Updated SI prefixes extension: ronto(r), quecto(q), ronna(R), quetta(Q)

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Abstract

The General Conference on Weights and Measures (CGPM), at its 27th meeting, has introduced new prefixes to SI-units in resolution 3 to cover the very large and tiny measurable units that can be stated on a human size with the aid of SI prefixes (pfxs) while still using SI units. Here are the reasons for the widening of the existing domain of SI prefixes, also suggesting the names and symbols for the multipliers ronna (R, 10^{27}), ronto (r, 10^{-27}), quetta (Q, 10^{30}) and quecto (q, 10^{-30}). It is suggested that there are only potential advantages to broadening the scope of SI prefixes. The new prefixes won't confuse or harm anyone; instead, they will become widely used and familiar among people who require them. However, individuals who don't use them won't ever get familiar with them.

Keywords: **CGPM, SI prefixes, SI units, metrology, ronna, ronto, quetta, quecto**.

1 Introduction

The metric system of measurement (SI) as it is currently known was founded on the SI prefixes, along using SI-derived units and the SI base units [1, 2]. Utilization of the units, and equations connecting different quantities' numerical values have the exact equations between the quantities themselves have the same form because the SI's base and derived units make up a coherent set. When reporting measurement data, a quantity's value, Q, is represented as a number's product,[3] and a unit, "[Q]" so, $Q = \{Q\}[Q]$. The SI prefixes (SI pfxs) enable the consistency of the decimal multiples (DM) and submultiples of the SI units (SI-u). They are useful for elucidating the accounts of quantities that are significantly greater or smaller than the SI-u when the numeral account stated is (between 0.1 and 1000, and ideally between 1 and 100). This produces it simple to conceptualize, convey, and evaluate measurement data between time, between places, and across many technical disciplines. This article explores these variations and looks into the factors that have influenced the historical acceptance of new SI prefixes. It then considers whether these and other conditions ought to prompt new SI prefixes (SI pfx) that are being introduced soon. The review also speculates on possible names and symbols for the potential future (pfxs). As far as the author is aware, there are no current, substantial studies that examine the kind of (SI pfxs) or offer a justification for extending the domain of (pfxs) that are currently accessible through the literature.

2 Historical narration

The dissemination of SI prefixes was unequal during the rare period between 1964 saw the 12th CGPM and 1975 saw the 15th CGPM. The domain of (SI pfxs) for the submultiples(subm.) 10^{-15} is asymmetric (there was an asymmetry before the SI was formally created between 1904 and 1935 when myria, for 10^{4}, was implemented, but only the (subm.) range went as far as milli, for 10^{-3}): femto (f), and 10^{-18}: atto had to be expanded in 1964 because of the need to measure time intervals and the diminutive size found in nuclear physics important to stable atomic phenomena with greater precision (a). However, the range of multiples has not seen a similar enlargement. Following this expansion, the Consultative Committee for Units of the International Committee for Weights and Measures (CIPM) [The Commission for the System of Units, which the CIPM had established in 1954, was replaced by the CCU in 1964] started thinking about extending to larger multiples and even talking about reintroducing compound, or double, prefixes to accomplish so. The CCU grudgingly recognised that the magnitudes then connected with menstruating the frequency domain of electromagnetic radiation needed to be addressed, global energy consumption, and radioactivity when expressed in becquerels in 1974, resurrecting an earlier proposal at the CCU in 1971 to increase the number of (pfxs) available using multiples 1015: peta (P); and 1018: exa(E). This was approved during the 1975's 15th CGPM. During the 1976 CCU meeting's ongoing prefix discussion, suggestions for whole new designations for articulating powers of 10 without use any SI prefixes were made. The CCU had previously started discussing what names and symbols could be needed for further expansion of the range of (SI pfxs) in 1974. These recommendations were discussed, but at the time there was no desire for more change. The CCU didn't have a serious discussion about increasing the domain of SI pfxs to between 1024 and 10-24 until 1990. The Avogadro constant's size and the requirement to describe molecular quantities in SI units with magnitudes more appropriate for molar quantities were at the time the key justifications for increasing the (subm.) direction's range. Due to improvements in analytical chemistry and spectroscopic techniques, it was now possible to detect minuscule portions of an attomole (the smallest amount that could be defined using the then-current SI prefixes), notably for macromolecules. A proposal to increase the range to between 1024 and 10-24 using the following notations: for 1021: zetta (Z); for 1021: zepto (z); for 1024: yotta (Y); and for 10-24: yocto (y). The 19th CGPM decided to adopt this in 1991. According to the CCU meeting in 1995, the use of the jansky (10-26 W m-2 Hz -1) in radio astronomy demonstrated the need for (SI pfxs) for 10-27 and 10-30. The fact that this CCU conference also gave rise to the suggestion that the (SI pfxs) should only be used to designate powers of ten and not powers of two. For usage in information technology, the International Electrotechnical Commission (IEC) was asked to suggest names and symbols for prefixes designating powers of two. These were published in 1999 and represent kilobinary through exabinary using the letters kibi (Ki) through exbi (Ei) (for 210 up to 260)[4]. By 2005, the whole spectrum of (SI pfxs) with binary analogues was covered by these IEC binary prefixes, up to yobi (Yi) for 280, which stands for yotta binary (albeit obviously only for multiples, not submultiples).

