

Basic Computer Organization and Architecture

MODULE 1

Digital Computers

Dr. Chhaya S Dule
Associate Professor
Dept of CSE
Sapthagiri NPS University
Bangalore

Syllabus

- **Module 1 : Digital Computers**
- **Introduction—Block diagram of Digital Computer— Definition of Computer Organization—Computer Design and Computer Architecture.**

Digital Computers

Introduction

- Digital system that performs various computational tasks
- Information is represented by variables that take a limited number of discrete values.
- Discrete values are processed internally by components that can maintain a limited number of discrete states.

Digital Computers

Introduction (Contd...)

- Decimal digit 0,1,2..... 9 provide 10 discrete values
- Digital computers use binary number system which has two digits 0 and 1 ,called bits
- Information is represented in Group of bits

Digital Computers

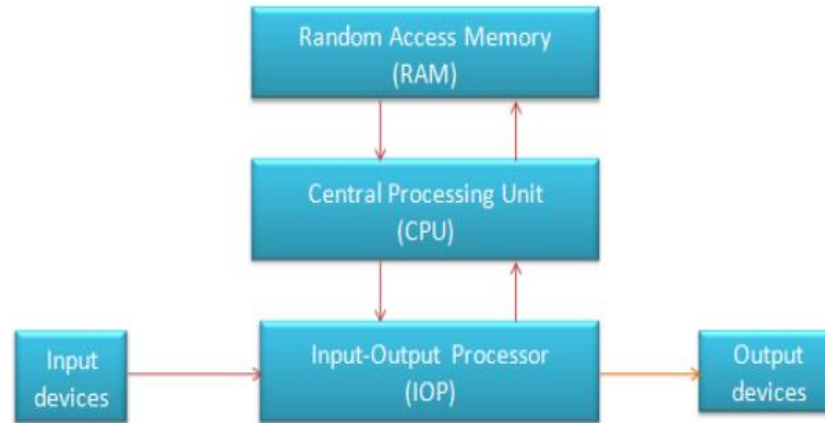
Computer System

A computer system is subdivided into two functional entities:

- **Hardware** : The hardware of the computer consists of all the electronic components and electromechanical devices that comprise the physical entity of the device.
- **Software** : Computer software consists of the instructions and data that the computer manipulates to perform various data-processing tasks.

Digital Computers

Computer System



Block Diagram of Computer System

Software:

- **Computer software consists of the instructions and data that the computer manipulates to perform various data-processing tasks.**
- **The system software of a computer consists of a collection of programs whose purpose is to make more effective use of the computer.**

Software:

- The programs included in a systems software package are referred to as the **Operating System**.
- The compiler that translates the high-level language program to machine language is a System Program.

Application Software:

- It is software that performs specific tasks for an end-user.
- Ex:
- A High-level language program written by user to solve particular data processing needs is an Application Program.

Computer Organisation :

Computer Organisation : is concerned with the way the hardware components operate and the way they are connected together to form the computer system.

The various components are assumed to be in place and the task is to investigate the organizational structure to verify that the computer parts operate as intended.

Computer Design :

Computer Design : is concerned with the hardware design of the computer. Once the computer specifications are formulated, it is the task of the designer to develop hardware for the system.

Computer Architecture : is concerned with the structure and behaviour of the computer as seen by the user. It includes the information formats, the instruction set, and techniques for addressing memory.

