Initial Modeling of the Measurement Concepts in the ISO Vocabulary of Terms in Metrology

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Summary

- Motivations and Objectives
- High Level Model of Metrology Concepts
- Detailed Models of each Category of Concepts
- Metrology Concepts in SWEBOK
- Conclusions and Future Work

Motivations and Objectives

- The field of 'software metrics': often discussed from the perspective referred to as 'measurement theory'
- 'Metrics': designed based on the intuitions of researchers and/or an empirical basis characterized by the ease of the counting of some entities of the development process
- Researchers: have used the concepts of 'measurement theory' as the foundation for their analytical investigation
- 'Measurement theory': deals with only a subset of the classical set of measurement concepts

- Researchers have investigated mainly the representation conditions, the mathematical properties of the manipulation of numbers, and the proper conditions for such manipulations

- Our survey of the literature on software metrics has not come up with references to the classical concepts of metrology

- Other disciplines: the domain of knowledge of 'Metrology' is the foundation for the development and use of measurement instruments and processes

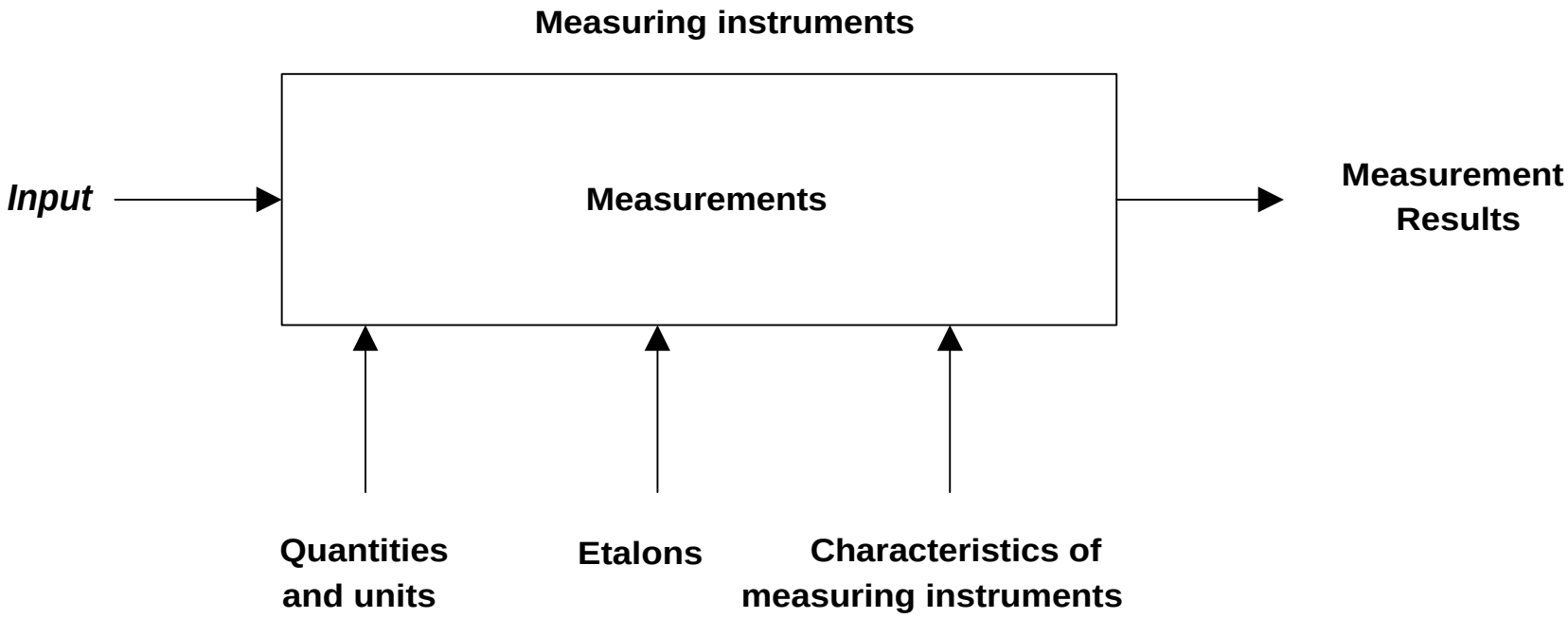
- ISO International Vocabulary of Basic and General Terms in Metrology (1993) contains the key metrology concepts

