



AMRITA
VISHWA VIDYAPEETHAM

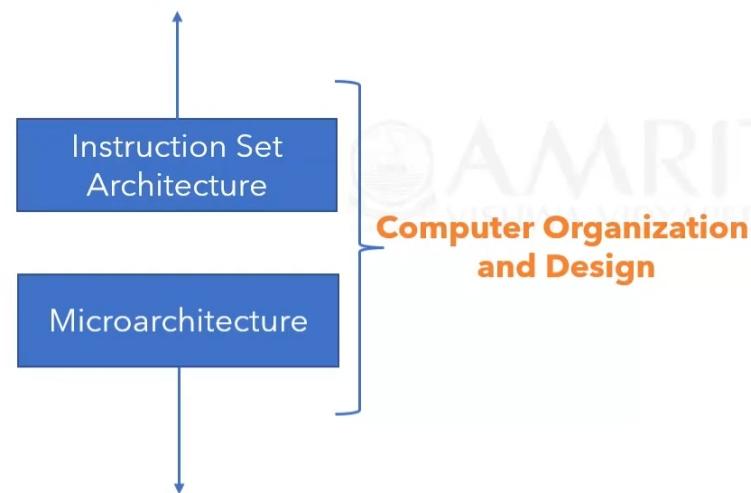
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Computer Organization and Design

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Objective

- Basics of Computer organization

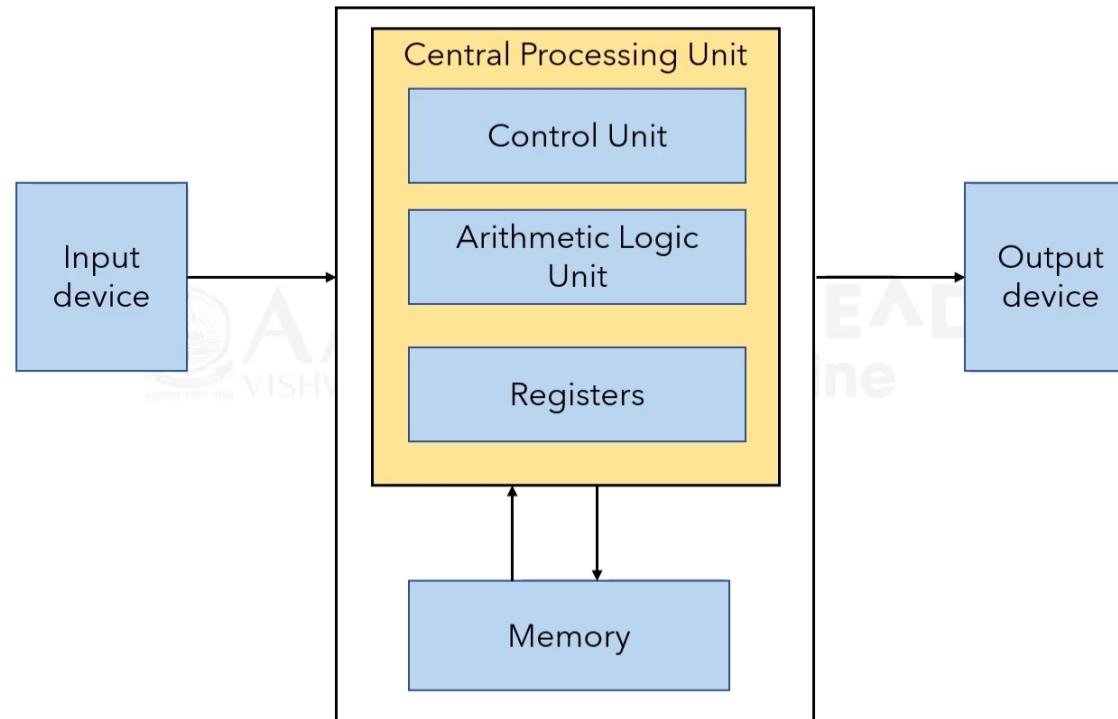


What's a computer

- An electronic device which take a program, accept the input data, process data and generates an output.
- Stored program architecture - Data and instructions are stored in the memory for processing.
- **Program** - Sequence of instructions
- **Instructions** - Binary sequence that specify the operation for the computer like 101110111100001....



