Extending the available range of SI prefixes

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The use of SI prefixes allows very large and very small numerical values to be expressed on an accessible 'human scale' whilst continuing to employ SI units. This paper sets out the rationale for extending the current range of SI prefixes, and proposes names and symbols for the multipliers 10^{30}, 10^{27}, 10^{-27} and 10^{-30}. More detail is given in [1].

Three main drivers may be considered for extending the range of SI prefixes:

- the advancement of science and technology requiring measurement across an expanded range of orders of magnitude for particular quantities;
- a desire to increase the use of SI units within scientific communities currently using non-SI units because the current range of SI prefixes does not meet their requirements;
- to ensure unofficial names for prefixes do not become used so widely that they become *de facto* adopted.

The main pressure for new SI prefixes comes currently from outside the SI, from information technology and data storage; in particular from 'units' for describing digital information and data size, such as 'bit', 'byte' and 'octet'. This discipline makes extensive use of the decimal SI prefixes, much more so than the binary IEC prefixes originally intended for expressing data size (kibi, mebi, gibi etc). Given the accelerating growth of data production rates and data storage requirements this field will soon require prefixes to cover orders of magnitude in excess of yottabytes. The popular scientific literature is already speculating on what these might be. This is a powerful combination of the first and third drivers listed above. Whilst there is no similar driver for an extension of SI prefix sub-multiples it would be foolish and unbalanced to only extend the range at one end.

If the need to an expansion of the range of SI prefixes is agreed, some general principles for identifying the names and symbols of new SI prefixes may be considered:

1. The names should be simple and, if possible, meaningful and memorable.
2. The names should have some connection to the powers of 10^3 that they represent.
3. The names should be based on either Latin or Greek as the most used languages previously.
4. Multiples should end '-a' and sub-multiples should end '-o'.
5. The symbols used should be the same letter for a given power of ten, in upper case for multiples and in lower case for sub-multiples.
6. Letters already in use for SI prefixes, SI units, other common units, or symbols that may otherwise cause confusion, should be avoided.
7. Following the precedent set recently, letters should be used in reverse English alphabetical order, suitably modifying chosen names, and skipping letters as appropriate.

The letters ‘x’, ‘w’, ‘v’, ‘u’, ‘t’ and ‘s’ are rejected for one or more of the reasons given above in point 6. ‘The letters ‘r’ and ‘q’ are almost entirely unused as unit symbols. ‘R’ is used for, röntgen, an historical non-SI unit of exposure to X- and γ-rays, but this is nowadays rarely employed. This leads to the suggestions in Table 1 for new SI prefix names and symbols to expand the available range by six orders of magnitude in each direction.

Submultiple	**Name**	**Symbol**	**Etymology**
10^{-27}	ronto	r	Greek & Latin, derived from ‘ennea’ and ‘novem’, suggesting 9 (ninth power of 10^3)
10^{-30}	quecto	q	Latin, derived from ‘decem’, suggesting 10 (tenth power of 10^3)

Multiple	**Name**	**Symbol**	**Etymology**
10^{27}	ronna	R	Greek & Latin, derived from ‘ennea’ and ‘novem’, suggesting 9 (ninth power of 10^3)
10^{30}	quecca	Q	Latin, derived from ‘decem’, suggesting 10 (tenth power of 10^3)

Table 1. Suggested names, symbols and derivations of SI prefixes for 10^{-27}, 10^{-30}, 10^{27} and 10^{30}.

It is worth reflecting that the choice of names and symbols for additional prefixes is not that important, although it seems important when proposals are made. For those who need the new prefixes they would be a welcome extension of the SI and become well used and familiar. For those who never use them they will never become well known. Nonetheless, there seem few drawbacks to expanding the range of SI prefixes. The implications of partial adoption of an addition to the SI where usage is optional are not problematic. There is no requirement for the current set of SI prefixes to be used in any given context: scientific notation and SI prefix notation are interchangeable and can coexist happily. Contrast this with the serious difficulties that would result from partial adoption of a change to the SI where usage is obligatory. A recent example would be proposals to adopt radian as an SI base unit. Angle must be present in the SI either with, or without, its own unique dimension: the two states cannot coexist.

Were it to be decided that the SI prefix range needed extending still further, few letters in the English alphabet remain free to be used: probably only ‘b’, yielding ‘bundecca’ and ‘bundecto’ for 10^{33} and 10^{-33}, respectively. If other character sets are excluded, since they are often not suitable for machine readability (for instance ‘u’ is used instead of ‘μ’ in most units of measurement ontologies), then it would be necessary to revisit the use of compound prefixes to find a solution. More detail is given in [2].

[1] Brown R J C, On the nature of SI prefixes and the requirements for extending the available range, *Measurement*, 2019, **137**, 339–343.
[2] Brown R J C, Considerations on compound SI prefixes, *Measurement*, 2019, **140**, 237–239.