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Inside the CPU

The Importance of the CPU

The **Central Processing Unit** (CPU) is the component on the motherboard of a computer where the processing of data takes place.
This makes the CPU the key part of the computer. Without it nothing could be done.

von Neumann's architecture says that the CPU needs to have:

1. a central control part
2. a central arithmetic part
3. access to memory to store data being processed

This architecture is the basis of the one used by modern General Purpose Computers.

> von Neumann also said computers need input and output devices and access to slow memory storage. These 3 are the elements of his architecture that are inside the CPU.

Inside the CPU

There are five key components inside the CPU.

1. the Control Unit
2. the Arithmetic Logic Unit
3. the Clock
4. a set of Registers
5. the Bus

> CPUs are actually much more complex than this and contain other components. These are the only ones you need to be concerned about.

You need to know a little detail about how each of these work.

1. Control Unit (CU):

The **Control Unit** directs what the CPU does. It carries out instructions in the right order and controls what the other parts of the CPU do. It manages the storage of data.

2. Arithmetic Logic Unit (ALU):

The **ALU** carries out all mathematical and logical operations, as instructed by the Control Unit. Maths is done by adding or subtracting. Logic tests work out whether a statement is True or False and use **Boolean logic** circuits within the ALU.

3. Clock:

The **clock** sends out an **electronic pulse** at regular intervals. Each pulse triggers the CU to carry out the next instruction. This synchronises operations within the CPU by keeping everything working to a regular cycle.
The **speed** of the clock determines how many pulses are sent every second – and, therefore, how many instructions can be processed each second. Modern computers are very fast. The machine I'm writing this on in a 2.6GHz processor. That means that the clock sends 2,600,000,000 pulses per second.

> A faster clock doesn't necessarily equate to a more powerful computer. That depends on other factors.

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4. Registers:

Registers are high-speed memory locations inside the CPU. This is the memory the CPU uses to store data and instructions that it is carrying out right now.

Registers are expensive because they are very high-speed memory. Typically there might be 16 registers in an older CPU (numbered from 0 to 15), while more modern CPUs may have 32 or 64 registers.
The number of registers is limited because of their cost but also because they need to be as close as possible to the processor. If data has to travel a longer distance this will slow down the speeds at which registers can work.

The more registers a CPU has the more pieces of data can be stored in them, so less movement has to occur.

Registers can each store a binary value. Modern registers will usually be capable of storing either 32-bit or 64-bit values.

Newer machines are usually 64-bit machines. This refers to the amount of binary digits able to be stored in one memory location.

The highest value that can be stored in a 32-bit memory location is about 2,147 million (a bit more than 2 billion). The highest number that can be stored in a 64-bit memory location is a bit more than 9 quintillion. That's 9 with 18 noughts after it (or 9,000 billion billion).

5 Bus:

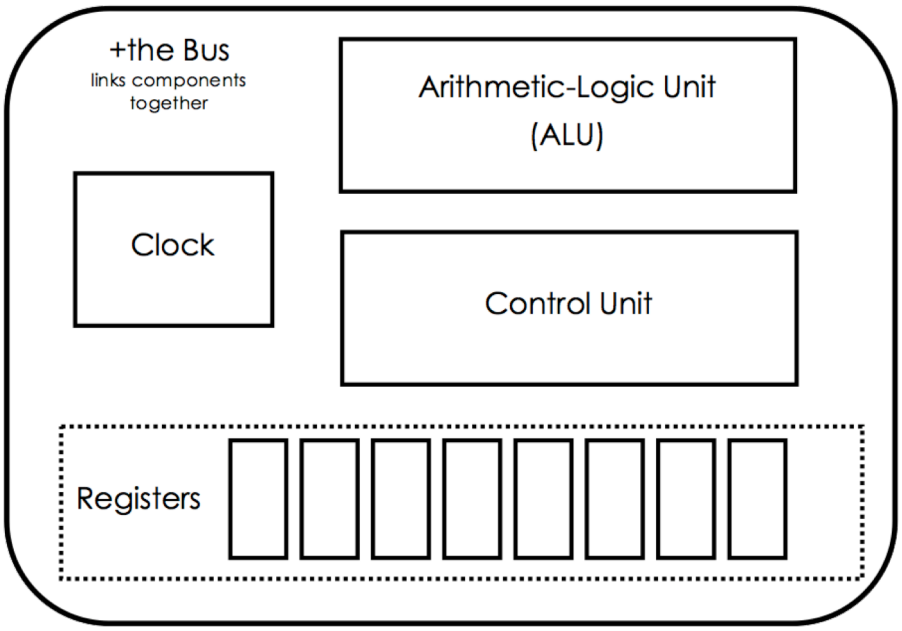
Buses link all of the components of the CPU together. Buses are electronic connections (**wires**) which carry **data and signals** around the CPU as well as from the CPU to other components inside the computer.

Don't forget about Buses. They are one of the key things you need to know about the CPU. Signals include the clock pulse and other instructions.

Buses are specialised – the data bus carries data, the address bus carries memory addresses etc…

Buses can vary in speed. Quicker buses can transfer data more quickly, but are more expensive.

Buses link the components of the CPU together as well as providing links to other parts of the computer system.



You need to know:

1. what the CPU does
2. the 5 key components of the CPU
3. what each of the 5 key components does
4. how the key components relate to the von Neumann architecture