CSARCH Lecture Series: 2^x vs 10^y Ambiguity

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Overview

Reflect on the following question:

- Is 1 kbyte = 1000 (10^3) bytes or 1024 (2^{10}) bytes?

Overview

- This sub-module discusses the prefix ambiguity between 2^x and 10^y
- The objective is as follows:
  - ✓Describe the prefix ambiguity between 2^x and 10^y

2^x vs 10^y ambiguity

- 2^{10} bytes= 1024 bytes = 1 kibibyte (KiB)
- 10^3 bytes= 1000 bytes = 1 kilobyte (KB)

- How many bytes is 1 Kbyte?
- 1Kbyte may mean 1 kilobyte
- Is it 1024 bytes or 1000 bytes?
- The prefix *kilo* means 1000 in SI definition and this causes some confusion and conflict
- In 1998, International Electrotechnical Commission (IEC) established the binary prefix *kibi* (KiB) to mean 1024 and to differentiate it from *kilo*

2^x vs 10^y ambiguity

- Larger unit of binary prefixes are available as shown below:

Decimal term	Abbreviation	Value	Binary term	Abbreviation	Value	% Larger
kilobyte	KB	10^3	kibibyte	KiB	2^{10}	2%
megabyte	MB	10^6	mebibyte	MiB	2^{20}	5%
gigabyte	GB	10^9	gibibyte	GiB	2^{30}	7%
terabyte	TB	10^{12}	tebibyte	TiB	2^{40}	10%
petabyte	PB	10^{15}	pebibyte	PiB	2^{50}	13%
exabyte	EB	10^{18}	exbibyte	EiB	2^{60}	15%
zettabyte	ZB	10^{21}	zebibyte	ZiB	2^{70}	18%
yottabyte	YB	10^{24}	yobibyte	YiB	2^{80}	21%

Value	Value
2^{10}	1 024
2^{20}	1 048 576
2^{30}	1 073 741 824
2^{40}	1 099 511 627 776
2^{50}	1 125 899 906 842 624
2^{60}	1 152 921 504 606 846 976

- Binary prefix has a larger value than SI prefix

2^x vs 10^y ambiguity

- Binary prefixes (i.e., 2^x) are mainly use in memory capacity
- SI prefixes (i.e., 10^y) are usually use in data transfer rate or storage space
- This means 4GiB ($4*2^{30}$ or 2^{32} bytes) of main memory storage, 4TB ($4*10^{12}$ bytes) of hard disk and network speed of 100Mbps (10^8 or 100,000,000 bits per second)
- Both binary and SI prefixes are not limited to byte only, it can be used for other binary data organization (e.g., Kibibit (Kib), Megabit (4Mb))

2^x vs 10^y ambiguity

- So, how many bytes is 1 Kbyte?
- Answer: the term “kbyte” itself is non-existence or ambiguous. But, to put in “real-life” sense, if it is used to reference memory capacity, it means kibibyte (KiB). If it is used in reference to hard disk storage capacity, it means 1 kilobyte (KB)

Try

- If the laptop specification states that it has 8GB of memory.
  - [True of False] It has 8,000,000,000 bytes of memory.

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  - [True of False] It has 8,000,000,000 bytes of memory.

False. Even though GB means 10^9. But, the context is memory capacity, therefore “GB” is interpreted as GiB. Thus, it has $8*2^{30}$ or 8,589,934,592 bytes of memory

To recall…

- What we have learned:
  - ✓Describe the prefix ambiguity between 2^x and 10^y