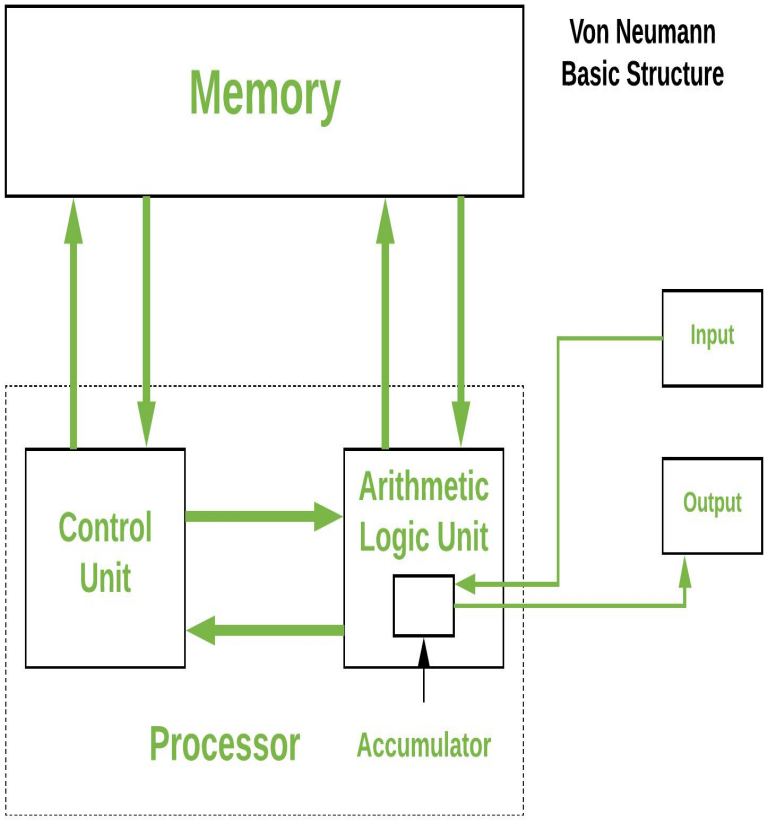
Computer System Architecture

Von Neumann Architecture

- Fixed Program Comptuers
  - For simple and specific functions; cann't be reprogrammed.
- 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.