Von Neumann Architecture



Components of Computer

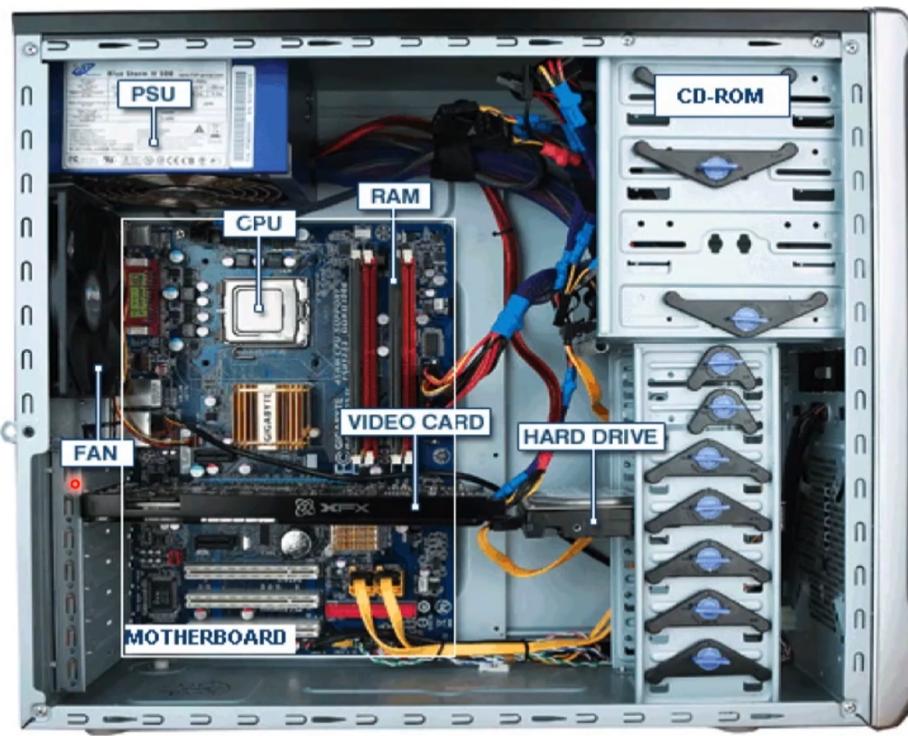
- **Input Unit** : Commands are given by the user to a computer using input devices like keyboard, mouse etc.
- **Output Unit** : Result of the processing that is stored and displayed to the user using output devices like monitor, printer etc.
- **Memory** : Hardware for storing data and program for processing or for future use.
 - Primary memory : Hold data and application temporarily
RAM, ROM, Cache memory etc.
 - Secondary memory : Store data and instruction permanently
Hard disk, floppy disk etc.



Components of Computer

- **Central Processing Unit (CPU)** : Brain of computer system
Takes all logical decisions and perform all the calculations necessary to execute any **program** on the system.
 - Arithmetic Logic Unit : Perform arithmetic and logical operations on instructions.
 - Control Unit : Generate the control signal by which it controls all the operations.
 - Registers : High speed storage area that temporarily stores data during processing.

Simplified model of computer



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Summary

- Familiarized the major components of digital computer





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Computer Memory

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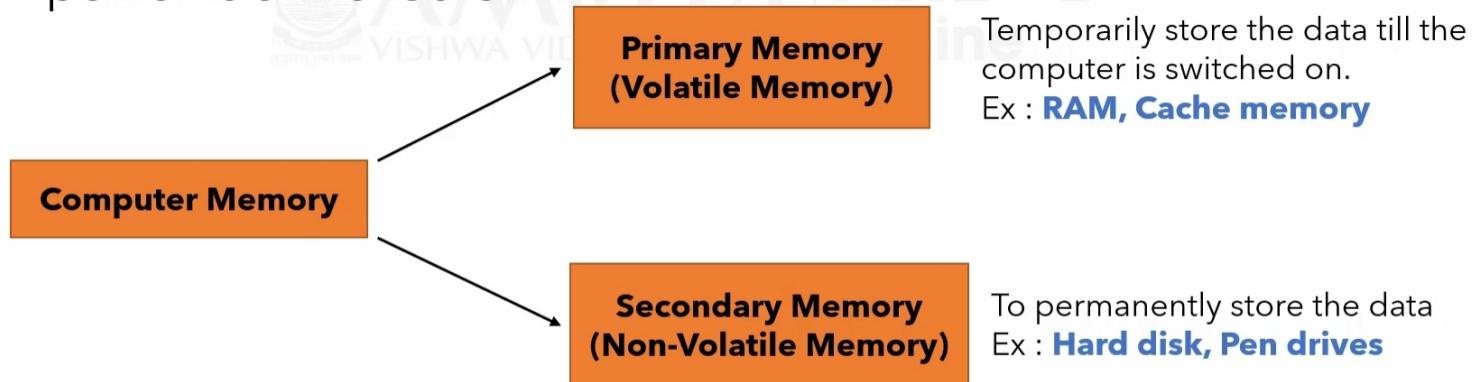
Objective

