Unit 3

Brief History of Computer :

First Generation Computer :

-> ENIAC & EDVIC in 1946 developed by Eckert & Mauchly in 1946
-> Vacuum tubes tech is used
-> 1946 - 1959
-> punch card and paper tape as storage device
-> had very limited storage
-> Non - portable
-> consumes lot of electricity
-> direct machine code is used

Second Generation Computer :

-> IBM-700, ATLAS
-> Transistors are used a core devices
-> 1959 - 1965
-> Paper Tapes & magnetic disk was used for secondary storage
-> High-level procedural language FORTAN & COBOL
-> less power usage then first gen vacuum tubes due to transistors
-> Smaller, reliable & faster then first get computer
-> magnetic-core was used for primary storage

Third Generation Computer

-> finally these have those small classic looking computers also called minicomputer
-> IBM - 360
-> IC (integrated circuits) are core of these computers
-> Magnetic disk was used for secondary storage
-> these also had time-sharing, multiprogramming operating system
-> Much smaller than 2nd gen
-> PASCAL, FORTRAN-II, ALGOL-68, COBOL, and BASIC languages used
-> 1965-1971

Fourth Generation Computer

-> 1970 - 1980
-> IBM1401, Apple II
-> Large Scale Integrated Circuits (LSIC) & Very Large (VLSIC) are used as core

-> Semi conductors are used as primary storage
-> Development of pcs and laptops as portable device
-> microprocessor are used
-> High level languages like, C, C++ & Dbms used
-> Applications developers by users are used like excel spreadsheets etc

Fifth Gen Of Computers

-> 1985 - currently
-> Laptops, tablet, smartphones are used
-> Ultra large scale IC's are used
-> Too small and blazing fast
-> RAM, ROM as primary storage used
-> HDD, SSD as secondary storage are used …
-> Java, python, c++, c, .net are used a programming language

Classification of Computers

The computer systems can be classified on the following basis:
1. On the basis of size.
2. On the basis of functionality.
3. On the basis of data handling.

Classification on the basis of size

1. **Super computers :** The super computers are the most high performing system. A supercomputer is a computer with a high level of performance compared to a general-purpose computer. The actual Performance of a supercomputer is measured in FLOPS instead of MIPS. All of the world's fastest 500 supercomputers run Linux-based operating systems. Additional research is being conducted in China, the US, the EU, Taiwan and Japan to build even faster, more high performing and more technologically superior supercomputers. Supercomputers actually play an important role in the field of computation, and are used for intensive computation tasks in various fields, including quantum mechanics, weather forecasting, climate research, oil and gas exploration, molecular modeling, and physical simulations. and also Throughout the history, supercomputers have been essential in the field of the cryptanalysis.
   eg: PARAM, jaguar, roadrunner.

2. **Mainframe computers :** These are commonly called as big iron, they are usually used by big organisations for bulk data processing such as statistics, census data processing, transaction processing and are widely used as the servers as these systems has a higher processing capability as compared to the other classes of computers, most of these mainframe architectures were established in 1960s, the research and development worked continuously over the years and the mainframes of today are far more better than the earlier ones, in size, capacity and efficiency.
   Eg: IBM z Series, System z9 and System z10 servers.
3. **Mini computers :** These computers came into the market in mid 1960s and were sold at a much cheaper price than the main frames, they were actually designed for control, instrumentation, human interaction, and communication switching as distinct from calculation and record keeping, later they became very popular for personal uses with evolution.
   In the 60s to describe the smaller computers that became possible with the use of transistors and core memory technologies, minimal instructions sets and less expensive peripherals such as the ubiquitous Teletype Model 33 ASR.They usually took up one or a few inch rack cabinets, compared with the large mainframes that could fill a room, there was a new term “MINICOMPUTERS” coined
   Eg: Personal Laptop, PC etc.

4. **Micro computers :** A microcomputer is a small, relatively inexpensive computer with a microprocessor as its CPU. It includes a microprocessor, memory, and minimal I/O circuitry mounted on a single printed circuit board.The previous to these computers, mainframes and minicomputers, were comparatively much larger, hard to maintain and more expensive. They actually formed the foundation for present day microcomputers and smart gadgets that we use in day to day life.
   Eg: Tablets, Smartwatches.

