EC-310 Microprocessor and Microcontroller Based Design

Inside Computers

Nazar Abbas Saqib

nazar.abbas@ceme.nust.edu.pk

Outline

1.Inside the Computer

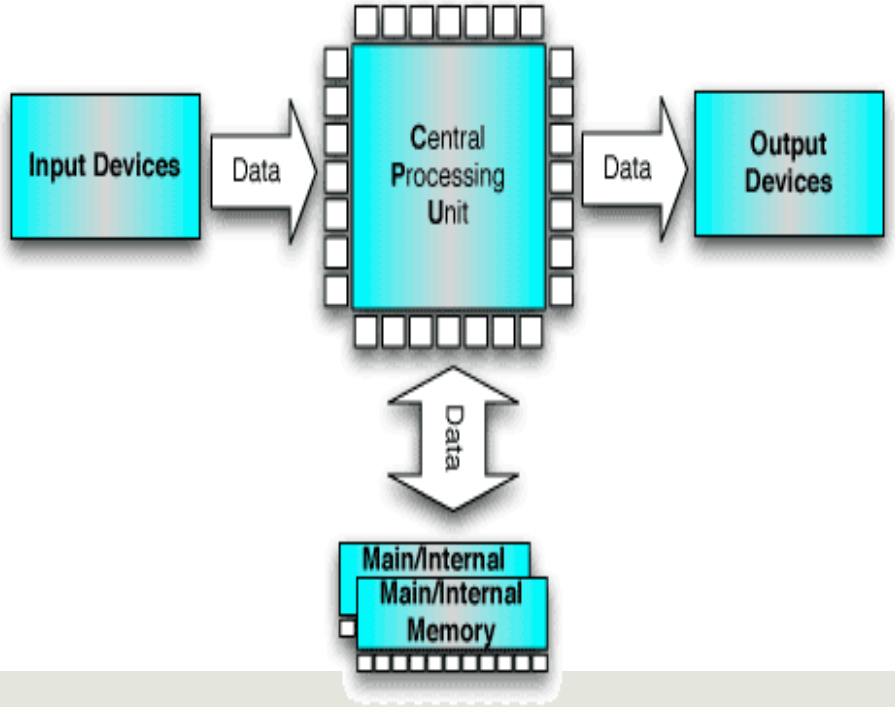
Inside the Computer

Some important terminologies

- Bit:
  - Smallest unit of information in digital world
  - Either 1 or 0.
- Nibble:
  - 4–bits
  - Decimal Values 0 – 15
- Byte:
  - 8–bits
  - Decimal Values 0 – 255