- Learn about the vital component of a computer called **Memory unit**



Introduction

- Computer memory can store information (data) and instructions(computer program).
- System memory is of 2 types based on data retention when electric power is switched off



RAM and hard disk



A stick of RAM



Hard drive

Basic Data Measures

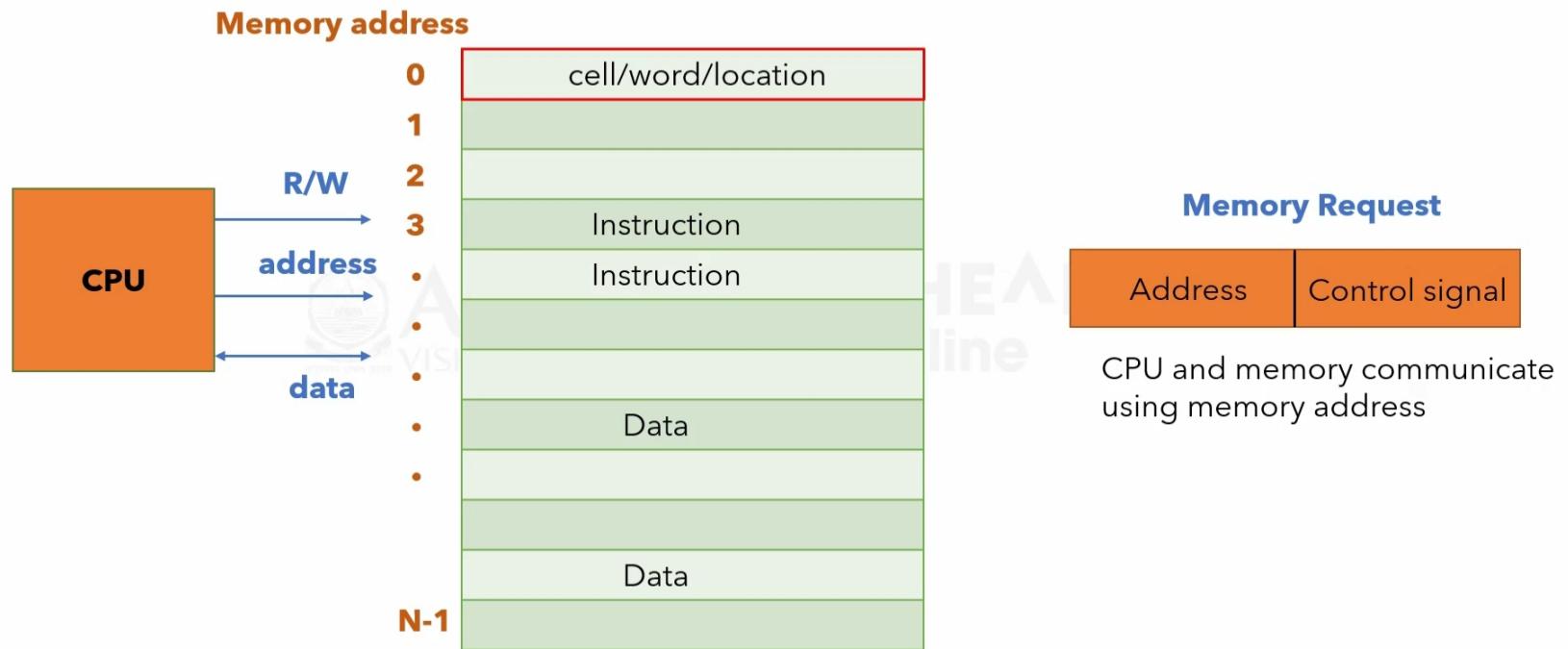
Unit	Symbol	Bits/Bytes
Bit	b	Binary digit : 0 or 1 (_)
Nibble	-	4 bits
Byte	B	8 bits (-----)
Kilobyte	KB	2^{10} bytes = 1024 bytes $\approx 10^3$
Megabyte	MB	2^{20} bytes $\approx 10^6$
Gigabyte	GB	2^{30} bytes $\approx 10^9$
Terabyte	TB	2^{40} bytes $\approx 10^{12}$

