BADJI MOKHTAR UNIVERSITY

SCIENCE AND TECHNIQUES DEPARTMENT
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Course 3: Computer Architecture

by

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1. Introduction

A **computer** is an electronic device that has the ability to **process, store**, and **retrieve** information. It is composed of two main parts:

1. **The Hardware** : is any part of the computer that has a **physical structure**, such as the keyboard, mouse, or all of the computer's internal parts.
2. **The Software**: is any **set of instructions** that tells the hardware **what to do** and **how to do it**.

Hardware

Software

What is Computer Architecture?

Computer architecture refers to the structure of a computer system(the arrangement of the components) that determines how its components interact with each other to process information.

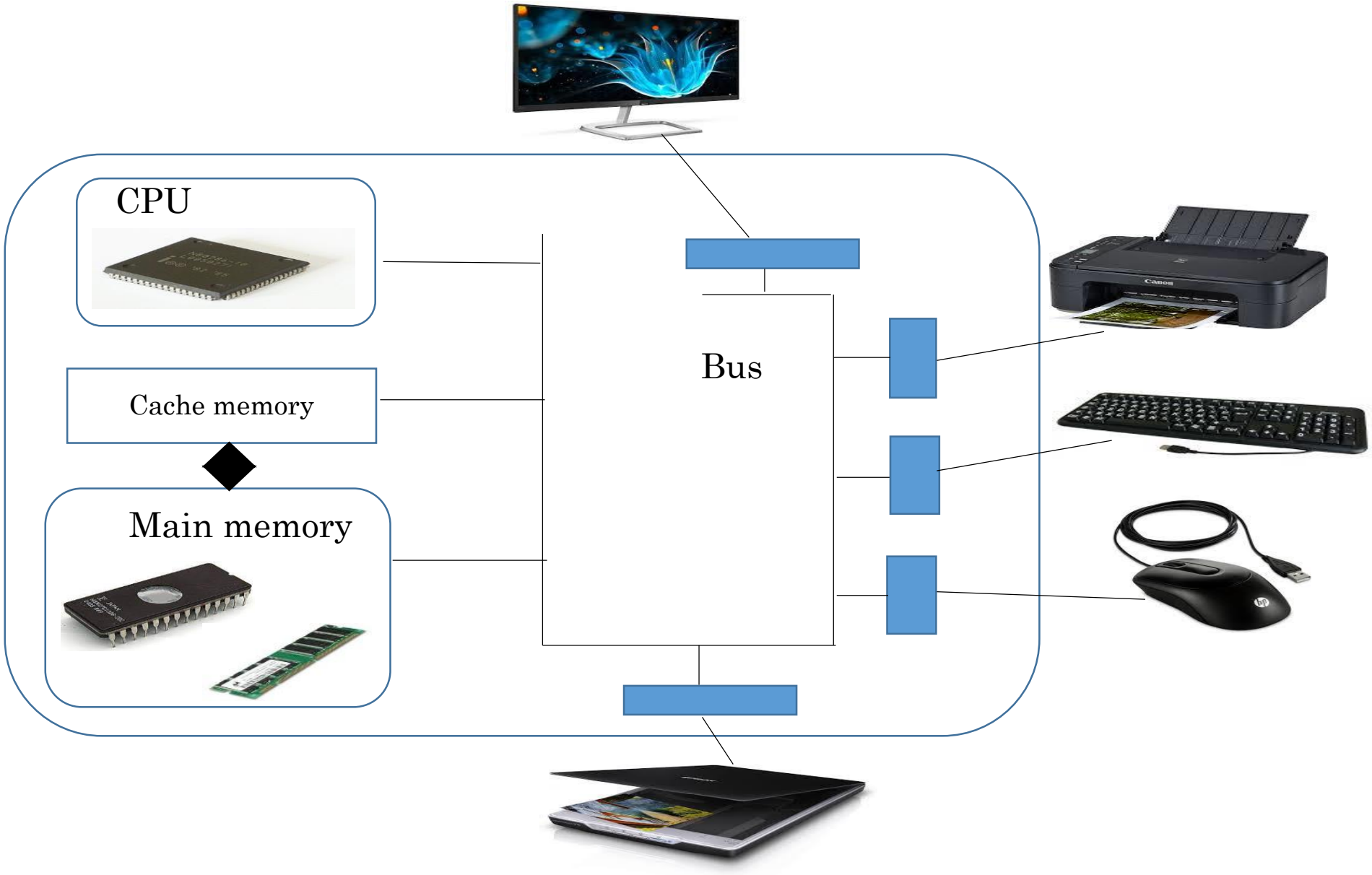
2.Components of Computer Architecture

The main components of a computer architecture are:

