

Computer Systems and Architecture Revision

*A combination of many connected parts all working together (interacting) to achieve a common goal is called a **Computer System**.*

The purpose of a computer system is to take in data, store it, process it and output the result.

Computer systems involve interaction between:

- Hardware
- Software
- Data
- The User

Hardware	The physical components that make up a computer system e.g. CPU, monitor, motherboard
Software	The programs that run on a computer system and control the hardware
Application software	Designed to allow users complete a specific task e.g Excel
System software	Provides a platform for the application software to run on and manages the systems resources. e.g Operating systems like ios or Windows

Description of the systems involved in a computer system

Types of Computer Systems

General Purpose	Perform a wide range of tasks, e.g A laptop
Dedicated systems	Designed to perform a specific function e.g washing machine
Embedded systems	A system built into another system that has a specific function. e.g autopilot in a car.

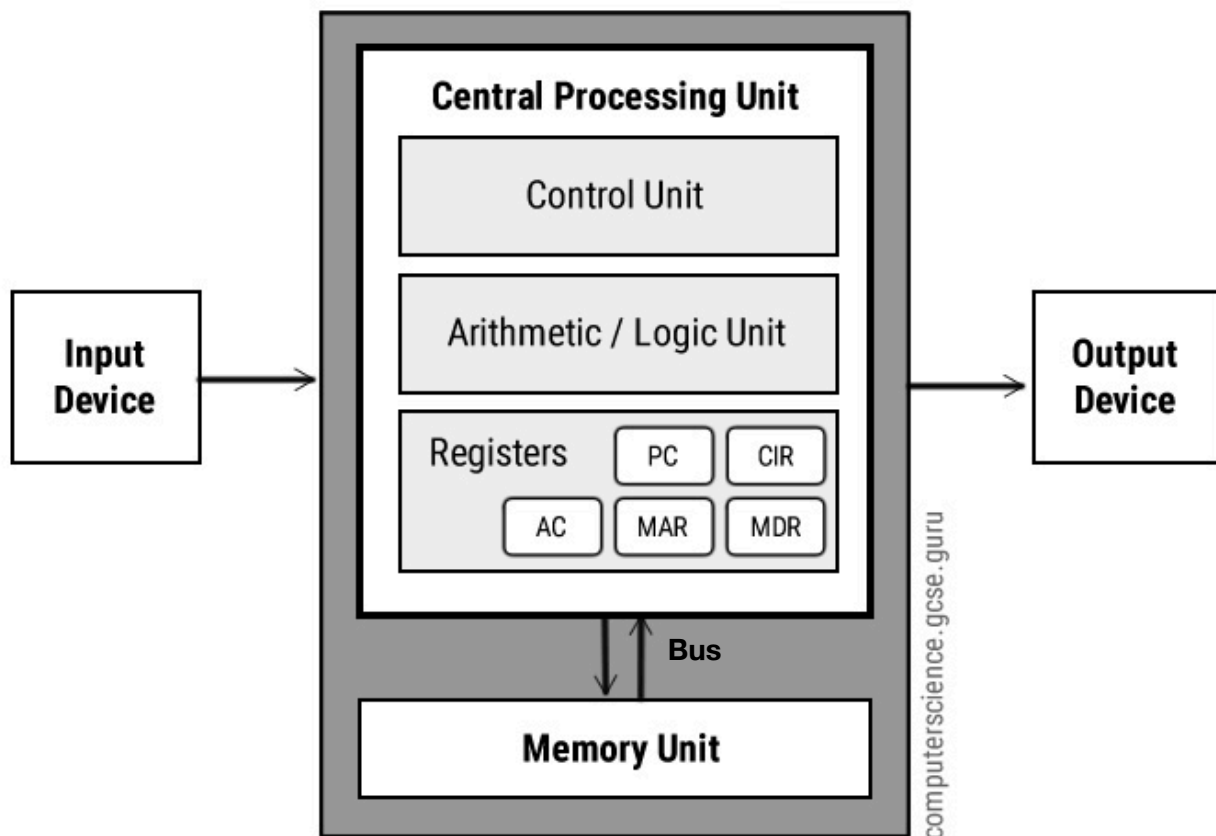
Examples of computer systems

Elements of Computer Systems

Many of today's computers share a common architecture, (think of a house, houses can have different layouts but they all contain common rooms, eg. bedroom, bathroom kitchen), similarly we have many different types of computer systems but they all will have common components. This architecture is known as the von Neumann architecture named after John von Neumann who first described it in 1945.