Main memory(RAM)

- All programs the computer/CPU executes are in the main memory called RAM (**Random Access Memory**).
- RAM is directly readable from the CPU.
- Memory is divided into large number of small parts called cells.
- Each memory location or cell has a **unique address** starting from 0 to (size of memory - 1) .
- N cell memory has address from 0 to N-1.

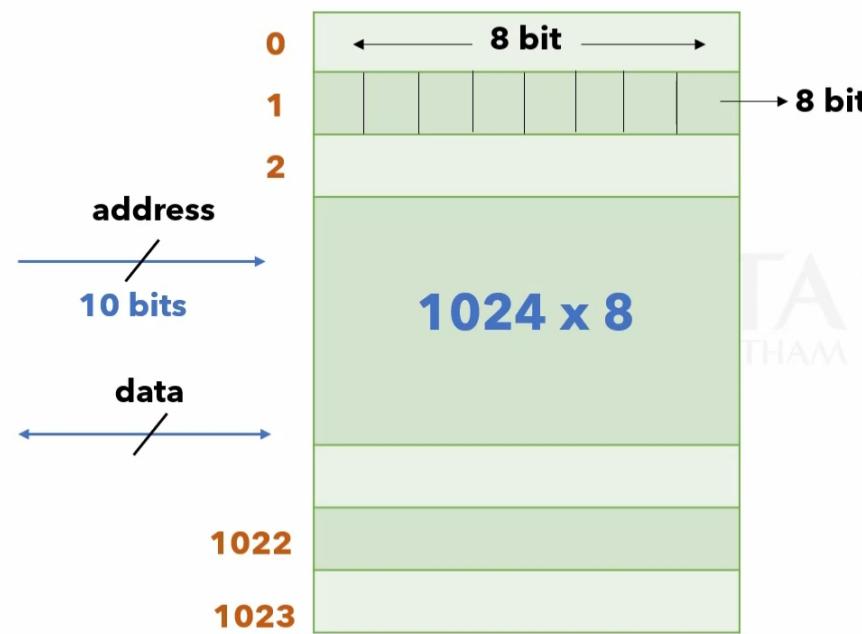


Logical view of memory



Memory Internals

$\sim : 2^1$
 $- - : 2^2$



Memory chip configuration

1024 x 8

of cells N

Size of each cell in bit

cells = $1024 = 2^{10}$ cells

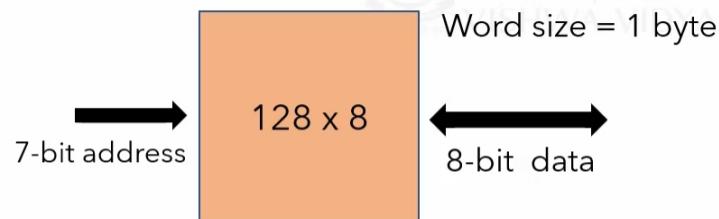
To represent 2^{10} address = 10 bits

Data transferred to and from CPU is 8 bits
(8 wires each wire/line can represent 1/0)

