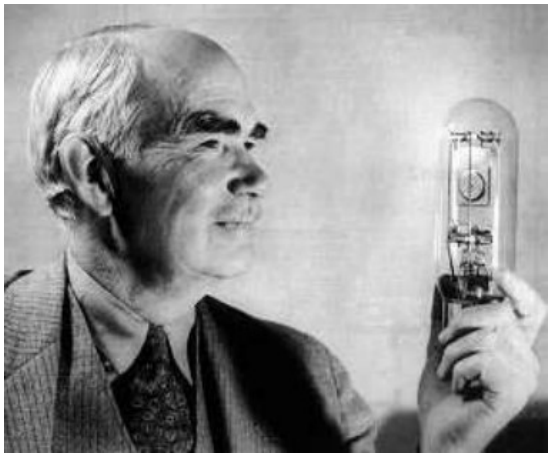


Introduction

- It had been around the 16th century when the evolution of the computer started.
- The initial computer faced many changes, obviously for the better.
- It continuously improved itself to urge the form of the fashionable day computer, in terms of:
  - **speed**,
  - **accuracy**,
  - **size**,
  - **price**.

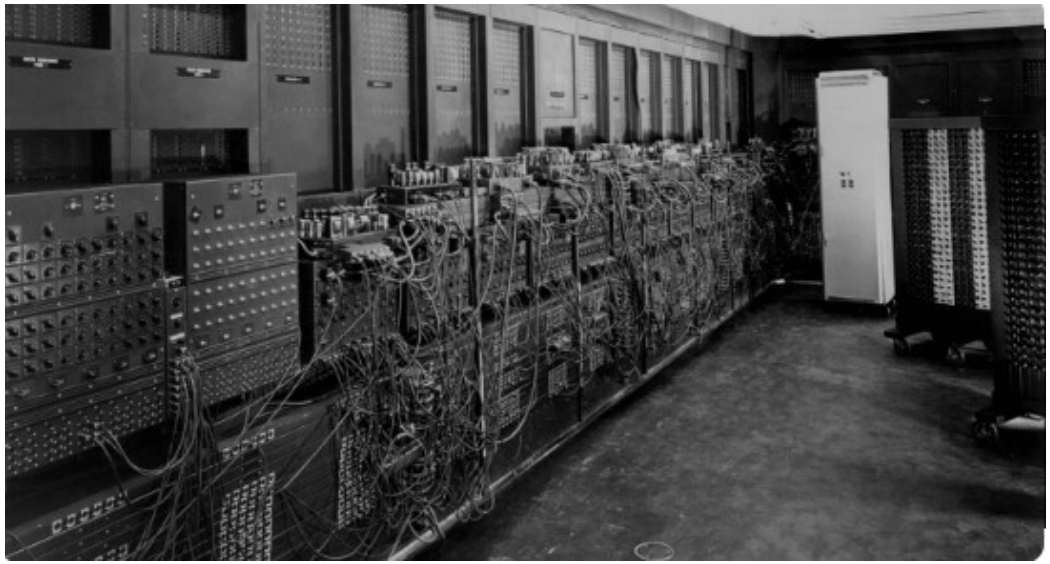
Computers generations

First Generation (1940-1956): Vaccume tube



- It is intended by William Mauchly and John Eckert in 1942.

- The first generation computers was ENIAC (Electronic Numerical Integrator and Calculator)
- It were developed by using vacuum tube.



First Generation (1940-1956): Vaccume tube

ENIAC (Electronic Numerical Integrator and Calculator)

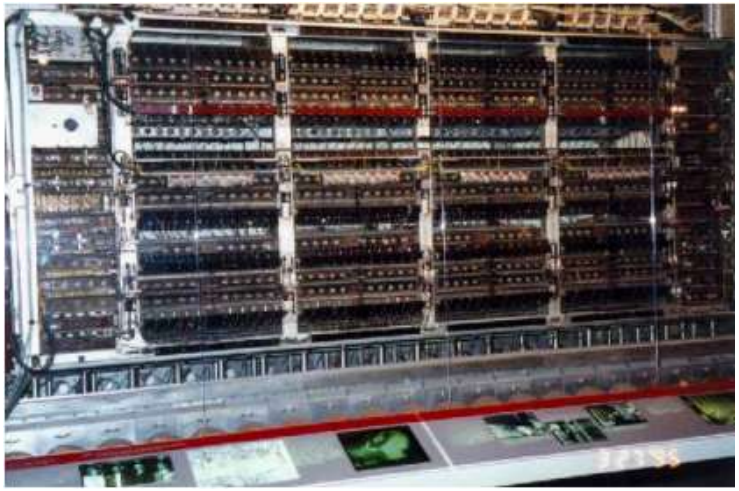
Structure :
The ENIAC pc was terribly serious and huge.
Size : 50-foot-long basement area
weight : 30 tons.
Composition : over 18,000 vacuum tubes.
Power consumumption: 150 kilowatts,
Cost : $400,000

Calculations :
The first use of ENIAC was to hold out arithmetic calculations. ENIAC was capable of doing 5000 additions per second. Its memory consisted of twenty accumulators, every capable of holding a 10-digit decimal range. Every digit was pictured by a hoop of ten vacuum tubes.

Use:
Its first task was doing calculations for the construction of a hydrogen bomb.

First Generation (1940-1956): Vaccume tube

Examples of the first generation include: EDVAC, IBM-650, IBM-701, Manchester Mark 1, Mark 2, etc



EDVAC: Electronic Discrete Variable Automatic Computer, designed by **Von Neumann.**

IBM 650 produced by **IBM** in the mid-1950s.

