Part 1 | Computer Theory

Contents

Fundamentals of Hardware and Software

Applications and Implications

Introduction to Programming

Chapter 1

The Basic Components of Computers

What is a Computer?

Many people see a computer as a sort of magical grey box that you get from Compaq or IBM which you use to run programs (and the occasional game when your boss or parents aren't watching). However, the formal definition of a computer is somewhat broader. Simply put, a computer is an electronic device that can accept data and instructions, process them or store them for later retrieval, and sometimes generate output (usually based on the processing) (see Figure 1.1). As you would expect, this definition includes more than the PC (personal computer) that you have at home or at school. For example, most new models of cars come with a computer to manage their fuel injection systems.

Advantages of Using Computers

Computers obviously wouldn't be as popular as they are now if they did not offer advantages over doing tasks manually. Some of these advantages are:

- Computers can perform calculations much more quickly and accurately than humans. For example, modern computers can perform hundreds of millions of calculations per second.
- Large amounts of data can be stored in a small amount of space. For example, hundreds of pages worth of text can be stored on a 3½ inch floppy disk.
- Computers can work continuously and perform repetitive tasks well. Unlike their human counterparts, computers do not get bored or tired.

- Computers can simulate things that would take too long, be too dangerous or simply impossible for humans to attempt.

Drawbacks of Using Computers

What? There are disadvantages to using computers? As hard as it is to believe, computers do have their drawbacks. These include:

- The introduction of computers can cause redundancy in the workplace. Employees may lose their jobs if a computer can do a job more efficiently and ultimately more cheaply.
- Computers make it easy for people to misuse information. Computers make it easy to store large amounts of information about people. In some cases this information can be freely and easily accessed and used for purposes for which it was not originally intended.
- Down time happens when a computer breaks down or data becomes corrupted. Businesses often rely so much on technology that when computers fail they have no back-up manual systems and are temporarily rendered helpless as a result.
- The introduction of computer systems in the workplace is expensive. The cost is not only due to the purchasing of the equipment; in some companies, the time it takes to train the staff to use the system causes several thousands of dollars of lost productivity.
- There are health risks associated with excessive or improper use of computers. The glare from the screen
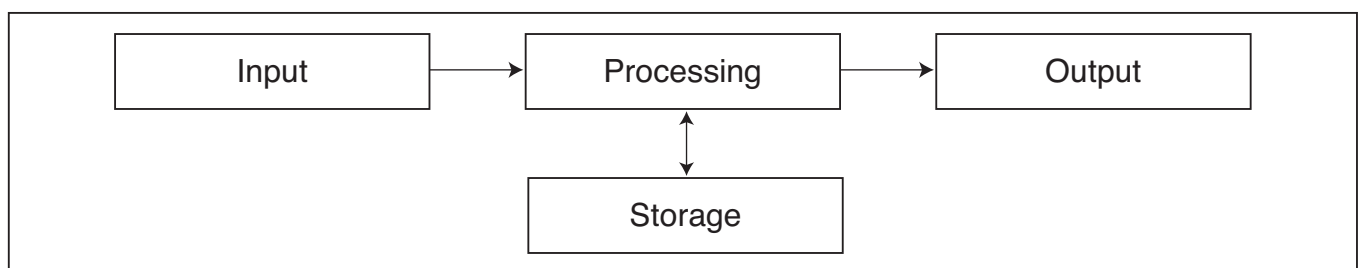

FIGURE 1.1 *A diagram outlining how the typical computer system functions*

can cause eyestrain and inadequate support for the wrists when typing can cause carpel-tunnel syndrome.

However, most people see these disadvantages as minor (especially when compared with the tremendous benefits); hence the popularity of computers today.

Types of Computer

Ask the average person what types of computer he/she knows and the response will probably be, "That's easy! Dell, Gateway, Compaq, IBM ...". However, these are merely *brands* of computers. The types of computer are (roughly in order of size and speed): supercomputers, mainframes, minicomputers and microcomputers.

Supercomputer

Supercomputer is the general term given to the fastest computers in the world. These computers are very large and may take up several rooms. Because of their tremendous processing power, supercomputers are used in fields that require vast amounts of complex mathematical calculations, such as simulation and nuclear research.

Did you know?

The fastest computer in the world is the new IBM ASCI White supercomputer. It can do 12.3 trillion calculations per second, making it over 4000 times faster than the fastest Pentium 4 Processor (at the time of printing). It weighs 106 tons and is the size of two basketball courts.

Mainframe

Like supercomputers, mainframes are very fast large-scale computer systems. Mainframes have a large number of terminals and peripheral devices because they are used simultaneously by hundreds (or even thousands) of persons. As a result, mainframes may be even larger than supercomputers. To meet the demands of the large number of users, they have a large memory and large storage capacity.