Memory Addressability

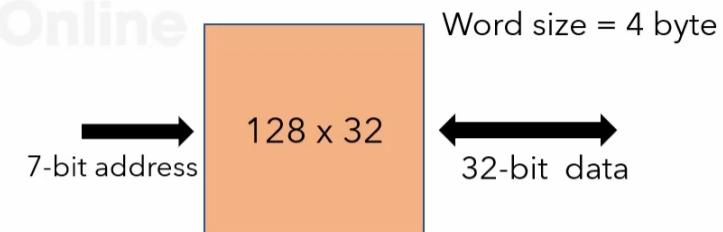
- **Byte Addressable**

CPU can access 1 byte at a time



- **Word Addressable**

CPU can access 1 word at a time



Summary

- Introduction to memory unit organization





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Computer Registers

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Objective

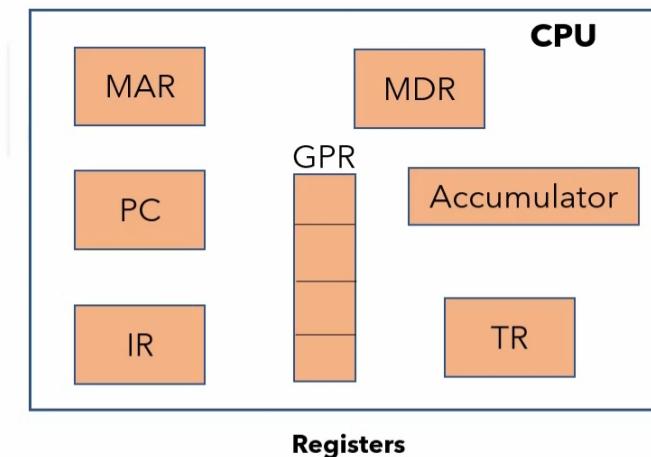
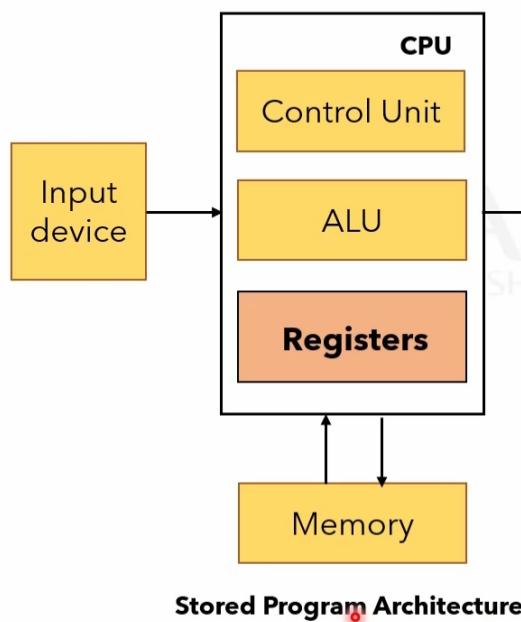
- Introduction to Computer Registers (sub- component of CPU)



Computer Registers

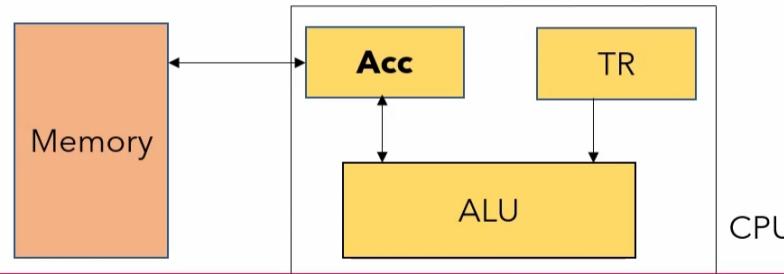
- Registers are basically memory within CPU which can hold small amount of data.
- Purpose of having registers is fast retrieval of data for processing by CPU.
- Registers hold data temporarily during execution of a program.
- Normally measured by the number of bits registers can hold i.e., "8-bit register" , "16-bit register" or even more

Computer Registers



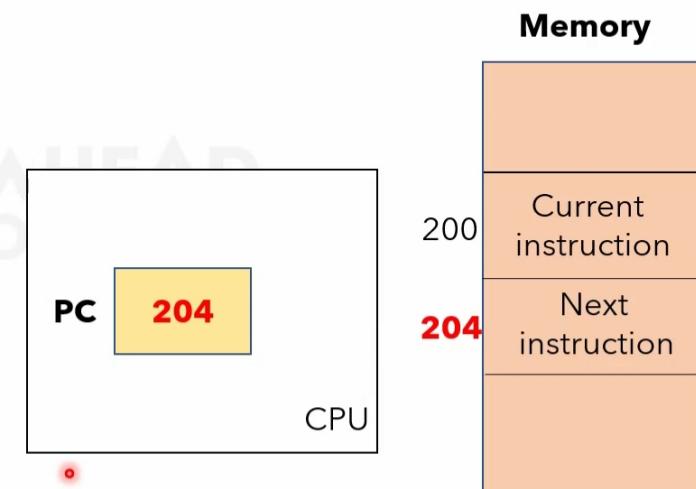
Accumulator (ACC)

- General purpose register used by ALU (Arithmetic Logic Unit) for performing arithmetic and logical operations.
- ALU operates on data stored in acc register and the intermediate results from ALU is stored back in the accumulator register.
- Main purpose is to provide high speed memory for ALU operation.