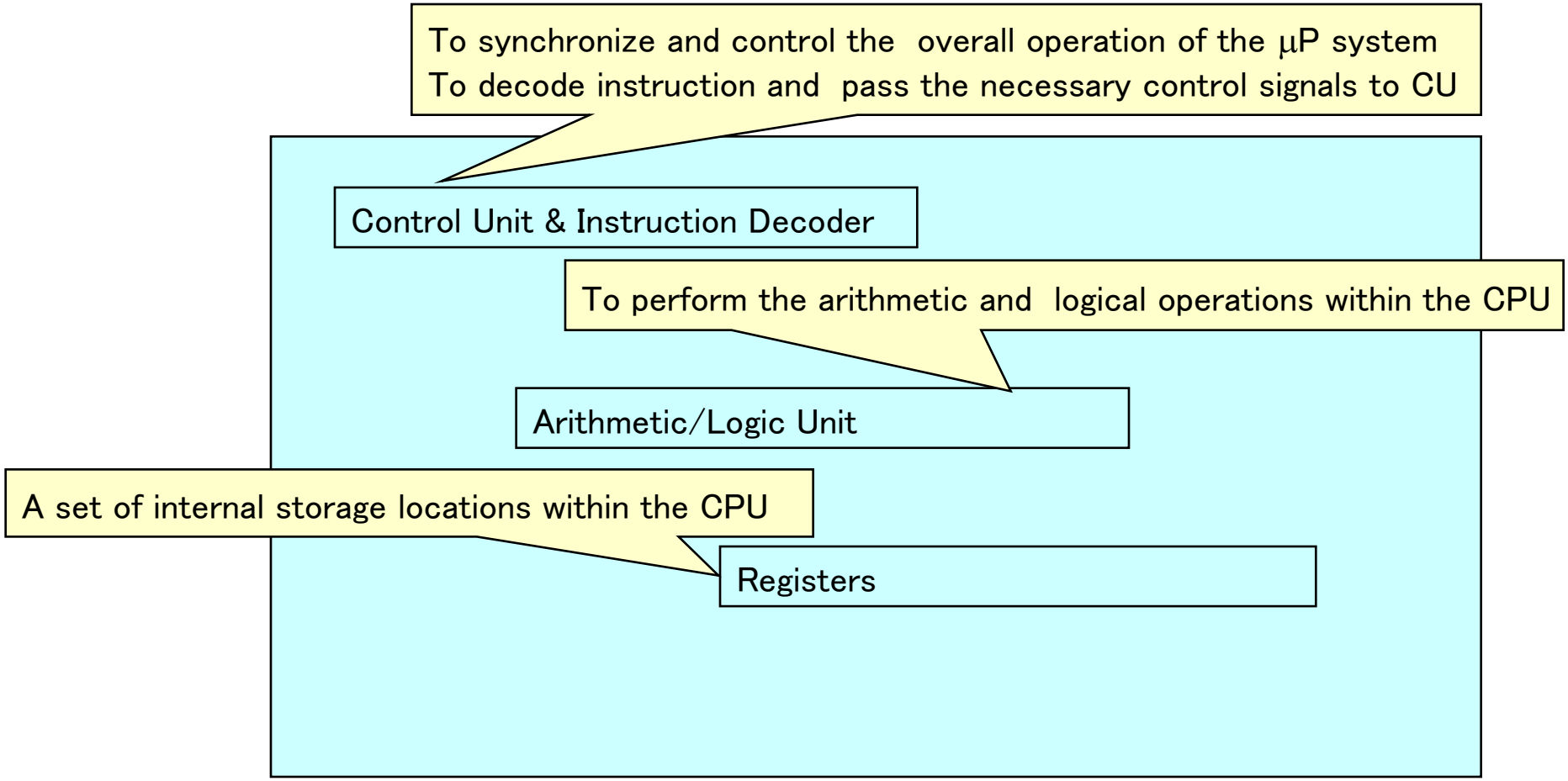
Inside the Computer

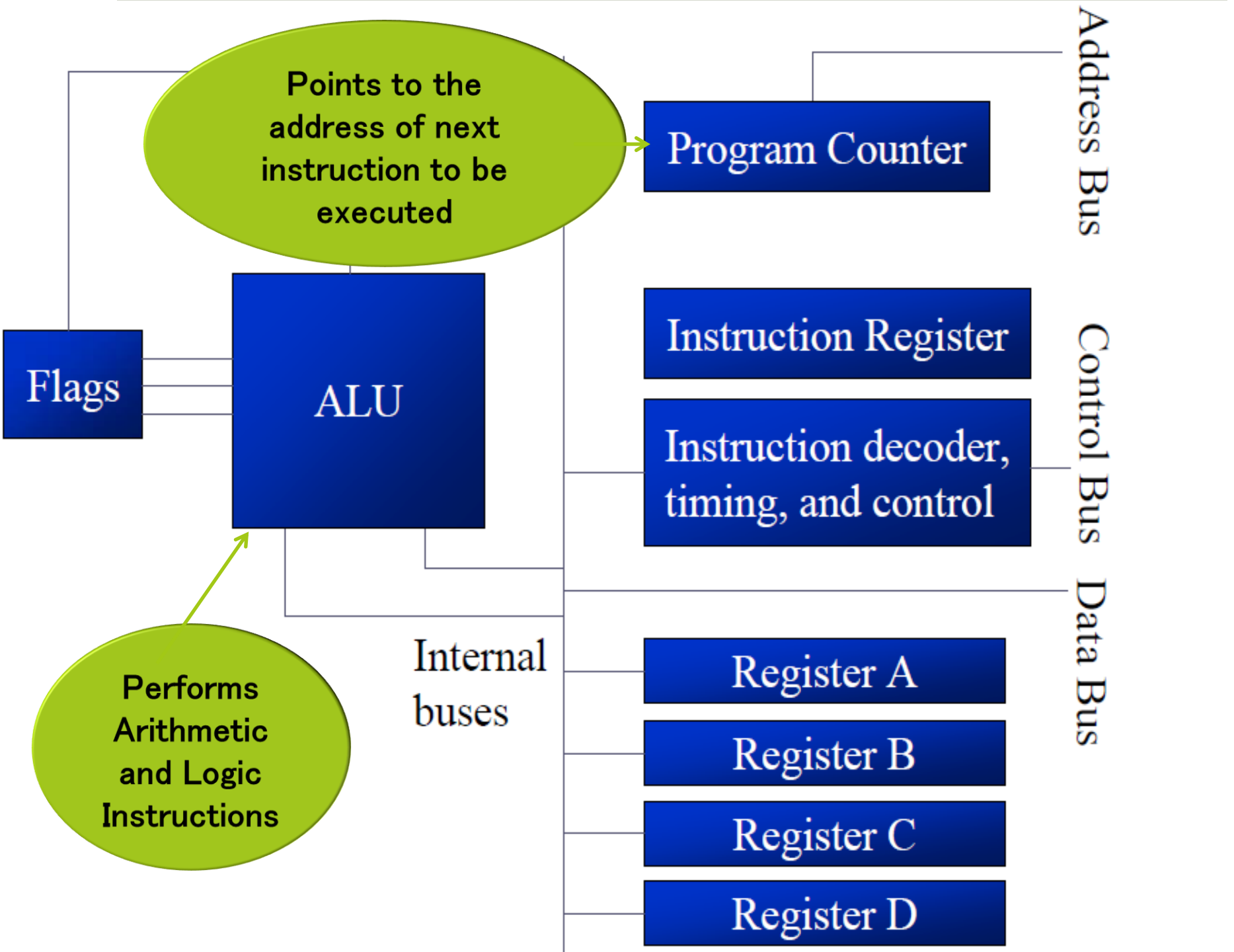
- Internal Organization of Computers
- Can be divided into three parts:
  - CPU (Central Processing Unit)
  - I/O (Input/Output) Devices
  - Memory