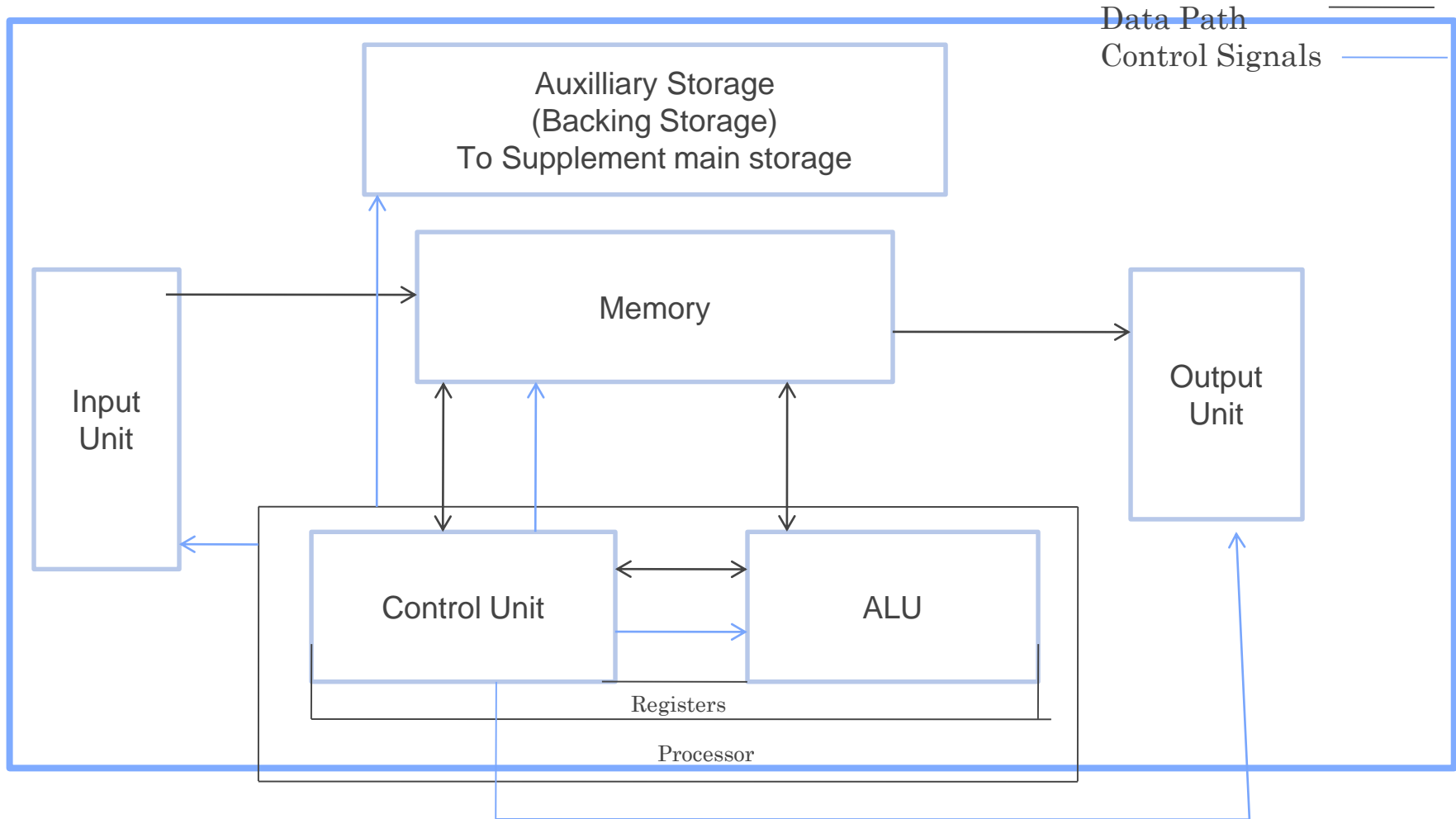
Architectural Design :

- The **Architectural Design** of a computer system is concerned with the specifications of the various functional modules, such as processors and memories, and structuring them together into a computer system.

•

Digital Computers

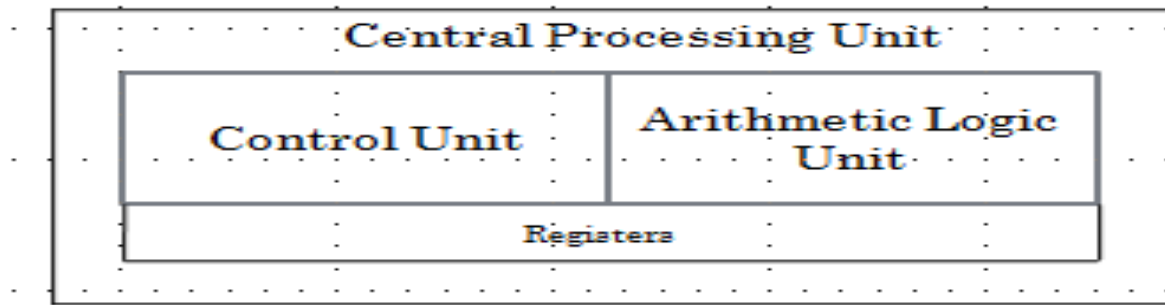
- Just as buildings, each computer has a visible structure, referred to as its architecture.
- In computer science and engineering computer architecture is the practical art of selecting and interconnecting hardware components to create computers that meet functional, performance and cost goals and the formal modeling of those systems.
- The functional blocks in a computer are of four types:
 1. Central Processing Unit
 2. Memory
 3. Input Unit
 4. Output Unit



Central Processing Unit

- The CPU or the microprocessor (or simply processor) is referred as the brain of a computer system.
- CPU consists of three main subsystems, the Control Unit (CU), the Arithmetic Logic Unit (ALU), and the Registers.
- Speed of the computer system is defined by the architecture of the processor being used.

