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இலங்கை திறந்த பல்கலைக்கழகம்
The Open University of Sri Lanka

EEX3373 Communication and Computer Technology

Day School 02

Day School 02 Outline

- Where these arithmetic and logic operations are done in a computer
- Components connected to a microprocessor
- How operations are done in a microprocessor
- How to use machine instructions to solve problems

What you lean in this Day School

- You will learn about the main components of a processor with their functions.
- You will understand how the operations – mainly mathematical and logical operations are performed inside the processor.
- You will be acquainted with the necessary components required for these operations.

Arithmetic Operations

- What is an arithmetic operation?

- Operators: Add (+), Subtract (-), Multiply (*), Divide (/)
  - Ex: 8 + 3 = 11

Logical Operations

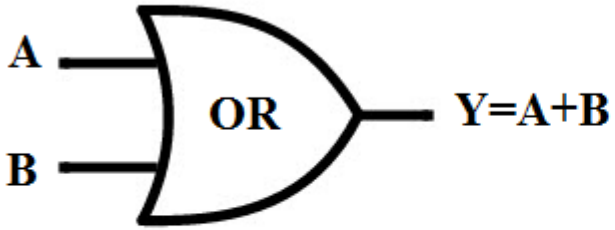
- What is a Logic Operation?

- Operators: OR, AND, NOT, NOR, NAND, XOR
  - Ex: A OR B

Logical Operations: OR Gate

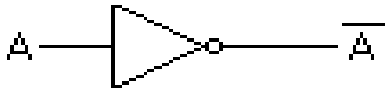
- Ex:

  A OR B

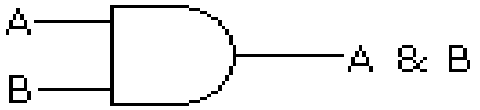


Inputs		Output
A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

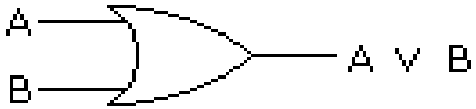
Logical Operations: Other



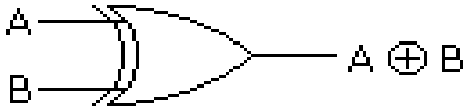
A	NOT A
0	1
1	0



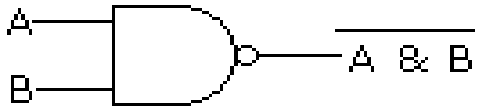
A	B	A AND B
0	0	0
0	1	0
1	0	0
1	1	1



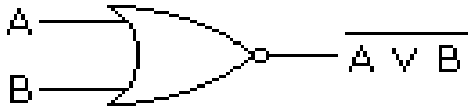
A	B	A OR B
0	0	0
0	1	1
1	0	1
1	1	1



A	B	A XOR B
0	0	0
0	1	1
1	0	1
1	1	0



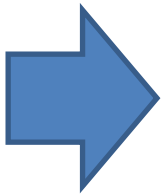
A	B	A NAND B
0	0	1
0	1	1
1	0	1
1	1	0



A	B	A NOR B
0	0	1
0	1	0
1	0	0
1	1	0

The Coffee Making Machine

Figure 4.1 Coffee/Tea making machine



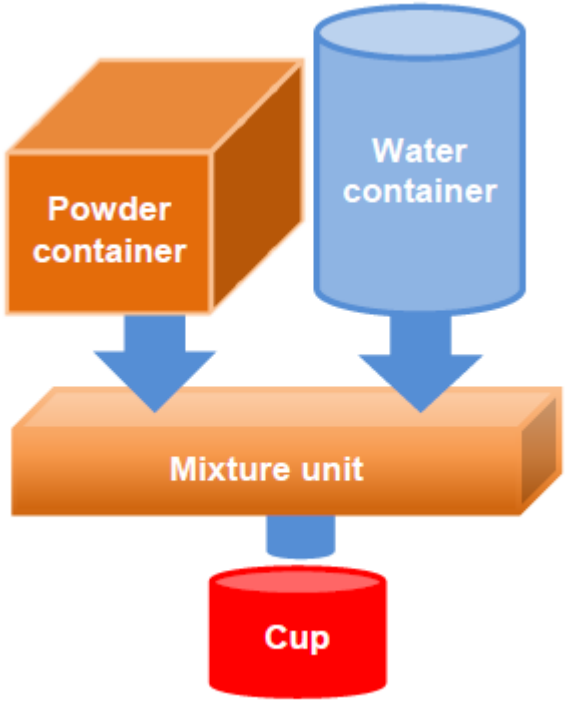
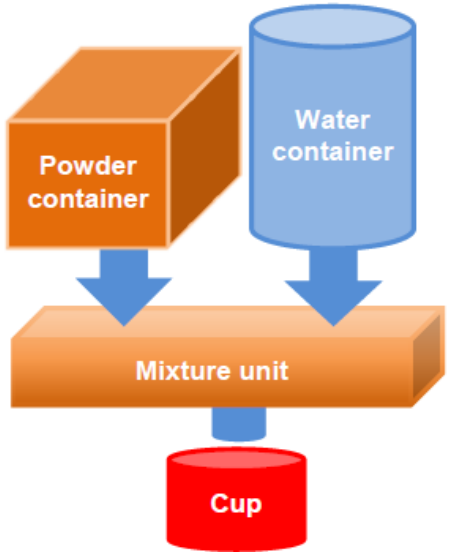


Figure 4.2. Diagram of Coffee/Tea making machine

Coffee Machine and ALU

- Where these arithmetic and logic operations are done in a computer.



