CIS11032 Logic Designing & Computer Organization

Lesson 04 Basic Components & Organization of Computer

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Learning Outcomes

At the completion of this lesson students should be able to,

- Differentiate Computer Organization from Computer Architecture
- Identify the basic components of Computer
- Identify the basic components of CPU

COURSE OUTLINE

- Computer Organization vs Architecture
- Basic Functions of Computer
- Basic Components of Computer
- Basic Components of CPU

Computer Organization vs Computer Architecture

- Computer architecture refers to the design and structure of a computer system — what a computer is supposed to do.
- Deals with the **abstract, logical aspects of the system**

- Computer organization refers to the implementation details — how the architecture is actually realized in hardware.
- Deals with **physical components and how they work together**.

Computer Organization vs Computer Architecture contd.

- **Architectural Attributes**

  Instruction set architecture, the number of bits used to represent various data types (e.g., numbers, characters), Data formats, I/O mechanisms, techniques for addressing memory (Addressing Modes), Hardware-software interface

- **Organizational Attributes**

  Hardware details transparent to the programmer, such as control signals; interfaces between the computer and peripherals; and the memory technology used, Control signals, Memory hierarchy (cache, RAM)Bus systems, ALU, registers, and how data flows

Computer Organization vs Computer Architecture contd.

Aspect	Computer Architecture	Computer Organization
Focus	What the system does	How the system does it
Level of Abstraction	High-level (conceptual)	Low-level (implementation)
Concerned With	Instruction set, data types	Circuits, signals, memory, timing
Audience	System designers, software devs	Hardware engineers
Analogy	Blueprint of a building	Plumbing, wiring, actual structure

