32 – Internal Hardware of a Computer

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The Processor

The processor carries out computation of data by following instructions. They contain millions of transistors that are used to control the flow of electrical pulses that are timed via the computer's clock. In theory a 2GHz processor can carry out 2000 million instructions per second. In reality, it takes multiple clocks to perform a single operation.

Main Memory

Memory is used to store data (working variables) and instructions. It is connected to the processor which will fetch the data and instructions that it needs from memory and decode them. This cycle is called the fetch-execute-decode cycle appropriately.

RAM (random access memory) is temporary storage space that can be accessed quickly. The cells can be accessed as they are needed by the processor, by referencing the address. When a program is run, its contents are loaded into RAM before the processor starts executing its instructions.

ROM is a non-volatile which means that the contents of ROM are not lost when you switch off the computer. The purpose of ROM is to handle the boot process of the computer when it is first switched on.

Buses

Buses are groups of parallel microscopic wires that connect the processor to the various input and output controllers being used by the computer.

The data bus carries data to and from memory and to and from I/O controllers. This means they are bi-directional. The width of the data bus is called the word length and is usually determined by the type of processor. Two common examples are 32bit and 64 bit.

The address bus only goes in one direction – from the processor to memory. It is used to share the memory address of the next instruction or data item. The size of the address bus is determined by the size of addressable memory. E.g. a 8 bit address bus would allow the addressing of 256 different addresses.

The control bus is a bi-directional bus which sends control signals to different components of the computer. For example, it could dictate the direction of the data transmission along the data bus.

Input / Output Controllers

Some examples of I/O *devices* are keyboard, monitor, mouse, etc. Physically, these devices are connected via I/O ports, for example USB and HDMI. The processor does *not* communicate directly with these devices, instead it does so through controllers that consist of their own specialised circuitry. For example, a monitor controller and a hard disk controller. A key feature of an I/O controller is that it can buffer data sent to the I/O device which will usually not be able to process data as fast as the main processor.

Von Neuman and Harvard Architectures (Stored Program Concept)

In the Harvard architecture, there are two data buses connected to the processor, instead of one, because data and instructions are stored separately. The Harvard architecture is faster than the Von Neuman architecture because instructions and can be accessed simultaneously which reduces the bottleneck of a single bus. It also improves security as data cannot be executed as code.