First Generation (1940-1956): Vaccume tube

Limitations of First Generation of Computers :

•Computers were larger.

•They consumed an outsized quantity of energy.

•Constant maintenance was needed.

•Not transportable.

•Generates too much heat

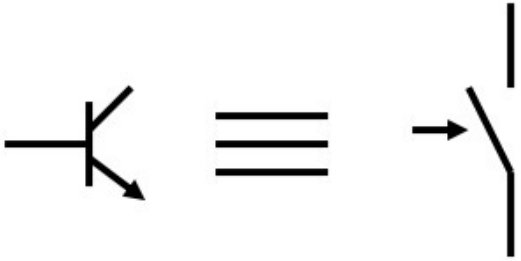
•Costly business production.

•Very less work potency.

•Limited programming capabilities.

Second Generation (1957-1963): Transistors

The Second Generation computers used the technology of Transistors. These transistors were invented in 1958 in the Bell Labs by Jhon Barden Walter Brattain, Willian Shocley



These transistors made the Second Generation Computer **powerful** and **faste**r than the previous ones. Transistors made these computers **smaller** and **generated less heat** compared to the vacuum tubes they replaced.

Second Generation (1956-1964): Transistors

1956 : The **TRADIC** (for **TRA**nsistor **DI**gital **C**omputer or **TR**ansistorized **A**irborne **DI**gital **C**omputer) was the first transistorized computer by Bell Labs in the USA.

Features:

800 transistors

the new computer requires less than 100 watts to operate

The TRADIC's construction benefitted in numerous ways over the vacuum tube computers it replaced, most notably in increased speed, smaller size, faster operations, higher reliability, greater safety (no high voltages), and lower power consumption.

Second Generation (1956-1964): Transistors

1958 : The **CDC 1604** is known as one of the first commercially successful transistorized computers. designed and manufactured by Seymour Cray and his team at the Control Data Corporation (CDC).

Processor 48 bits
Executed about 100,000 operations per second.

Second Generation (1956-1964): Transistors

Second generation computers were smaller, faster, reliable and generated much less heat in comparaison to first generation computer.

Also they consumed much less electricity in comparaison to first generation computer

Third Generation (1964-1971): Integrated Circuits

Integrated circuit (IC)

Invented in 1958 byJack Kilby (Texas Instruments)

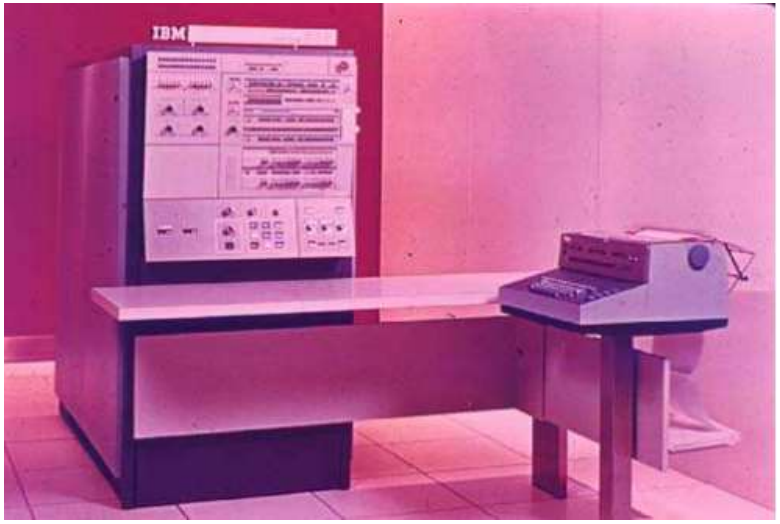
It is a semiconductor wafer on which thousands or millions of tiny resistors, capacitors, diodes and transistors are fabricated.

This generation of computers has increased memory space and efficiency

Third Generation (1964-1971): Integrated Circuits

Some of the examples of Third Generation Computers are IBM 360, IBM 370, PDP-11, NCR 395, B6500, UNIVAC 1108

1965 : First computer based on Integrated circuit were IBM 360



Third Generation (1964-1971): Integrated Circuits

- The third generation of computers was much faster than previous generations, with computational times reduced from microseconds to nanoseconds.
- New input devices like the mouse and keyboard were introduced.
- New functionalities, like multiprogramming and time-sharing, and remote processing, were introduced, allowing for more efficient use of computer resources.

Fourth Generation (1971-Present): Very Large Scale Integration

The Fourth Generation Computers have been developed using the technology of Very-large-scale integration (VLSI)

VLSI: has thousands of transistors on a single microchip.

VLSI circuits contained about 5000 transistors on a very compact chip and could conduct a wide range of high-level activities and computations.

Fourth-generation computers were more adaptable, had a larger primary storage capacity, were faster and more reliable, were portable, were very compact and small, and so on, thanks to the technology utilized to make them.

Fourth Generation (1971-Present): Very Large Scale Integration

1981 : VIC 20 **were** 8-bit personal computer that was built by Commodore International

5 KB of RAM

Sale: up to 9000/day. 1 million of models sold in 1983

- Some examples of Fourth Generation Computers are IBM PC, STAR 1000, APPLE II, Apple Macintosh, Alter 8800, etc,

Fifth Generation (Present-future): Ultra Large Scale Integration

The 5th Generation Computers use the Ultra Large-Scale Integration (ULSI) technology and parallel processing method.
ULSI: has millions of transistors on a single microchip
Parallel processing method : uses two or more microprocessors to run tasks simultaneously.