- The memory (storage unit)
- The CPU
- The peripherals

All these elements are linked by buses

2. Components of Computer Architecture



2.1 The memory / Storage unit

- The memory contains numerous computer parts that are employed to store data. It is typically separated into:

➢ Main memory or primary storage unit

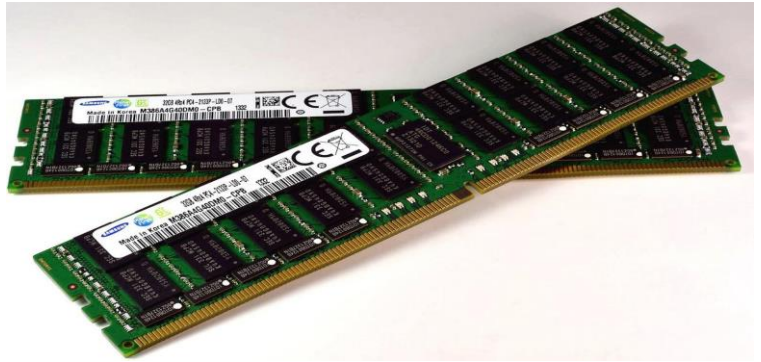
➢ Secondary (External) memory .

a. The main memory (primary storage unit)

- The main memory is utilized for storing information and instructions during program execution.
- There are two kinds of main memory: Random access memory (RAM) and read-only memory (ROM).

a. The main memory

- ***RAM*** (Random Access Mémory): provides the necessary information straight to the CPU. There are several technologies (SRAM, DRAM, SDRAM…..)