Classification on the basis of functionality

1. **Servers :** Servers are nothing but dedicated computers which

are set-up to offer some services to the clients. They are named depending on the type of service they offered. Eg: security server, database server.

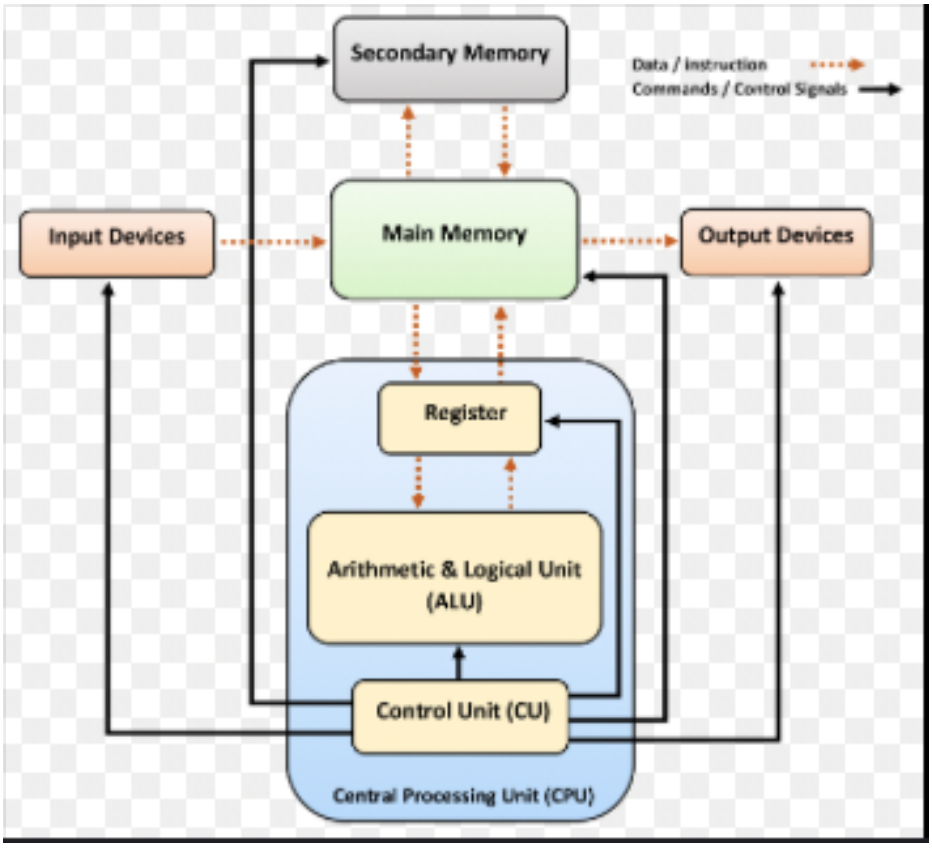
2. **Workstation :** Those are the computers designed to primarily to be used by single user at a time. They run multi-user operating systems. They are the ones which we use for our day to day personal / commercial work.
3. **Information Appliances :** They are the portable devices which are designed to perform a limited set of tasks like basic calculations, playing multimedia, browsing internet etc. They are generally referred as the mobile devices. They have very limited memory and flexibility and generally run on "as-is" basis.
4. **Embedded computers :** They are the computing devices which are used in other machines to serve limited set of requirements. They follow instructions from the non-volatile memory and they are not required to execute reboot or reset. The processing units used in such device work to those basic requirements only and are different from the ones that are used in personal computers- better known as workstations.

Classification on the basis of data handling

1. **Analog :** An analog computer is a form of computer that uses the continuously-changeable aspects of physical fact such as electrical, mechanical, or hydraulic quantities to model the problem being solved. Any thing that is variable with respect to time and continuous can be claimed as analog just like an analog clock measures time by means of the distance traveled for the spokes of the clock around the circular dial.
2. **Digital :** A computer that performs calculations and logical operations with quantities represented as digits, usually in the binary number system of "0" and "1", "Computer capable of solving problems by processing information expressed in discrete form. from manipulation of the combinations of the binary digits, it can perform mathematical calculations, organize and analyze data, control industrial and other processes, and simulate dynamic systems such as global weather patterns.
3. **Hybrid :** A computer that processes both analog and digital

data, Hybrid computer is a digital computer that accepts analog signals, converts them to digital and processes them in digital form.