Von Neumann Architecture

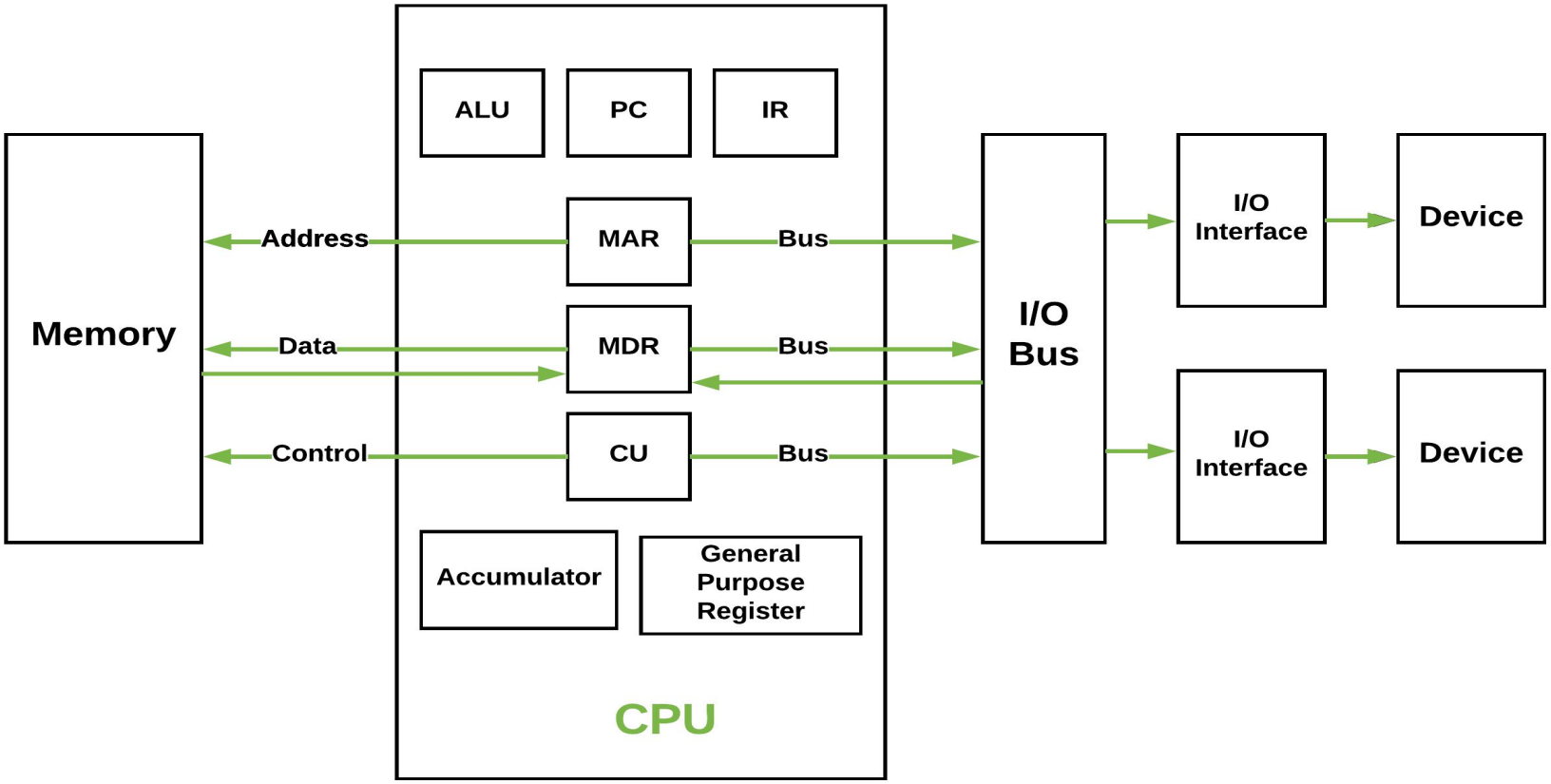


It is also known as ISA (Instruction set architecture) computer and is having three basic units:

- CPU
- Main Memory Unit
- The Input/Output Device

Von Neumann Architecture

- CPU- It comprises { **CU, ALU, {Registers}}**



Von Neumann Architecture

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 Logic Unit

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.

Von Neumann Architecture

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 :-

Accumulator: Stores the results of calculations made by ALU. It holds the intermediate of arithmetic and logical operatoins.it act as a temporary storage location or device.

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).

Memory Address Register (MAR): It stores the memory locations of instructions that need to be fetched from memory or stored in memory.

Memory Data Register (MDR): It stores instructions fetched from memory or any data that is to be transferred to, and stored in, memory.

Current Instruction Register (CIR): It stores the most recently fetched instructions while it is waiting to be coded and executed.

Instruction Buffer Register (IBR): The instruction that is not to be executed immediately is placed in the instruction buffer register IBR.

Von Neumann Architecture

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:

Data Bus: It carries data among the memory unit, the I/O devices, and the processor.

Address Bus: It carries the address of data (not the actual data) between memory and processor.

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.

Von Neumann Architecture

- **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.

First Generation Computers

The first generation (1946-1959) computers were slow, huge and expensive. In these computers, vacuum tubes were used as the basic components of CPU and memory. These computers were mainly depended on batch operating system and punch cards. Magnetic tape and paper tape were used as output and input devices in this generation;

Some of the popular first generation computers are;

- ENIAC (Electronic Numerical Integrator and Computer)
- EDVAC (Electronic Discrete Variable Automatic Computer)
- UNIVACI(Universal Automatic Computer)
- IBM-701
- IBM-650

Second Generation Computers

The second generation (1959-1965) was the era of the transistor computers. These computers used transistors which were cheap, compact and consuming less power; it made transistor computers faster than the first generation computers. In this generation, magnetic cores were used as the primary memory and magnetic disc and tapes were used as the secondary storage.