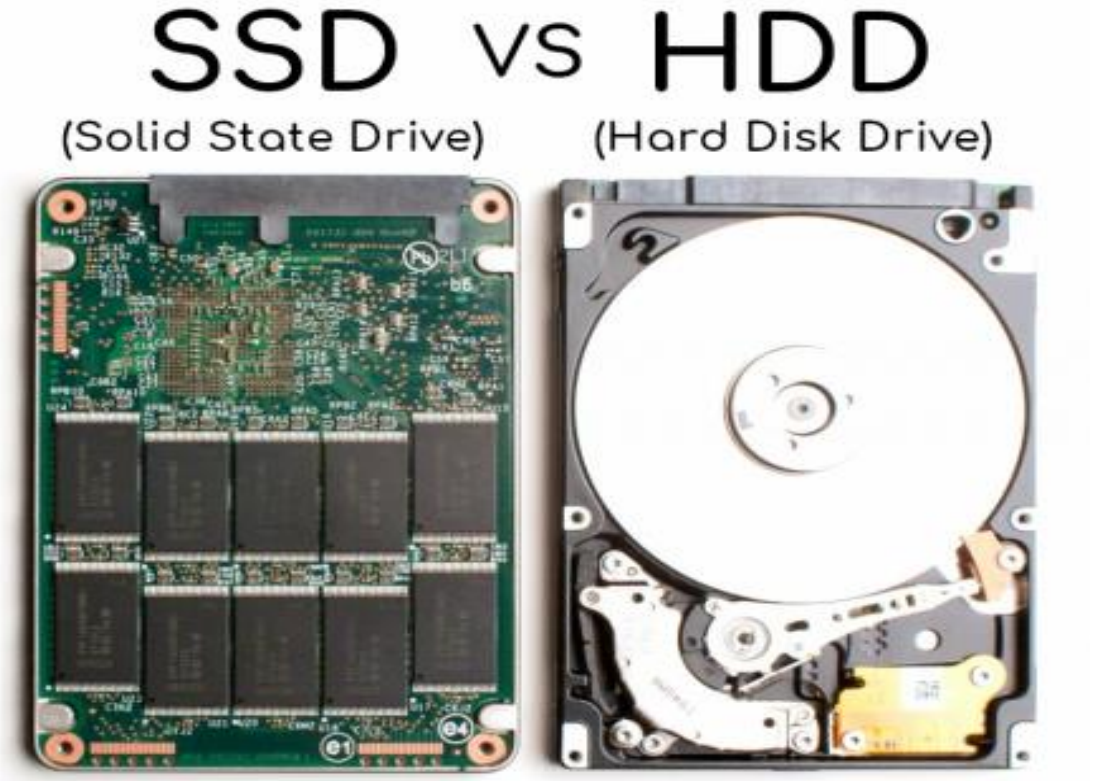


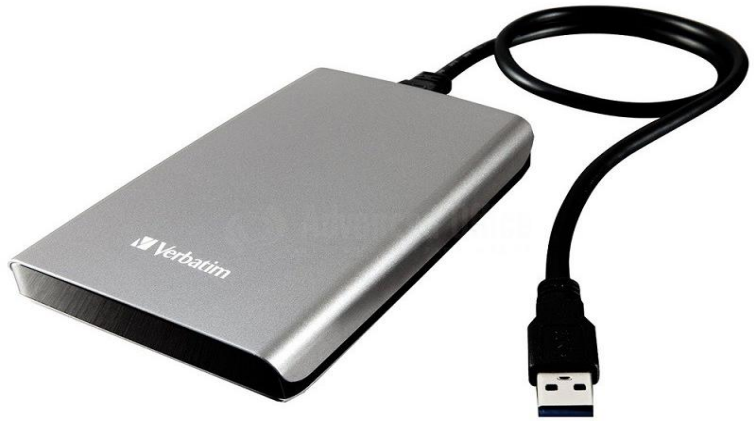
- **ROM** : (Read Only Mémory) is a memory type that contains pre-installed instructions. Its content is persistent and cannot be modified. ROM is utilized to boot the machine upon initial startup. It instructs it on how to set up the computer architecture, and finally locate the hard drive so that the operating system can be launched..

b. External memory

- External or secondary memory is inaccessible directly to the CPU. Before the CPU uses secondary storage data, it must be transferred to the main memory
- External memory retains vast amounts of data.
- Examples include hard disk drives (HDDs), solid-state drives (SSDs), compact disks (CDs), etc.