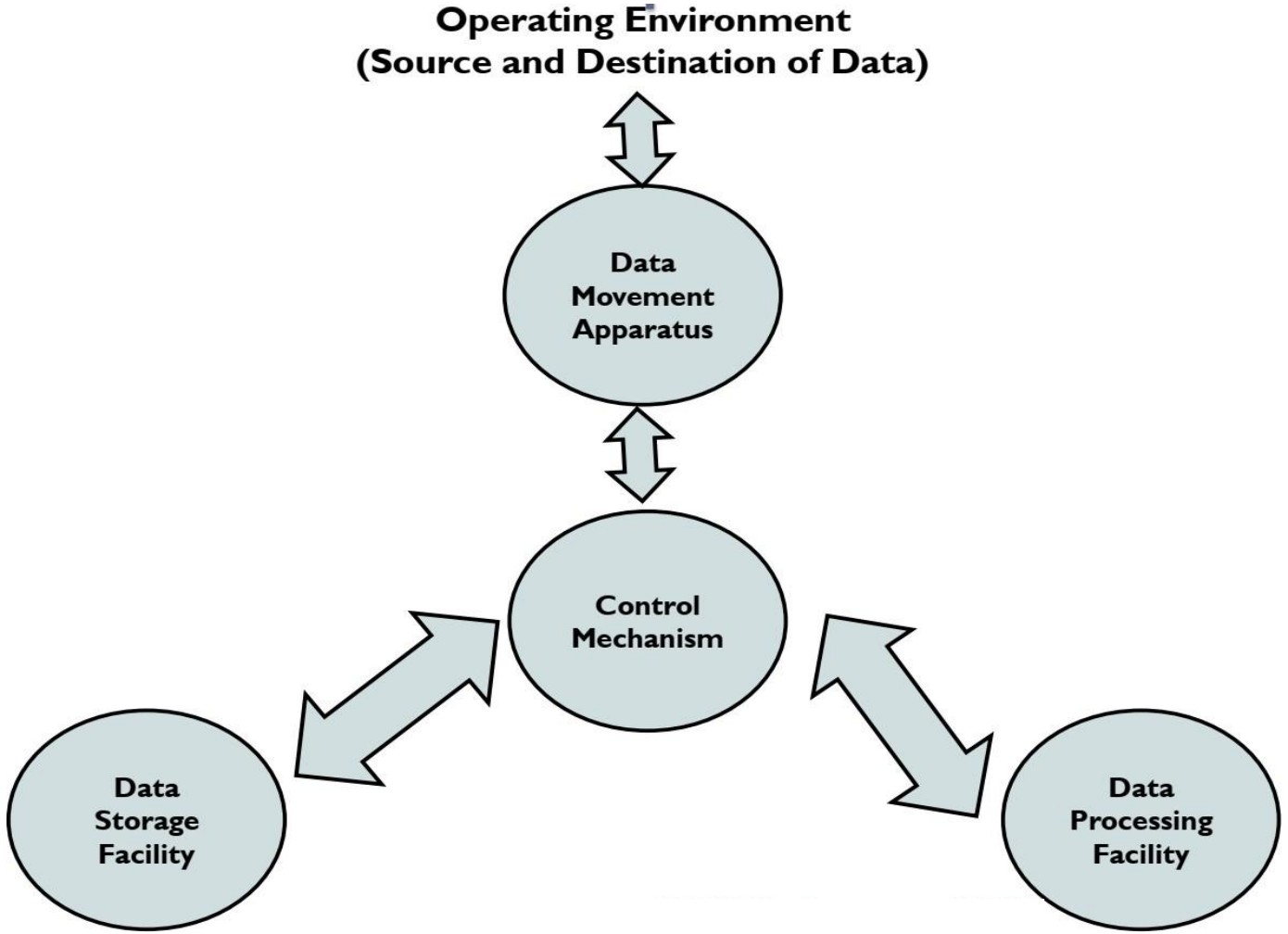
SUMMARY

- **Think:** Architecture is like deciding how a car *should* perform (speed, fuel efficiency), while **organization** is about how the engine, transmission, and fuel system are built to achieve that performance.
- Many computer manufacturers offer a family of computer models, all with the **same architecture** but with **differences in organization.**

Basic Components of Computer

- A computer has the following functions in main: **Data processing, Data Storage, Data Movement and Control.**
- To achieve the above functions, basically, there are four main structural components
  - **Central processing unit (CPU)**
  - **Main memory**
  - **I/O**
  - **System interconnection**

Functional View of Computer



01. CPU

- Controls the operation of the computer and performs its data processing functions; often simply referred to as processor
- Traditionally, there has been just a single processor. In recent years, there has been increasing use of multiple processors in a single computer.

CPU contd.

- There are 04 major components in a CPU
  1. **Control unit:** Controls the operation of the CPU and hence the computer.
  2. **Arithmetic and logic unit** (ALU): Performs the computer's data processing functions.
  3. **Registers:** Provide storage internal to the CPU.
  4. **CPU interconnection:** Some mechanism that provides for communication among the control unit, ALU, and registers. (System Bus)

CPU contd.

- The Control Unit (CU) is responsible for directing operations within the CPU by generating control signals based on the instructions it receives.
- There are **two** main approaches to implementing a Control Unit:

1. Hardwired Control Unit
2. Microprogrammed Control Unit

CPU contd.

1. **Hardwired Control Unit**

Uses fixed logic circuits (like gates and flip-flops) to generate control signals.

Control signals are produced using combinational logic, based on the instruction opcode.

Characteristics:

Fast execution

Difficult to modify or update

Ideal for simple or high-speed processors

CPU contd.

2. **Microprogrammed Control Unit**

Uses a set of instructions (called microinstructions) stored in memory (Control Memory) to generate control signals.

Each machine instruction is broken down into micro-operations, which are executed by interpreting microinstructions.

Characteristics:

