Computer Basics

Computers manipulate digital data. Every sort of information a computer deals with — text, sound, graphics, to name a few — is represented within the computer as a stream of numbers.

Computers represent these numbers using the binary system. While modern human number systems are based on 10 (we have 10 digits, 0 through 9) computers use a base 2 system. In base 2, there are only 2 digits: 1 and 0. These binary digits are called bits. Everything a computer does involves moving, manipulating, calculating and storing numbers using the base 2 system. While computers may translate these base 2 numbers into other sorts of information that is easier for humans to work with, a computer's only true ability is the manipulation of these base 2 numbers.

Computers are built of a collection of components or subsystems, each performing a different task. Three critical ones are processing, short term storage and long term storage.

Most processing is handled by the computer's CPU, its Central Processing Unit. The CPU can be likened to the engine of the computer. This is where the data (remember, we're talking 1s and 0s here) is manipulated. A CPU can only perform a few basic arithmetic operations, such as adding, subtratacting and shifting groups of numbers around. However, since modern computers can perform billions of these basic operations per second, large and complex tasks can be performed on computers by breaking the tasks down into billions of very simple arithmetical operations, the kind of operation a computer's CPU is designed to do.

The timing of these operations is synchronized by a component of the CPU called the clock. The clock generates a metronome-like signal at regular intervals. The clock speed of modern computers is measured in billions of clock signals per second, (gigahertz, abbreviated GHz).

While the CPU manipulates data, the data also needs to be stored somewhere so that the CPU can access the raw data and store the results of its calculations. Most computer systems have two types of storage: long-term storage and short-term storage.

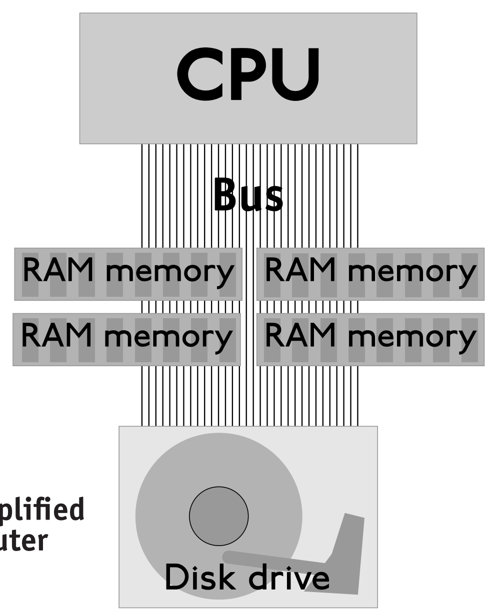
The CPU's ability to deal with billions of basic arithmetical operations per second means it needs to be fed data at a very high rate. The data that supplies the CPU's appetite is held in short-term storage. On most computer systems, this takes the form of Random Access Memory chips, or RAM. The data the CPU needs to access is held in RAM. It is then moved to the processor along a path called a bus (think of a bus as a many-laned highway for binary digits). The CPU makes the necessary calculation on a small number of bits, and the result of the calculation is shuttled along the bus back to the RAM memory, where it is held in storage. The cycle is then repeated.

RAM memory allows for very fast access to data, but it has two inherent disadvantages. One it that it is relatively expensive. A greater disadvantage is that most types of RAM memory can only store data as long as the memory chips are supplied with electrical power. Cut off the electricity, and the data vanishes instantly. These two drawbacks are the reasons we have a second sort of storage, long-term storage.

In most computer systems, long-term storage takes the form of disk drives. Disk storage is much slower than RAM, but it is also much cheaper. More importantly, and unlike RAM, information stored on a disk is preserved when the supply of electricity is shut off. While not fast enough to directly feed the CPU's ravenous appetite for data, disk storage is used to store information not immediately needed by the computer's CPU, and to store all information when electrical power is shut off. While many computers now use SSDs, solid-state disks with no moving parts, an SSD is still much slower than RAM storage.

Computers generally move information from the disk to RAM as the information is needed, shuttling it back and forth between RAM and CPU as the information is manipulated, and finally storing the information back in long-term storage (a hard drive or similar system) when the processed information needs to be saved. The rate at which data can be shuttled from disk to RAM to CPU and back is often a more important factor when gauging the overall speed of a computer then the speed of the CPU alone.