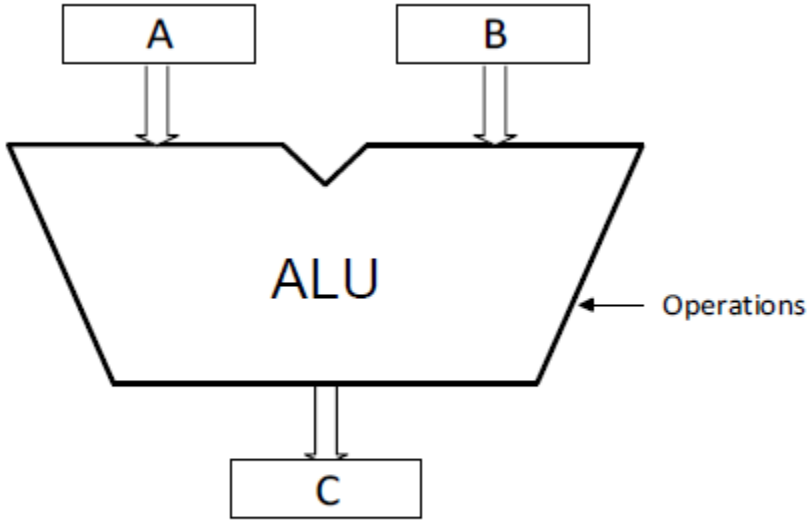


Figure 4.3. Arithmetic and Logic Unit (ALU)

The ALU

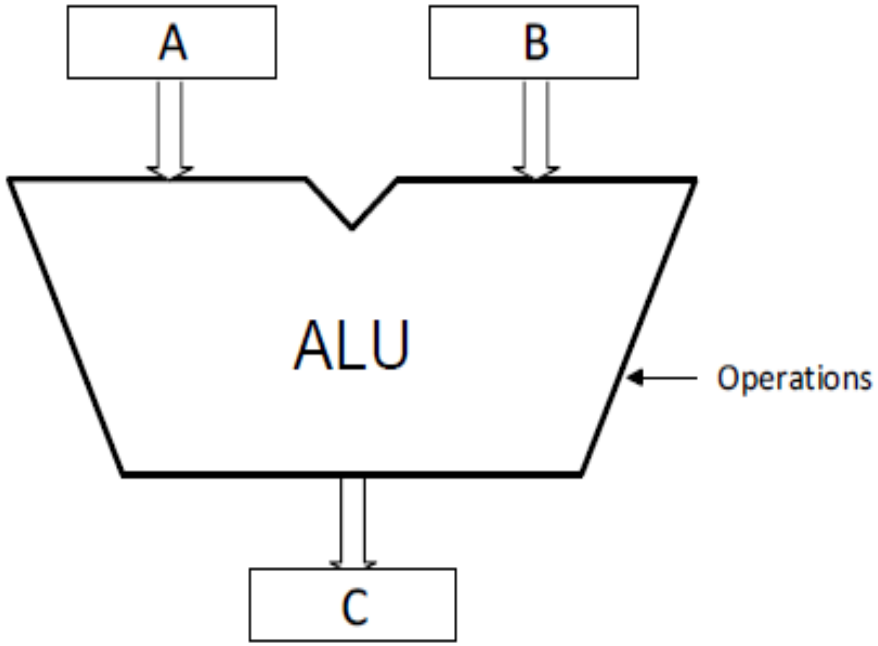


Figure 4.3. Arithmetic and Logic Unit (ALU)

The ALU needs to **keep** two **operands** (A and B) to perform the operation (to **hold operands until it finishes** the operation).

To keep (store) these operands, we use processor registers.

Processor Register: a local storage space inside a processor that holds data being processed by CPU.

The processor registers *A* and *B* store the values required for the operation.

There is a cup to hold the prepared coffee. Similarly, **processor register *C*** is used to **store** the **result** after completing the ALU operations.

How ALU to Performs..