Structure Of Computer :



Hardware

- **Central Processing Unit (CPU)**: Often referred to as the brain of the computer, the CPU executes instructions from programs and performs calculations. It consists of:
  - **Arithmetic Logic Unit (ALU)**: Performs arithmetic and logical operations.
  - **Control Unit (CU)**: Directs operations of the CPU and coordinates activities between hardware components.
- **Memory**:
  - **Random Access Memory (RAM)**: Volatile memory used to store data and instructions temporarily while the computer is running.
  - **Read-Only Memory (ROM)**: Non-volatile memory that contains essential instructions for booting the computer.
- **Storage**:

    - **Hard Disk Drive (HDD)** or **Solid State Drive (SSD)**: Non-volatile storage for data and programs. SSDs are faster and more reliable than HDDs.
    - **Optical Drives**: Used to read/write data on optical discs (e.g., CDs, DVDs).
- **Input Devices**: Allow users to interact with the computer, such as keyboards, mice, scanners, and microphones.
- **Output Devices**: Present information to the user, including monitors, printers, and speakers.
- **Motherboard**: The main circuit board that connects all hardware components, including the CPU, memory, and storage.
- Memory Address Register (MAR)
  A special-purpose register that stores the memory address of data to be written or retrieved. It allows the CPU to interact with the main memory.
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Memory Data Register (MDR)
A register that holds the data being transferred between the main memory and the CPU registers.

Control Processing Unit
The arithmetic logic unit (ALU) and the control unit (CU) are two main parts of a computer's central processing unit (CPU):

Arithmetic logic unit (ALU)
A digital circuit that performs arithmetic and logic operations, such as addition, subtraction, division, and logical AND and OR. The ALU is a fundamental building block of the CPU, and modern CPUs have very powerful and complex ALUs.

Control unit (CU)
Decodes instructions and controls all the other internal components of the CPU. The CU monitors and gives instructions to all parts of the computer.

The ALU and CU work together in the following way:

1. The ALU loads data from input registers.
2. The CU tells the ALU what operation to perform on the data.
3. The ALU stores the result in an output register.

4. The CU moves the data between the registers, the ALU, and memory.

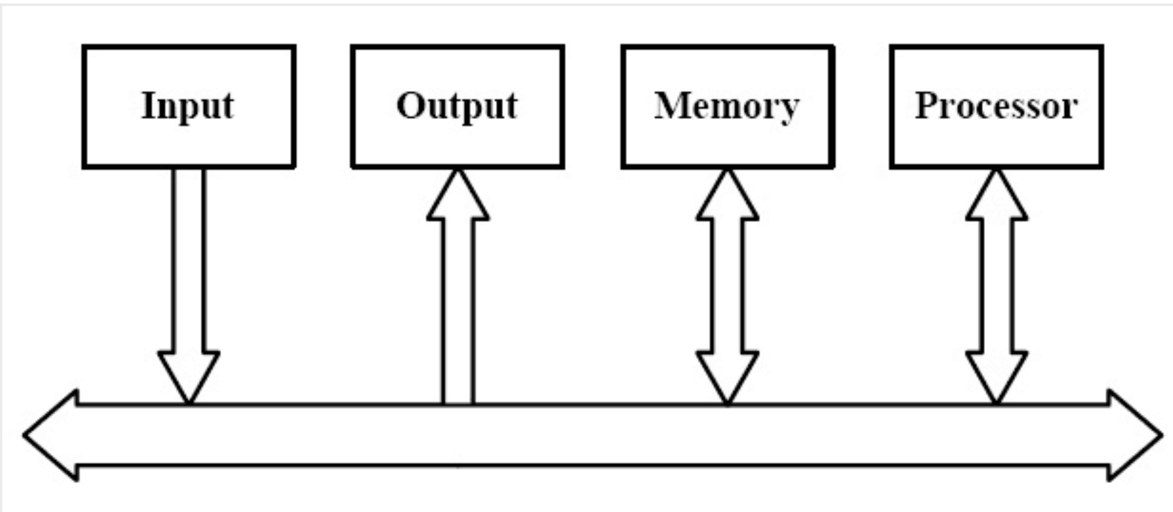
Bus Structure

A “bus structure” refers to the arrangement and organization of buses within a computer system. The bus structure defines how these buses are interconnected and how they facilitate data transfer and control within the system.
There are many ways to connect different parts inside the computer together. First way is Single Bus Structure and second is Multi-Bus structure.