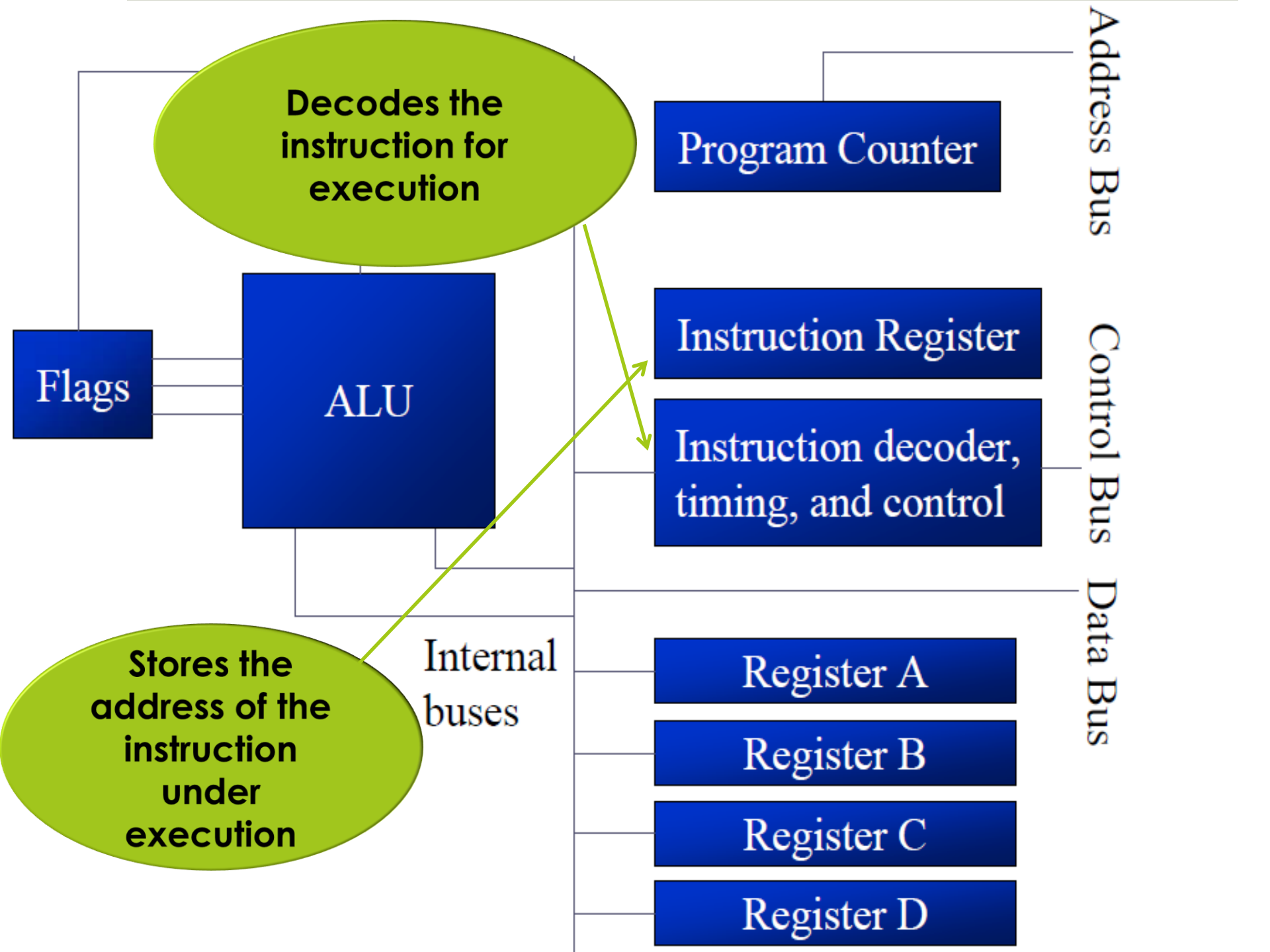


Inside the Computer

The Central Processing Unit (or μP)

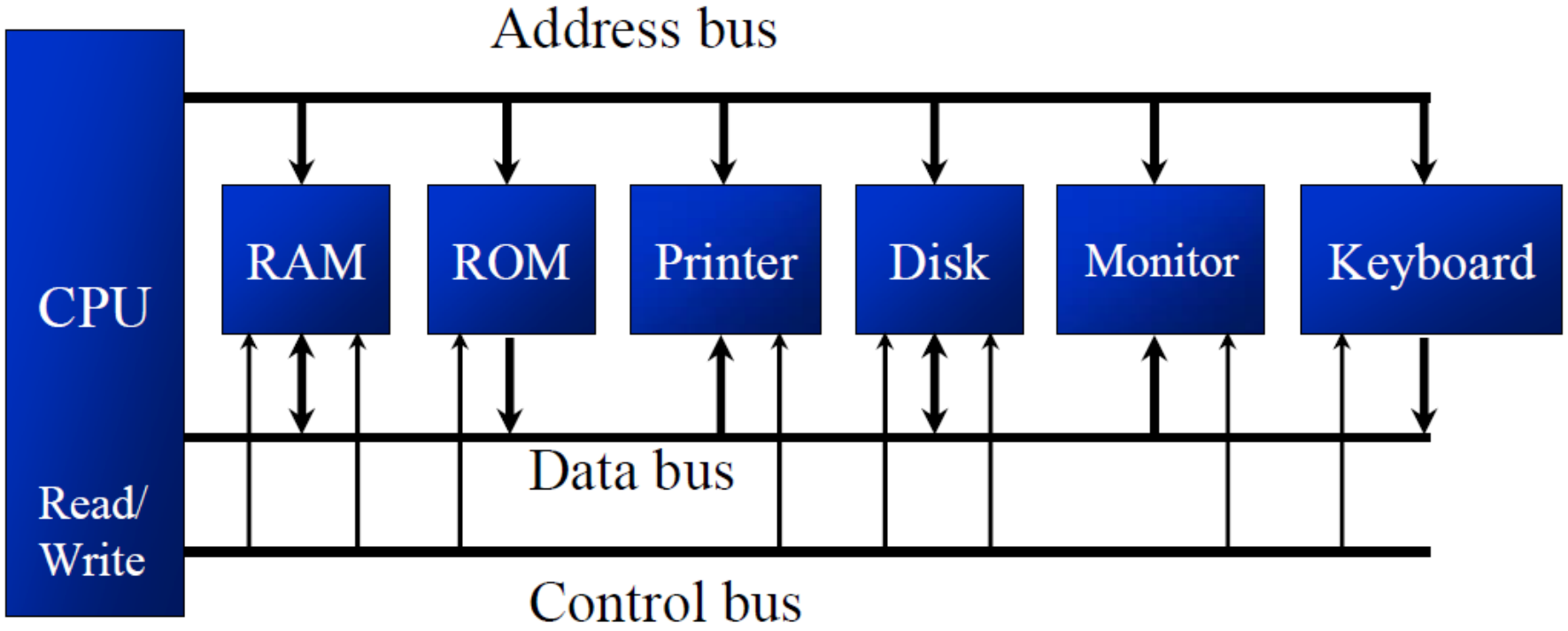



Points to the address of next instruction to be executed
Program Counter
Address Bus
Flags
ALU
Instruction Register
Instruction decoder, timing, and control
Control Bus
Data Bus
Internal buses
Register A
Register B
Register C
Register D
Performs Arithmetic and Logic Instructions


