SNS COLLEGE OF TECHNOLOGY

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COURSE NAME : 23ITT202 – COMPUTER ORGANIZATION AND ARCHITECTURE

II YEAR/ III SEMESTER

UNIT – I OVERVIEW AND INSTRUCTION

Topic: Functional Units & Basic Operational Concepts

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Computer Organization and Architecture

- Computer Organization and Architecture is the study of internal working, structuring, and implementation of a computer system.

- Computer Architecture is the combination of the hardware units which implements the instructions & the specification of an instruction set.
- Computer architecture comprises rules, methods, and procedures that describe the execution and functionality of the entire computer system.

Functional Units

A computer in its simplest form comprises of five functional units namely

- **input unit,**
- **output unit,**
- **memory unit,**
- **arithmetic & logic unit &**
- **control unit**.

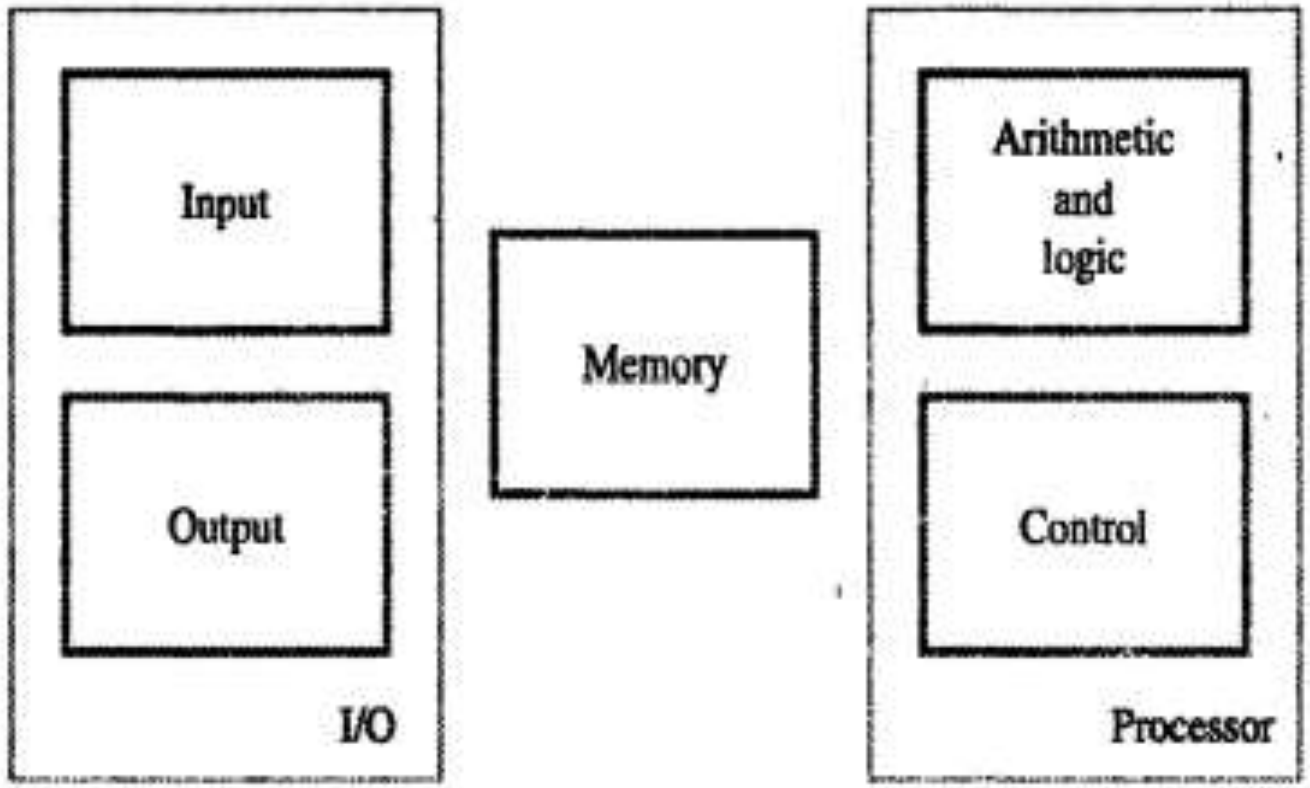

Figure 1.1 Basic functional units of a computer.

Input Unit:

- Computer accepts encoded information through input unit.
- The standard input device is a keyboard.
- Whenever a key is pressed, keyboard controller sends the code to CPU/Memory.

Examples include Mouse, Joystick, Tracker ball, Microphone, Light pen, Digitizer, Scanner etc.

Output Unit:

- Computer after computation returns the computed results, error messages, etc. via output unit.

- The standard output device is a monitor (video monitor, LCD/TFT monitor)
- Other output devices are printers, speaker, plotters etc.

Memory Unit:

- Memory unit stores the program instructions (Code), data and results of computations etc.