3 Conditions for adding new (SI pfxs)

The main advantage of (SI pfxs) is the simplification and unification of phrases for numerical values connected with measurement results that would otherwise be awkwardly large or small. As research and technology in numerous fields have progressed, the scale of measurement results under consideration has met or exceeded the SI pfxs available for expressing results. In certain cases, this has led to the creation of non-SI units unique to particular technological specialties as a means of producing succinct naming conventions for expressing results. This has the effect of making cross-disciplinary technical communication difficult and inaccurate. Expanding the list of SI prefixes has historically been the solution to reactivate coherent communication using SI units throughout all scientific disciplines.The fact that non-SI units are still widely used casts doubt on the efficacy of this solution; the lesson to be learned from this is to prepare enough SI prefixes in advance of any eventual necessity. Because some technological sectors continue to employ non-SI units, retrospective solutions are rarely used. It is vital to define what should be considered before deciding whether to introduce additional SI pfxs in order to ensure that the metrology community is adequately prepared for the future. These factors must be based on the anticipated and existing needs for practical measurement in the near future, taken in its broadest sense. However, unless the numbers involved are the subject of routine, continuous actual mensuration and inter-disciplinary relationship, it should not just represent hypothetical extremes of magnitude. It appears that no conventional scientific group is actively pursuing an expansion of the SI pfxs system due to any expected or actual future demand for increased measurement ranges. However, it is still possible to promote the use of the SI and decrease the usage of non-SI units by adding new SI pfxs to cover current mensuration domains, such as in particle physics and astronomy. But it is clear that it will be extremely hard to end using non-SI units for an extended period of time in specialised sectors. Consideration must be given to the pull of technology for new SI prefixes as well as the push of rumours regarding unapproved prefixes promoted by the public and popular scientific media. This is frequently accompanied with suggestions for names for an expanded list of SI prefixes, varied in seriousness. Unofficial name suggestions should be given more consideration when they are adopted widely due to a new necessity

