

Computer Architecture



Computer architecture and classification

BURKINA INSTITUTE OF TECHNOLOGY

Computer Science and Entrepreneurship
(C.S.E)

Academic year : 2024-2025

Semester 1

14 février 2025

Course outline

- 1 Von Neumann Architecture
- 2 Types and characteristics of computers
- 3 Examples

1. Von Neumann Architecture

1. Von Neumann Architecture

1.1. Introduction

- Computer Organization is like understanding the *blueprint* of how a computer works internally.
- One of the most important models in this field is the Von Neumann architecture, which is the foundation of most modern computers.
- Named after **John von Neumann**, this architecture introduced the concept of storing both data and instructions in the same memory.

1. Von Neumann Architecture

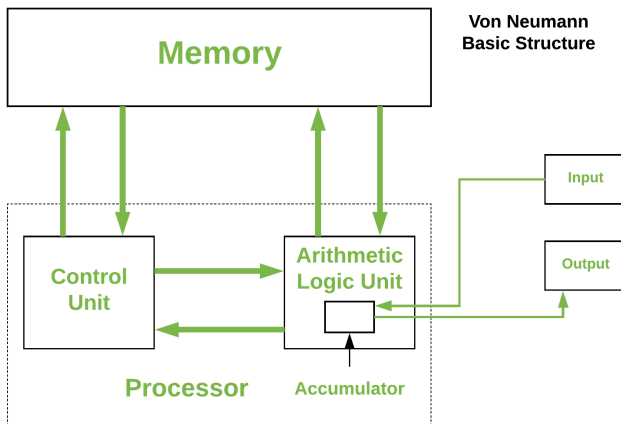
1.2. Types of computers

Historically there have been 2 types of Computers:

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

1. Von Neumann Architecture

1.2. Architecture



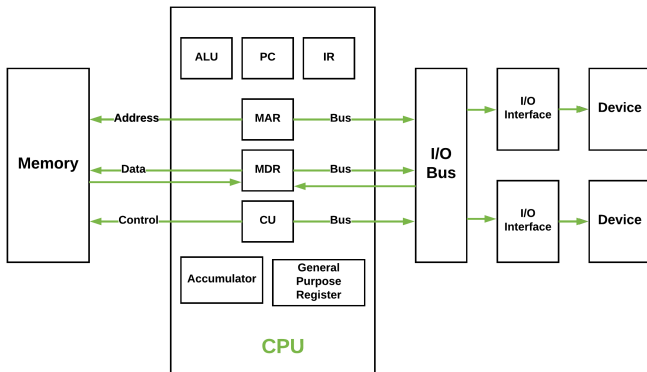
1. Von Neumann Architecture

1.3. Characteristics

- **Memory:** This is where data and instructions are stored. It is a crucial part of the computer system that allows for the storage and retrieval of information.
- **Control Unit:** This component manages the operations of the computer. It directs the flow of data between the CPU and other components.
- **Arithmetic Logic Unit (ALU):** The ALU performs arithmetic and logical operations. It is responsible for calculations and decision-making processes.
- **Processor:** The processor, or CPU, is the central component that carries out the instructions of a computer program. It includes the ALU and Control Unit.
- **Accumulator:** This is a register in the CPU that stores intermediate results of arithmetic and logic operations.

1. Von Neumann Architecture

1.2. Architecture



1. Von Neumann Architecture

1.4. Key Characteristics of Von Neumann Architecture

- **Single Memory for Data and Instructions:** Both data and program instructions are stored in the same memory.
- **Shared Bus:** A single bus is used for transferring data, addresses, and control signals, which can limit performance.
- **Sequential Execution:** Instructions are executed one at a time in a sequential manner.

1. Von Neumann Architecture

1.4 The Bus

- The bus is a communication system that transfers data, addresses, and control signals between the CPU, memory, and I/O devices. In Von Neumann architecture, a single bus is shared for both data and instructions, which can create a bottleneck.
- **I/O Interface**: Connects the CPU and memory to input/output devices.
- **Device**: Refers to external hardware like keyboards, monitors, or storage devices.

1. Von Neumann Architecture

1.5. Advantages of Von Neumann Architecture

- **Simplified Design**: Uses a single memory for data and instructions, reducing hardware complexity.
- **Cost-Effective**: Lower production costs due to fewer components.
- **Flexibility**: Can run various programs and makes it suitable for general-purpose computing.
- **Ease of Programming**: Unified memory structure simplifies software development.
- **Widely Adopted**: Forms the foundation of most modern computers hence, ensures widespread compatibility.

1. Von Neumann Architecture

1.6. Limitations of Von Neumann Architecture

- **Memory Bottleneck**: Shared memory slows down data and instruction transfer.
- **Sequential Processing**: Cannot process data and instructions simultaneously.
- **Scalability Issues**: Struggles with high-performance tasks requiring rapid memory access.
- **Energy Inefficiency** : Frequent memory access increases power consumption.
- **Latency**: Data and instruction fetch delays reduce overall system efficiency.

1. Von Neumann Architecture

1.7. Applications of Von Neumann Architecture

- **General-Purpose Computing:** Powers desktops, laptops, and smartphones.
- **Embedded Systems:** Used in simple devices where cost and simplicity are priorities.
- **Software Development:** Shapes programming tools and languages due to its unified structure.
- **Education:** A foundational concept in computer science courses.
- **Gaming and Multimedia:** Supports complex applications like video games and editing software.

