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9. Discussion on the SI in the digital world

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SI in the digital world

- The SI is a result of cultural, political and historical compromises
- It is a practical system used by humans able to interpret context
- The corollary is that the SI is not systematic, unambiguous or rigorous
- These qualities are needed by computer science for easy parsing and interpretation

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Quantities, units and computing

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ABSTRACT

Quantities and units are concepts central to our measurement and manipulation of the physical world, but their representation in information systems is barely codified and often ignored. The lack of formalization of metrological concepts, operations, symbols and characters has resulted in multiple reinvention (or more dangerously, omission) of these entities in informatics systems. At best, this creates ambiguity and inconvenience; at worst, the potential for an engineering disaster. The computer representation of quantities and SI units is reviewed at these four levels. Three implementations (languages, calculators and sensor data transfer) supporting units of measure are examined. Some suggestions for a hierarchy of metrological-informatics standards are given.

Contents

Abbreviations: BIPM, International Bureau for Weights and Measures; CIPM, International Committee on Weights and Measures; GUM, Guide to the expression of uncertainty in measurement; IEEE, Institute of Electrical and Electronics Engineers; ISO, International Organization for Standardization; ISQ, International System of Quantities; SI8, 8th edition of the SI Brochure; VIM3, International vocabulary of measurement, 3rd edition.

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Issues of semantics:

- Description of quantities of objects, formalisation of metrology concepts

Issues of definition:

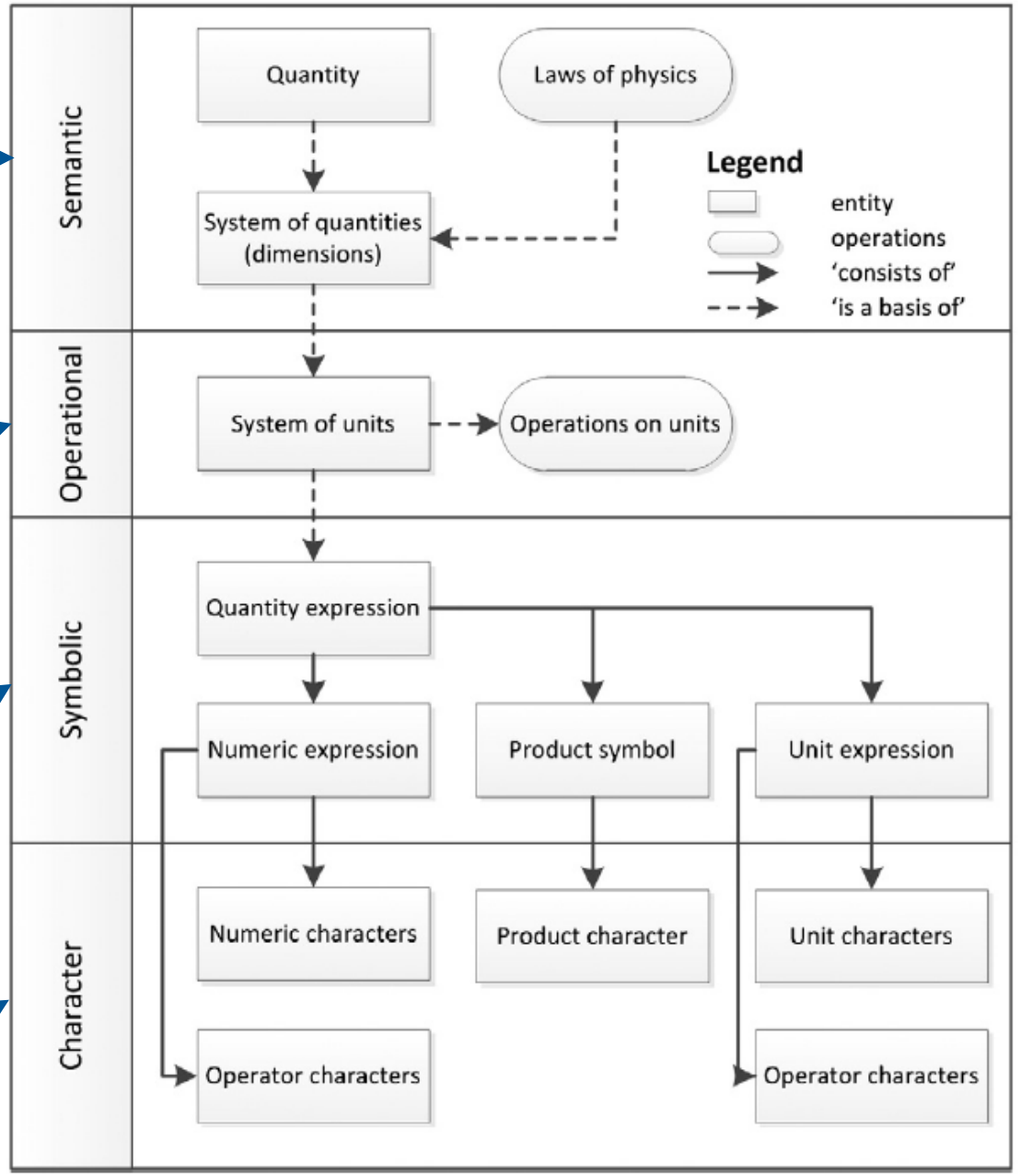
- Relationship between base units and base quantities, inconsistent rules and concepts, dimension and unit 1