=> Data Bus -> carries data, 2 bytes of lines,
=> Control Bus -> It monitors activity on other buses and system, it control and carries memory input and output signals
=> Address Bus -> the bus width depends on the capacity of mircroprocessor, carries address of a particular memory

-> data & control bus are bidirectional
-> address bus are unidirectional

Single Bus Structure:
In this architecture, a single shared bus is used to connect various hardware components like CPU, Memory I/O devices etc within the computer system.



Advantages of Single Bus Structure:

1. Simplicity: Single bus architectures are relatively simple to design and implement, making them cost-effective for many applications.

2. Cost-Efficiency: The use of a single bus reduces the complexity and cost of the hardware compared to more elaborate bus structures.

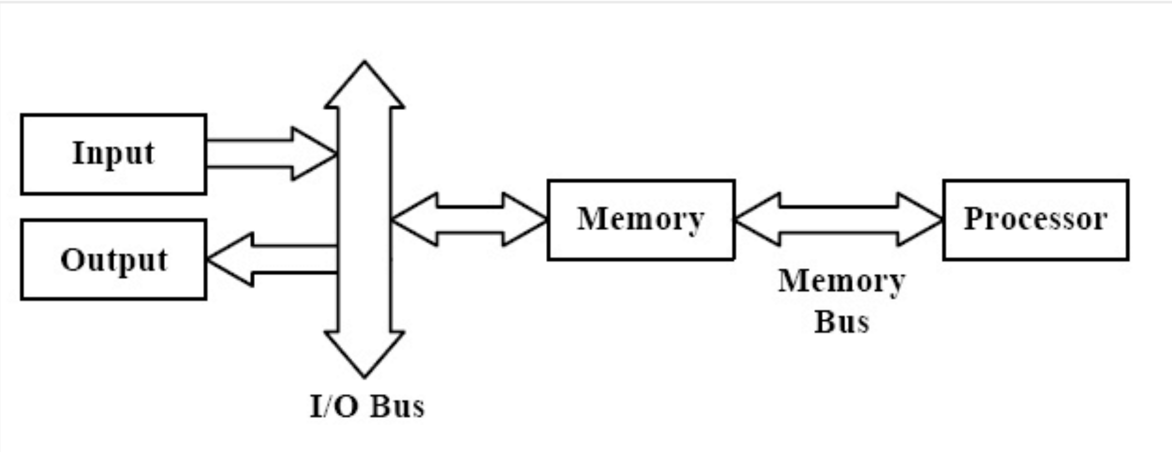
Disadvantages of Single Bus Structure:

1. Limited Bandwidth: A single bus structure can become a bottleneck in terms of data transfer bandwidth, as all components share the same bus. This can limit the overall performance of the system.
2. Scalability: As computer systems become more complex and require higher bandwidth for data transfer, a single bus structure may struggle to scale efficiently.
3. Contention: Contention for the bus can occur when multiple components attempt to access it simultaneously, leading to delays and potential performance issues.

Single bus architectures are commonly found in simple and cost-effective computer systems, such as personal computers and small embedded systems.

Multi-Bus Structure:

Multi-bus structure is used to enhance the performance and scalability of a computer system.



Advantages of Multi-Bus Structure:

1. Improved Performance: By segmenting the buses, a multi-bus structure can increase the data transfer bandwidth and reduce contention, improving overall system performance.
2. Scalability: Multi-bus architectures are more scalable than single bus architectures. As the system's complexity grows, additional buses can be added to accommodate more devices and higher data transfer rates.
3. Reduced Bus Contention: With dedicated buses for specific

purposes or peripheral devices, bus contention is minimized, resulting in smoother and more efficient data transfers.

4. Specialized Communication: I/O buses allow for specialized communication between the CPU and peripheral devices, optimizing data exchange for specific tasks like graphics rendering or data storage.

Disadvantages of Multi-Bus Structure:

1. Complexity: Multi-bus structures are more complex to design and implement than single bus structures, which can increase system cost and complexity.
2. Higher Hardware Costs: The use of multiple buses may require additional hardware components, increasing the overall cost of the computer system.