1. Introduction to computer architecture

1.8. Questions

- 1 Explain the von Neumann architecture.
- 2 What are the 5 stages of the von Neumann architecture?
- 3 What are the 5 components of the von Neumann architecture?
- 4 What are the two principles of the von Neumann architecture?

2. Types and characteristics of computers

2. Types and characteristics of computers

2.1. Introduction

- A computer is an electronic device that has storage, computations, input (data), output (data) and networking capabilities.
- With the growing AI, computers also have learning capabilities from the data provided.
- The input and output data can be in different forms like text, images, audio and video.
- A computer processes the input according to the set of instructions provided to it by the user and gives the desired output.
- Computers are of various types and they can be categorized in two ways on the basis of size and on the basis of data handling capabilities.

2. Types and characteristics of computers

2.2. Types of computer

- Super Computer
- Mainframe computer
- Mini Computer
- Workstation Computer
- Personal Computer (PC)
- Server Computer
- Analog Computer
- Digital Computer
- Hybrid Computer
- Tablets and Smartphone

2. Types and characteristics of computers

2.2. Types of computer: Super Computer

- They are the biggest and fastest computers (in terms of speed of processing data).
- It is basically used in scientific and engineering applications such as weather forecasting, scientific simulations, and nuclear energy research.
- It can calculate up to ten trillion individual calculations per second, this is also the reason which makes it even faster.

2. Types and characteristics of computers

2.2. Types of computer: Super Computer



2. Types and characteristics of computers

2.2. Types of computer: Mainframe Computer

- Mainframe computers are designed in such a way that they can support hundreds or thousands of users at the same time.
- It also supports multiple programs simultaneously.
- So, they can execute different processes simultaneously.
- All these features make the mainframe computer ideal for big organizations like banking, telecom sectors, etc., which process a high volume of data in general.

2. Types and characteristics of computers

2.2. Types of computer: Minicomputer

- Minicomputer is a medium size multiprocessing computer. In this type of computer, there are two or more processors, and it supports 4 to 200 users at one time.
- Minicomputer is similar to Microcontroller.
- Minicomputers are used in places like institutes or departments for different work like billing, accounting, inventory management, etc.
- It is smaller than a mainframe computer but larger in comparison to the microcomputer.

2. Types and characteristics of computers

2.2. Types of computer: Workstation Computer

- A workstation computer is designed for technical or scientific applications.
- It consists of a fast microprocessor, with a large amount of RAM and a high-speed graphic adapter.
- It is a single-user computer. It is generally used to perform a specific task with great accuracy.
- It provides large storage capacity, better graphics, and a more powerful CPU when compared to a PC.

2. Types and characteristics of computers

2.2. Types of computer: Personal Computer (PC)

- Personal Computers is also known as a microcomputer.
- It is basically a general-purpose computer designed for individual use.
- It consists of a microprocessor as a central processing unit(CPU), memory, input unit, and output unit.
- This kind of computer is suitable for personal work such as making an assignment, watching a movie, or at the office for office work, etc.
- For example, Laptops and desktop computers.
- It is designed for personal use.

2. Types and characteristics of computers

2.2. Types of computer: Server computer

- Server Computers are computers that are combined data and programs.
- Electronic data and applications are stored and shared in the server computer.
- The working of a server computer is that it does not solve a bigger problem like a supercomputer but it solves many smaller similar ones.
- Examples of server computer are like Wikipedia, as when users put a request for any page, it finds what the user is looking for and sends it to the user.

2. Types and characteristics of computers

2.2. Types of computer: Analog computer

- Analog Computers are particularly designed to process analog data.
- Continuous data that changes continuously and cannot have discrete values are called analog data.
- It is used where we don't need exact values or need approximate values such as speed, temperature, pressure, etc.
- It can directly accept the data from the measuring device without first converting it into numbers and codes.
- It measures the continuous changes in physical quantity.
- It gives output as a reading on a dial or scale.
- For example speedometer, mercury thermometer, etc.

2. Types and characteristics of computers

2.2. Types of computer: Digital computer

- Digital computers are designed in such a way that they can easily perform calculations and logical operations at high speed.
- It takes raw data as input and processes it with programs stored in its memory to produce the final output.
- It only understands the binary input 0 and 1, so the raw input data is converted to 0 and 1 by the computer and then it is processed by the computer to produce the result or final output.
- All modern computers, like laptops, desktops including smartphones are digital computers.

2. Types and characteristics of computers

2.2. Types of computer: Hybrid computer

- As the name suggests hybrid, which means made by combining two different things.
- Similarly, the hybrid computer is a combination of both analog and digital computers.
- Hybrid computers are fast like analog computers and have memory and accuracy like digital computers.
- So, it has the ability to process both continuous and discrete data.
- For working when it accepts analog signals as input then it converts them into digital form before processing the input data.
- So, it is widely used in specialized applications where both analog and digital data are required to be processed.
- A processor which is used in petrol pumps that converts the measurements of fuel flow into quantity and price is an example of a hybrid computer.

2. Types and characteristics of computers

2.2. Types of computer: Tablets and Smartphones

- Tablets and Smartphones are the types of computers that are pocket friendly and easy to carry as these are handy.
- This is one of the best use of modern technology.
- These devices have better hardware capabilities, extensive operating systems, and better multimedia functionality.
- Smartphones and tablets contain a number of sensors and are also able to provide wireless communication protocols.

2. Types and characteristics of computers

2.3. Questions

- Which computer can deal with analog data?
- ... is also known as a Microcomputer.
- Which type of computer has two or more processors and supports 4 to 200 users at one time?
- All modern computers, like laptops, desktops including smartphones, are ... computers.

3. *Applications*

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