An overview of the VIM4 2CD

Luca Mari

lmari@liuc.it
https://lmari.github.io

30 November 2023

Measurement is everywhere…

... and several organizations are interested in its standardization

“In 1997 the **Joint Committee for Guides in Metrology** (JCGM) was formed

...

- to develop and maintain, at the international level, guidance documents addressing the general metrological needs of science and technology, and to consider arrangements for their dissemination
- to promote worldwide adoption and implementation of the results of its work;
- to provide advice, when requested, on questions related to the implementation of its guidance documents”

JCGM

The current membership of the Joint Committee:

- the two inter-governmental organizations concerned with metrology:
    1. the Bureau International des Poids et Mesures (**BIPM**)
    2. the Organisation Internationale de Métrologie Légale (**OIML**)
- the two principal international standardization organizations:
    3. the International Organization for Standardization (**ISO**)
    4. the International Electrotechnical Commission (**IEC**)
- three international unions:
    5. the International Union of Pure and Applied Chemistry (**IUPAC**)
    6. the International Union of Pure and Applied Physics (**IUPAP**)
    7. the International Federation of Clinical Chemistry and Laboratory Medicine (**IFCC**)
- one international accreditation organization
    8. the International Laboratory Accreditation Cooperation (**ILAC**)

https://www.bipm.org/en/committees/jc/jcgm

The decision-making principle

Decisions of the Joint Committee shall be by **consensus**, bearing in mind the following definition:

consensus: General agreement characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments.
Note Consensus need not imply unanimity

[ISO/IEC Guide 2:2004, Standardization and related activities – General vocabulary, ISO, IEC, 2004]

JCGM guidance docs

the “VIM”

the “GUM”

https://www.bipm.org/en/committees/jc/jcgm/publications

Toward the VIM4

1984: VIM1

1993: VIM2

2007: VIM3

2012: VIM3 with corrections

2012 - 2017: “VIM definitions with informative annotations” https://jcgm.bipm.org/vim/en

2021: VIM4 1CD (about 2 k comments received)

2023: VIM4 2CD (about 750 comments received)

https://www.bipm.org/documents/20126/115700832/VIM4_2CD_clean/c6d0dfb2-ddbf-059e-1f74-9b025c9c59d8

With the aim of making the transition as smooth and transparent as possible, the CDs include an annex “Significant changes with respect to the VIM3”

Why the VIM?

VIM1 Foreword, 1984:

All branches of science and technology need to choose their vocabulary with care. Each term must have the same meaning for all of its users; it must therefore at the same time express a well-defined concept and not be in conflict with everyday language. This applies particularly in metrology ...

… and in the meantime our society has become global and digitalization is widespread

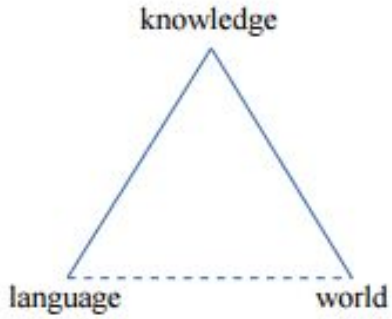
Why a (technical) vocabulary?

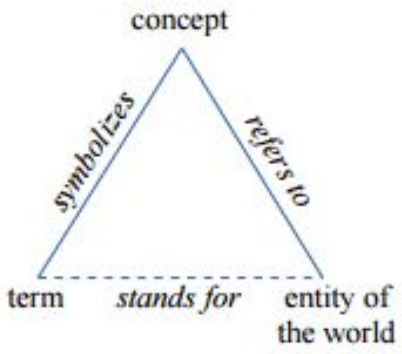
entities: What is measurement?