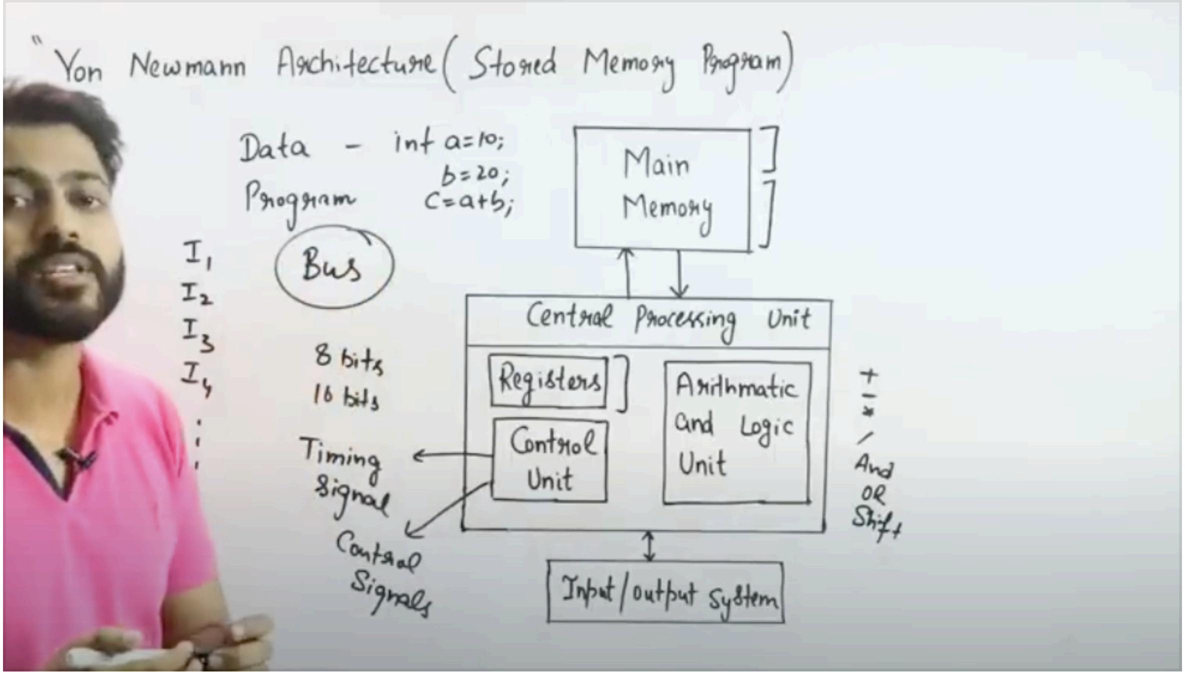
Multi-bus structures are often found in high-performance computing systems, workstations, and servers.

Differences between Single Bus and Double Bus Structure :

S. No.	Single Bus Structure	Double Bus Structure
1.	The same bus is shared by three units (Memory, Processor, and I/O units).	The two independent buses link various units together.
2.	One common bus is used for communication between peripherals and processors.	Two buses are used, one for communication from peripherals and the other for the processor.

3.	The same memory address space is utilized by I/O units.	Here, the I/O bus is used to connect I/O units and processor and other one, memory bus is used to connect memory and processor.
4.	Instructions and data both are transferred in same bus.	Instructions and data both are transferred in different buses.
5.	Its performance is low.	Its performance is high.
6.	The cost of a single bus structure is low.	The cost of a double bus structure is high.
7.	Number of cycles for execution is more.	Number of cycles for execution is less.
8.	Execution of the process is slow.	Execution of the process is fast.
9.	Number of registers associated are less.	Number of registers associated are more.
10.	At a time single operand can be read from the bus.	At a time two operands can be read.
11.	Advantages- • Less expensive • Simplicity	Advantages- • Better performance ◦ Improves Efficiency

Von Newmann Architecture :