b. External memory





External hard drive

DVD

Flash disk

CD

Memory capacity

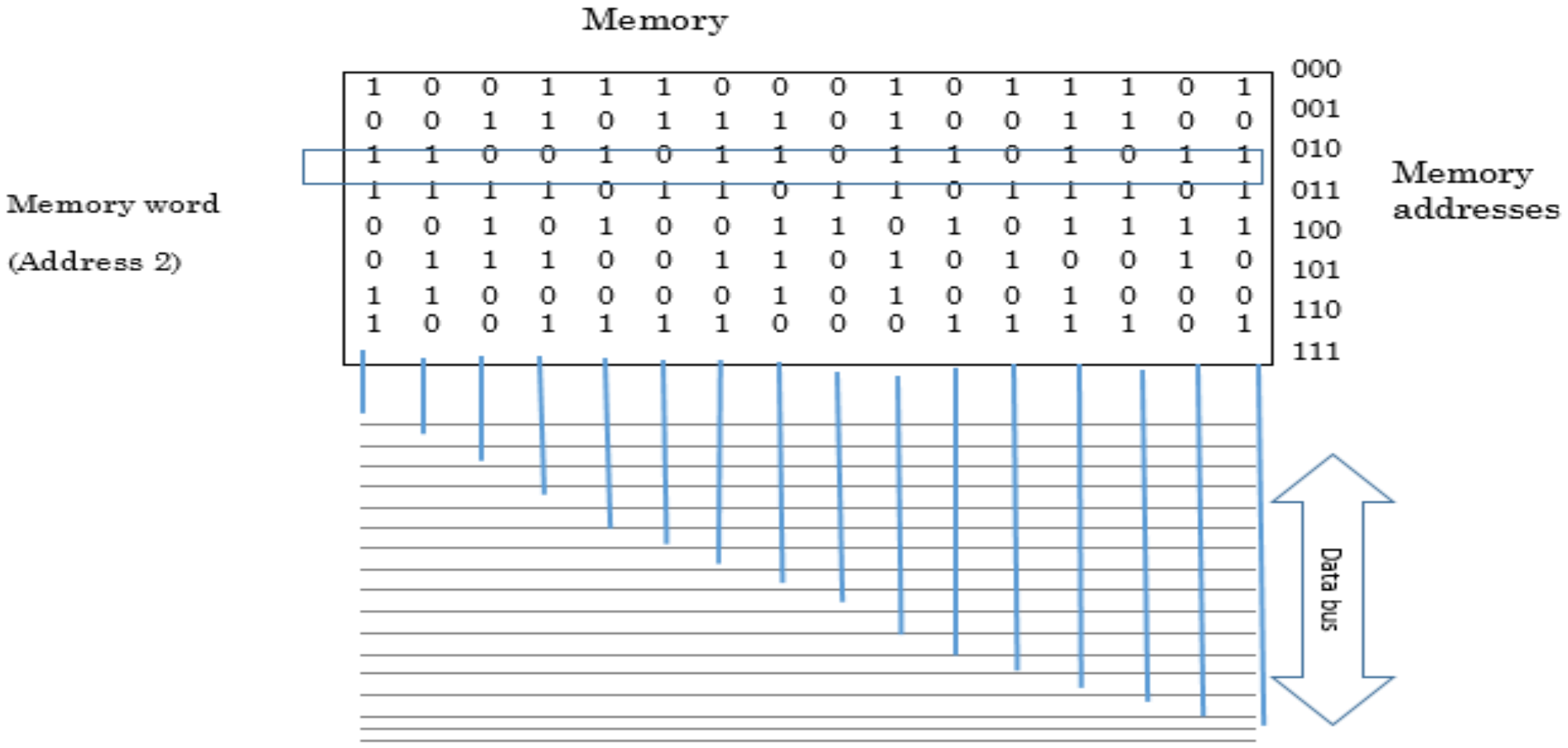
- The memory is formed of a large number of cells (memory words) containing the same number of bits (binary digit);
- Each memory words has a number which corresponds to its address.
- The Bit (binary digit) is the smallest unit of information transmitted by a computer.

Memory capacity

- The data stored in a memory is accessible by word.
- Memory capacity is defined as the number of words constituting it, generally expressed in Gégabyte.

Memory capacity

In the figure, the memory capacity is 8 words of 2 bytes each. Thus, it has a capacity of 16 bytes.



Memory capacity

In computing, Memory capacity is typically measured in units such as:

1 Byte (B) =	8 bits
1 Kilobyte (KB) =	2^{10} Byte
1 Megabyte (MB) =	2^{20} Byte
1 Gegabyte (GB) =	2^{30} Byte
1 Terabyte (TB) =	2^{40} Byte
1 Petabyte (PB)=	2^{50} Byte