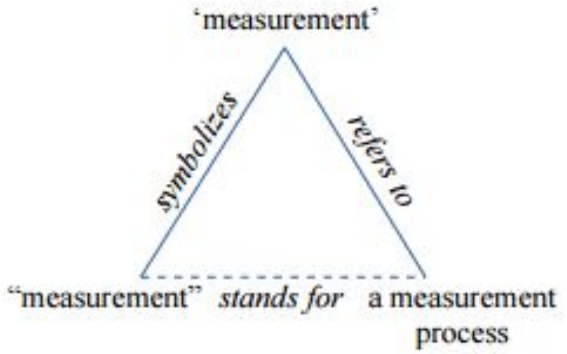
concepts: How do you define ‘measurement’?

terms: What do you mean by “measurement”?

The semiotic triangle

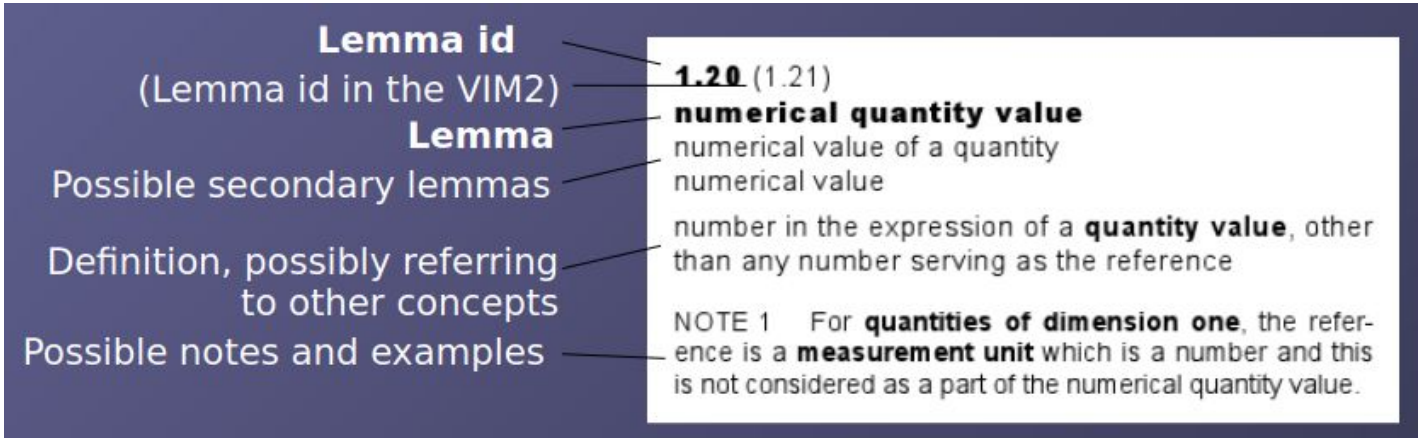






https://www.iec.ch/standards-development/role-terminology

The VIM as a vocabulary



The definitions and terms given in this fourth edition, as well as their formats, comply as far as possible with the rules of terminology, as outlined in ISO 704, ISO 1087 and ISO 10241. In particular, the substitution principle applies: that is, it is possible in any definition to replace a term for a concept defined elsewhere in the VIM by the definition corresponding to that term, without introducing contradiction or circularity.

In some definitions, the use of non-defined concepts (also called “primitives”) is unavoidable. In this Vocabulary such non-defined concepts include: object, system, component, property, reference, experiment, material, device, and signal.

From VIM3 to VIM4 2CD: structure

VIM3

(number of entries)

1 Quantities and units (33)

2 Measurement (52)

3 Devices for measurement (12)

4 Properties of measuring devices (28)

5 Measurement standards (Etalons) (17)

VIM4 2CD

1 Quantities and units (35, no structural changes): quantities, both quantities having a unit and ordinal quantities, including units, scales, and values

2 Measurement (17, subset of Ch 2): structure of measurement, including measurement principle, method, procedure, and model

3 Measurement quality (30, merged part of Ch 2 and part of Ch 4): quality of measuring instruments and systems, and of measurement and its results, including measurement uncertainty and measurement accuracy and error

4 Measuring devices and their properties (33, merged Ch 3 and part of Ch 4): measuring instruments and systems, including properties such as sensitivity, selectivity, resolution, and stability

5 Measurement standards (etalons) and metrological traceability (27, merged Ch 5 and parts of Ch 2 and 4): metrological systems, thus including measurement standards and calibration, and what is required to guarantee the metrological traceability of the outcomes of measuring systems

6 Nominal properties and examinations (20, new): nominal properties and the process of their evaluation

Some significant changes...