Issues of utility:

- ambiguous notation, angle problem, concept of dimension, rules of use

Issues of usability:

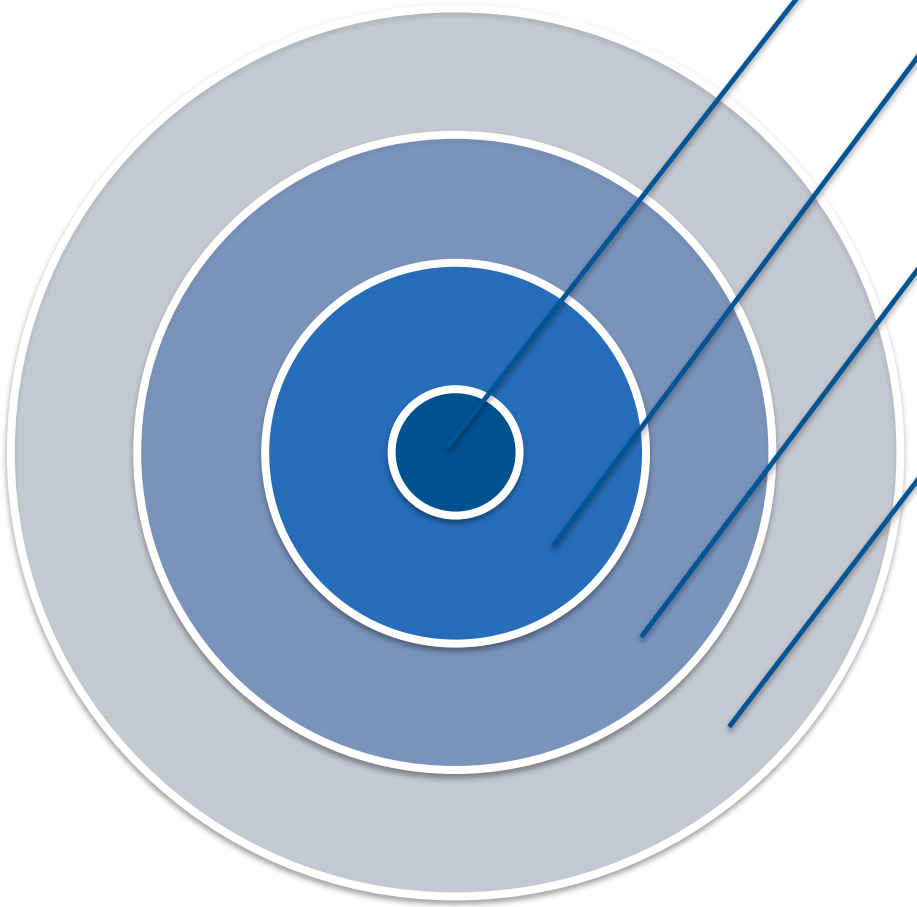
- non-systematic, inconsistent or inconvenient notation