- Memory unit is classified as:
    - Primary /Main Memory
    - Secondary /Auxiliary Memory

Primary /Main Memory

- **Primary storage** (also known as main **memory**) is the component of the computer that holds **data**, **programs** and **instructions** that are currently in use.
- Primary storage is located on the **motherboard**. As a result, data can be read from and written to primary storage extremely quickly.
- This gives the **processor** fast access to the data and instructions that the primary storage holds.

Different Types of Primary Memory

- Main Memory.
- Cache Memory.
- Register Memory.

Main Memory

- The size of Main memory is the largest when compared to Cache Memory and Register memory but the cost is the lowest among them.

- Main memory can be divided into two main types viz.,
- Random Access Memory (RAM),
- Read-only memory (ROM), and each of these is divided into further sub-types.

The two main types are

- ROM, which is **non-volatile**, &
- RAM, which is **volatile**.

- Non-volatile memory keeps its contents even when the computer is switched off.
- Volatile memory loses its contents when power is lost.

- **Random access memory (RAM)** is **volatile** primary storage. Once the computer is switched off the **data** and **instructions** held in RAM are lost. RAM is given the term ‘random access’ because data and instructions can be stored and accessed from any location within the **memory**).
- RAM is used to hold data and instructions that are currently in use.

RAM has two subcategories:

a. **Static Random Access Memory (SRAM):** Transistors are used in this memory and constant power flow is needed to keep it alive. Data remains static in this memory and hence no refresh is needed at any point in time. It has a short read/write cycle, smaller in size, more expensive than dynamic RAM, and faster in data retrieval and write, and hence it is deployed in special applications like cache memory.

b. **Dynamic Random Access Memory (DRAM):** Capacitors are used in this type and it tends to lose energy gradually over a period of time and hence the data is likely to be lost. A periodic refresh is required to retain the data. It is a high-density type, cheaper than SRAM but slower than it, larger in size, used in main memory mostly.

- **Read-only Memory (ROM) is a** non-volatile type of memory that continues to hold the contents even when the power is switched off.
- As per the name, contents can only be read from these memory locations and it cannot be erased or rewritten. Contents like boot program, firmware, mathematical tables in scientific applications are stored during the manufacturing stage and sold with pre-stored contents.
- These contents are used during the operation of the device and it cannot be altered.

ROM has two subcategories:

a. **Programmable ROM (PROM):** Difference between normal ROM and PROM is that ROM is preloaded with contents when it is sold whereas PROM is sold as a device with a blank memory and the contents are stored in PROM using a device called PROM Programmer.

b. **Erasable Programmable ROM (EPROM):** ROM once programmed can be erased and reprogrammed. The electrical signal can be used to erase the contents stored already. Such a PROM is known as EEPROM. Contents can be erased using UV rays also and such devices are called UV EPROM. The process of erasing the data using an Electric signal is simpler than operating with UV rays.

Cache memory

- **Cache memory** is a type of high-speed **volatile random access memory (RAM)** which is built into the **processor.**
- **Data** can be transferred to and from cache memory more quickly than from RAM. As a result, cache memory is used to temporarily hold data and **instructions** that the processor is likely to reuse. This allows for faster processing as the processor does not have to wait for the data and instructions to be **fetched** from RAM.
- The more cache memory a computer has, the faster it runs. However, because of its high-speed performance, cache memory is more expensive to build than RAM. Therefore, cache memory tends to be very small in size.

Register Memory

- Registers as part of CPU, are used to hold the memory addresses of the data, next instruction, and intermediate results during the program execution.
- It also acts as transit storage between the main memory and the Processor.
- It is the costliest of all the memory and size-wise it is the smallest.

Secondary /Auxiliary Memory

- The secondary memory is always a non-volatile memory.
- Secondary memory is known as a Backup memory or Additional memory or Auxiliary memory.
- Data cannot be accessed directly by the processor. It is first copied from secondary memory to primary memory. Only then CPU can access it.
- It's a non-volatile memory so that that data can be retained even after power failure.
- Secondary memory is accessed by I/O channels.
- Secondary memory is cheaper than primary memory.

Arithmetic and logic unit:

- ALU consist of necessary logic circuits like adder, comparator etc., to perform operations of addition, multiplication, comparison of two numbers etc.

Control Unit:

- Control unit co-ordinates activities of all units by issuing control signals.
- Control signals issued by control unit govern the data transfers and then appropriate operations take place.
- Control unit interprets or decides the operation/action to be performed.

The operation of a computer can be summarized as follows:

- The computer accepts information in the form of programs and data through an input unit and stores it in the memory.
- Information stored in the memory is fetched, under program control, into an arithmetic and logic unit, where it is processed.
- Processed information leaves the computer through an output unit.
- All activities inside the machine are directed by the control unit.