Central Processing Unit



Arithmetic Logic Unit

- The ALU contains electronic circuits necessary to perform arithmetic and logical operations.
- The arithmetic operations are ADD, SUBTRACT, MULTIPLY, DIVIDE, etc.
- The logical operations include COMPARE, SHIFT, ROTATE, AND, OR, etc
- The control unit analyses each instruction in the program and sends the relevant signals to all other units – ALU, Memory, Input unit and Output unit

Communication Inside Computer

- A computer program consists of both instructions and data. The program is fed into the computer through the input unit and stored in the memory.
- In order to execute the program, the instructions have to be fetched from memory one by one.
- This fetching of instructions is done by the control unit.
- After an instruction is fetched, the control unit decodes the instruction.

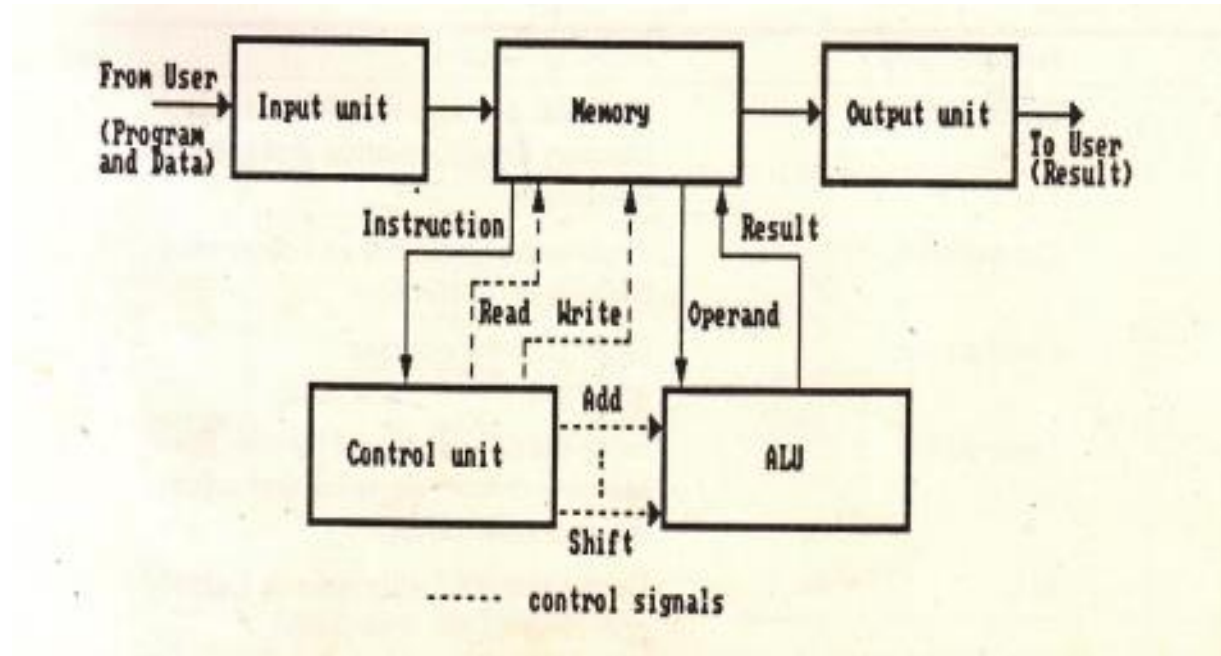
Communication Inside Computer

- According to the instruction, the control unit issues control signals to other units.
- After an instruction is executed, the result of the instruction is stored in memory or stored temporarily in the control unit or ALU, so that this can be used by the next instruction.
- The results of a program are taken out of the computer through the output unit.
- The control unit, ALU and registers are collectively known as Central Processing Unit (CPU)

Communication Inside Computer

- According to the instruction, the control unit issues control signals to other units.
- After an instruction is executed, the result of the instruction is stored in memory or stored temporarily in the control unit or ALU, so that this can be used by the next instruction.
- The results of a program are taken out of the computer through the output unit.
- The control unit, ALU and registers are collectively known as Central Processing Unit (CPU)

Communication Inside Computer



Interconnection of Units

- A computer program consists of both instructions and data.
- The program is fed into the computer through the input unit and stored in the memory.
- In order to execute the program, the instructions have to be fetched from memory one by one and store it into registers (working memory) for processing.
- This fetching of instructions is done by the control unit.