Memory capacity measurement units

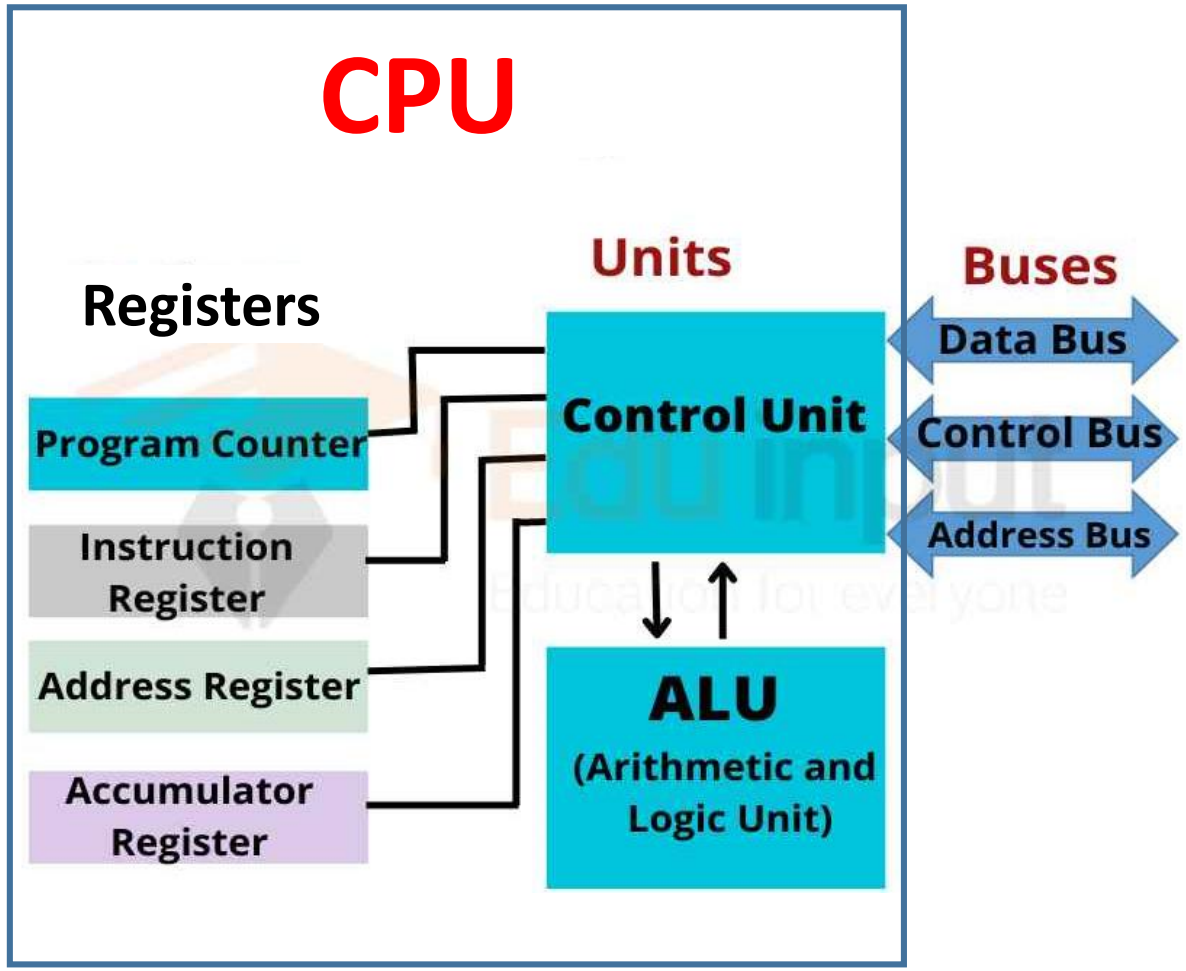
Transfer unit

- The transfer unit between the processor and the memory is the memory word.
- The size of a memory word depends on the type of processor:
  - ✓ 1 byte (8 bits) in 8-bit processors;
  - ✓ 2 bytes in 16-bit processors
  - ✓ 4 bytes in 32-bit processors
  - ✓ 8 bytes in 64-bit processors

2.2 Central processing unit (CPU)

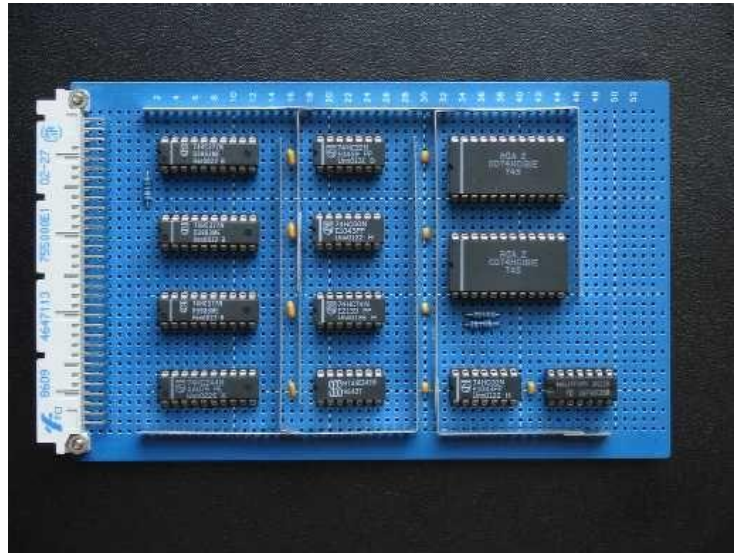
- The CPU is the brain of the computer. It includes arithmetic logic unit (ALU), control circuits and registers
- The CPU interacts with all the other parts of the computer architecture to process the data and deliver the necessary output.