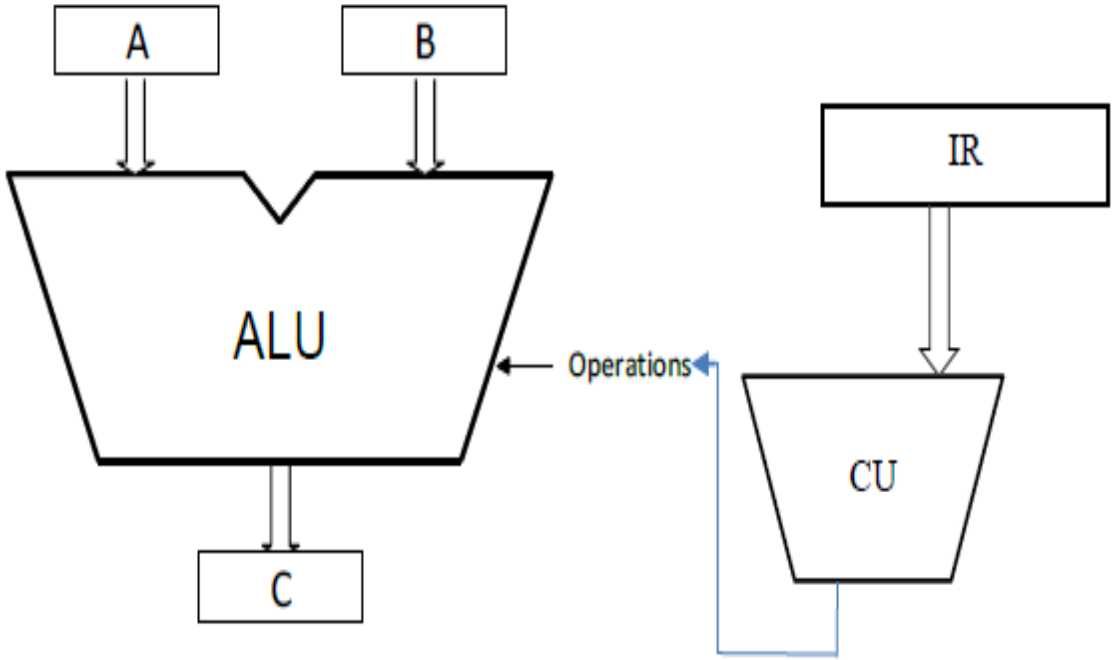


Figure 4.4 Integration of CU and IR with ALU.

Control Unit (CU): Provide necessary signals (commands) to the ALU for operations.

Instruction Register (IR): A special register to hold the instruction being executed inside the processor.

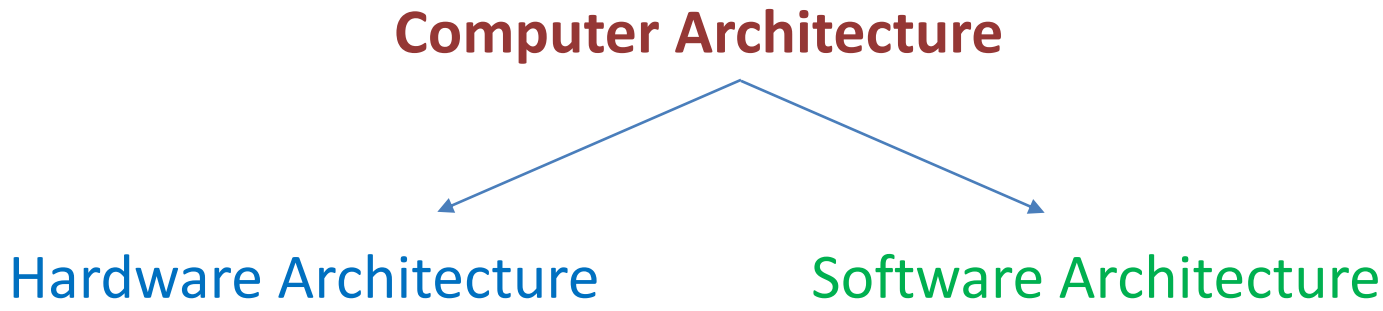
Other Components that help ALU to Perform

- Special purpose registers (SFR): Used for different purposes to help the ALU to perform its operations. Ex:
  - Accumulator (AC)
  - Instruction Register (IR)
  - Program Counter (PC)
  - Memory Address Register (MAR)
  - Index Register (IR)
  - Memory Buffer Register (MBR)
- General Purpose Registers (GPR)
- Memory
- Stack

Computer Architecture

How a computer system is designed.