Information technology is the key field where this is becoming an issue, particularly when characterising the volume of digital data. Figure1. illustrates how the range of pfxs used within the Metre Convention have changed over time from 1875.Additionally, in this context, the prefixes SI are frequently used with "units" such the bit (symbol: bit), the byte (B), and the octet (o). Despite the fact that ISO/IEC 80000-13:2008[4] standardises their use, these "units" are not SI. According to a reliable prediction, the "global data sphere" [5] will rise at a rate of 30 zettabytes per year in 2018, 140 zettabytes per year in 2025, and an ever-increasing rate after that. Thus, it is conceivable that by the early 2030s, the size of the entire global data sphere will have surpassed one yottabyte. It is highly likely that information technologists will need Given this rate of expansion and the necessity to consider data sizes bigger than what is currently required, particularly with the emergence of disruptive technologies like quantum computing, it will soon be necessary to debate data sizes of 10^{27} and 10^{30} bytes. That "brontobyte" is a result is not surprising.[6] and "geopbyte" have started to appear in the media more frequently. Whether data "measurement" is actually a counting problem with unique unit names that can be solved with SI pfxs is an interesting question to investigate. However, these units are not an aspect of the SI. The SI pfxs only apply to powers of 10, and Powers of two should not be represented by them, according to a comment in the margins of the 8th SI Brochure (for instance, one kilobit corresponds to 1000 bits, not 1024 bits). Instead, you should use the prefixes for binary powers that the IEC has recommended. Similar, minor notes advocating zebi, Zi, and yobi, Yi for 2^{70} and 2^{80}, respectively, may be found in the present form of the 9th SI Brochure[7].The IEC created and formalised binary prefixes , which were then included in IEC 60027-2:2005, which has now been replaced by ISO/IEC 80000-13:2008, in order to avoid encouraging the usage of the SI pfxs with data size. Since the "bit" and "byte" were mathematical constructs rather than actual physical units, there was also doubt as to whether the SI pfxs were suitable for usage in these circumstances. Whether or not this reasoning is accepted, it is evident that prefixes are frequently used with the terms "bit" and "byte," even though these terms are typically not used to indicate precise measurements but rather approximations of data amounts.

3.1 Principles of nomenclature and symbols for SI-unit pfxs

At one time, a variety of sources have been used to create the names(ns) and symbols(sym.) for SI pfxs [8]. The (ns) and (sym.) for new SI pfxs have generated a lot of media interest. This is understandable, but the choice regarding whether to broaden the spectrum should be given the utmost consideration. Even if it initially looks crucial, the choosing of names is ultimately not as important. Those who utilise the new prefixes will eventually grow accustomed to and familiar with them. The initial letter of the name and the symbol selection are more crucial to get correctly because they shouldn't conflict with current usage. According to a review of the symbols now in use for SI pfxs, SI-u, regularly used non-SI u, there are just two characters in the English alphabet that are currently available for use: [r] and [q]. The use of these in reverse alphabetical order corresponds to the practise at the time the SI pfxs domain was latter increased in 1991. The request for ubiquitous data transfer, machine readability, and digital reproduction precluded the use of characters other than those found in the English alphabet. There have been many various methods of generating prefix names in the past. More recently, to create the prefix multiplier, these have (in the distant past) relied on raising 1000 by employing the Latin and Greek numerals. To generate a word that flows well with unit (ns) when documentary and talking and has no unintended implications in other languages, the final letter is altered to a "a" for multiples or a "o" for (subm.). The initial letter of these words is then correctly changed to fit the prefix sign. The author suggested the names 10^{27}, 10^{-27} for ronna [R], ronto [r], quetta [Q] for 10^{30}, and quecto[q] for 10^{-30}, loosely based on the Greek for nine, ennea (for $(10^3)^9$) and the Greek and Latin for ten, deka and decem (for $(10^3)^{10}$) [q]. The author's suggestions were reviewed in the scientific literature[6]and at the CCU in 2019 and 2021[9], where they received widespread support. The idea was acknowledged as a balanced addendum to the SI that was helpful but whose usage was not required. As a result, nothing would be lost and no harm or confusion would result even if the modern SI pfxs were not excessively utilised[10]. As a result, the 27th CGPM in 2022 voted to increase the number of SI pfxs that were accessible.

