# Computer Hardware – the Motherboard

## Inside the box

Take care opening a computer! It's obvious to make sure it's not attached to the mains, but you can also damage it through static electricity as well..

The components inside a general purpose computer box are **hardware** in the same way that input and output devices are. They are physical components that can be touched and require an electricity supply to function.

## The Motherboard

**Printed circuit boards** have electrical circuits etched on them allowing other components to be attached to the board. This allows electricity to flow around the system.

The key components of a general purpose computer system are either housed on or connected to the **motherboard**. This is a **printed circuit board** which forms the central component of the system.

Components attached to the motherboard will include the **Central Processing Unit** (CPU), memory, hard drives, peripheral ports etc… Basically everything you plug in to a computer ends up being linked to the motherboard.

The key components attached to the motherboard include:

- the CPU
- memory – RAM and ROM
- connectors to link peripheral devices
- graphics cards
- network cards
- hard drives

The architecture, including precisely how the CPU is organised, is known as the von Neumann architecture. We'll move on to how it works exactly next.

These components and the way they interact form the basic **architecture** of all modern general purpose computers. The precise specification may vary between computers, but the overall architecture remains the same.

## 1. The Central Processing Unit (CPU)

Sometimes the CPU is referred to as the "brain" of the computer, but that's not that helpful an analogy.

This is the component where the processing of data takes place. The precise way in which it works is complex, but in simple terms it allows the computer to process data, organise where things are stored and deal with inputs and outputs.

The CPU is an **integrated circuit** chip usually made of very pure **silicon** and which consists of a large number of tiny **transistors**. Electricity flows through the circuit and the transistors control the flow. You can think of the transistors as tiny switches.

The computer I'm typing this on has a 2.6GHz processor. This means it can carry out $2.6 \times 10^9$ instructions per second: 2,600,000,000 instructions

The CPU can carry out many switch commands each second. The number of instructions is the **processor speed**, usually measured in Megahertz or, more commonly now, Gigahertz.

The number of switch commands per second creates lots of heat as waste energy. As a result the CPU gets very hot. Because of this a fan is usually mounted directly above the CPU to cool it.

## 2. Memory

**Dual In-line Memory Module (DIMM)** slots allow the working memory of a computer to be inserted, linking the memory to the motherboard – and so to the CPU. This type of memory is called **RAM (Random Access memory)**. Data isn't stored permanently in RAM, but is stored there when the computer needs to work with it.
Data stored in RAM can be accessed quickly and efficiently by the CPU – much more quickly than if it were stored on a hard drive.

> Each program you have running requires RAM. The more RAM you have the easier it is to run multiple pieces of software at any given time.

The motherboard will also have **ROM (Read Only Memory)** chip(s) attached to it. These store the data required to boot the system on a permanent basis. They aren't used for processing data.

> We'll come back to RAM and ROM later in the unit.

## 3. Peripheral Connectors

The motherboard will have a series of connectors, or ports, attached to it. These allow for input and output devices to be connected to the system – for example, a mouse, keyboard, monitor, speakers etc… Most modern computers have a number of USB connectors which can be used for a variety of roles, including connecting secondary storage devices.

> USB connectors are flexible and can be used for different purposes. USB stands for Universal Serial Bus.

## 4. Peripheral Component Interconnect slots (PCI)

These allow other components, including graphics cards, network interface cards (so enable a LAN connection, Wi-Fi or Bluetooth) and hard drives to be connected to the motherboard. This provides the flexibility to add different components to the same motherboard, depending on the needs of the user.

> Input and output devices can be connected using Bluetooth or Wi-Fi. I'm typing this using a Bluetooth keyboard and trackpad.

**Hard drives** allow data to be stored permanently even when the computer is turned off. Data from the hard drive can be fetched into RAM when it is needed by the CPU.

> By moving data from the hard drive to RAM it can be accessed much more quickly when needed by the CPU.

## 5. Battery

A simple button battery is a key component of a motherboard. This allows systems such as the clock to be kept powered even when the system is turned off.
A buzzer is sometimes included as well. This allows the motherboard to communicate directly, particularly if faults occur. An LED is also often linked to the board.

## 6. Buses

The etched circuits that carry electricity around the motherboard also include links to carry data around the system. These are called **buses**.

> For example, data is carried from memory to the CPU via the system bus.

**Activity:**

a) Label an image of a motherboard to show the key components
b) Annotate your diagram to explain, briefly, what each component does
c) Explain what a bus does