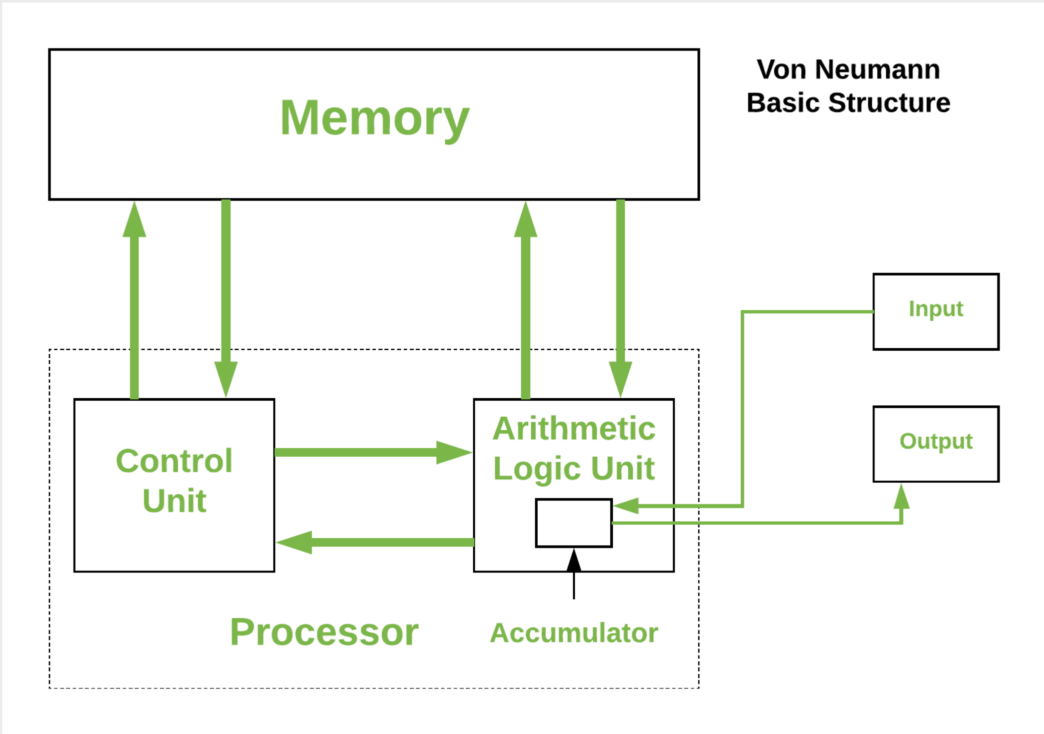


Von-Neumann computer architecture:

Von-Neumann computer architecture design was proposed in 1945.It was later known as Von-Neumann architecture.
Historically there have been 2 types of Computers:

1. **Fixed Program Computers –** Their function is very specific and they couldn't be reprogrammed, e.g. Calculators.
2. **Stored Program Computers –** These can be programmed to carry out many different tasks, applications are stored on them, hence the name.

Modern computers are based on a stored-program concept introduced by John Von Neumann. In this stored-program concept, programs and data are stored in the same memory. This novel idea meant that a computer built with this architecture would be much easier to reprogram.
The basic structure is like this,



It is also known as **ISA** (Instruction set architecture) computer and is having three basic units:

1. The Central Processing Unit (CPU)
2. The Main Memory Unit
3. The Input/Output Device Let's consider them in detail.

1. Central Processing Unit: The central processing unit is defined as the it is an electric circuit used for the executing the instruction of computer program.

It has following major components:
1.1 Control Unit(CU)
1.2 Arithmetic and Logic Unit(ALU)

3. Variety of Registers

- **Control Unit –**
  A control unit (CU) handles all processor control signals. It directs all input and output flow, fetches code for instructions, and controls how data moves around the system.

- **Arithmetic and Logic Unit (ALU) –**
  The arithmetic logic unit is that part of the CPU that handles all the calculations the CPU may need, e.g. Addition, Subtraction, Comparisons. It performs Logical Operations, Bit

Shifting Operations, and Arithmetic operations.