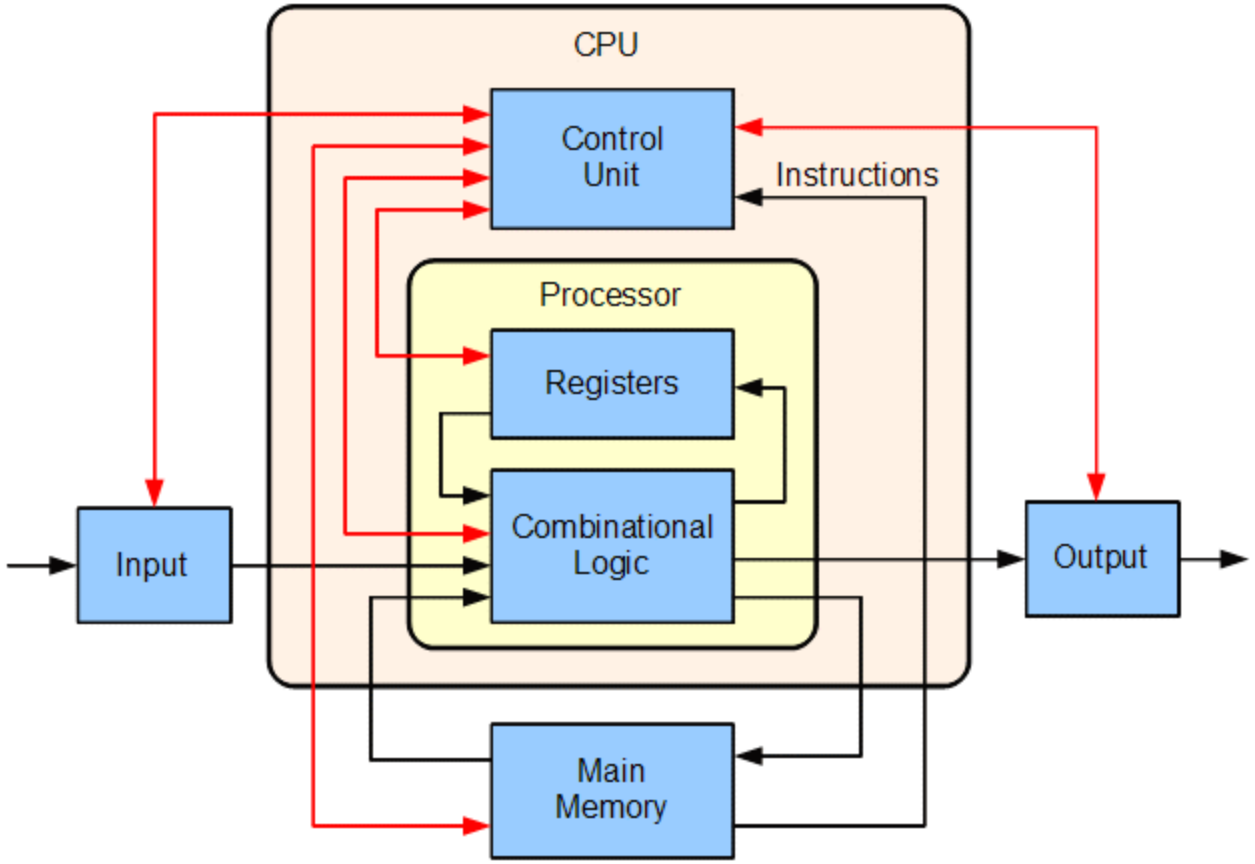
Detailed specification of the hardware and software technology standards interact to form a computer system or platform.



computer architecture, structure of a digital computer, encompassing the design and layout of its instruction set and storage registers

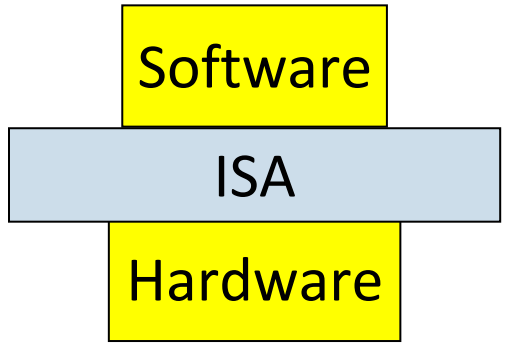
-Britannica

Hardware Architecture: Example



Instruction Set Architectures (ISA)

