

AP COMPUTER SCIENCE A – STORAGE TERMINOLOGY

Bits.

1 bit \equiv the smallest storage location (with 2 possible values, *i.e.*, 0 or 1)

Bytes.

1 byte \equiv 8 bits = 2^3 bits

A byte has values 0 through $11111111_2 = 255_{10}$ (inclusive), or $2^8 = 256$ possible values.

Example #1.

In Java, an `int` consists of four bytes, which has $256^4 = (2^8)^4 = 2^{32}$ possible values. Recall that `Integer.MIN_VALUE` = -2^{31} and that `Integer.MAX_VALUE` = $2^{31} - 1$, which corresponds to the

$$|-2^{31}| + 1 + |2^{31} - 1| = 2^{31} + 1 + 2^{31} - 1 = 2^{32}$$

(negative values) (zero) (positive values)

possible values.

Storage Units.

Prefix	Abbreviation	Physics (base 10)	Computer Science (base 2)
kilo	k	$1000 = 10^3$	$1024 = 2^{10}$
mega	M	10^6	$1024^2 = 2^{20}$
giga	G	10^9	$1024^3 = 2^{30}$
tetra	T	10^{12}	$1024^4 = 2^{40}$

Example #2.

a) A tetra-byte (or Tbyte) consists of 2^{40} bytes = $8 \cdot 2^{40}$ bits = 2^{43} bits $\approx 8.8 \times 10^{12}$ bits.

b) A tetra-byte of storage has $(256)^{2^{40}} \approx 10^{2,600,000,000,000}$ different values, *i.e.*, distinct configurations.

CLASS WORK

- 1) Look up the values of `Long.MIN_VALUE` and `Long.MAX_VALUE` in the Java documentation. In Java, how many bytes does a long occupy?

$$\begin{array}{c} \nearrow -2^{63} \qquad \nearrow 2^{63} - 1 \\ | -2^{63} | + 1 + | 2^{63} - 1 | = 2^{63} + 1 + 2^{63} - 1 = 2^{64} = 256^8 \Rightarrow 8 \text{ bytes} \end{array}$$

neg zero pos

$(256^8 = (2^8)^8 = 2^{64})$

- 2) A 1080p television screen consists of a $1,920 \times 1,200$ array of pixels. Each pixel of the television's image requires 4 bytes, *i.e.*, an `int`, of storage (in the alpha-red-green-blue system of colors)*. How many mega-bytes of storage are required to represent the television's image?

$$\frac{(1920)(1200)(4)}{1024^2} = 8.79 \text{ Mbytes}$$

* In the alpha-red-green-blue system, a pixel's color is represented by the hexadecimal number `0xaaarrggbb`. We have talked about `rrggbb` before. In any case, `aa = 00` corresponds to transparent, and `aa = ff` corresponds to opaque.