Easier to modify and update

Slower compared to hardwired control

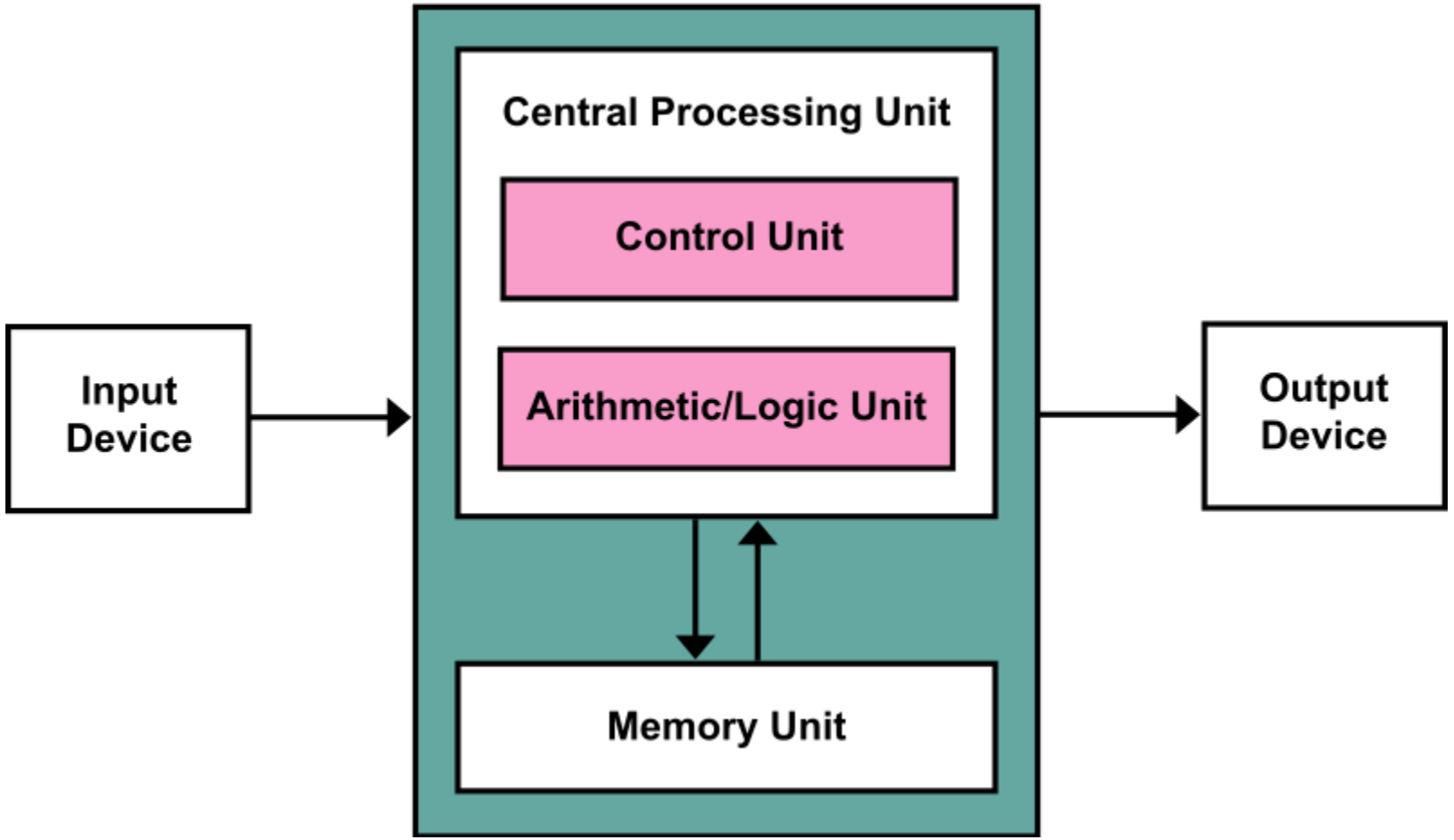
Computer Architecture

- Virtually all contemporary computer designs are based on concepts developed by John von Neumann referred to as "**Von Neumann Architecture".**
- This architecture is based on three key concepts
  - Data and instructions are stored in a single read–write memory.
    - *Both program instructions and data are stored in the same memory.*
  - The contents of this memory are addressable by location, without regard to the type of data contained there.
  - Execution occurs in a sequential fashion (unless explicitly modified) from one instruction to the next
    - *The CPU fetches and executes these instructions sequentially unless directed otherwise (like with loops or branches). Each instruction is fetched, decoded, and executed — known as the* ***fetch-decode-execute cycle****.*

Components of Von Neumann Architecture

Component	Role
Memory	Stores both data and instructions
CPU	Processes instructions and data
ALU	Performs arithmetic and logical operations
Control Unit	Directs the execution of instructions
Registers	Temporary fast storage for data/instructions
I/O Devices	Enables communication with the outside world

Components of Von Neumann Architecture



02. I/O Module

- An **Input module** contains basic components for accepting data and instructions in some form and converting them into an internal form of signals usable by the system
- The **Output module** is important for reporting the results.
- Both modules together are known as **I/O Components**

03. Memory or Main Memory

- A program is not invariably executed sequentially whereas the data or instructions reach sequentially.
- Hence, Data and instructions need to be stored temporarily.
- That module is termed as "**Main Memory**"
- Thus, main memory is the place where the computer temporarily stores data and instructions that are currently in use.

03. Memory or Main Memory contd.

Main components of Memory

1. RAM (Random Access Memory)
   - **Volatile** memory – loses content when power is off.
   - Stores data and instructions currently being used.
   - **Types**:
     - **DRAM (Dynamic RAM)**: Needs constant refreshing.
     - **SRAM (Static RAM)**: Faster and doesn't need refreshing, but more expensive.