Some of the popular second generation computers are;

- IBM 1620
- IBM 7094
- CDC 1604
- CDC 3600
- UNIVAC 1108

Third Generation Computers

The third generation computers used integrated circuits (ICs) instead of transistors. A single IC can pack huge number of transistors which increased the power of a computer and reduced the cost. The computers also became more reliable, efficient and smaller in size. These generation computers used remote processing, time-sharing, multi programming as operating system.

Some of the popular third generation computers are;

- IBM-360 series
- Honeywell-6000 series
- PDP(Personal Data Processor)
- IBM-370/168
- TDC-316

Fourth Generation Computers

The fourth generation (1971-1980) computers used very large scale integrated (VLSI) circuits; a chip containing millions of transistors and other circuit elements. These chips made this generation computers more compact, powerful, fast and affordable. These generation computers used real time, time sharing and distributed operating system.

Some of the popular fourth generation computers are;

- DEC 10
- STAR 1000
- PDP 11
- CRAY-1(Super Computer)
- CRAY-X-MP(Super Computer)

Fifth Generation Computers

In fifth generation (1980-till date) computers, the VLSI technology was replaced with ULSI (Ultra Large Scale Integration). It made possible the production of microprocessor chips with ten million electronic components. This generation computers used parallel processing hardware and AI (Artificial Intelligence) software.

Some of the popular fifth generation computers are;

- Desktop
- Laptop
- NoteBook
- UltraBook
- ChromeBook

Moore's Law

An observation that the number of transistors on a microchip roughly doubles every two years, whereas its cost is halved over that same timeframe.

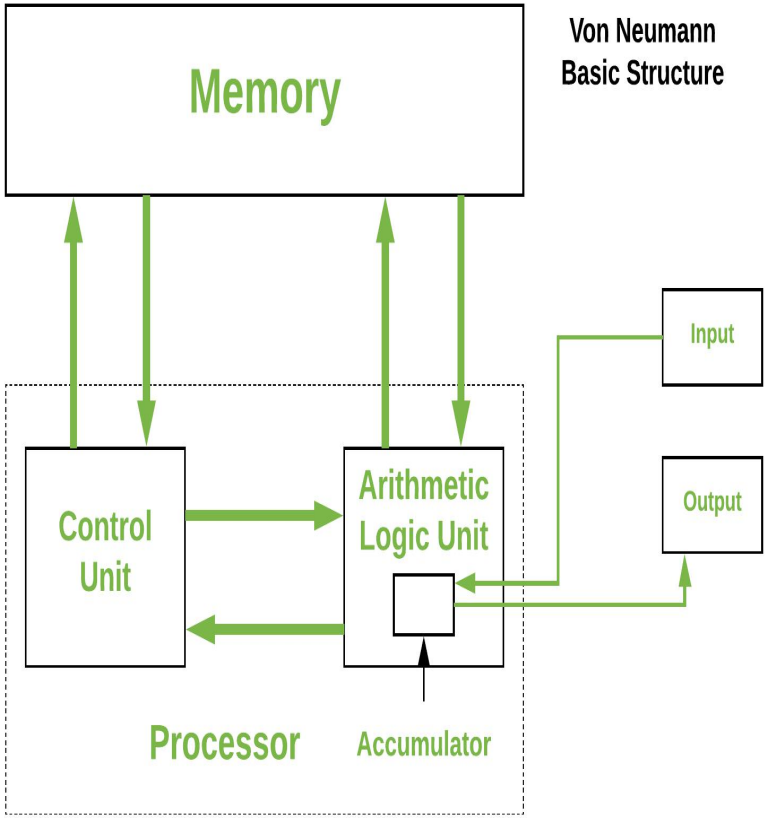
Types of Computers

- Micro Computer
- Laptop Computer
- Work Station
- Super Computer
- Main Frame
- Hand Held
- Multi core