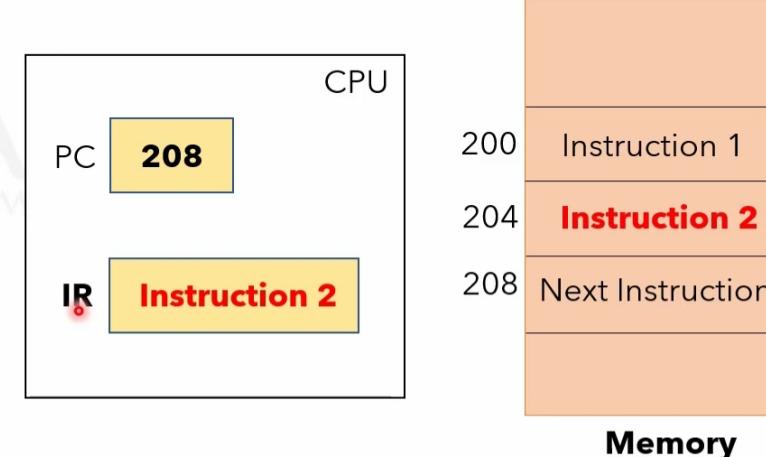
Program Counter(PC)

- Store the address of the next instruction to be executed from the memory after the current instruction is executed.
- Acts as a pointer which points to the memory location where the next instruction is stored.
- PC register keeps track of the execution sequence of the CPU.



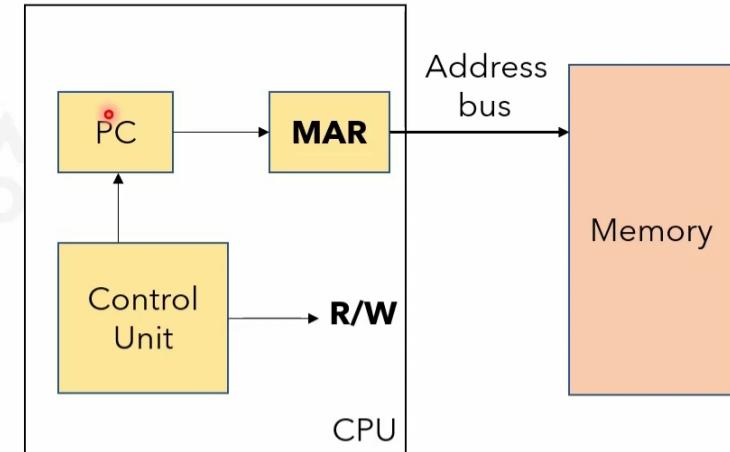
Instruction Register(IR)

- CPU fetches the instruction one by one from memory for execution.
- Stores the current instruction fetch by CPU from memory in Instruction Register.



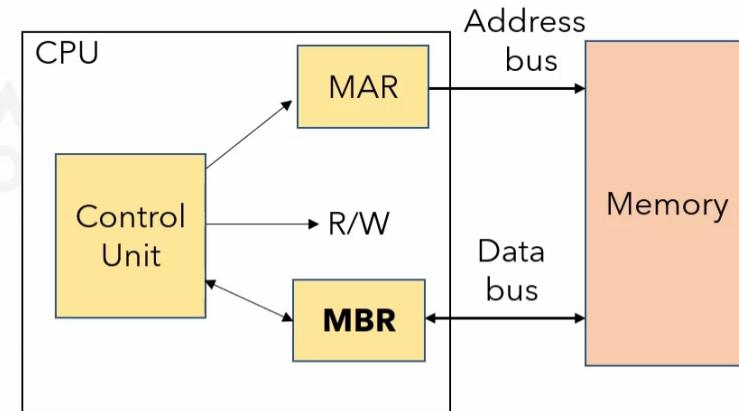
Memory Address Register(MAR)

- If CPU wants to send any address to memory for read or write operation, address first comes to MAR and then send through address bus to memory.
- Control Unit temporarily places the address in MAR to fetch from memory.