2. ROM (Read Only Memory)
   - **Non-volatile** – retains data when power is off.
   - Contains firmware or system-level instructions (like BIOS).
   - Data is usually read-only, though some types can be rewritten.

03. Memory or Main Memory contd.

Main components of Memory

3. Cache Memory
   - Very small and fast memory located close to or inside the CPU.
   - Stores frequently accessed data and instructions to speed up processing.
   - Levels:
     - **L1 Cache (fastest, smallest)**
     - **L2 Cache**
     - **L3 Cache (largest, slower than L1/L2 but still faster than RAM)**
4. Registers
   - Located inside the CPU, technically not part of RAM but still part of main memory hierarchy.
   - Extremely fast storage for immediate instruction execution.
   - **Examples:** Accumulator, Program Counter (PC), Instruction Register (IR).

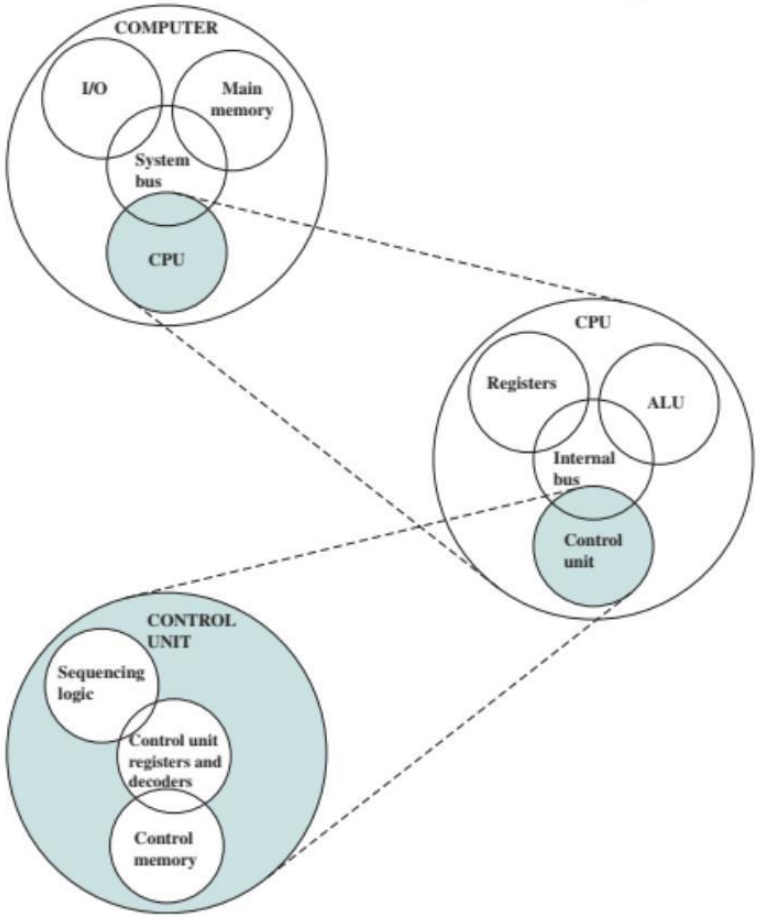
Registers

- **Accumulator (ACC)**
  - Stores ALU operation results
- **Program Counter (PC)**
  - Points the next instruction
- **Memory Address Register (MAR)**
  - Specifies the address in memory for the next read or write
- **Instruction Register**
  - Holds current instruction
- **Memory Buffer Register/Memory Data Register (MDR/MBR)**
  - Contains the data to be written into memory or receives the data read from memory
- **I/O Address Register**
  - Specifies a particular I/O device
- **I/O Buffer Register**
  - Used for the exchange of data between an I/O module and the CPU.

Things to Remember

- A computer consists of **CPU (central processing unit), memory, and I/O components**, with one or more modules of each type.
- These components are **interconnected** in some fashion to achieve the basic function of the computer
- The process of connecting the various components in the desired configuration is known as **"Programming".**

Top Level Structure of Computer



Sample questions:

1. What is the difference between computer architecture and computer organization?
2. Compare and contrast Von Neumann and Harvard architectures.
3. Describe the microprogrammed and hardwired control units. What are their advantages and disadvantages?
4. What are the main functions of a computer system?
5. Define and differentiate between RAM and ROM.
6. What is a register? Name at least four types of registers in the CPU.

Thank you