Three applications of the use of a mainframe computer are:

- In banks for processing customer accounts
- By utility companies for processing telephone, water and electricity bills
- By airlines for making flight arrangements

What is the difference between a supercomputer and a mainframe?

If mainframes and supercomputers are both very large and fast computers, what is the difference between them? The mainframe divides its processing power among several users and programs at the same time (multiprocessing). A supercomputer, on the other hand, runs very few programs at the same time, so that those programs are run as quickly as possible.

Minicomputer

A minicomputer is a multiprocessing computer system that is smaller and slower than a mainframe. The term "mini" is a bit misleading, though, because minicomputers are still a lot larger than the PCs people have in their homes. Minicomputers support fewer users than mainframes (200 is the limit used in some definitions).

If you are beginning to think that you do not see much of a difference between a mainframe and a mini-computer, don't worry. The distinction between the two is becoming increasingly blurred and is based mainly on the size and number of users.

Two examples of the applications of a minicomputer are:

- In networking, the operations in an automobile sales and service outlet
- In manufacturing, for inventory control, accounts and process control

Microcomputer

"Microcomputer" is a term used to refer to computers that contain a microprocessor. You know this type of computer by its more familiar name – the PC. This is the type of computer that you are most likely to use. As the name suggests, a microprocessor is a very small processor. This is in the form of a silicon chip like the Pentium Processor.

Since they use smaller processors, microprocessors are much smaller than other forms of computers. Note that for this same reason, microprocessors are nowhere near as powerful as other types of computer. Microcomputers come in different types and sizes:

- The desktop, which is the most popular type, is usually supplied with separate units such as the tower, a monitor, keyboard, mouse and external speakers.
- The laptops or notebooks are small portable computers. These machines come with the monitor, keyboard and CPU assembled as a single unit.

FIGURE 1.2 *A notebook computer*

Three examples of the application of a microcomputer are:
- In homes for recreation
- In an office for producing documents and processing data, such as payroll, inventory and billing
- For communication through the use of Internet services

Computer Systems

A computer system is the combination of **hardware** and **software**. The hardware consists of the physical components of the computer, such as the monitor or the keyboard. In other words, the parts of the computer that you can touch are all hardware. "Software" is the term that is used to refer to the programs that run on the hardware. Neither one is much use without the other, since without hardware you would not be able to run software and without software you would just have an expensive piece of equipment that does nothing.

The two main types of software are the operating system and the application programs that run on top of the operating system.

Categories of Computer Hardware

There are four main categories of computer hardware:
1 The Central Processing Unit (CPU)
2 Input devices, which allow data to be entered into the computer
3 Output devices, which are used for outputting ("sending out") data from the computer
4 Storage devices, both primary and backing

The Central Processing Unit (CPU)

As its name suggests, the Central Processing Unit (CPU) is the part of the computer that does the processing. It also controls the transfer of data between memory and the other devices that make up the computer system. The CPU consists of:
- The Control Unit (CU)
- The Arithmetic/Logic Unit (ALU)
- Small, very fast areas of memory. The smallest and fastest memory is in the form of registers. There is also cache, which is larger and slower than the registers but is still much faster than RAM (you do not have to worry too much about these terms)
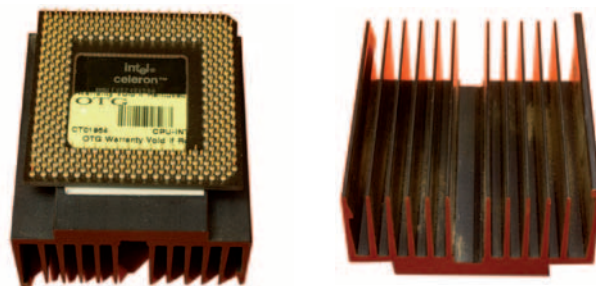

FIGURE 1.3 *The front and back of a CPU chip*

Did you know?

The best-known register is the **accumulator**. It is the place in the CPU where results of calculations are temporarily stored.

The Control Unit (CU)

The Control Unit (CU) is the part of the CPU, which, as you may be able to guess, controls the operations of the CPU. It is used:
- To direct the operation of the internal processor components (components that process the data)
- To control the flow of programs and data in and out of the primary memory (main memory)
- To read and interpret program instructions (instructions that allow the computer to perform various tasks)
- To control the flow of information to and from all the components of the computer, eg input and output devices (I/O devices), disk drives and printers

The Arithmetic/Logic Unit (ALU)

This is the part of the CPU that does the following:
- Performs arithmetic operations. These operations include addition, subtraction, division, multiplication, etc.

4