4.1.1 Processor Components

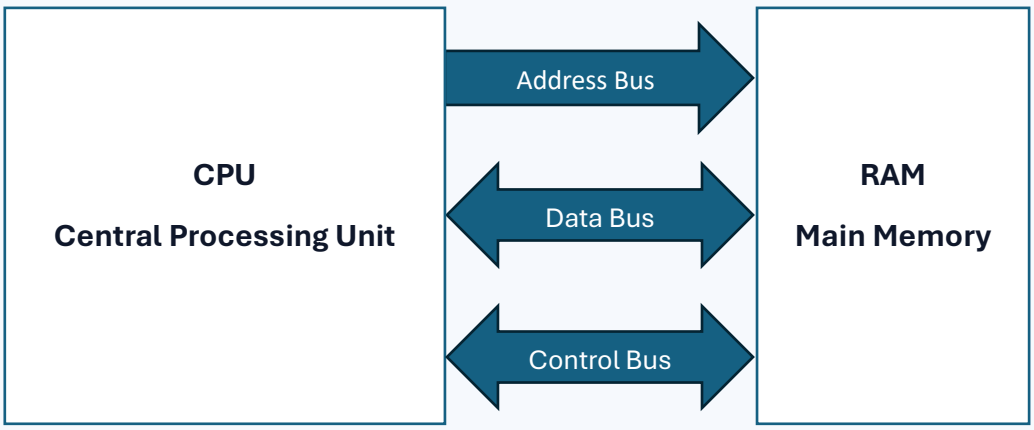
The Processor

The **central processing unit (CPU)**, also known as the processor, has the task of fetching instructions from main memory, decoding the instructions and then carrying out these instructions. This cycle of fetching, decoding and executing is performed over and over as it runs the software programs being used on the computer.

It is made up of a number of different components. These include:

- Control Unit
- System Clock
- Arithmetic Logic Unit
- Buses
- Registers

The CPU is connected to main memory by buses



Main Memory

Random access memory (RAM) makes up the primary part of a computer's main memory.

Programs are stored in secondary storage devices, such as HDD or SSD drives, and loaded into RAM when a program is run.

The processor can then retrieve the instructions and data of the program via the buses during the fetch, decode, execute cycle.

RAM has much faster access than secondary storage drive but has a fraction of the capacity.

It is **volatile memory** meaning that the data on it is wiped when the power to the computer is turned off.

Buses

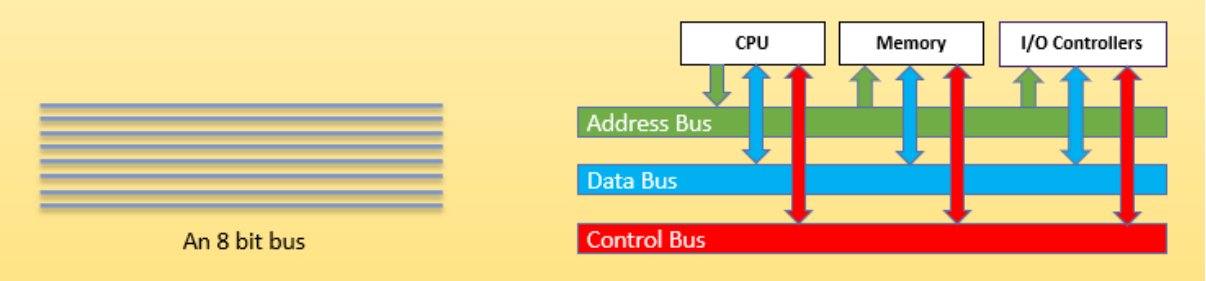
A bus is a **set of parallel wires which connect components of a computer and CPU together.**

They carry instructions, data and control signals between these components.

A bus can be unidirectional (allowing movement of data and signals in one direction) or bidirectional (allowing movement of data and signals in both directions

There are three types of bus:

- **Address Bus** – a unidirectional bus that carries addresses to memory locations in main memory.
- **Data Bus** – a bidirectional bus that carries data around the CPU as well as between the CPU and main memory.
- **Control Bus** – a bidirectional bus that carries control signals from the control unit.



Registers

A register is **a small, temporary memory location in the CPU used for a specific purpose. They have faster access speeds than RAM.**

The size of register varies depending on the processor architecture, but most modern computers are 32 or 64-bit in size.

There are **special-purpose registers**; that have dedicated roles; and **general-purpose registers** that can be used to hold any temporary data.

A 32-bit general-purpose register

R_0 | 01010010111010101010010101011011

Special-purpose registers

Register	Role
Program Counter (PC)	Holds the address of the next instruction to be fetched.
Memory Address Register (MAR)	Holds the address of the instruction or data in main memory that is being read from or written to.
Memory Data Register (MDR)	Holds an instruction or data that has been retrieved from main memory or is to be stored in main memory.
Current Instruction Register (CIR)	Holds the instruction that is to be decoded and executed.
Accumulator (ACC)	Holds the result of calculations performed by the arithmetic logic unit (ALU). May hold inputs and outputs in the Little Man Computer assembly language.

Arithmetic Logic Unit (ALU)

The Arithmetic Logic Unit **performs arithmetic operations (adding, subtraction…) and logical operations (AND, OR…)** on data. It stores the result in the accumulator (ACC) register.

System Clock

A system clock is an electronic circuit that generates regular timing pulses to **synchronise the operations of all components within the CPU**. The clock speed is measured in hertz (Hz) and represents the number of clock cycles per second.

Control Unit

The control unit is the part of the CPU that **manages and coordinates the fetching, decoding and executing of the instructions**.

It is responsible for:

- Decoding instructions in the CIR.
- Sending control signals over the control bus to coordinate the movement of data through the processor.
- Controlling the buses.

The control unit sends:

- a **'memory write'** control signal over the control bus to write data on the data bus into main memory.
- a **'memory read'** control signal over the control bus to retrieve data from main memory by placing the data on the data bus.

I/O Controllers

Input/output controllers (I/O controllers) are devices that act as intermediaries between the processor and peripheral devices such as keyboard, mice and monitors.

As different peripherals operate at different speeds and use different data formats the I/O controllers handle these differences to free up the CPU from being tied up waiting for the devices.