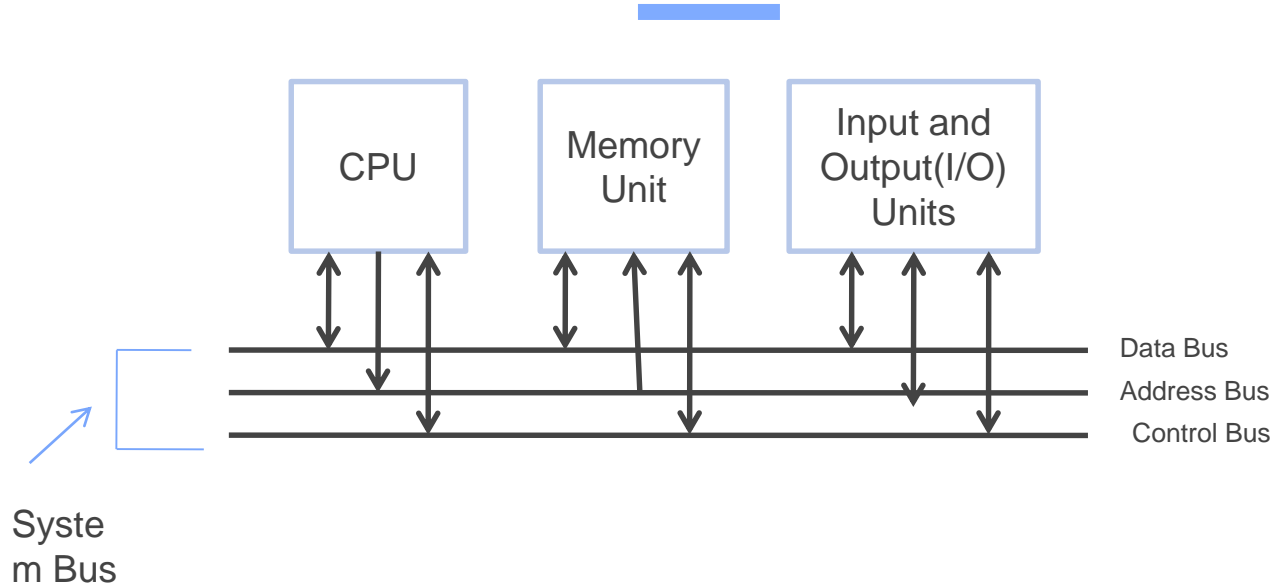
Interconnection of Units

- Set of wires used for interconnection is known as system bus which carry group of bits (information) in a controlled manner.
- It is further divided into three logical units, namely the address bus, the data bus, and the control bus.
 - **Data Bus:** The data bus is used when any unit is sending data, instruction or command code to some other units.
 - **Address Bus:** The address bus is used when one unit is sending an address information i.e. location of the data residing in the memory to another unit.

Interconnection of Units

- Set of wires used for interconnection is known as system bus which carry group of bits (information) in a controlled manner.
- It is further divided into three logical units, namely the address bus, the data bus, and the control bus.
 - **Data Bus:** The data bus is used when any unit is sending data, instruction or command code to some other units.
 - **Address Bus:** The address bus is used when one unit is sending an address information i.e. location of the data residing in the memory to another unit.

Interconnection of Units



Interconnection of Units

- **Control Bus:** The control bus is responsible for making CPU, memory and I/O devices work together as a functional system, carrying signals that report the status (ready, not ready) of various units.
- The function of a control bus is to determine and instruct according to the operation type (Read or Write). For example, if the processor or an I/O device wants to read or write a value from memory, the control bus will specify it.

Registers

- It is a special temporary storage location within the CPU.
- Registers quickly accept, store and transfer data and instructions that are being used immediately.
- To execute an instruction, the control unit of the CPU retrieves it from main memory and places it onto a register.

Control Unit

- It is responsible for directing and coordinating most of the computer system activities.
- It does not execute instructions by itself. It tells other parts of the computer system what to do.
- It determines the movement of electronic signals between the main memory and arithmetic logic unit as well as the control signals between the CPU and input/output devices.

Memory

- **Memory is the computer's electronic scratchpad or local store in computer terminology.**
- **Used for temporary storage of calculations, data, and other work in progress.**
- **Two types: Primary and Secondary**
- **Primary memory or the main memory is part of the main computer system.**

Memory

- The primary memory itself is of two types.
- The first is called random access memory (RAM) and the other is read only memory (ROM).

Random Access Memory

- The processor directly stores and retrieves information from it.
- Memory is organized into locations. Each memory location is identified by a unique address. The access time is same for all location.
- It is volatile: when turned off, everything in RAM disappears.

Read Only Memory

- Data stored in ROM cannot be modified, or can be modified only slowly or with difficulty, so it is mainly used to distribute.
- The instructions in ROM are built into the electronic circuits of the chip which is called firmware.
- Random access in nature and non-volatile.

Input Devices

- Any peripheral used to provide data and control signals to an information processing system such as a computer or other information appliance.
- Common input devices: Keyboard, Mouse
- Other devices: microphone, digital camera, scanner.

Output Devices

- **Any piece of computer hardware equipment used to communicate the results of processed data to the user.**
- **Examples: Monitors, Printers, Speakers, etc.**