2.2 Central processing unit (CPU)



a.Arithmetic logic unit (ALU)

- The Arithmetic logic unit (ALU) performs any arithmetic (additions, subtractions, multiplication, division) and logical (<, >, AND, OR, etc.) computations.
- Registers are used by the ALU to retain the data being processed.



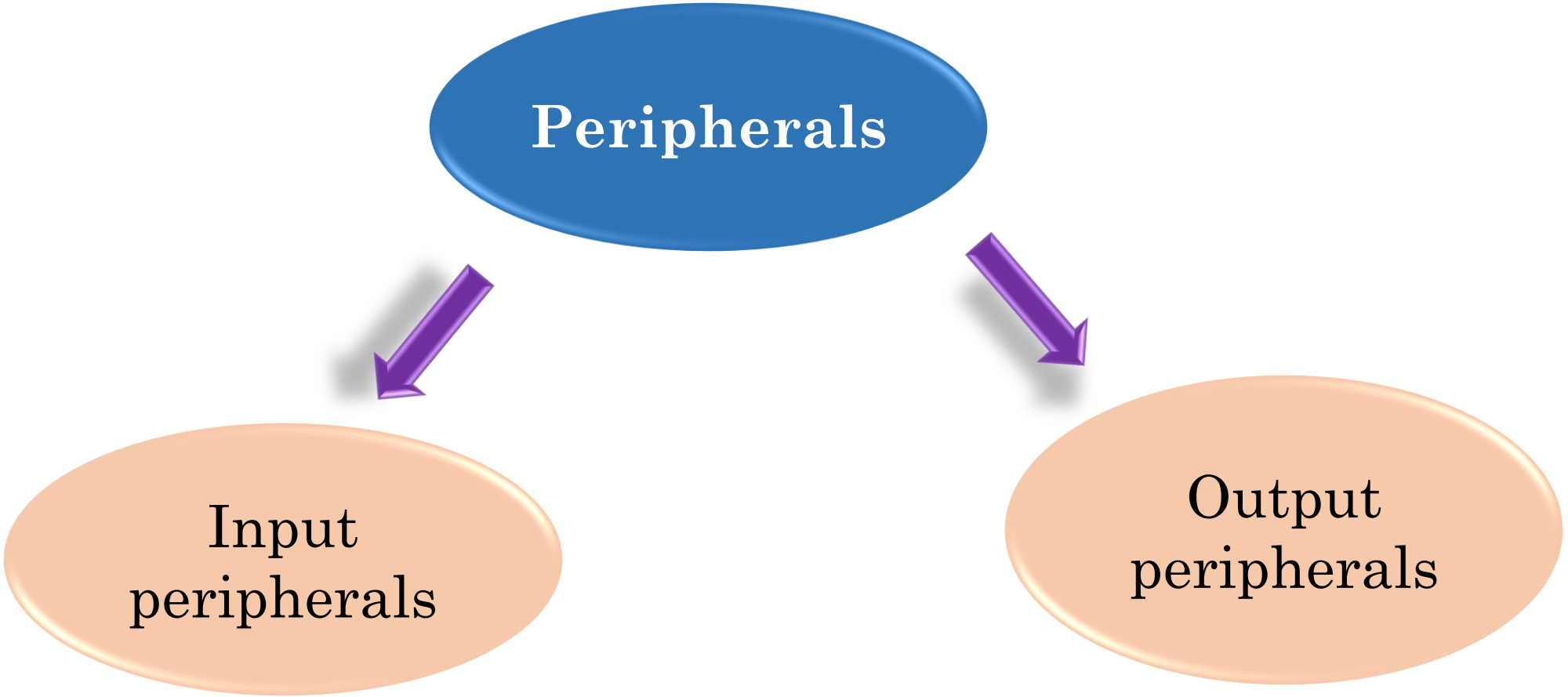
b. The control unit (CU)