The Fifth Generation of Computers has been built using the technology called Artificial Intelligence (AI). This technology encourages computers to behave like humans. Some of the applications of AI have been seen in features like voice recognition, entertainment, etc. The speed of the Fifth Generation of Computers is the highest while the sizes are the smallest.

Components of computer architecture

Hardware

Software

Components of computer architecture

Input unit and associated peripherals

- The input unit provides external data sources to the computer system. Therefore, it connects the external environment to the computer. It receives information from input devices, translates it to machine language, and then inserts it within the computer system

- The keyboard, mouse, or other input devices are the most often utilized and have corresponding hardware drivers that allow them to work in sync with the rest of the computer architecture.

Components of computer architecture

Output unit and associated peripherals

- The output unit delivers the computer process's results to the user. A majority of the output data comprises music, graphics, or video.

- A computer architecture's output devices encompass the display, printing unit, speakers, headphones, etc.

Components of computer architecture

Central processing unit (CPU)

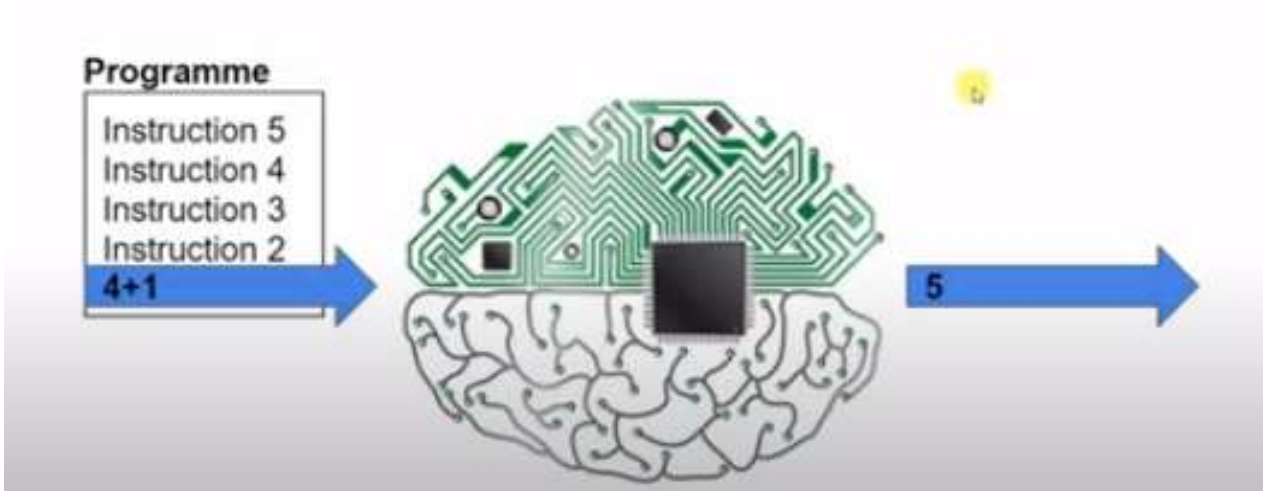
The CPU is often simply referred to as **the processor**.

- The CPU is the main and most crucial integrated circuitry (IC) chip in a computer, as it is responsible for interpreting most of computers commands.
- CPUs will **perform most basic arithmetic**, **logic and I/O operations**, as well as **allocate commands for other chips and components running in a computer.**

Components of computer architecture

Central processing unit (CPU)

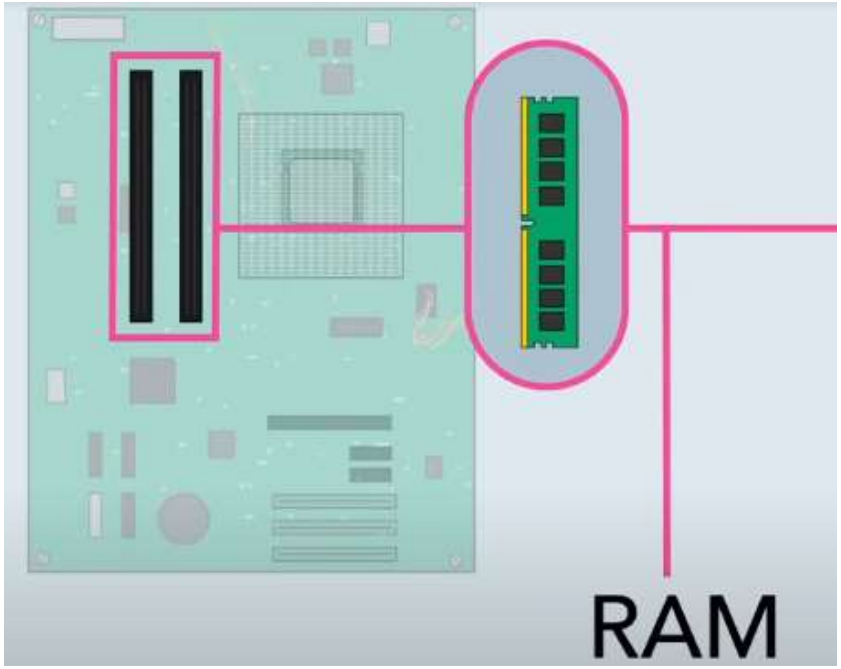
- The CPU is essentially the brain of the computer system.
- It consists of an arithmetic and logic unit (ALU), a control unit, and various registers.



