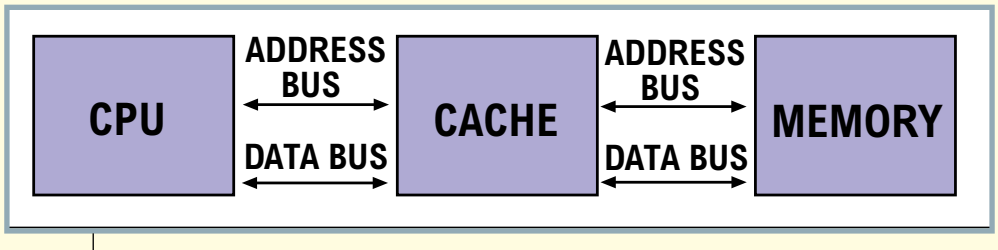
Hardware **basics**

Eleanor Turton-Hill looks under the bonnet to demistify and explain the workings of your PC's engine components.

Judging by some of the emails and letters I've been getting recently, there's still a fair amount of confusion out there when it comes to understanding hardware.

All computers have four basic elements: a processor, memory, storage devices and I/O devices. Understanding the relationship between these four units is an essential starting point if you're trying to get to grips with hardware, so here's an overview.



A "cache hit" occurs when data required by the CPU is found in the cache. Because the cache provides data at high speed, it can dramatically improve the performance of the whole system

CPU

One of the first things you'll hear people talking about is the type of processor in their machine. This is the central processing unit (CPU) and is the single most important component in the machine because it processes data and controls all other parts of the computer.

Even the simplest processor is an extremely complex device. I'm not going to go into great detail here, but it is useful to have an outline of its main functions.

If you take the lid off your computer you will see several flat, black, blocks stuck to a green board. The CPU is the big square one usually marked "Intel" but sometimes "Cyrix" or "AMD".

Essentially, what the processor does is to store, move and manipulate data. It can only do very simple things like move numbers from one place to another or perform very basic mathematical operations, but it does all of these things very fast.

The CPU works by continually retrieving instructions from memory that tell it where to get data, what operations to perform on the data and where to store the results. The particular instructions which the CPU is following at any one time are determined by the program it is running.

If I say that my computer is able to produce reports, what I mean is that it has a program which instructs the CPU to execute a particular group of instructions which create a report. If I say that my computer knows my friend's phone number, what I actually mean is that the number is stored on my PC's hard disk.

Often, the CPU performs several operations on the same data, or it may need to hold the result from one operation, to be used on the next. Such data needs to be stored somewhere close at hand so it is put into address registers and data registers on the CPU itself. This prevents the processor from having to access the memory every time it generates data.

RAM

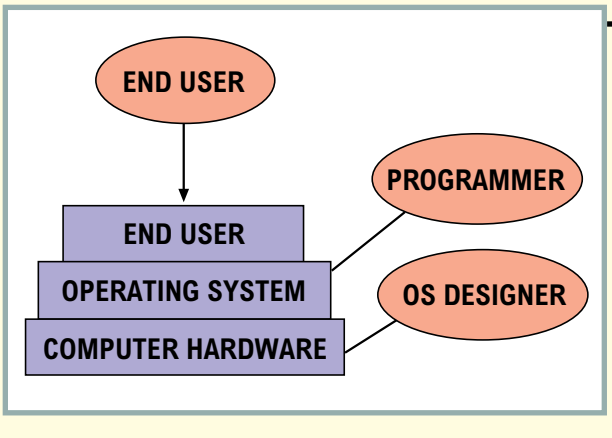
One of the concepts which confuses beginners is that of the location of data. The CPU spends its time fetching instructions and executing them according to what program is running. But where is the data? Is it in the hard disk?… the memory?… the cache? Well, the answer is that data is continually moved around. It's in different places depending on the particular stage of the CPU cycle.

The CPU can perform operations directly on data stored in its own registers, but it can also perform operations on the data in memory and on data stored on disks or tapes. But data on your hard disk or tape must first be brought into memory before the CPU can do anything with it.

RAM stands for Random Access Memory. It's the working memory used by your computer to store instructions and data before they can be committed to the hard disk. Because RAM works much faster than the hard disk, it's used for handling all the data which is in constant use while programs are running. The hard disk is used for dumping any data which the system does not currently need.

Cache

Modern computers have a very large amount of memory compared with the first



The hierarchical view of hardware can be extended to software. The ultimate aim of a computer is to provide a set of applications for the end-user. These applications are developed by the application programmer using a particular operating system (OS). The OS masks the details of the hardware from the programmer and provides the programmer with a convenient interface for using the system

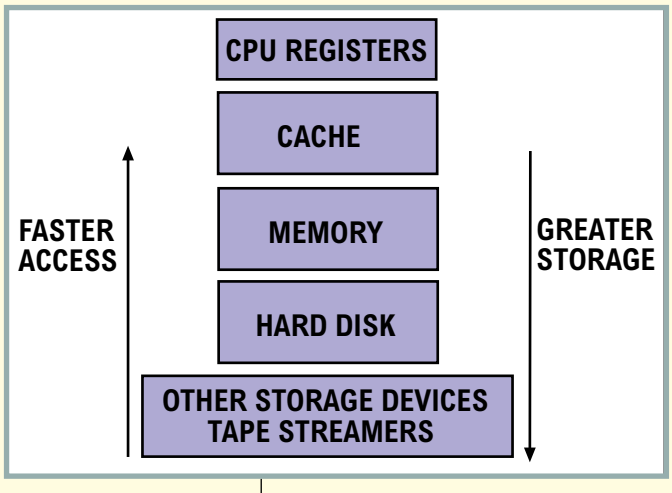
PCs of the early eighties and this has had an effect on the development of the PC's architecture.