Decodes the instruction for execution
Program Counter
Address Bus
Flags
ALU
Instruction Register
Control Bus
Instruction decoder, timing, and control
Internal buses
Data Bus
Stores the address of the instruction under execution
Register A
Register B
Register C
Register D

Inside the Computer

CPU Connection with Peripherals and Memory Via Buses



Inside the Computer - Memory

- For the CPU to process information, the data must be stored in RAM or ROM, which are referred to as primary memory
- ROM provides information that is fixed and permanent
  - Tables or initialization program
- RAM stores information that is not permanent and can change with time
  - Various versions of OS and application packages.
- CPU gets information to be processed first form RAM (or ROM) if it is not there, then seeks it from a mass storage device, called secondary memory, and transfers the information to RAM

Inside the Computer

- **Memory**
- There are two main types of memories in microcomputers:
  - **RAM** (**R**andom **A**ccess **M**emory)
  - **ROM** (**R**ead **O**nly **M**emory)
- RAM:
  - Temporary Storage
  - Data is lost when power is switched off
  - Also known as Volatile Memory

Inside the Computer

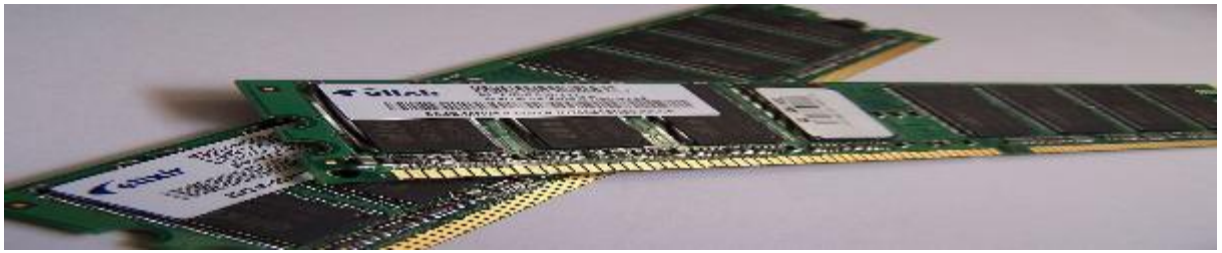
- There are two main types of RAMs:
  - SRAM
  - DRAM

SRAM	DRAM
1-bit is stored in flip flop	1-bit is stored in capacitor/transistor pair
Faster as compared to DRAM	Slower
Less Power Requirement	More Power Requirement
Used in cache memory	Used in general RAMs

Inside the Computer

- ROM
  - Read only memory
  - Stores information essential for operation of computers
  - Information is permanent
  - Information stays even when power is switched off.
  - Hence also known as non-volatile memory.
  - Example: EEPROM, flash memory etc.