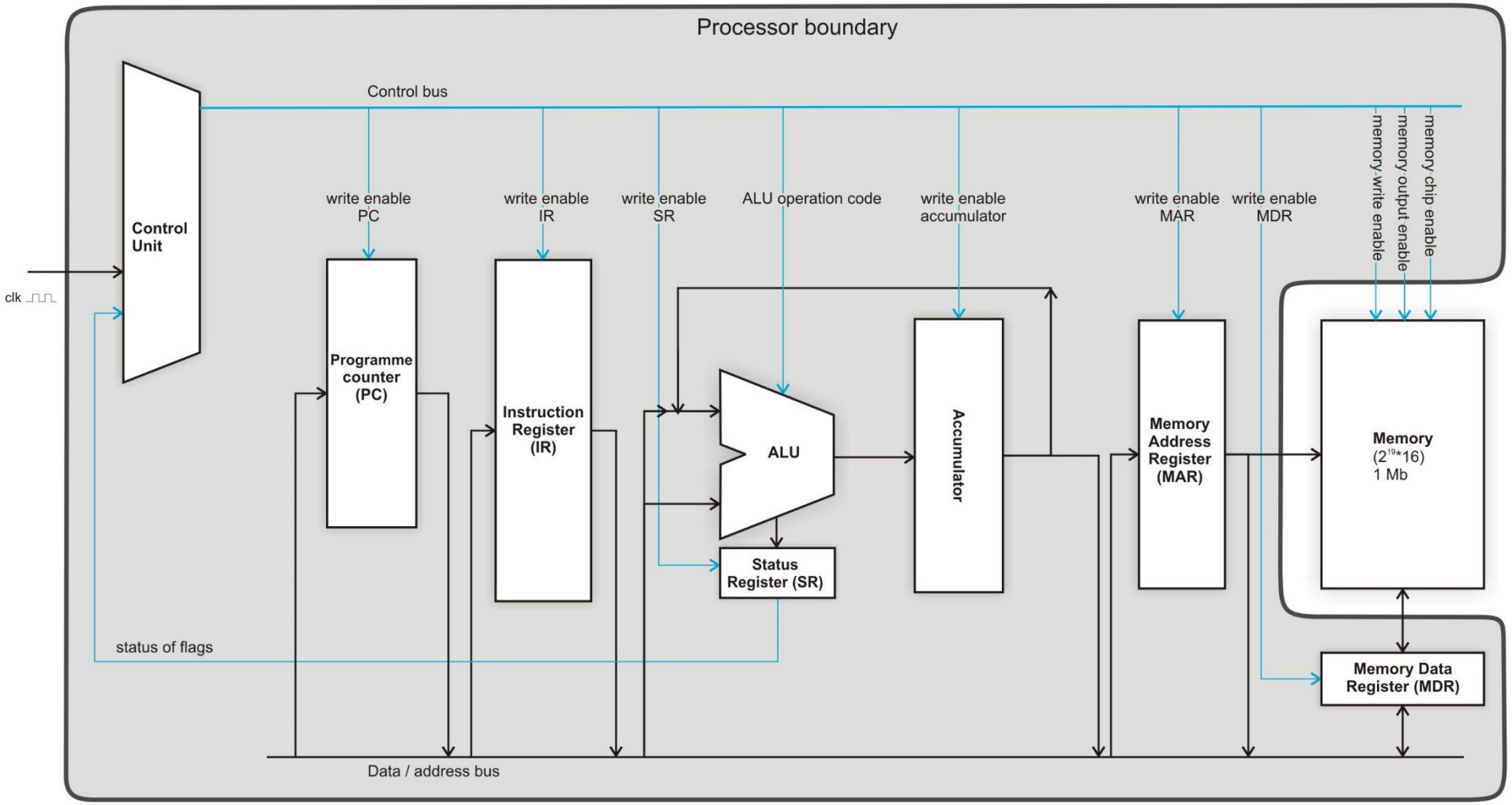
- Part of the **abstract** model of a computer that defines how the CPU is controlled by the software.
- The ISA acts as an **interface** between the hardware and the software.
- The ISA provides **commands** to the processor to tell it what it needs to do.
- The ISA consists of addressing modes, instructions, native data types, registers, memory architecture, interrupt, and exception handling, and external I/O.