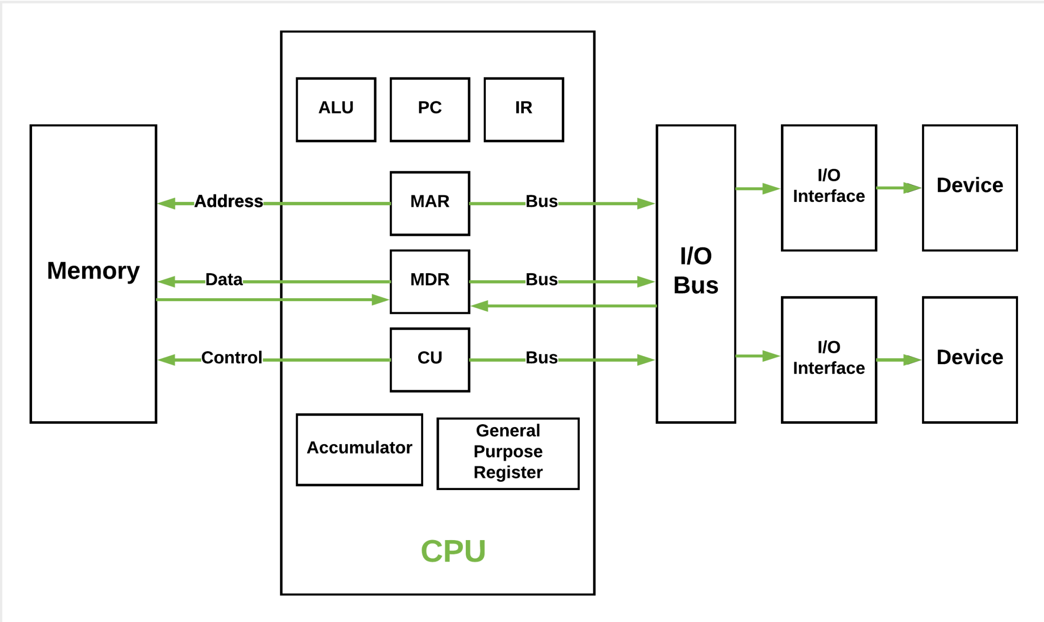


Figure – Basic CPU structure, illustrating ALU

- **Registers –** Registers refer to high-speed storage areas in the CPU. The data processed by the CPU are fetched from the registers. There are different types of registers used in architecture :-
  1. **Accumulator:** Stores the results of calculations made by ALU. It holds the intermediate of arithmetic and logical operatoins. it acts as a temporary storage location or device.
  2. **Program Counter (PC):** Keeps track of the memory location of the next instructions to be dealt with. The PC then passes this next address to the Memory Address Register (MAR).
  3. **Memory Address Register (MAR):** It stores the memory locations of instructions that need to be fetched from memory or stored in memory.
  4. **Memory Data Register (MDR):** It stores instructions fetched from memory or any data that is to be transferred to, and stored in, memory.
  5. **Current Instruction Register (CIR):** It stores the most recently fetched instructions while it is waiting to be coded and executed.
  6. **Instruction Buffer Register (IBR):** The instruction that is not to be executed immediately is placed in the instruction buffer register IBR.

- **Buses –** Data is transmitted from one part of a computer to another, connecting all major internal components to the CPU and memory, by the means of Buses. Types:
  1. **Data Bus:** It carries data among the memory unit, the I/O devices, and the processor.
  2. **Address Bus:** It carries the address of data (not the actual data) between memory and processor.
  3. **Control Bus:** It carries control commands from the CPU (and status signals from other devices) in order to control and coordinate all the activities within the computer**.**
- **Input/Output Devices –** Program or data is read into main memory from the *input device* or secondary storage under the control of CPU input instruction. *Output devices* are used to output information from a computer. If some results are evaluated by the computer and it is stored in the computer, then with the help of output devices, we can present them to the user.

Von Neumann bottleneck –
Whatever we do to enhance performance, we cannot get away from the fact that instructions can only be done one at a time and can only be carried out sequentially. Both of these factors hold back the competence of the CPU. This is commonly referred to as the 'Von Neumann bottleneck'. We can provide a Von Neumann processor with more cache, more RAM, or faster components but if original gains are to be made in CPU performance then an influential inspection needs to take place of CPU configuration.
This architecture is very important and is used in our PCs and even in Super Computers.

What Is Bootstrapping in OS

Bootstrapping in operating systems refers to the process of loading and initializing the operating system on a computer. During bootstrapping, the computer's hardware is powered on and the basic components of the operating system are loaded into memory. This initial bootstrapping process is essential because it prepares the system for more complex operations and allows the user to interact with the computer. Bootstrapping is crucial as it ensures that the system is in a functional state and ready to execute programs and handle user requests effectively.