Informatics levels for units of measurement

MP Foster, *Computer Standards & Interfaces* 35 (2013) 529–535

Hierarchy of standards for metrology entities

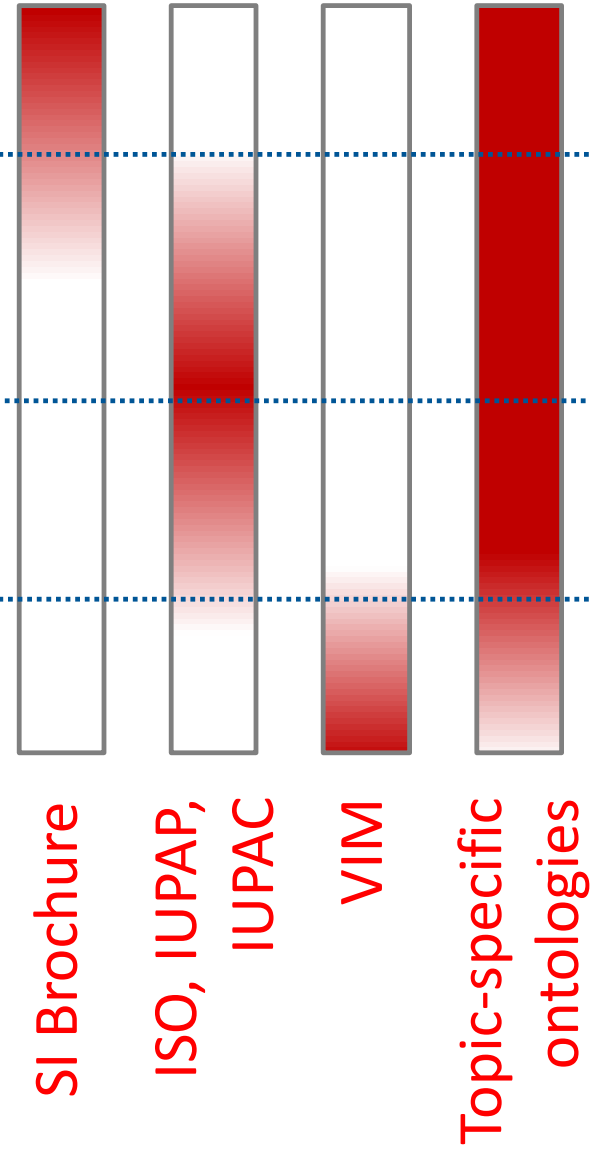


Characters for units, prefixes, operators

Rules for unit and quantity expressions and precedence

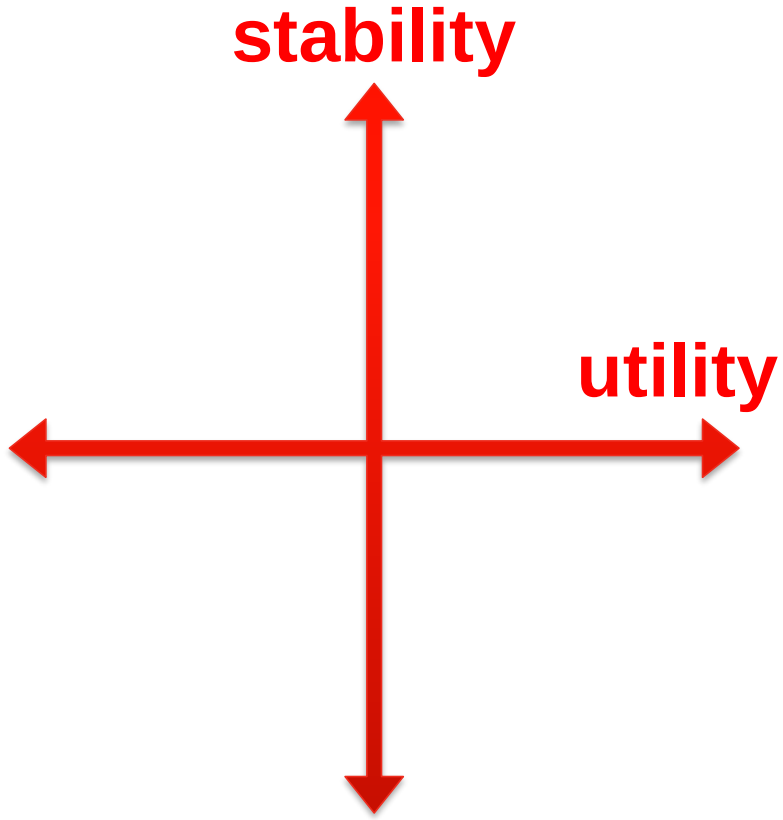
ISQ and operations on units and quantities

Metrology concepts



Fit for purpose?

- The SI is currently a stable, well known and well used system
- Balance between stability and utility to be struck
- Big changes to the SI to accommodate digitation would not be accepted
- Resolved by externally agreed convention(s) and local implementation
- For instance software can use complete equations and other local solutions
- Work with user communities to establish unit ontologies & agreed, clear implementations



Relevant NPL activities: near term

- WP leaders in EMPIR SmartCom project
- WP leader on Quality Management Framework for Software and Data in MATHMET JNP
- Task leaders in EURAMET TC-IM projects
  - 1448: Digital calibration certificates
  - 1449: Research data management and the European Open Science Cloud
- Characterisation of the uncertainty contribution arising from numerical computation
- Uncertainty quantification for new measurement modalities
  - Imaging
  - Sensor networks

Relevant NPL activities: medium term

- Reduction in confusion through replacement of *ad hoc* units and other references by machine-readable knowledge representation:
  - Dynamic, digital traceability chains
  - Characterisation of material properties
  - Chemical engineering, pharmaceutical manufacture
  - Imaging data and meta-data in life sciences and health