Basic Computer Architectures

- Accumulator Architecture
- Load/Store Architecture
- Register-Memory Architecture
- Memory-Memory Architecture
- Stack Architecture

Accumulator Architecture (Hardware diagram)



Word in Compute Terminology

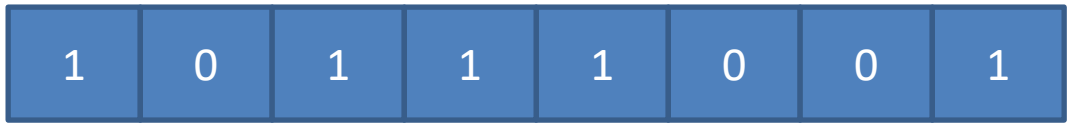
A **word** is a group of **binary** digits that can occupy a storage location.

Even a word made of several binary digits (bits), the computer handles each word as a **single unit**.

This is the **fundamental** unit of information used in the computer.

A word can be a **data** or an **instruction**.

Ex:



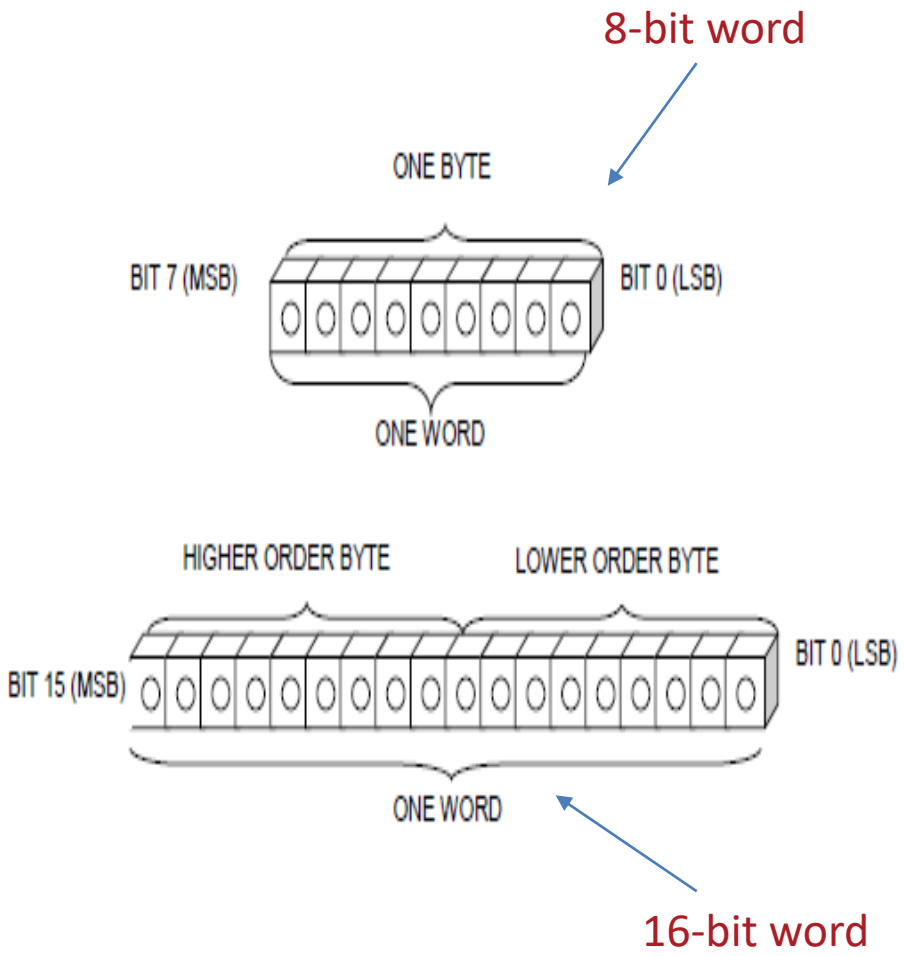
The Word Length

One of the most important characteristics of any processor is **word length** it can handle.

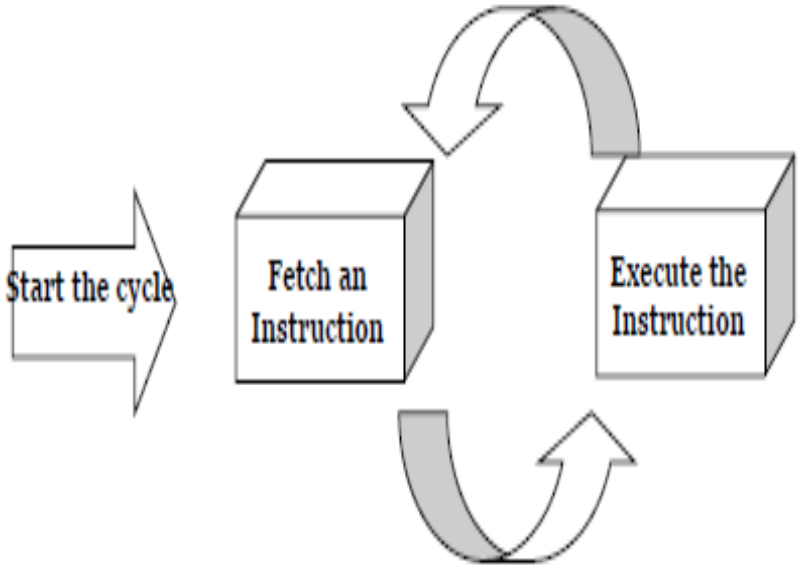
If it is 8 bits, numbers, addresses, instructions and data are represented by 8-bit binary numbers.

The lowest 8-bit binary number is $0000\ 0000_2$ and the highest is $1111\ 1111_2$. In decimal, this range is from 0 to 255_{10} (256_{10} unique values).

The least significant bit (LSB) is the right most bit.
The most significant bit (MSB) is the left most bit.



Fetch – Execute Cycle



When a computer is executing a program, it goes through a fundamental cycle that is repeated over and over again.

These instructions should be stored in the memory in an orderly manner.

Instructions are fetching, one at a time, from memory by the Procession Unit (PU). Then the fetched instruction is executed by the PU.

When the PU is initially started, it enters the **fetch phase**. Here the instruction is taken from the memory and decoded by the PU.