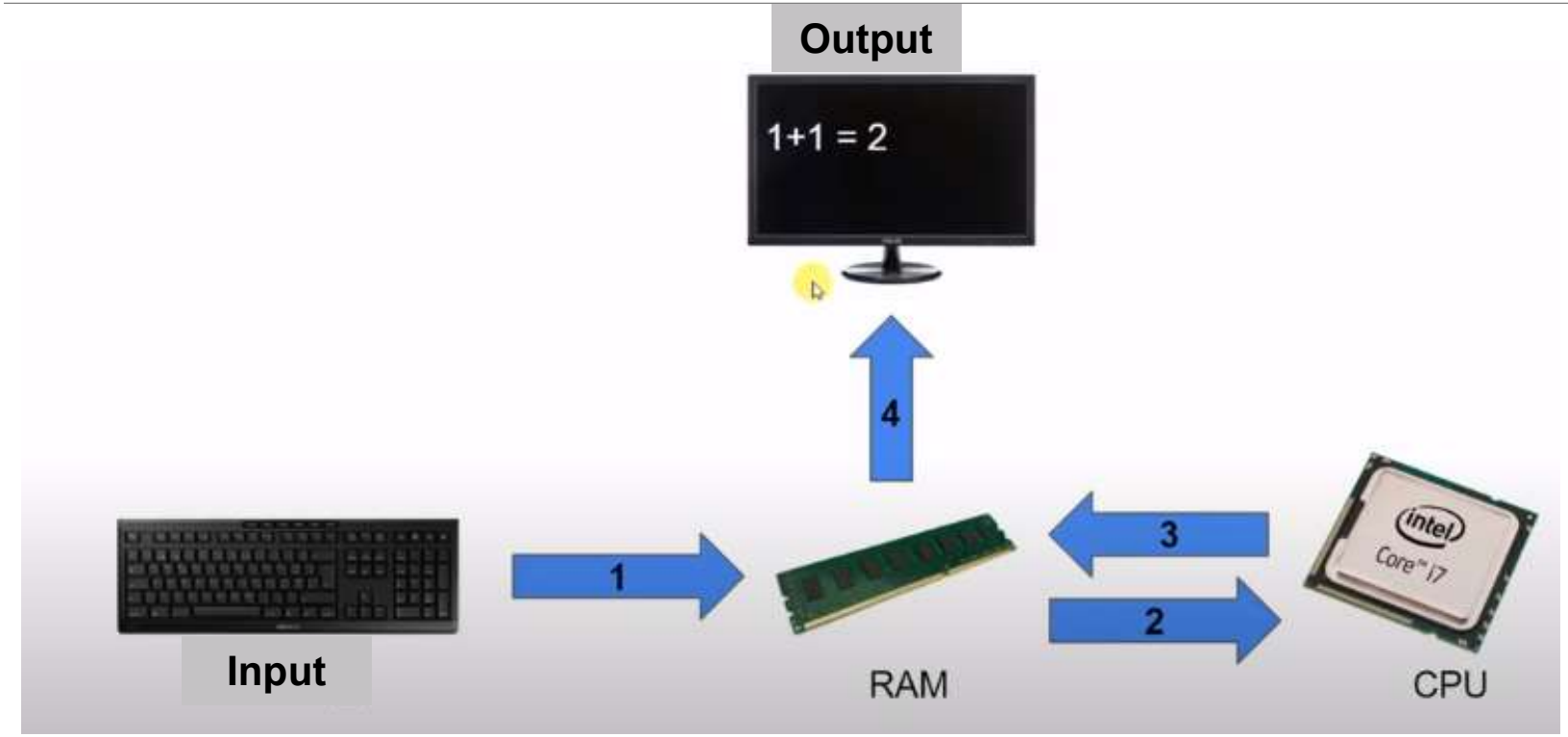
Components of computer architecture

Random Accsess Memory (RAM)

- Short term memory, it lets you open apps and files quickly.
- Stores the data that helps your computer perform its most important tasks, such as loading apps, browsing websites, and editing documents.
- Cleared when you turn off the computer