NUMBER SYSTEM

Binary()2, Octal()8, Hexadecimal()16, Decimal()10

Binary -> Octal = 110 101. 101 -> 3 bit to decimal -> 65.5 in octal
Binary -> Hexadecimal = 0011 1101. 1010 -> 4 bit to decimal -> 3D.A
Binary -> Decimal = 101 -> 1×2^2 + 0 × 2^1 + 1 × 2^0 = 5;

Octal -> Binary = 65 -> 6 = 110, 5 = 101 => 110 101 in binary
Octal -> Binary -> Hexadecimal
Octal -> Decimal = 65 -> 6 * 8^1 + 5 * 8^0

Hexadecimal-> Binary = 3D -> 3 = 0011 , D = 1101 => 0011 1101 in binary
Hexadecimal -> Binary -> Octal
Hexadecimal -> Decimal = 3A -> 6 * 16^1 + 10 * 16^0

Decimal -> Binary = 2 se divide and remainder Wala seen, 0.625 * 2 -> 1.250, 0.250 * 2 -> 0.5, 0.5 * 2 -> 1.0 -> 101 in binary
Decimal -> Octal = 8 se divide and remainder
Decimal -> Hexadecimal = 16 se .....

Substraction using 1′s and 2′s compliment

1011 -> 1′s compliment -> 0100 - > 2′s compliment +1 -> 0101

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  9.   -> Minuend
 -7.   -> Subtrahend
 ____
  2
```

A) smallest number from larger one
-> **Take 1′s compliment or 2′s compliment of subtrahend smaller number I mean**
-> Add 1′s/2′s compliment to Minuend
-> In 1′s compliement add the carry to result else in 2′s ignore it and got the result

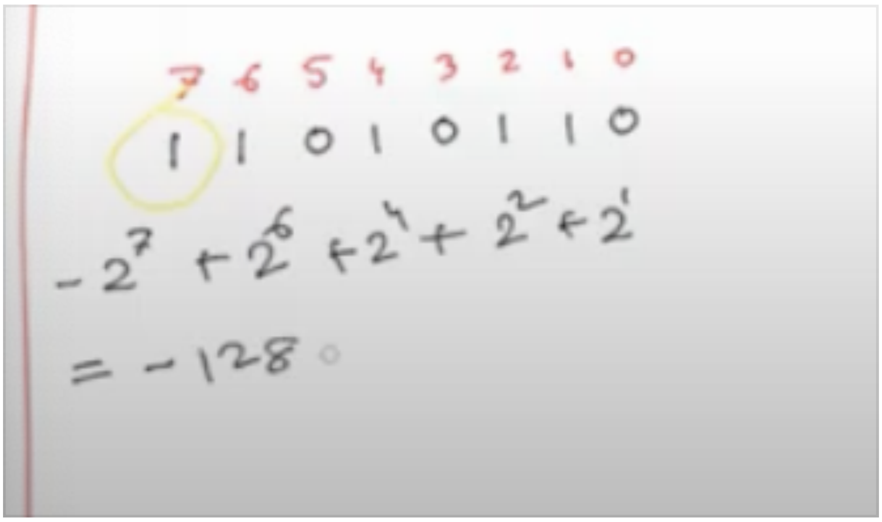
B) larger from smaller result will be negative
-> **Take 1′s compliment or 2′s compliment of subtrahend smaller number I mean**

-> Add 1′s/2′s compliment to Minuend
-> In 1′s/ 2′s the result also will be in 1′s and 2′s compliment ignore carry and take 1′s and 2′s compliment of result the answer is there ....

Unsigned & Signed Number

Unsigned number (positive only) :
1 Byte = 0 to 255

Signed Number (positive & negative) ;
1 Byte = -128 to 127
-> here the left most bit is signed bit where 0 means positive and 1 means negative ..
-> 11010110
-> here lab -> 1 = -128 remember



Normalization:

-- Two types.

1. **Explicit Normalization:** Move the radix point to the LHS of the most significant '1' in the bit sequence.

   $(101.101)_2 \rightarrow 0.101101 \times 2^3$

2. **Implicit Normalization:** Move the radix point to the RHS of the most significant '1' in the bit sequence.

   $(101.101)_2 \rightarrow 1.01101$