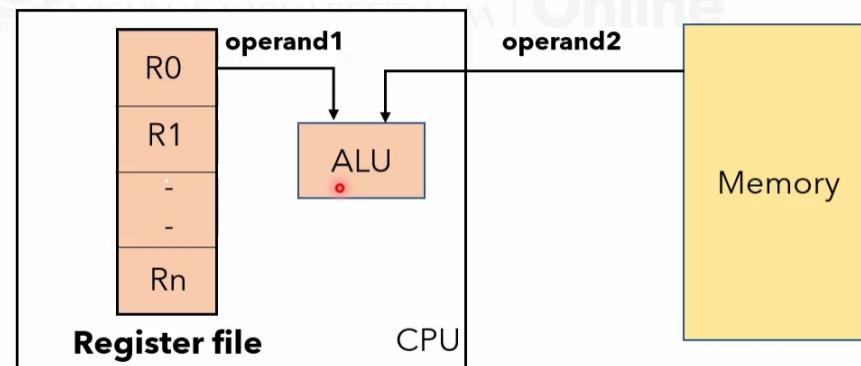
Memory Buffer Register(MBR)

- MBR is also called Data Register.
- Temporarily stores the data that the CPU wants to read from memory or sent to memory.
- The data sent from memory is stored in MBR before being accessed by the control unit.

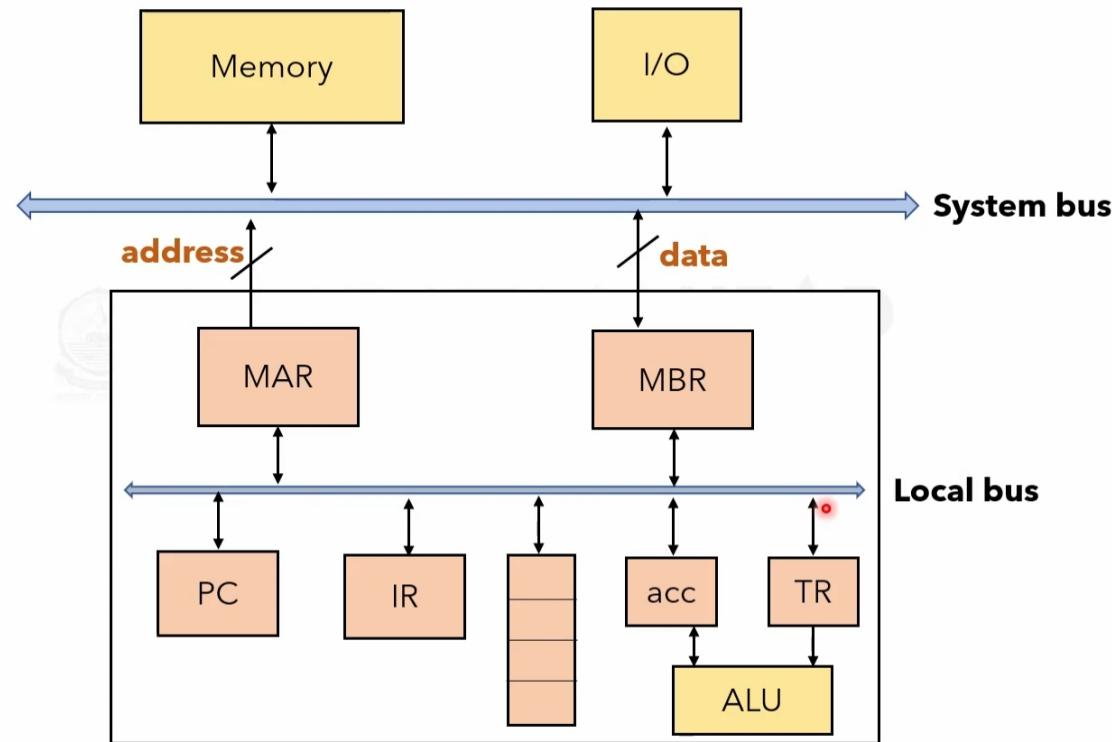


General purpose Registers(GPR)

- Collection of registers called register file in the CPU used for memory address or data when needed.
- Temporarily hold the data which can be used by the programmers.