Other components, such as graphics cards, input/output controllers, and network interface cards (NICs) communicate with external devices such as displays and peripherals such as printers.



A simplified computer

Storage Units

Digital systems store information as binary digits. Each binary digit has two possible values: on or off, one or zero. Digital systems reduce all information — text, sound, image, or any other type of data — to a series of binary digits.

A binary digit is called a bit — short for *binary digit*. The bit is the smallest unit of data in any digital system. A single bit on its own is only enough information to store two possible states — for example, whether an element of an image is to be white or black. To allow us to deal with more possible states, bits are linked up in larger units.

The most common of these units is called the byte, which is made up of eight bits. Each byte represents one of 256 possible values, since 2 (states per bit) raised to the 8th power (bits per byte) equals 256.

One byte is frequently used to represent a single character of text. The Latin alphabet of 26 letters (including upper and lower case), numerals, punctuation and special symbols, along with a number of invisible characters called “control codes” comprise about 200 commonly-used characters.

One byte can also be used to store a single element, or pixel, of a grayscale image. Each pixel can be assigned one of 256 possible values, in this case, shades of grey.

To store information such as pieces of text, images, or sounds takes many bytes. 1024 bytes (2 raised to the 10th power) makes up a kilobyte (abbreviated KB, or K). One K is equal to about half a page of typed text (1024 characters, including spaces.) Officially, a kilobyte is 1000 bytes and 1024 bytes is a kibibyte, but this is rarely seen.

When using computers for such things as imaging or animation, a kilobyte is too small a unit to conveniently describe the huge amounts of data required. Larger chunks of data are usually measured in megabytes (abbreviated MB, or meg). A megabyte is equal to 1024 kilobytes. A single, low resolution colour image (about 4x5 inches) would be more than 1 megabyte of data.

Even larger chunks of data are measured in gigabytes (GB, or gig). A gigabyte is equal to 1024 megabytes. A music CD contains two-thirds of a gigabyte of digital data. One gigabyte is the amount of capacity needed to store about 5 minutes of DV video, the type created by most digital video cameras. A terabyte (TB) is equal to 1024 gigabytes. The entire theatrical release print of a Hollywood movie is equal to about one terabyte of image data.

Remember that both short-term memory (RAM) and long-term storage is measured using the same units: bits, bytes, and their multiples.

COMMON STORAGE MEDIA

Optical disks: CD-ROM, DVD, Blu-ray

Based on the same technology as music CDs, ROM stands for Read Only Memory. This means data can be read from the disk, but not written to it, the same as music CDs.

Two related technologies allow data to be written to CD. CD-R (CD-Recordable) allows data to be written to the disk only once. CD-RW (CD-ReWritable) allows disks to be erased and written to repeatedly.

DVDs can store much greater amounts of information — up to 8.5 GB. The newest type of optical disk, Blu-ray, ican store 25-50 GB. Blu-ray disks use similar technology to DVD but pack more information into the same area. Blu-ray drives never became common on computers. Most computer no longer come with optical drives of any type.

Hard drive

Available in a variety of capacities, hard drives are usually fixed — that is, they cannot be removed from the computer in everyday use. Current hard drive capacities range from 500 GB to 10TB.

Portable hard drives can also be mounted in a protective case, and connected to computers via USB, eSATA or Thunderbolt connections.

Solid state storage: SSDs, memory cards and flash drives

Digital cameras, cellphones, digital music players and other small devices often use removable memory cards based on a special type of memory chip called flash memory, which can store information without electrical power.

A large range of incompatible formats of camera memeory cards exist, including Compact Flash and Sony Memory Sticks and SD (Secure Digital) cards.

Flash drives are flash memory chips encased in a protective shell. They are useful for transporting files from one computer to another. Typical sizes are 1-128 GB.

Many laptops now -use a variant of flash memory (called SSD*, or solid state drives*) instead of a hard drive. This saves weight and reduces power consumption, but are much more expensive than regular hard drives.