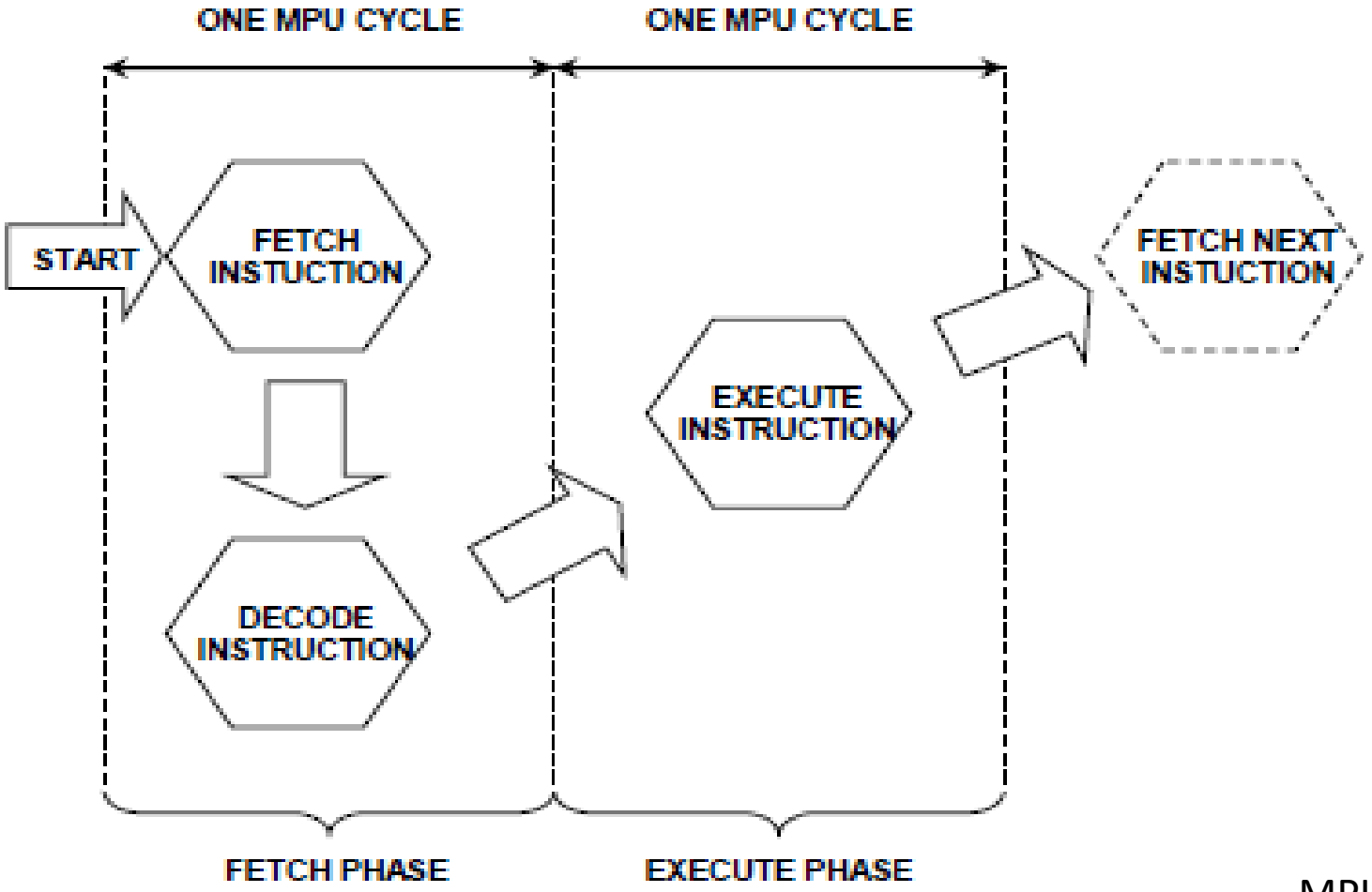
Once the instruction is decoded, the PU switches to the **execute phase**. During this phase, the MPU carries out the operation given by the instruction.

Addressing Modes

What is an Addressing Mode?

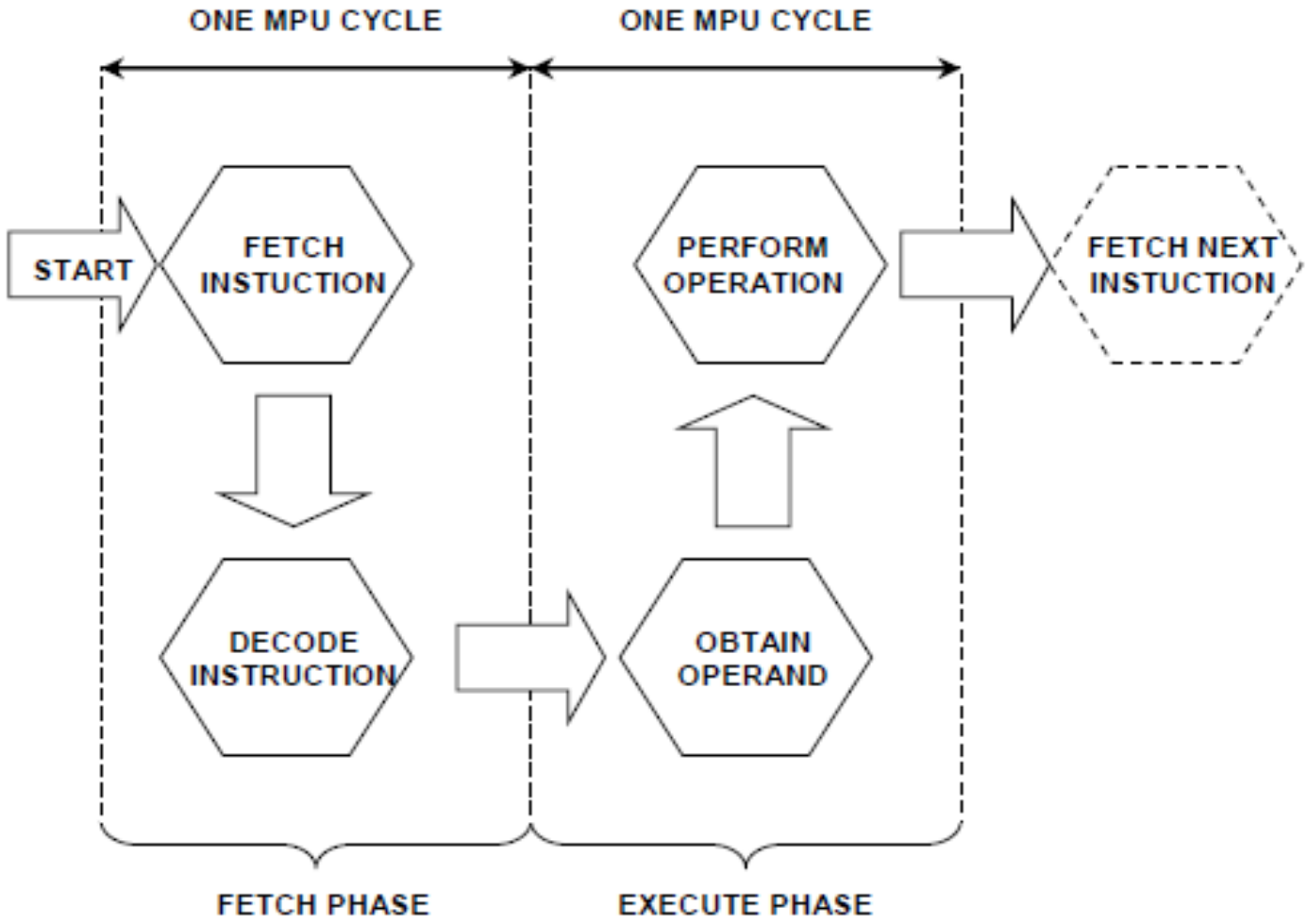
Ex: Direct
Indirect
Immediate
Relative
Indexed
Indexed with indirect
Autoincrement/ autodecrement
Extended memory