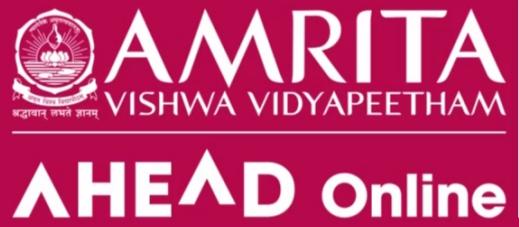
Computer Registers



Summary

- Explained about storage unit within CPU called **Registers**





System Bus Configuration

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Objective

- Introduction to **Bus Configuration** : communication system inside a computer



System Bus Configuration

- **BUS** : Collection of electronic wires/lines that can send address, data, control signals etc.
- Three types of lines
 - Address lines : Collectively called Address bus.
 - Always outgoing from CPU to memory or I/O devices and not back so, the lines are unidirectional.
 - Number of lines in address depend on type and architecture of bus.

System Bus Configuration

- Data lines : Bidirectional lines which transfer data in both directions.
CPU can read data from memory or I/O and can write data from CPU to memory or I/O.
Collectively called data bus.
- Control lines : Transmit and receive control signals between the microprocessor and various devices attached to it.
Control signals are **read** (Memory & I/O) and **write** (Memory & I/O)



Bus Configuration

- Types of buses
- System bus : Connects all the major components on the system i.e., CPU, main memory & I/O devices.

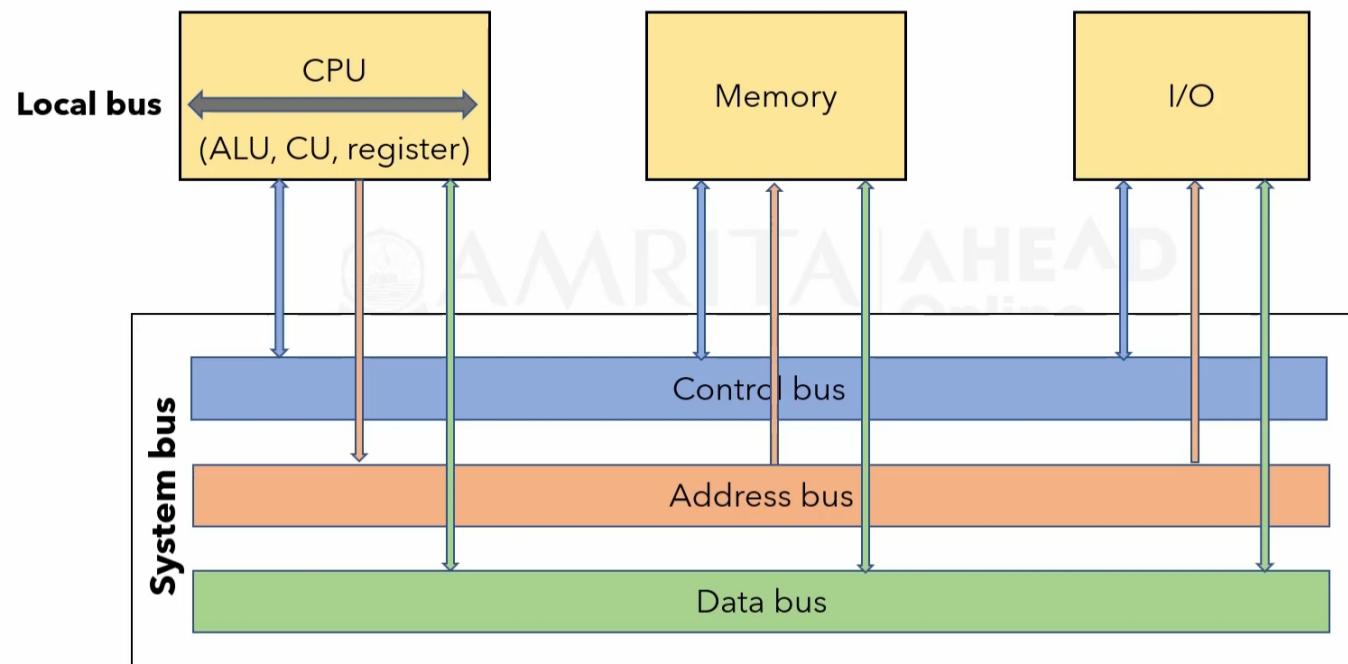
Bus with address line, data lines and control lines.

- Local bus : Bus within the CPU which connects all the registers within the CPU.

Can transfer anything between registers since all connected to the local bus.



Bus Configuration



Summary

- Explained about Bus configuration within the computer.

