- **Computing system consists of three main parts**

1-processor. 2-memory. 3-I/O.

- **Computing system has two types:**

1-general purpose

2-specific purpose (single purpose) it has constraints in time, cost, speed and size.

To generate embedded system

1-system board (SB) gathering the component in the breadboard.

2-system on chip (SOC) buying an IC

SB vs SOC

	SB	SOC
Size	greater	smaller
Cost	expensive	cheap
Power	greater	smaller
Performance	same	same

So why do we use SB?? The only advantage is that the system is applicable (can be modified) and that is suitable in the phase of design.

- **IC (integrated circuit):** single chip to do specific task.
- **VLSI:** millions of transistors of the same size and with more functionalities.
- **MPU:**

-processor (vacuum tubes)

-CPU (primary)

-microprocessor(transistor).

MCU: computing system has MPU in it

MPU: is a part of MCU

Note:

- SOC with high performance consist of MCU with primary MP and secondary MP used in OS applications ex: RPI
- MPU with low performance used in BareMetal applications.

Processor:

Consist of:

1-ALU (arithmetic and logic unit). 2-CU (control unit). 3-Registers files.

Instruction life cycle: (f>>fitch d>>decode e>>execute)

- The control unit fitches the instruction from ROM to a register called IR (instruction register) in the registers file.
- Instruction decoder is a circuit in CU makes decode to the instructions, it need two things to make decode 1-INST-set 2-INST_format
- ALU has a signal from CU to do the operations, so it executes it and store it in the

General purpose in the registers files.

Note: machine language different from one MP to another

- To understand the INST, we need 1-HW (instruction decoder). 2-SW (compiler).
- If the hardware understands less instruction so it needs high compiler to help him and vice versa.

ISA: instruction set architecture

1-RISC (reduced instruction set computing):

Understand less instruction.

2-CISC (complex instruction set computing):

Understand more instruction.

- **ID (INSTRUCTION DECODER)** manufactured different depend on ISA

1-**hard wired:** consist of logic gates used in (RISC).

2-**memory mapped:** search in the memory for the required INST used in (CISC).

RISC vs CISC

	RISC		CISC
Size	ID bigger, ALU smaller	=	ID smaller, ALU bigger
Cost	SW high, HW low	=	SW low, HW high
Power	ALU low, ID high	=	ALU high, ID low
Performance	the time taken by the compiler	=	the time taken in memory

Register files: Has to types

1-GPR (general purpose register): store data temporarily.

2-SPR (specific purpose register):

1-program counter (PC): next instruction to be executed

2-SP (stack pointer)

3-ACC: store the output of ALU temporary

4-IR (instruction register).

5-PSW (process status word): flags, store the flags of the last operation the ALU did it

Like sign flag, overflow flag and zero flag.

Memory:

- Location =byte=8bit
- Bit can store zero or one
- Access time for write is longer than read
- Basic memory element is flip flop (D)

Characteristic of memory

1-capacity: address lines

2-speed 3-orgnization

Memory types:

1-volatile (RAM).

2-non-volatile (ROM)

3-hyprid

Types of RAM (volatile):

a-SRAM (static): based on transistors (flipflop uses 6 transistors at minimum)

doesn't need refreshment circuit.

SRAM is faster than DRAM but more cost per bit .

So we use it in embedded system and we have constrain in size.

b-DRAM (dynamic): based on capacitors with refresh circuit (DRAM controller)

so the refresh circuit must have more priority than CPU so the access time increased and the speed decreased.

Adv:

1-simple HW.

2-low cost per bit.

3-high density (can be used in large size).

4-low power.

SRAM vs DRAM

	SRAM	DRAM
Size	low	high
Cost	high	low
Power	low	high
Performance	fast	slow