- Micro Computer
  - A personal computer; designed to meet the computer needs of an individual
- Laptop Computer
  - A portable, compact computer that can run on power supply or a battery unit.
- Work Station
  - Powerful desktop computer designed for specialized tasks.
- Super Computer
  - fastest in the world
- Work Station
  - Large expensive computer capable of simultaneously processing data for hundreds or thousands of users.
- Hand Held
  - A computer that fits into a pocket, runs on batteries, and is used while holding the unit in your hand.
- Multi Core
  - Have Multiple Cores – parallel computing platforms.

Functional Units

- Five main functional units
  - Input Unit
  - Output Unit
  - Memory Unit
  - Arithmetic & Logic Unit
  - Control Unit



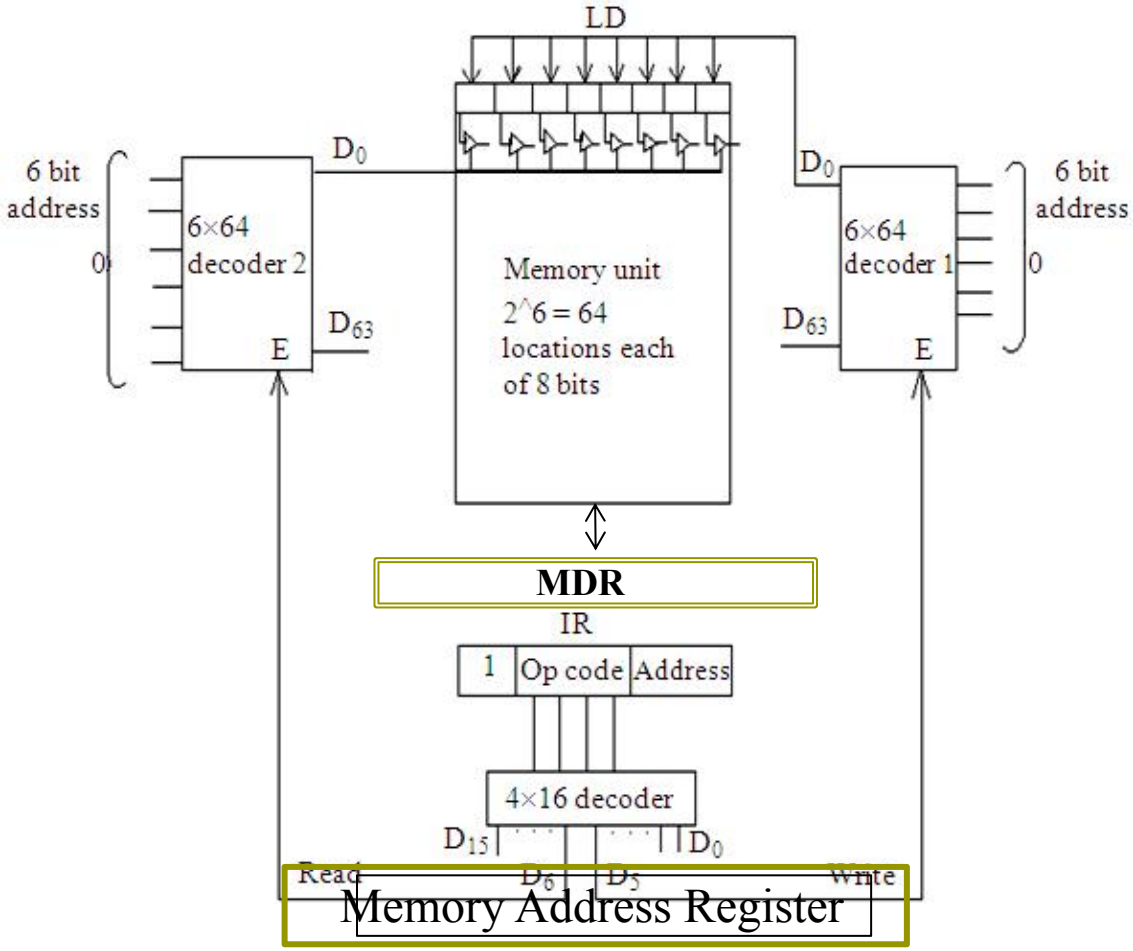
The operations of a computer can be summarized as follows:

1. A set of instructions called a program reside in the main memory of computer.
2. The CPU fetches those instructions sequentially one-by-one from the main memory, decodes them and performs the specified operation on associated data operands in ALU.
3. Processed data and results will be displayed on an output unit.
4. All activities pertaining to processing and data movement inside the computer machine are governed by control unit.

Types of Memory

- Depending on the mechanism used to store and retrieve data:
- Random Access Memory
  - Read-Write Memory
  - Read-Only Memory
- Content Addressable Memory or Associative Memory
- Sequential Access Memory
- Direct Access Memory

Random Access Memory/RWM



Random Access Memory/ROM

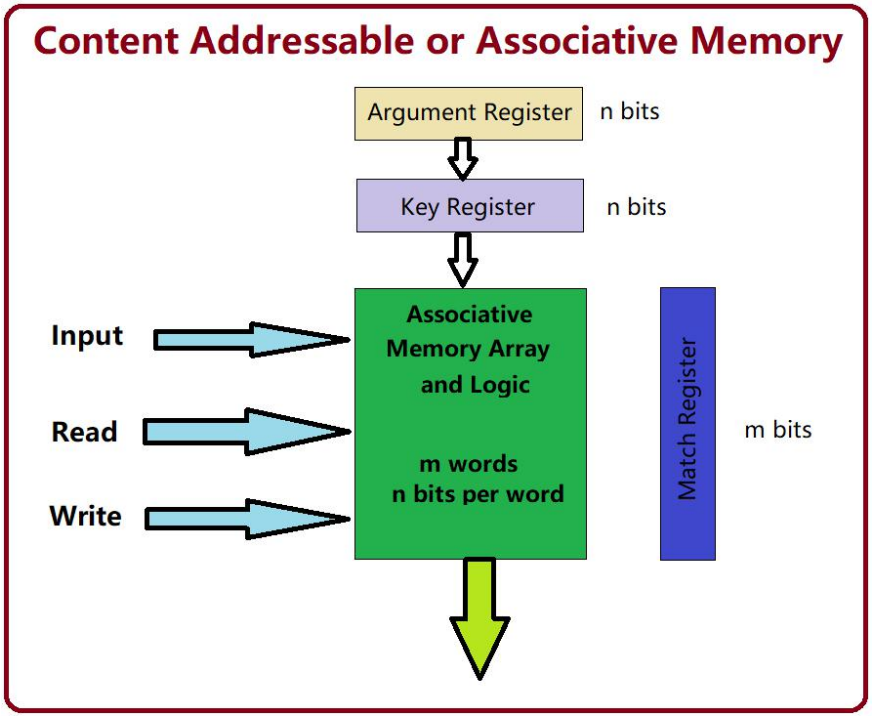
- ROM is also a random access memory, except that data can only be read from it.
- Data are either by the memory manufacturer or by the user
- Contains data and program that are not usually altered in real time during the system operation.