Inside the Computer – Memory Addressing



Memory Address-1 → Memory Location-1

Memory Address-2 → Memory Location-2

Memory Address-n → Memory Location-n

1	2	3	4	5	6	7	8

1 byte = 8-bit data

1 word= 2 bytes

1 double = 2 words

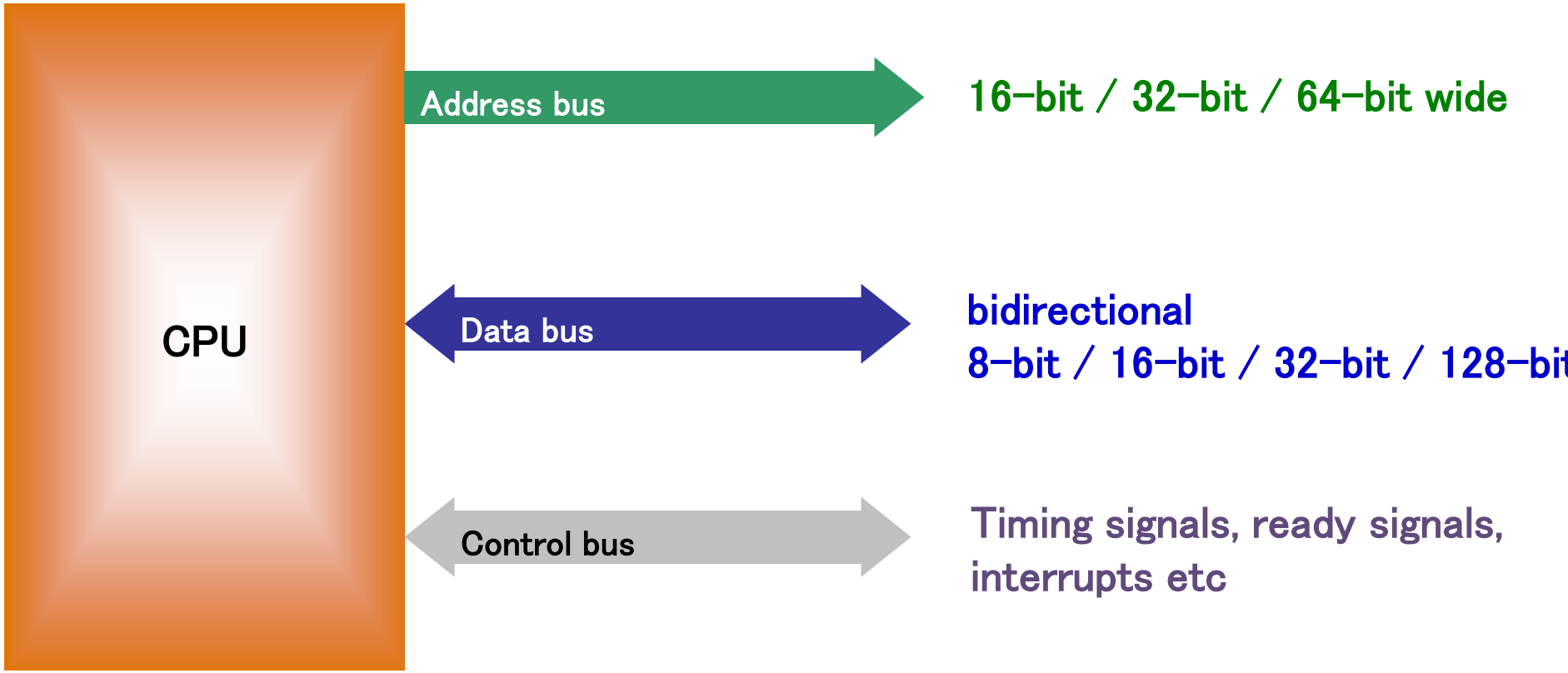
Number of addresses 2^N (where N is an integer)

Inside the Computer

- I/O Devices:
  - Means for communication with the CPU
  - Input Devices: Keyboard, Mouse, Scanner, Bar Code Reader etc.
  - Output Devices: Printer, Monitor, Plotter, Speakers etc.
- Bus:
  - Information transfer between I/Os, memory and CPU is carried out by a collection of wires known as a ‘bus’.
  - Bus carries information from place to place within a computer.

Inside the Computer

- Bus:
  - Information transfer between I/Os, memory and CPU is carried out by a collection of wires known as a ‘bus’.
  - Bus carries information from place to place within a computer
- Types of Buses in a computer system: 1. Data Bus 2. Address Bus 3. Control Bus

