# Bits and Bytes

A bit is a binary digit, the smallest increment of data on a computer. A bit can hold only one of two values: 0 or 1, corresponding to the electrical values of off or on, respectively.

Because bits are so small, you rarely work with information one bit at a time. Bits are usually assembled into a group of eight to form a byte. A byte contains enough information to store a single ASCII character, like "h".

A kilobyte (KB) is 1,024 bytes, not one thousand bytes as might be expected, because computers use binary (base two) math, instead of a decimal (base ten) system.

Computer storage and memory is often measured in megabytes (MB) and gigabytes (GB). A medium-sized novel contains about 1 MB of information. 1 MB is 1,024 kilobytes, or 1,048,576 (1024x1024) bytes, not one million bytes.

Similarly, one 1 GB is 1,024 MB, or 1,073,741,824 (1024x1024x1024) bytes. A terabyte (TB) is 1,024 GB; 1 TB is about the same amount of information as all of the books in a large library, or roughly 1,610 CDs worth of data. A petabyte (PB) is 1,024 TB. 1 PB of data, if written on DVDs, would create roughly 223,100 DVDs, i.e., a stack about 878 feet tall, or a stack of CDs a mile high. Indiana University is now building storage systems capable of holding petabytes of data. An exabyte (EB) is 1,024 PB. A zettabyte (ZB) is 1,024 EB. Finally, a yottabyte (YB) is 1,024 ZB.

Many hard drive manufacturers use a decimal number system to define amounts of storage space. As a result, 1 MB is defined as one million bytes, 1 GB is defined as one billion bytes, and so on. Since your computer uses a binary system as mentioned above, you may notice a discrepancy between your hard drive's published capacity and the capacity acknowledged by your computer. For example, a hard drive that is said to contain 10 GB of storage space using a decimal system is actually capable of storing 10,000,000,000 bytes. However, in a binary system, 10 GB is 10,737,418,240 bytes. As a result, instead of acknowledging 10 GB, your computer will acknowledge 9.31 GB. This is not a malfunction but a matter of different definitions.

**We count in base 10 by powers of 10:**

$10^1 = 10$

$10^2 = 10*10 = 100$

$10^3 = 10*10*10 = 1{,}000$

$10^6 = 1{,}000{,}000$

**Computers count by base 2:**

$2^1 = 2$

$2^2 = 2*2 = 4$

$2^3 = 2*2*2 = 8$

$2^{10} = 1{,}024$

$2^{20} = 1{,}048{,}576$

So in computer jargon, the following units are used:

| Unit | Equivalent |
|---|---|
| 1 kilobyte (KB) | 1,024 bytes |
| 1 megabyte (MB) | 1,048,576 bytes |
| 1 gigabyte (GB) | 1,073,741,824 bytes |
| 1 terabyte (TB) | 1,099,511,627,776 bytes |
| 1 petabyte (PB) | 1,125,899,906,842,624 bytes |

**Note:** The names and abbreviations for numbers of bytes are easily confused with the notations for bits. The abbreviations for numbers of bits use a lower-case "b" instead of an upper-case "B". Since one byte is made up of eight bits, this difference can be significant. For example, if a broadband Internet connection is advertised with a download speed of 3.0 M**b**ps, its speed is 3.0 mega**bits** per second, or 0.375 mega**bytes** per second (which would be

abbreviated as 0.375 M**B**ps). Bits and bit rates (bits over time, as in bits per second [bps]) are most commonly used to describe connection speeds, so pay particular attention when comparing Internet connection providers and services.