Content Address Memory or Associative Memory

- No such concept of address
- the memory logic searches

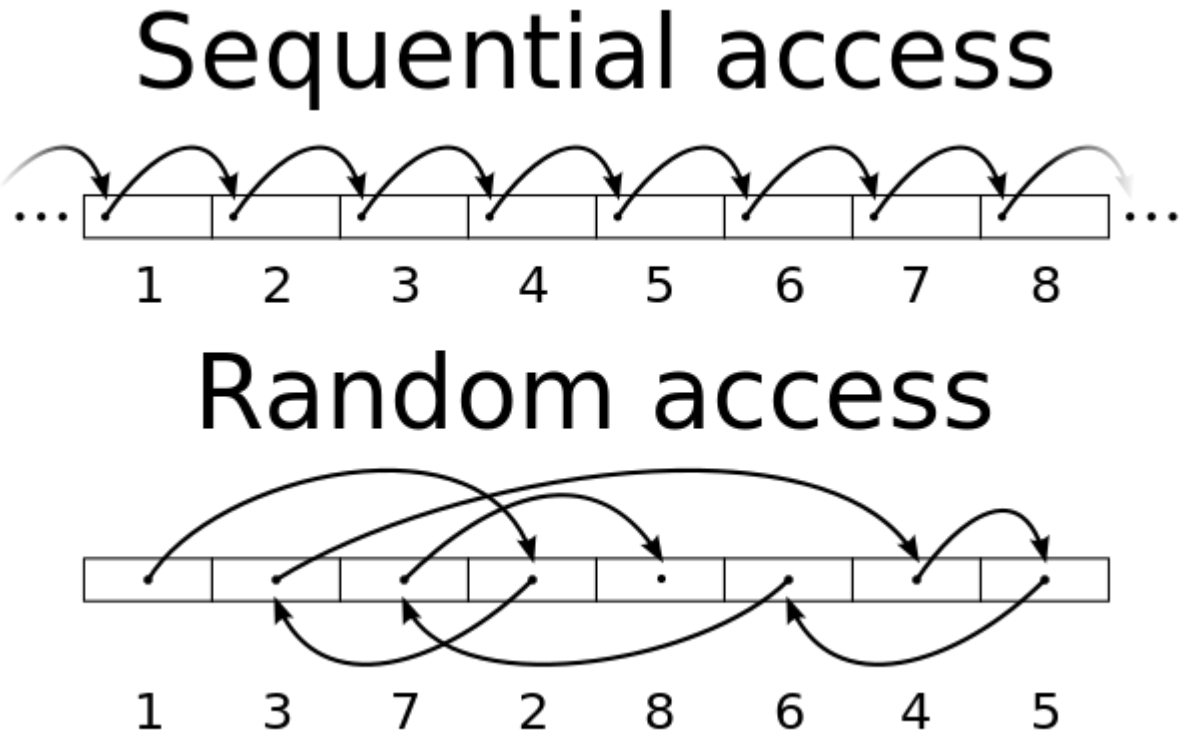
for the location containing a

specified data pattern and



hence the descriptor “content-addressable” or “associative”.

Sequential Access Memory



Direct Access Memory/Semi Random Access Memory

- Direct Access Memory Device (A Magnetic Disk)
- Data Access in two steps
  - The transducers move a particular position determined by the addressing mechanism (cylinder, track)
  - The transducers access the data on the selected track sequentially until the data are found.
- This type of memory is used for secondary storage.
- Also know as Semirandom access memory

RISC

- Simplifying hardware by using an instruction set composed of a few basic steps for loading, evaluating, and storing operations. **"Simpler, Faster, and Lower Power Consumption"**
- Characteristics of RISC
  - Simpler instruction, hence simple instruction decoding.
  - Instruction comes undersize of one word.
  - Instruction takes a single clock cycle to get executed.
  - More general-purpose registers.
  - Simple Addressing Modes.
  - Fewer Data types.
  - A pipeline can be achieved.

CISC

- A single instruction will do all loading, evaluating, and storing operations. **"Reduced Code Size, More Memory Efficient, Widely used"**
- Characteristics of CISC
  - Complex instruction, hence complex instruction decoding.
  - Instructions are larger than one-word size.
  - Instruction may take more than a single clock cycle to get executed.
  - Less number of general-purpose registers as operations get performed in memory itself.
  - Complex Addressing Modes.
  - More Data types.