Basic Operational Concepts

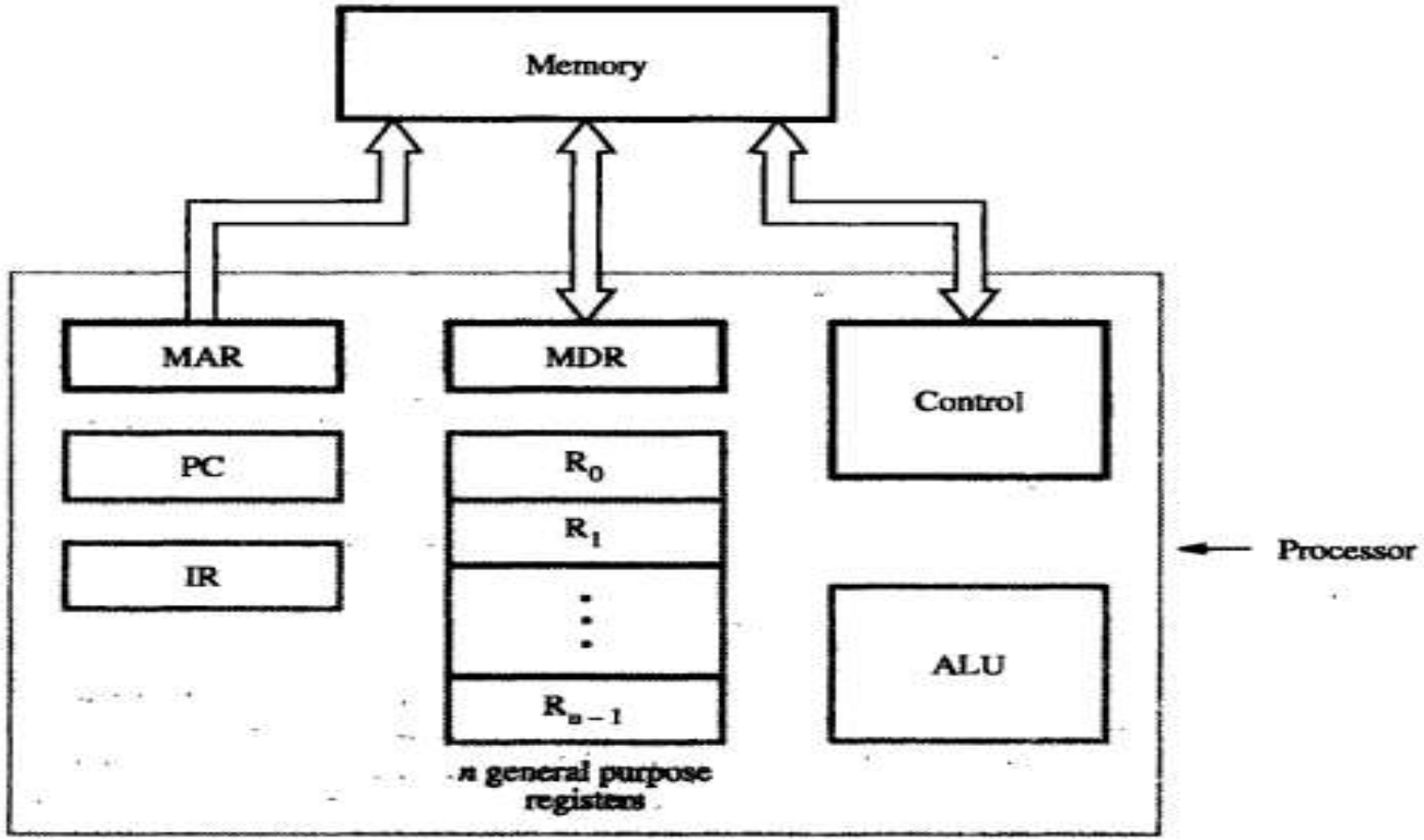

Figure 1.2 Connections between the processor and the memory.

Instruction Register

- The instruction register (IR) or current instruction register (CIR) is **the part of a CPU's control unit that holds the instruction currently being executed or decoded**.
- The IR is used **to store the instruction word**.
- When the CPU fetches an instruction from memory, it is temporarily stored in the IR.
- The instruction is a binary word or code that defines a specific operation to be performed.

Program Counter

- The program counter (PC) is another specialized register
- It keeps track of the execution of a program
- It contains memory address of next instruction to be fetched & executed
- During execution of an instruction, the contents of program counter are updated to address of next instruction.

MAR

memory address register (MAR) –

- It holds address of the location to be accessed.
- It holds the address of the current instruction that is to be fetched from memory, or the address in memory to which data is to be transferred

MDR

memory data register (MDR) -

- It contains data to be written into or read out of address location.
- It holds the contents found at the address held in the MAR, or data which is to be transferred to primary memory.
- **The read operation read a previously stored data and the write operation stores a value in memory**

Interrupt Signals-

- Interrupt Signal is a request from I/O device for service by the processor.
- The processor provides the request service by executing an appropriate interrupt service routine.

Basic Instruction Example

1. Add LOCA, R0

2. Load LOCA, R1

   Add R1,R0


THANK
YOU!