Von Neumann model

Von Neumann was a mathematician who developed a lot of the early theoretical frameworks used to create modern computers.

The Von Neumann model is the architecture used in most modern computers - in a Von Neumann computer the main memory is used to store both data and instructions separately from the processor, and instructions are fetched, one at a time, from RAM to the processor, where they are translated and then executed. This uses the idea of a ‘stored program’ - i.e. a computer does not have a program ‘built into it’, but rather that we copy a program into memory which it then works its way through, one instruction at a time. This means we gave computers who can do many things - we can load many different programs into them - rather than having devices built on electronics or machinery which can only do the one job they were built to do.

The Fetch-Execute Cycle

A processor works in cycles - performing the same actions over and over again. Each cycle a single instruction is ‘fetched’ from main memory (i.e. a single instruction is copied from RAM into the processor), translated (i.e. the CPU works out what to do with it) and then executed (i.e. the CPU performs the instruction). It then fetches the next instruction, in time with the next time pulse from the clock.

Components of a Processor

The processor is made up of the following three components -
The Memory unit - this stores data within the CPU. Data is stored in registers, or accumulators. This data may be numbers to be processed, or the command that the CPU is going to perform.
The Arithmetic Logic Unit (ALU) - The ALU is the part of the processor that performs arithmetic and logical operations, i.e. it does maths, but also works out decisions (like we find in commands like ‘If x<20 then…’)
The Control Unit - this unit that directs the operations of the CPU. It tells the other components of the CPU how to respond to, and deal with, the instructions that have been sent to the processor.

A **Register** is a small area of data storage found within the processor. Registers have specialist purposes. Access to the data within processors is incredibly fast, because the data is already within the processor itself.

A CPU also contains a **clock**. This clock gives out regular time pulses which are used to synchronise the activity of the processor.

Buses

A bus is a device for transferring data within a computer. It's easiest to think of a bus as a cable, or collection of wires used together, but in fact a bus can mean a variety of different types of hardware. Buses carry data between different components within the computer, e.g. between the processor and the RAM.

There are three buses which connect to the processor -

- **The data bus** - this carries data to and from the processor.
- **The address bus** - this carries the address which data is to be read from, or written to. Unlike the other two buses this is a one-way bus - addresses only ever come *from* the CPU.
- **The control bus** - this carries commands that the CPU sends to other components.

The buses work together to perform a task. For instance, if the processor requires a specific piece of data from within RAM, the control bus will carry the command 'read from RAM' from the CPU, the address bus will carry the address of the data that is needed, and then that piece of data will travel back along the data bus from the RAM to the CPU.