Systems architecture

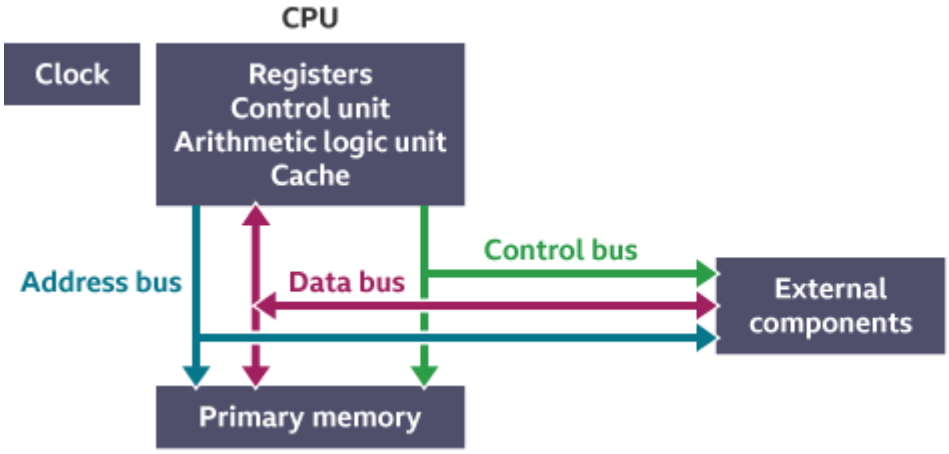
Von Neumann architecture provides the basis for the majority of the computers we use today. The fetch-decode-execute cycle describes how a processor functions.

Common CPU components

The central processing unit (CPU) consists of six main components:

- control unit (CU)
- arithmetic logic unit (ALU)
- registers
- cache
- buses
- clock

All components work together to allow processing and system control.



Control unit

The CU provides several functions:

- it fetches, decodes and executes instructions
- it issues control signals that control hardware
- it moves data around the system

Arithmetic logic unit

The ALU has two main functions:

- It performs arithmetic and logical operations (decisions). The ALU is where calculations are done and where decisions are made.
- It acts as a gateway between primary memory and secondary storage . Data transferred between them passes through the ALU.

The ALU performs calculations and makes logical decisions.

Registers

Registers are small amounts of high-speed memory contained within the CPU. They are used by the processor to store small amounts of data that are needed during processing, such as:

- the address of the next instruction to be executed
- the current instruction being decoded
- the results of calculations

Different processors have different numbers of registers for different purposes, but most have some, or all, of the following:

- program counter
- memory address register (MAR)
- memory data register (MDR)
- current instruction register (CIR)
- accumulator (ACC)

Cache

Cache is a small amount of high-speed random access memory (RAM) built directly within the processor. It is used to temporarily hold data and instructions that the processor is likely to reuse. This allows for faster processing as the processor does not have to wait for the data and instructions to be fetched from the RAM.

Clock

The CPU contains a clock which is used to coordinate all of the computer's components. The clock sends out a regular electrical pulse which synchronises (keeps in time) all the components.

The frequency of the pulses is known as the clock speed. Clock speed is measured in hertz. The higher the frequency, the more instructions can be performed in any given moment of time.

In the 1980s, processors commonly ran at a rate of between 3 megahertz (MHz) to 5 MHz, which is 3 million to 5 million pulses or cycles per second. Today, processors commonly run at a rate of 3 gigahertz (GHz) to 5 GHz, which is 3 billion to 5 billion pulses or cycles per second.

Buses

A bus is a high-speed internal connection. Buses are used to send control signals and data between the processor and other components.

Three types of bus are used:

- Address bus - carries memory addresses from the processor to other components such as primary memory and input/output devices.
- Data bus - carries the actual data between the processor and other components.
- Control bus - carries control signals from the processor to other components. The control bus also carries the clock's pulses.

Factors affecting CPU performance

Even though today's **processors** are tremendously fast, their performance can be affected by a number of factors:

- Clock speed
- Cache size
- Number of cores

Clock speed

Clock speed is the number of pulses the central processing unit's (CPU) **clock** generates per second. It is measured in **hertz**.

CPU clocks can sometimes be sped up slightly by the user. This process is known as overclocking. The more pulses per second, the more **fetch**-**decode**-**execute** cycles that can be performed and the more instructions that are processed in a given space of time. Overclocking can cause long term damage to the CPU as it is working harder and producing more heat.

Cache size

Cache is a small amount of high-speed **random access memory (RAM)** built directly within the processor. It is used to temporarily hold **data** and **instructions** that the processor is likely to reuse.

The bigger its cache, the less time a processor has to wait for instructions to be fetched.

Number of cores

A processing unit within a CPU is known as a core. Each core is capable of fetching, decoding and executing its own instructions.

The more cores a CPU has, the greater the number of instructions it can process in a given space of time. Many modern CPUs are dual (two) or quad (four) core processors. This provides vastly superior processing power.

Processor performance can be affected by clock speed, cache size and the number of cores the processor has.