… from the VIM3 to the VIM4 2CD

Together with many smaller or more specific changes,
coordinated revision of the entries about:

1. properties, thus including quantities and nominal properties
2. measurement accuracy, error, etc
3. examination of nominal properties

… as presented in the “Significant changes with respect to the VIM3” Annex

1. Properties

The object of measurement are **properties**, and more specifically quantities

The terms “quantity”, “ordinal quantity”, and “nominal property” refer to both things like length and blood group (**properties in the general sense**) and things like given lengths and given blood groups (**individual properties**)

The distinction is simple but fundamental:

- comparisons, by equivalence, order, or ratio, apply to *individual* properties
- measurements are about *individual* properties
- the distinction base vs derived quantities is about *general* quantities
- ...

→ ***individual*** **properties are instances of** ***general*** **properties**

The terminological choice

Introducing this distinction would make the Vocabulary clearer and more consistent, but terms like “property” and “quantity” are too widely used to be changed (e.g., length is a quantity; the length of this rod is a quantity)

VIM3

quantity
property of a phenomenon, body, or substance, where the property **has a magnitude that can be expressed as a number and a reference**

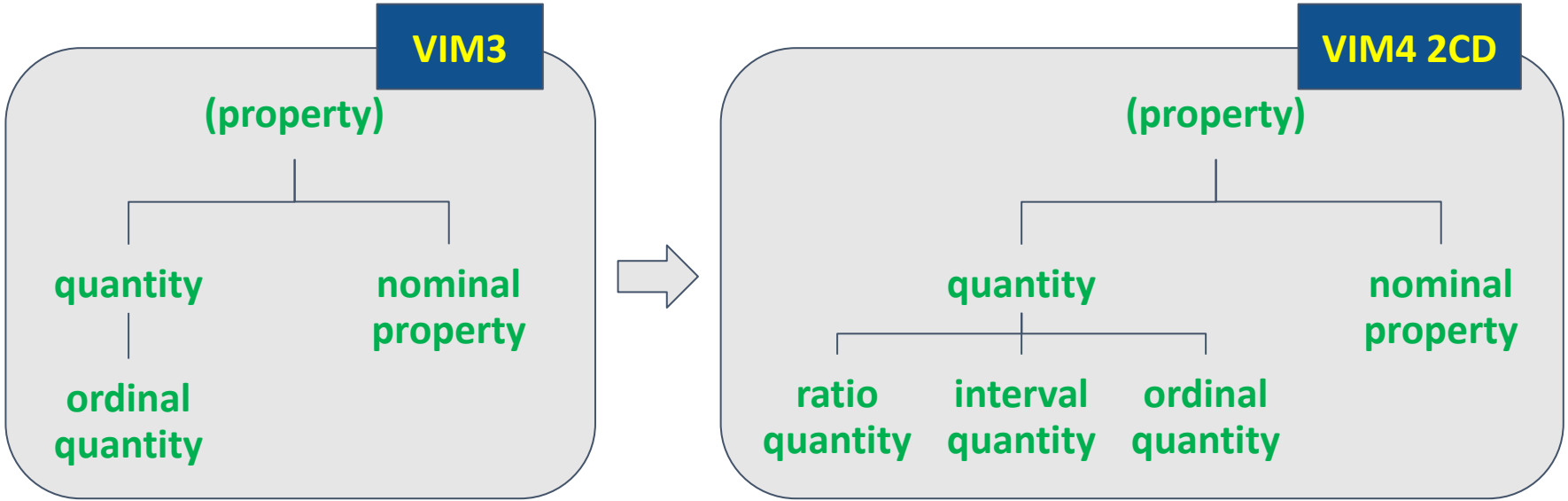
VIM4 2CD

quantity
property for which **comparability by ratio, or by difference, or by order applies**