Von Neumann Architecture

- Memory
- Central Processing Unit
- Input and Output devices
- Computer bus



Typical Von Neumann Architecture

Memory

Primary storage	Secondary storage
Example : RAM (Random Access Memory)	Example: Hard Drive, USB
Data is lost when it loses power (volatile)	Data is not lost when power is lost (Non-volatile)
Temporary data storage	Larger capacity
Read only	Read and Writeable
Quick to respond	Slower than primary storage

RAM - Random Access Memory

- RAM is temporary memory, it holds data and instructions of a program that is currently being executed by the CPU.
- It is constantly being written to and read from.
- Needs a constant power supply to retain its contents.
- When computer is turned off everything stored in its RAM is lost.
- Easy to upgrade and relatively cheap.



ROM - Read Only memory

- ROM is non-volatile, its contents remain even when you turn off the computer.
- You cannot write over the contents once it has been created, it is read only.
- ROM usually programmed by a computer's manufacturer.
- Used in BIOS loaded which is required at the start-up of the computer.

CPU

The Central Processing Unit (CPU) has a number of roles:

- Processes data and instructions coming from input and storage devices.
- Controls other components within the computer.
- Carry out computations on data by following instructions

The CPU is made up of the control unit, arithmetic/logic unit (ALU) and registers.

Control Unit: The control unit directs the operations of the CPU.

ALU: Performs all arithmetic and logic operations of the CPU. Receives instructions and data and operates on the data according to the instructions.

Registers: Temporary storage locations that can be accessed quickly when carrying out operations. Small memory, fast.

- Program Counter: Stores where the CPU is in a program sequence. Contains the memory location of the next instruction to be executed
- Accumulator: Stores the output of the ALU
- Memory Address Register: Stores memory addresses, a value that indicates a specific location in memory
- Memory Data Register: Holds data of an instruction temporarily

Clock: Generates a signal consisting of a continuous stream of electrical pulses at a stable frequency (GHz). Ensures all circuits operate together at the right timing. Each impulse activates a fetch-execute cycle.

Bus: Connects CPU and memory. Computers typically have more than one, a communication channel that carries data between internal components. USB = Universal Serial Bus

Inputs and Outputs: Apart from the memory, CPU and bus, all other parts of the von Neumann architecture are considered to be either an input or an output. This includes things like keyboards (input), Display devices (output), secondary storage (both input and output).

Fetch - Decode - Execute Cycle

As a CPU process instructions it runs through a continuous cycle over and over again. In this cycle the CPU retrieves a program instruction from memory and then executes that instruction before then repeating the cycle and getting the next instruction.

1. The address of the next instruction to be executed is copied from the program counter (PC) register to the memory address register (MAR).
2. The Program Counter increments so its points to the **next** instruction to be fetched.
3. The instruction in the MAR is copied to the Current Instruction Register (CIR).
4. The control Unit decodes the instruction in the Current Instruction Register to see what must be done next.
5. The instruction is executed

Factors Affecting CPU Performance

Factor	How it affects CPU Performance
Clock Speed	The faster the clock, the more fetch-execute cycles can take place and therefore more instructions processed
Number of Cores	Dual-core: 2 processor cores, 2 instructions executed simultaneously Quad-core: 4 processor cores, 4 instructions executed simultaneously.
Cache Memory Amount	Very fast memory (temporary) located in the CPU er capacity More cache memory allows CPU to store more instructions, reducing time lost waiting to retrieve data from RAM

Operating System

An operating system is type of system software. It controls the general operation of a computer and provides an easy way for us to interact with a computer and run application software.



The operating system performs several key functions:

- **Interface** - provides a user interface so it is easy to interact with the computer
- **Manages the CPU** - runs applications and executes and cancels processes
- **Multi-tasks** - allows multiple applications to run at the same time
- **Manages memory** - transfers programs into and out of memory, allocates free space between programs, and keeps track of memory usage
- **Manages peripherals** - opens, closes and writes to peripheral devices such as **storage** attached to the computer
- **Organises** - creates a file system to organise files and directories
- **Security** - provides security through user accounts and passwords
- **Utilities** - provides tools for managing and organising **hardware**