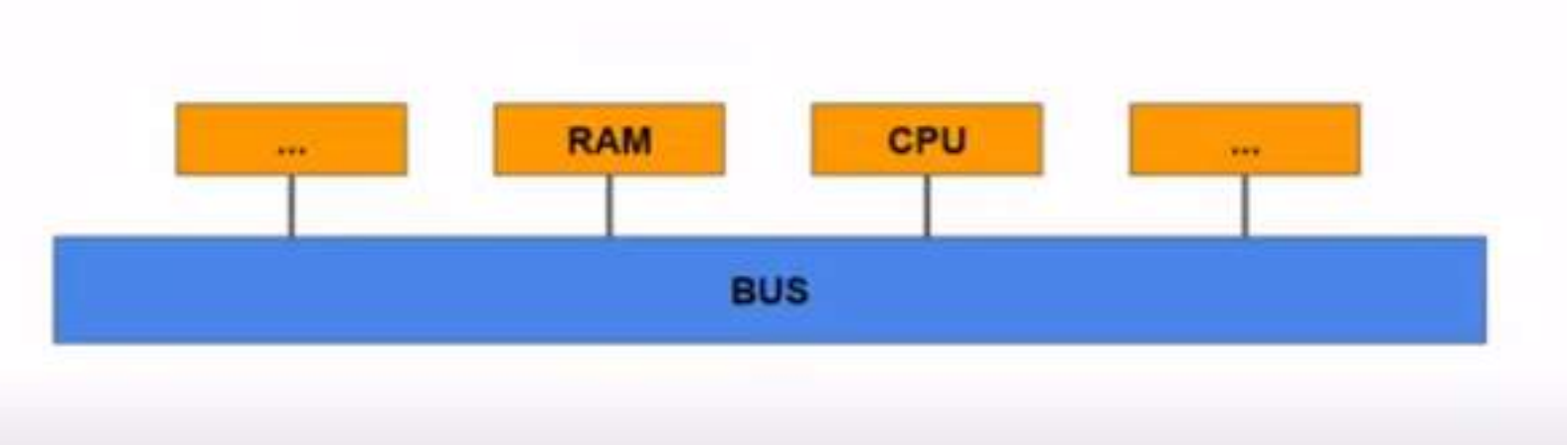
Process of an instruction



Components of computer architecture

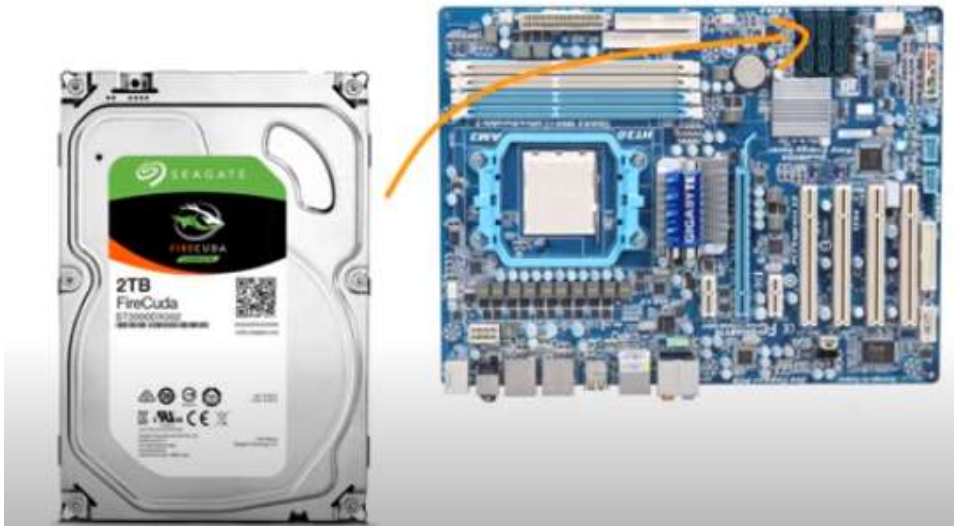
Bus

- Bus enables the flow of electrical impulses between various components of a computer's design, transferring information from one system to another.



Components of computer architecture

Hard disk drives (HDDs)



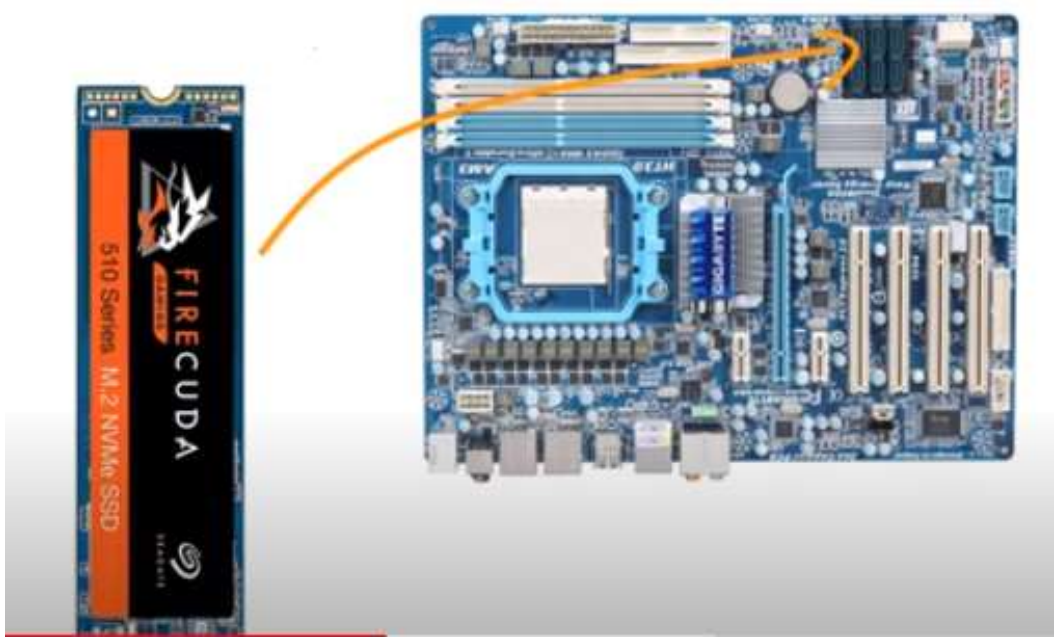
HDDs are **long term storage**

HDDs are traditional storage devices with spinning platters that read and write data