- The control unit directs and coordinates most of the operation in the computer
- It instructs the computer to execute stored program instructions via communication with the ALU and registers.
- The control unit aims to arrange data and instruction processing.

c. Registers

- Registers are high-speed temporary memory devices.
- They are accessed and modified directly by the CPU throughout execution rather than being referred to by their address
- Registers contain information, commands, addresses, and intermediate processing results.
- There are different types of registers among which:
  - Program counter
  - Instruction register
  - Address register
  - Accumulator

2.3 Peripherals



2.3.1. Input peripherals

- The input peripherals provides external data sources to the computer system.
- Inpute peripherals includes :

- Keyboard

– Microphone

– Mouse

– Optical drive (CD or DVD drive)

- Scanner

Clavier livré en AZERTY

2.3.2 Output peripherals

- The output peripherals deliver the computer process's results to the user.
- Output peripherals encompass the display, printing unit, speakers, headphones, etc.

Headphones

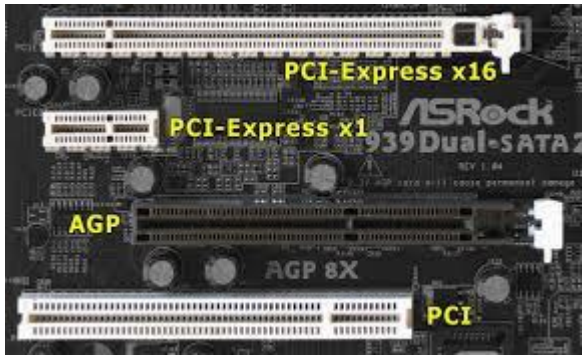
Speakers

Printing unit

the Display

2.4 The buses

- A bus is a collection of signal lines with a linked purpose.
- Buses enable the transfer of information from one system to another.
- The size of a bus is the count of information-transferring signal lines. A bus with a size of 8 bits, for instance, transports 8 data bits .
- a good example of buses is the universal serial bus (USB)



2.4.1 Buses types

There are different types of buses:

- The address bus: transports the addresses of the memory cells, where the processor wishes to read or write data.
- The data bus: transmits data between the different components of the computer.
- The control bus (command bus): transports orders and synchronization signals from the control unit to all hardware components, and also the responses of these components to the control unit.
- Expansion bus: used to connect computer peripherals such as printer, modem and scanner with the processor.

Bus characteristics

- The width of the bus: designates the number of lines in the bus, and thus defines the amount of information that the bus can transport.

For example a 3-lines bus makes it possible to convey $2^3 = 8$ different pieces of information

The address bus is a unidirectional bus (only the processor sends addresses). If it is composed of N lines; that's mean, that we use N-bit addresses. So the memory can have a maximum of 2^N memory words (locations).

3. The Software

This part is essential to the functioning of a computer as the hardware itself, it contains programs, applications and data,

Software can be divided into three main

1. Operating systems or OS (Operating System) such as Windows, Linux, Mac OS, etc.

2– Application programs: These are executable programs designed for an operating system, which allow you to perform functions, such as Microsoft Office, PhotoShop, Auto CAD, Games, etc.

3– Programming Languages: software used to develop applications and software, such as C/C++, Java, Pascal, Matlab, etc.

The software is saved on the hard drive and runs in random access memory (RAM).

The Software

- An operating system is a set of software that allows a computer to function, by allocating the necessary resources for the execution of each program.
- It ensures the connection between users, applications and computer's hardware resources;
- The operating system market is dominated by Windows (win7, win8 win10) (Microsoft) and Mac OS (Apple), but the majority of companies operate with Linux distributions.

Questions