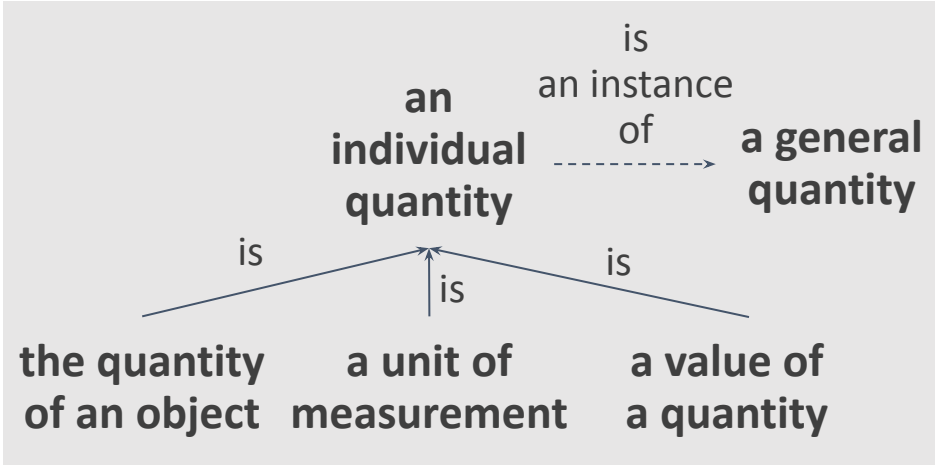
References to the concept ‘magnitude’ are avoided

Definitions are based on operational concepts

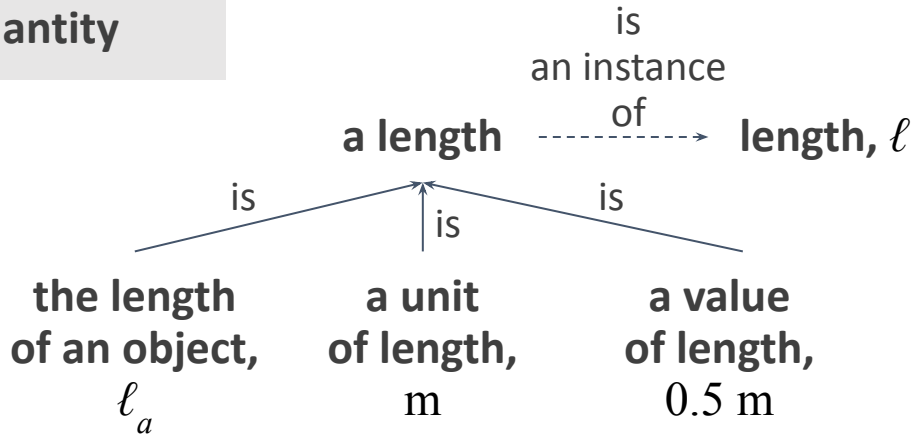
Property types



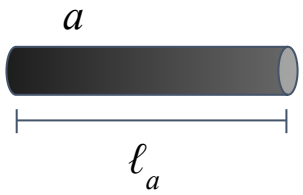
Properties: general and individual



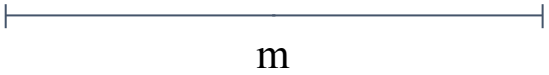
for example:



Interpreting measurand = measured value

Given 

the equation $\ell_a = 0.5\ \mathrm{m}$ is meant that

there is an individual length called “the metre” 

such that $\dfrac{\ell_a}{\mathrm{m}} = 0.5$ and therefore that ℓ_a and $0.5\ \mathrm{m}$ are the same length

and therefore that **both units of length and values of length are lengths**, and therefore individual quantities