HDDs use mechanical spinning disks and a moving read/write head to access data

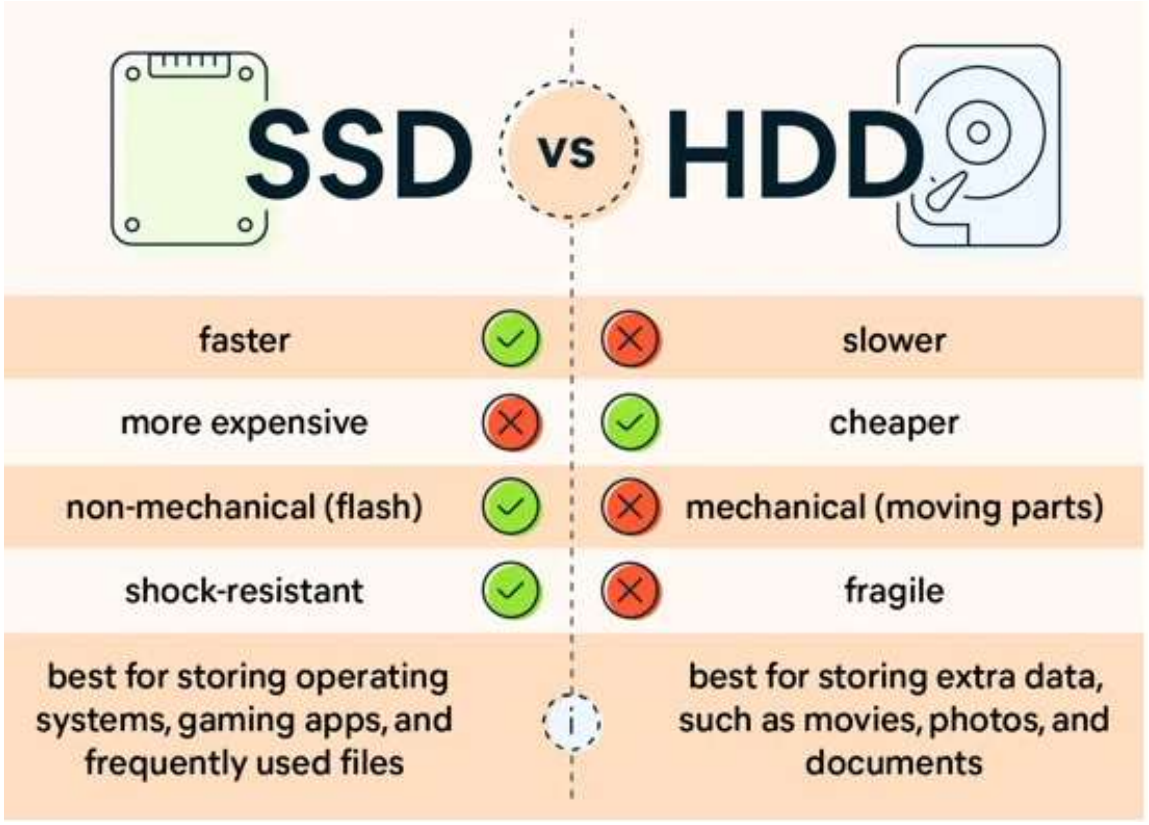
Components of computer architecture

Solid-state drives (SSDs)