Implied Addressing Mode

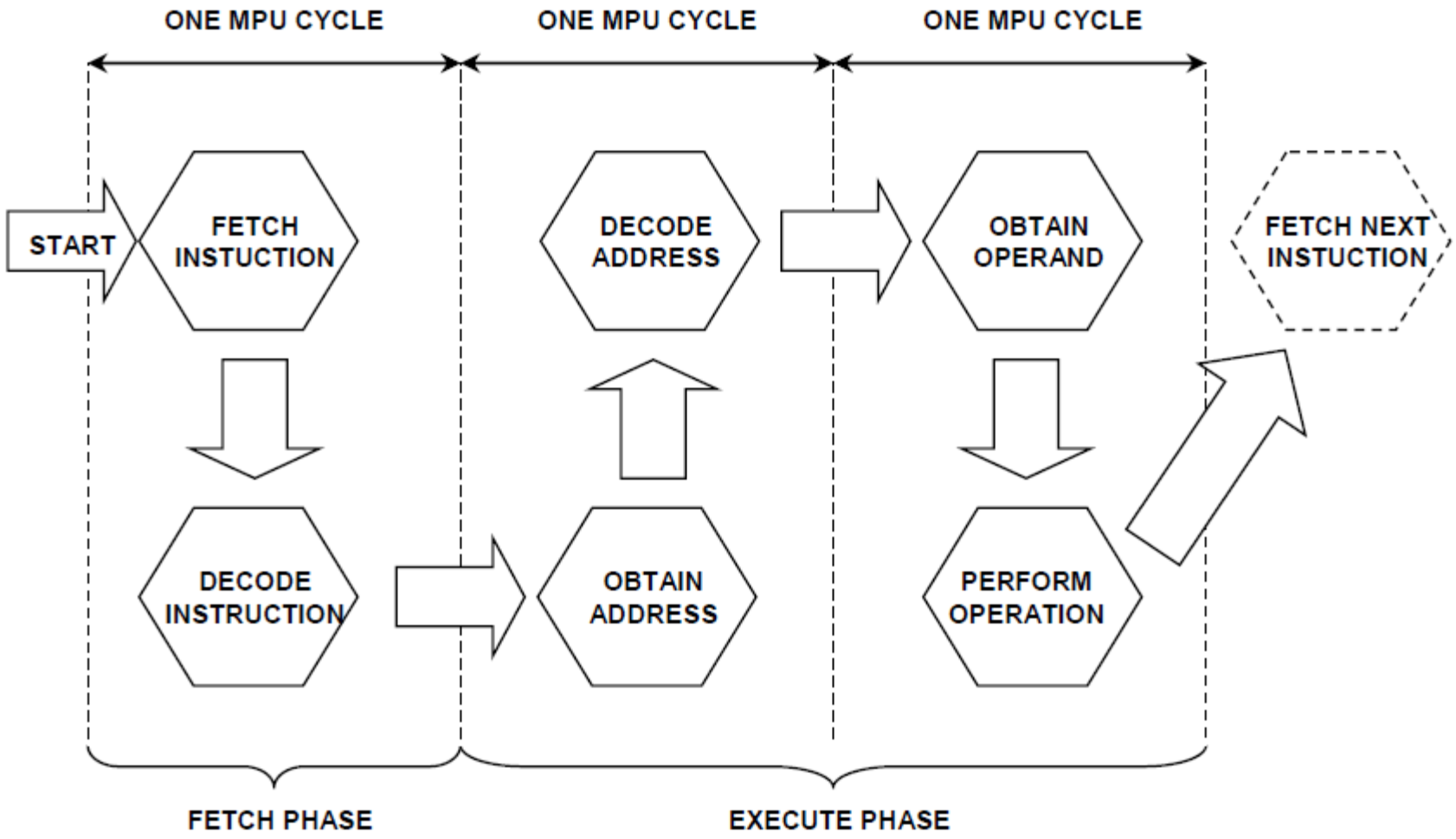


MPU: Main Processing Unit

Immediate Addressing Mode



Direct Addressing Mode



THANK YOU!

Questions?

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