3.1.1 CGPM meeting in 2022 and promotion

The extension suggestions received widespread support after being discussed at the CCU in 2019 and 2021 [11, 12] and in the scientific press[6]. Additionally, it was acknowledged that the suggestion was a neural addendum to the SI, one that was helpful but whose usage was not required. As a result, nothing would be lost and no harm or confusion would result even if the new SI pfxs were not broadly utilised [10]. As a result, the 27th CGPM in 2022 voted to increase the number of SI pfxs that were accessible, as stated in table1. The implementation in the SI Brochure, communication, and promotion are successful. There should be an update to IEC 80000-13(Quantities and units) due to the increased domain of SI-unit pfxs up to 1030.NIS has many recognized laboratories which have published a number of cmc in field of length, electricity, mass and pressure. All of aforementioned laboratories have SI pfxs , where they can calibrate devices working within nanoscales and Pico scales with uncertainties very small. So, according to technology development they will use the new extended SI pfxs in their work.

Table 1: *SI*-unit *pfxs with their symbols.*

Factor	**Prefix**	**Factor**	**Prefix**
10^{1}	deca “da”	10^{-1}	deci “d”
10^{2}	hector “h”	10^{-1}	centi “c”
10^{3}	kilo “kilo”	10^{-3}	milli “m”
10^{6}	mega “M”	10^{-6}	micro “µ”
10^{9}	giga “G”	10^{-9}	nano ”n”
10^{12}	tera “T”	10^{-12}	pico ”p”
10^{15}	peta “P”	10^{-15}	femto ”f ”
10^{18}	exa “E”	10^{-18}	atto “a”
10^{21}	zetta “Z”	10^{-21}	zepto “z”
10^{24}	yotta “Y”	10^{-24}	yocto “y”
10^{27}	**ronna “R”**	**10^{-27}**	**ronto “ r”**
10^{30}	**quecca “Q”**	**10^{-30}**	**quecto “q”**

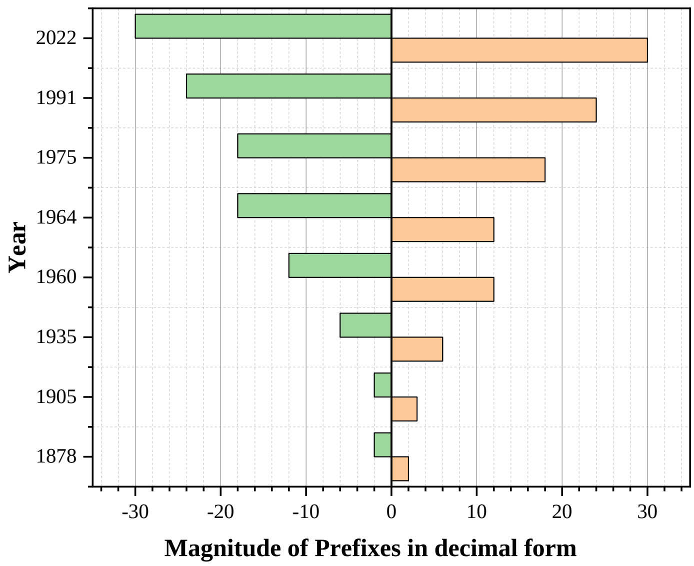

Figure 1: The changes in prefixes used within the Metre Convention since 1875 across time[1]

4 Conclusions

Prefixes in SI are still quite helpful. They provide the simple and straightforward expression of extremely high and extremely low numerical values related to measurement results without needing more intricate scientific notation. Currently, the information technology industry, particularly "units" for defining grilled datum and data size, is the main source of pressure for new SI pfxs. The availability of more SI pfxs may be increased by considering their primary drivers. The expansion of science and technology to include larger scales of a certain quantity is a desire to expand the usage of SI-u among scientific societies that currently employ non-SI units since the current SI pfxs do not cover their desired numeral domain. To prevent the de facto adoption of unofficial names for prefixes by preventing their widespread use.

5 Declarations

5.1 Competing Interests

The authors declare that there is no any potential conflict of interest exist in this article.

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