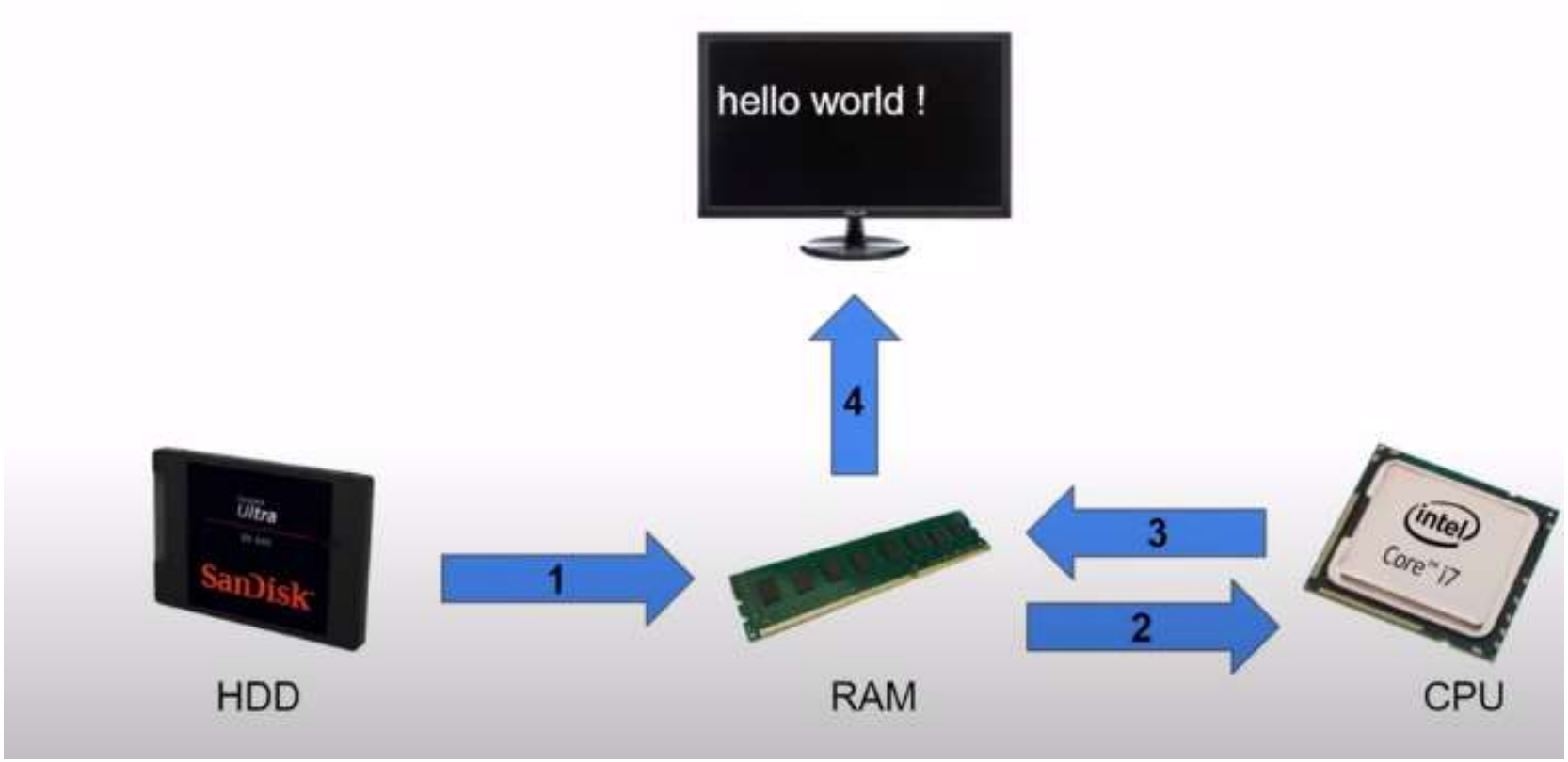


- SSDs use newer technology to store data on instantly-accessible **memory chips**

Components of computer architecture



Execution of a program



Components of computer architecture

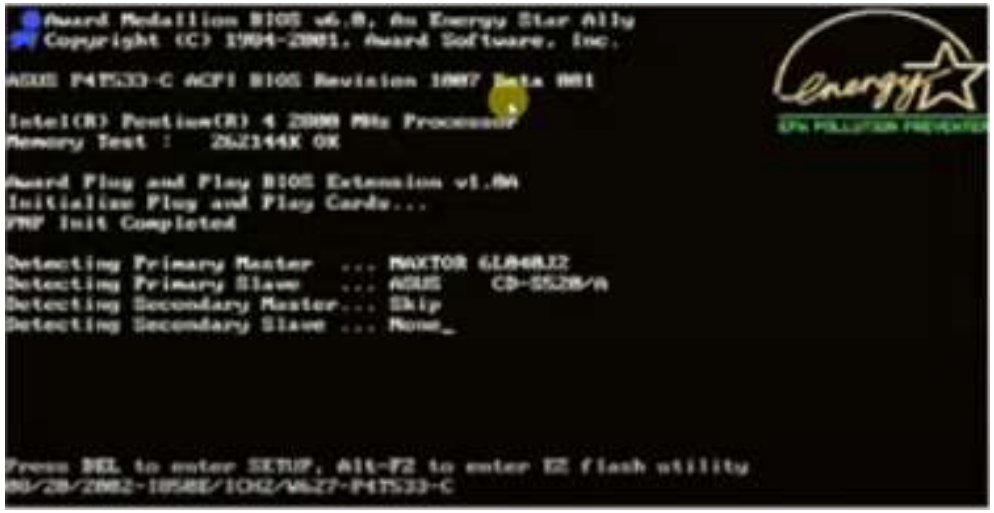
Graphics Processing Unit (GPU)

GPU is a hardware component which is designed to handle and speed up graphics processing tasks.

Components of computer architecture

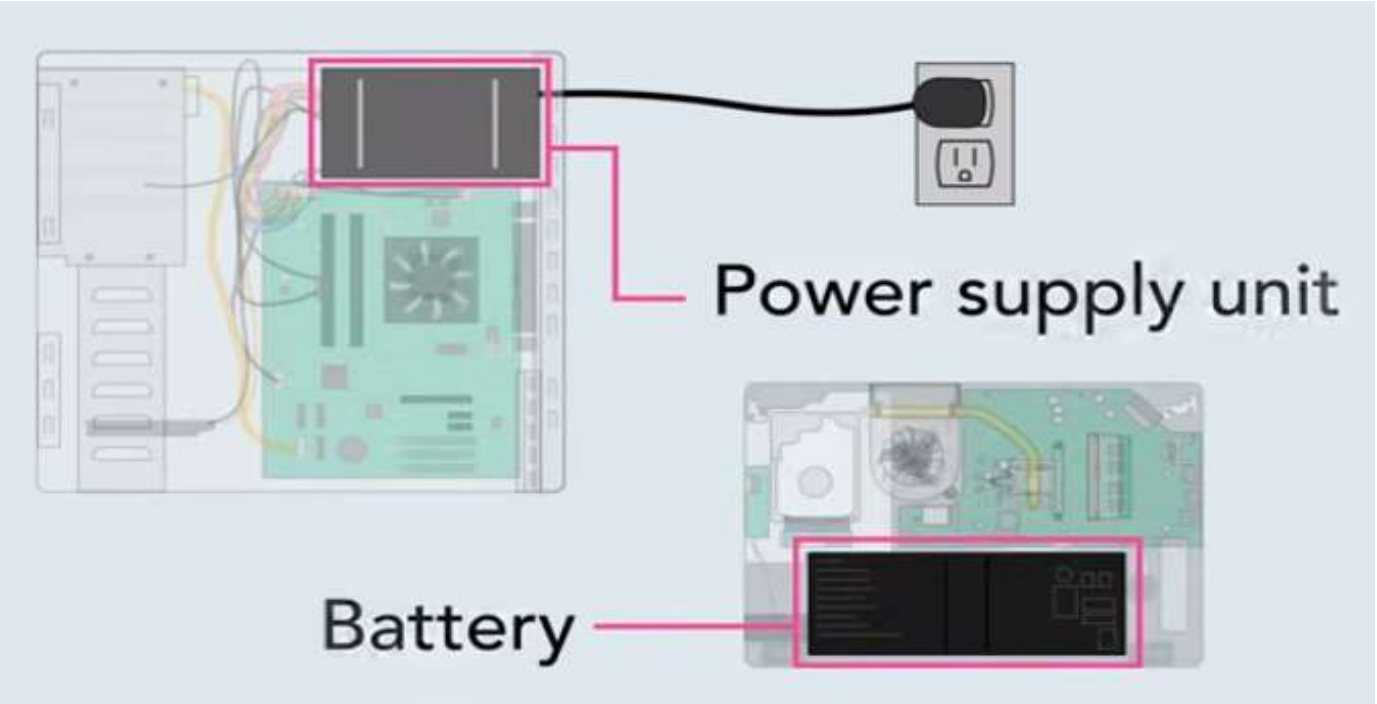
Basic Input Output System (BIOS)