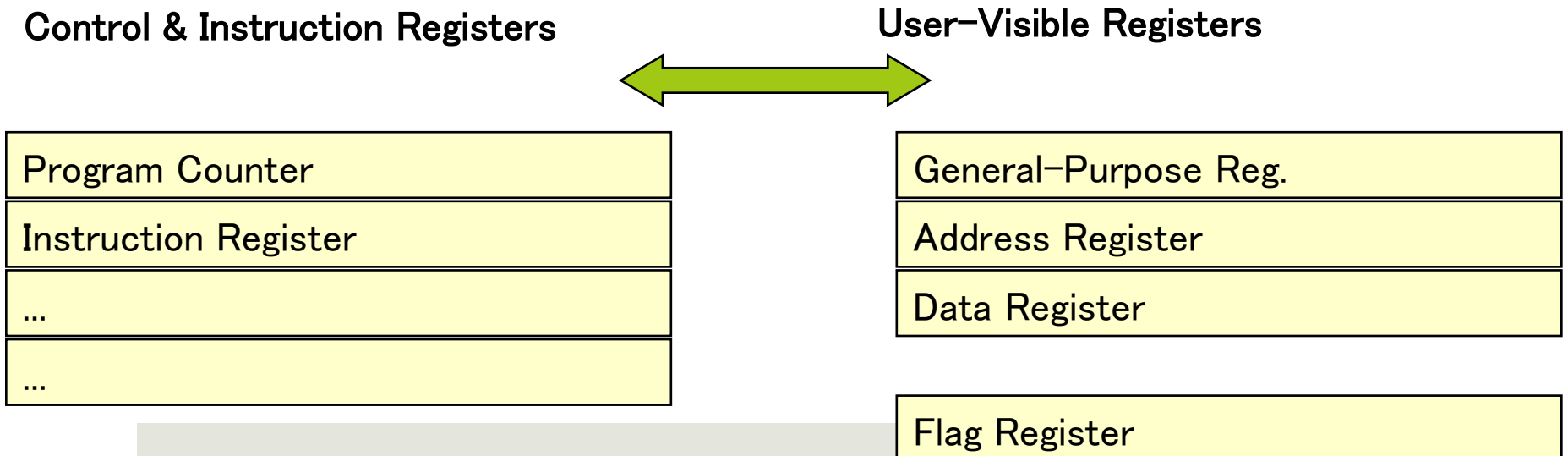


Inside the Computer - Bus

- **Data Bus:** Carries data from I/O or memory to CPU and vice versa.
  - More the data buses, better the CPU
  - Cost increases with increase in data buses
  - Processing Power of CPU is determined by size of data buses
  - 8–bit, 16–bit, 32–bit, 64–bit
  - Bidirectional
- **Address Bus:** Carries address of the peripherals, memory locations etc.
  - Identifies devices and memory connected with CPU.
  - Greater the address bus, more devices and memory location can be addressed.
  - Unidirectional: CPU sends out data only.

Inside the Computer

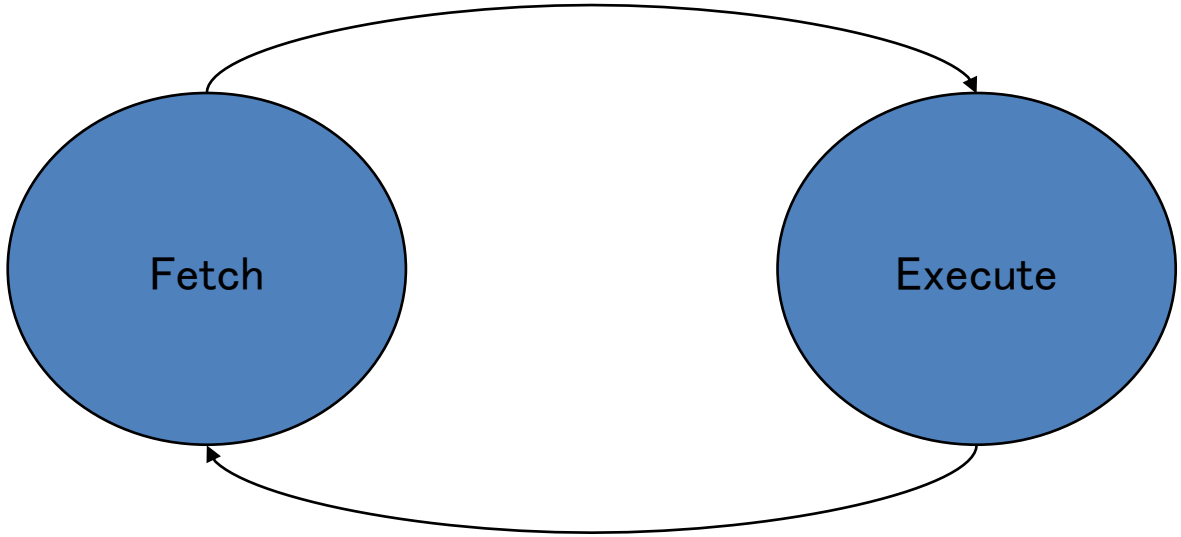
- **Registers**
  - The CPU uses registers to store information temporarily / values to be processed.
  - Address of value to be fetched from memory
  - In general, the more and bigger the registers, the better the CPU.
  - Registers can be 8, 16, 32, or 64-bit.
  - The disadvantage of more and bigger registers is the increased cost of such a CPU.