Storing and retrieving data from a very large block of memory is more time consuming than from a small block. With a large amount of memory, the difference in time between a register access and a memory access is very great and an extra layer is required in the storage hierarchy.

A device called a cache sits in between the CPU's registers and main memory. This cache is much faster than main memory but slower than the CPU's registers. Its advantage is that it can hold more data than can be held in registers and can work faster than main memory.

When the CPU goes to read data from a certain address in memory for the first time, the cache goes to find it from memory. When it has retrieved the data, it records the address and data in its own fast memory. Eventually, the cache's memory fills up with records of addresses and data that the CPU has requested and when those same pieces of data are requested again, they are taken directly from the cache.

When the requested data happens to be in the cache, a "cache hit" is said to have occurred. Any requests which are made for data which is not already in the cache result in a "cache miss" and one of the records in the cache is then replaced.



In order to perform satisfactorily, the PC uses a hierarchy of memory/ storage technologies. As you go down the hierarchy, the cost per bit decreases. Thus the smaller, more expensive memories are supplemented by the larger, cheaper, slower ones

Hard disk

The hard disk is the part of your system which holds all the programs, documents and data when your PC is switched off.

The longer you have your computer and the more documents you create and the more data you store, the more valuable your hard disk becomes. In fact, hard disks which crack up can put small companies out of business in a flash. Your hard disk is the storage place for all your valuable work.

The programs which you run (i.e. your word processor, graphics package or spreadsheet) are replaceable. When you buy your PC, you'll often get some of this software pre-installed on the hard disk, but you'll also get a set of floppy disks which you can use to re-install it if anything goes wrong. Anything else which you create should be instantly backed up onto a spare floppy disk.

The hard disk inside your PC is made of aluminium alloy covered with a magnetic coating. This makes the disk itself a pretty rigid plate: hence the name "hard" disk. Hard disks are completely sealed inside the disk drive and are not removable like many other media. They also spin very fast and have high recording densities, which means that they must be kept free from dust and any other kind of environmental contamination if they are to be maintained properly.

Thankfully, for the user, most hard disks look pretty much the same and people rarely know much about their internal workings. Hard disks have changed radically over the years, especially in terms of capacity. The smallest hard disks held a tiny 5Mb while these days 8Gb is the maximum hard disk capacity. The average PC bought today has between 500Mb and 1Gb in hard disk storage.

Data is recorded onto the magnetic surface of the hard disk in exactly the same way as it is on floppies or digital tapes. If you've ever defragmented your hard disk, then you probably have some mental image of how the surface of the disk looks. Essentially, the surface of your hard disk is treated as an array of dot positions, each of which can be identified and set to a binary "1" or "0". The position of each array element is not identifiable in an "absolute" sense, and so a scheme of guidance marks helps the recorder find positions on the disk. The need for these guidance markings explains why disks have to be formatted before they can be used.

Hard disk speed

The speed of a hard disk can be measured in lots of different ways, and it is important to know exactly what figures are being quoted when you're shopping for a new one. The performance of your hard disk is very important to the overall speed of the system: a slow hard disk will hinder a fast processor like nothing else in your system can.

As an initial gauge, look for the drive's "average access time". This is the time taken by the drive to locate the right track on which a piece of data is stored, and the specific place on the track where that data is sitting. This time is usually quoted in milliseconds.

As well as "average access time" look out for "transfer rates". The transfer rate is the speed at which the drive can deliver the data from the disk platters to the CPU. This is generally described in megabytes per second.

In order to get an accurate view of a hard drive's performance, the average access time and the transfer rate should be looked at together. Drive makers and dealers have a reputation for bending the truth on such issues and are often found to quote the fast access time of a drive without any mention of the transfer rate. You'll also see this in advertisements. Unfortunately, a high access time coupled with a slow transfer rate produces a slow drive.

Because access time is measured in milliseconds and transfer rate is measured in megabytes per second, the overall drive performance can be difficult to get your head around. Essentially, you're looking for the lowest possible access time and the highest possible transfer rate.

Another measure of hard disk performance of which you should be aware is "seek time", which is conveniently confused (by some) with the access time. Seek time is also measured in milliseconds and defines the amount of time it takes a hard drive's read/write head to find the physical location of a piece of data on the disk. The seek time says absolutely nothing about the speed of a hard drive. The importance of the access time and transfer rate is that they tell you how long a hard drive takes to locate and retrieve data.

PCW Contacts

Eleanor Turton-Hill welcomes feedback and suggestions from readers. She is on **ellie@pcw.ccmail.compuserve.com**