BIOS is firmware used to provide runtime services for operating systems and programs and to perform hardware initialization during the booting process (power-on startup)



Components of computer architecture

Power supply unit / Battery



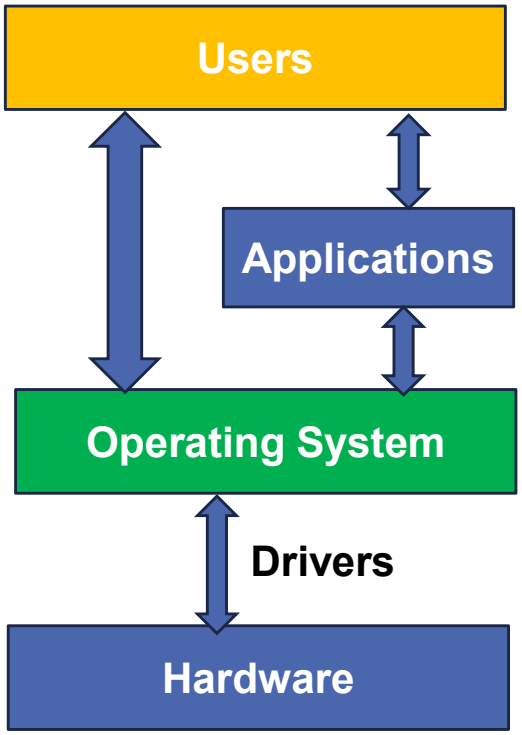
Components of computer architecture

Operating System

Operating System is a system software that manages all the resources of the computer. It also allows the communicate with the computer without knowing how to speak the computer's language.

Components of computer architecture

Operating System



Components of computer architecture

Operating System

Turning off the computer

Components of computer architecture

Operating System

- An operating system acts as an interface between the software and different parts of the computer hardware.
- The operating system is designed in such a way that it can manage the overall resources and operations of the computer.

Components of computer architecture

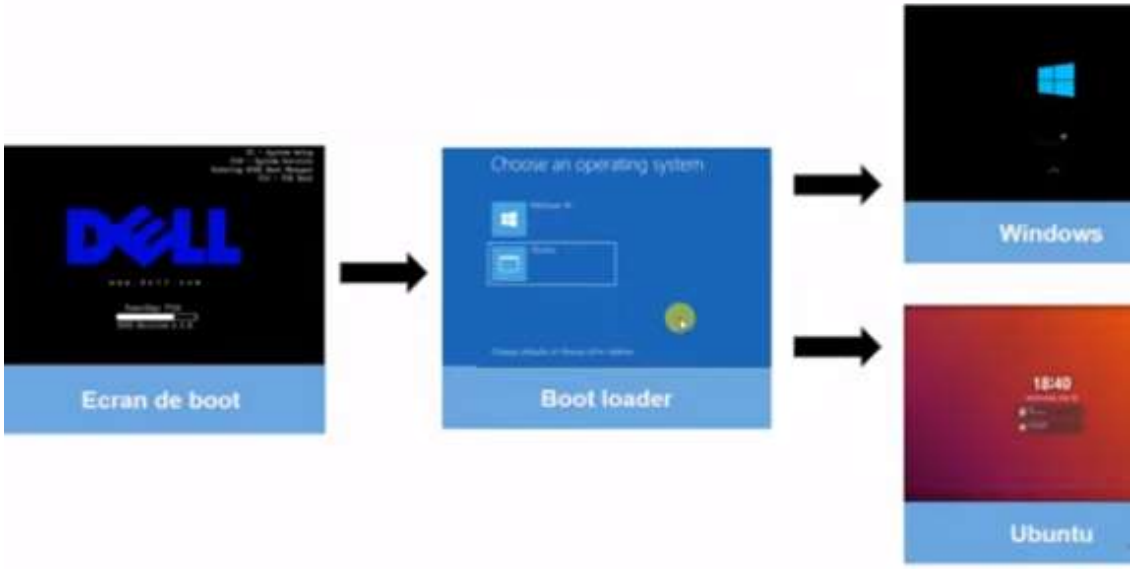
BIOS

Starting a computer

Components of computer architecture

Bootloader

Software allowing to launch one or more operating systems (multiboot), that is to say it allows the use of several systems, at different times, on the same machine.



Magnitude

- This involves presenting the orders of magnitude of the main units used in computer science
- Generally, for measuring capacitance, powers of 2 are used while powers of 10 are reserved for measuring time.
- A bit is the most basic information in computing, it can take the value 0 or 1.

Capacity measurement units

1 Octet (O)		= 8 bits
1 K	(Kilo)	= 2^{10}
1 M	(Méga)	= 2^{20}
1 G	(Giga)	= 2^{30}
1 T	(Téra)	= 2^{40}
1 P	(Péta)	= 2^{50}

Units of time measurement

1 ms	(milliseconde)	= 10^{-3}
1 µs	(microseconde)	= 10^{-6}
1 ns	(nanoseconde)	= 10^{-9}
1 ps	(picoseconde)	= 10^{-12}