Inside the Computer

Instruction Cycle (Fetch–Execute)

- The processor executes instructions one–by–one according to the sequence found in memory
- Everything is controlled by, what else, the **control unit** in the CPU.
- To execute an instruction, the processor must fetch it from memory.
- The complete steps the processor takes to execute one instruction is the **instruction cycle** or the **fetch–execute cycle**



Inside the Computer

Instruction Cycle Details

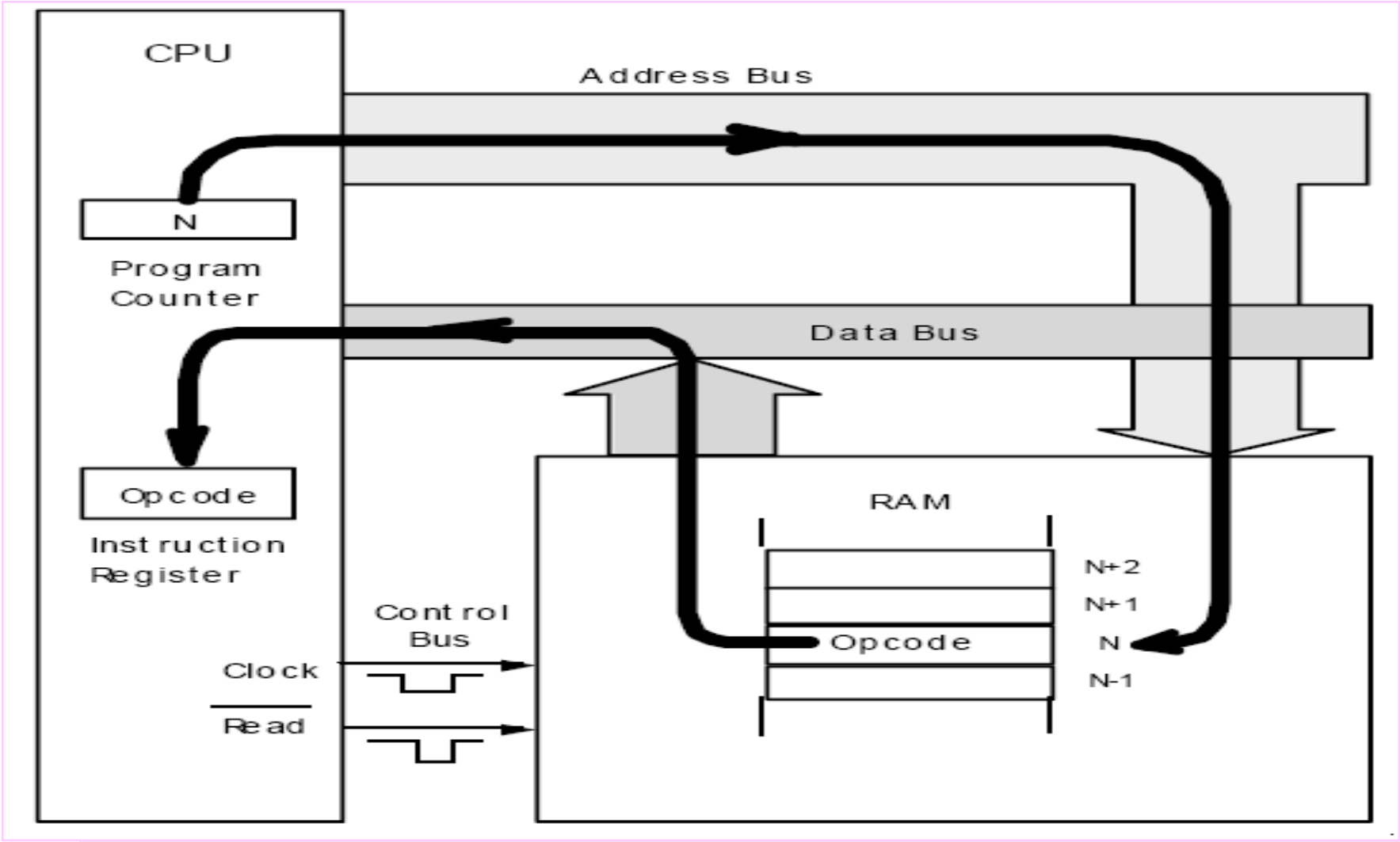
- **On program start:**
  0. Load the program counter (PC) with the address of the first instruction

- **Fetch phase:**
  1. Read the instruction and put it into the instruction register (IR)
  2. Control unit decodes the instruction; updates the PC for the next instruction

- **Execute phase:**
  3. Find the data required by the instruction.
  4. Perform the required operation.
  5. Store the results.
  6. Repeat from Step 1

Inside the Computer

Instruction Cycle Details



Inside the Computer

- Resources:
  - Textbook: PIC Microcontrollers and Embedded Systems by Muhammad Ali Mazidi.
  - Lecture Slides by Chung Ping Young, Department of Computer Science and Information Engineering, National Cheng Kung University, Taiwan
  - Online Resources