Consequence: some VIM4 2CD definitions

1.12 **measurement unit**
unit of measurement
unit

quantity identified and adopted by convention for empirically comparing it with other **quantities of the same kind**

1.23 **measurement scale**

function from a set of **reference quantities of the same kind** to a set of identifiers, where the function preserves the information of comparison about such **quantities**

1.24 **value of a quantity**
quantity value
value

individual **quantity** identified either as the product of a number and a **measurement unit** or on an **ordinal scale**

Consequence: some VIM4 2CD definitions

1.26 **true value of a quantity**
true quantity value
true value

value of a quantity of a given object such that the equation relating the **quantity** and the value is true

(if it is true that $\ell_a = 0.5\ \mathrm{m}$ then $0.5\ \mathrm{m}$ is a true value of ℓ_a)

Some significant changes...

… from the VIM3 to the VIM4 2CD

Together with many smaller or more specific changes,
coordinated revision of the entries about:

1. properties, thus including quantities and nominal properties
2. **measurement accuracy, error, etc**
3. examination of nominal properties

2. Measurement accuracy, error, etc

The VIM3 defines the three key features of **measurement accuracy**, **measurement trueness**, and **measurement error** according to a hybrid approach

VIM3

measurement accuracy
closeness of agreement between a measured quantity value and a **true quantity value** of a measurand

→ non operational / unknowable

measurement trueness
closeness of agreement between the average of an **infinite number** of replicate measured quantity values and a reference quantity value

→ non operational / unknowable

measurement error
measured quantity value minus a **reference quantity value**

→ possibly operational / knowable

Furthermore, the VIM3 remains silent whether these features refer to measurements, or measurement procedures, or measurement results, or measured values, or ...

An operational approach

The VIM4 2CD acknowledges that measurement accuracy etc may be of measurement, measurement results, etc, and in some cases they **may be known**, also in a quantitative sense

Accordingly, the approach has been followed to adopt **operational definitions** whenever possible, consistently in particular with the position of ISO 5725 (*)

‘measurement accuracy’ etc are defined about reference values,
of which true values are specific cases

(*) ISO 5725 Accuracy (trueness and precision) of measurement methods and results

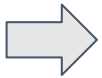
Consequence: some updated definitions

VIM3

measurement accuracy
closeness of agreement between a measured quantity value and a **true quantity value** of a measurand

measurement trueness
closeness of agreement between the **average of an infinite number of replicate measured quantity values** and a reference quantity value

measurement error
measured quantity value minus a reference quantity value



VIM4 2CD

measurement accuracy
closeness of agreement between a measured value and a **reference value** of a measurand

measurement trueness
closeness of agreement between the **average of measured values obtained by replicate measurements** and a reference value under specified conditions

measurement error
measured value minus a reference value

Some significant changes...

… from the VIM3 to the VIM4 2CD

Together with many smaller or more specific changes,
coordinated revision of the entries about:

1. properties, thus including quantities and nominal properties
2. measurement accuracy, error, etc
3. examination of nominal properties

A strategic endeavor

Following G. Nordin, et al. Vocabulary on nominal property, examination, and related concepts for clinical laboratory sciences (IFCC-IUPAC Recommendations 2017), some key definitions about quantities and measurement have been “mirrored” about nominal properties and their evaluation

VIM4 2CD

measurement
process of experimentally obtaining one or more **values** that can reasonably be attributed to a **quantity** together with any other available relevant information

examination of a nominal property
process of experimentally obtaining one or more **values** that can reasonably be attributed to a **nominal property** together with any other available relevant information

The definition of ‘measurement’ has not been changed

The definition of ‘metrology’ has been adapted to the new scenario:

VIM4 2CD

metrology
science of **measurement** and **examination**, and their applications

Thank you for your kind attention

Luca Mari

lmari@liuc.it
https://lmari.github.io

30 November 2023