  - This key ISO document is almost unknown in the 'software metrics' community

⊙ Objective

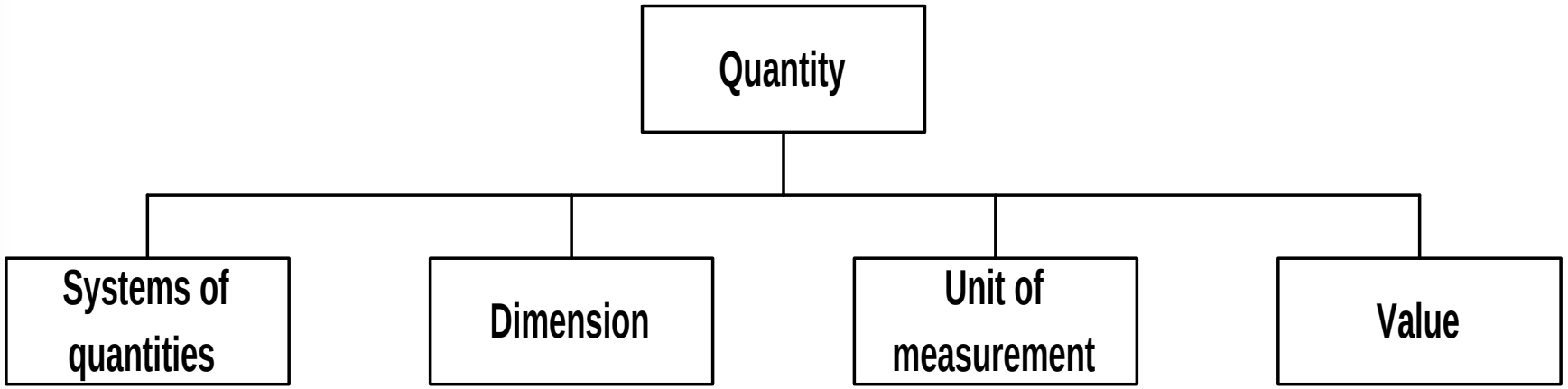
Introduce the key set of **metrology concepts** to the software engineering community for the design of new software measurement instruments, the evaluation of current ‘metrics’ proposals, and the design of improvements to current software 'metrics’

High Level Model of Metrology Concepts

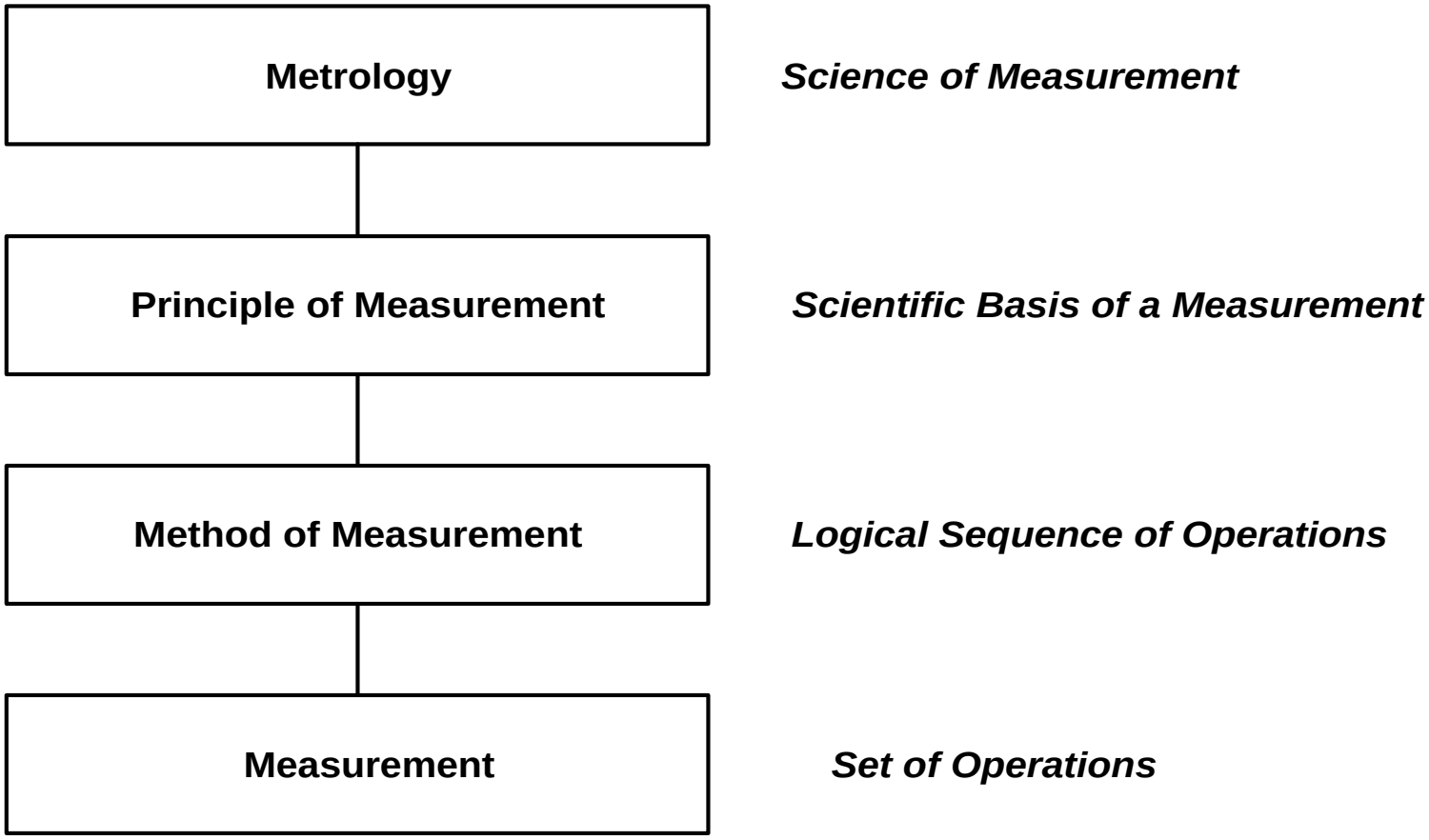


Detailed Models of each Related Concepts

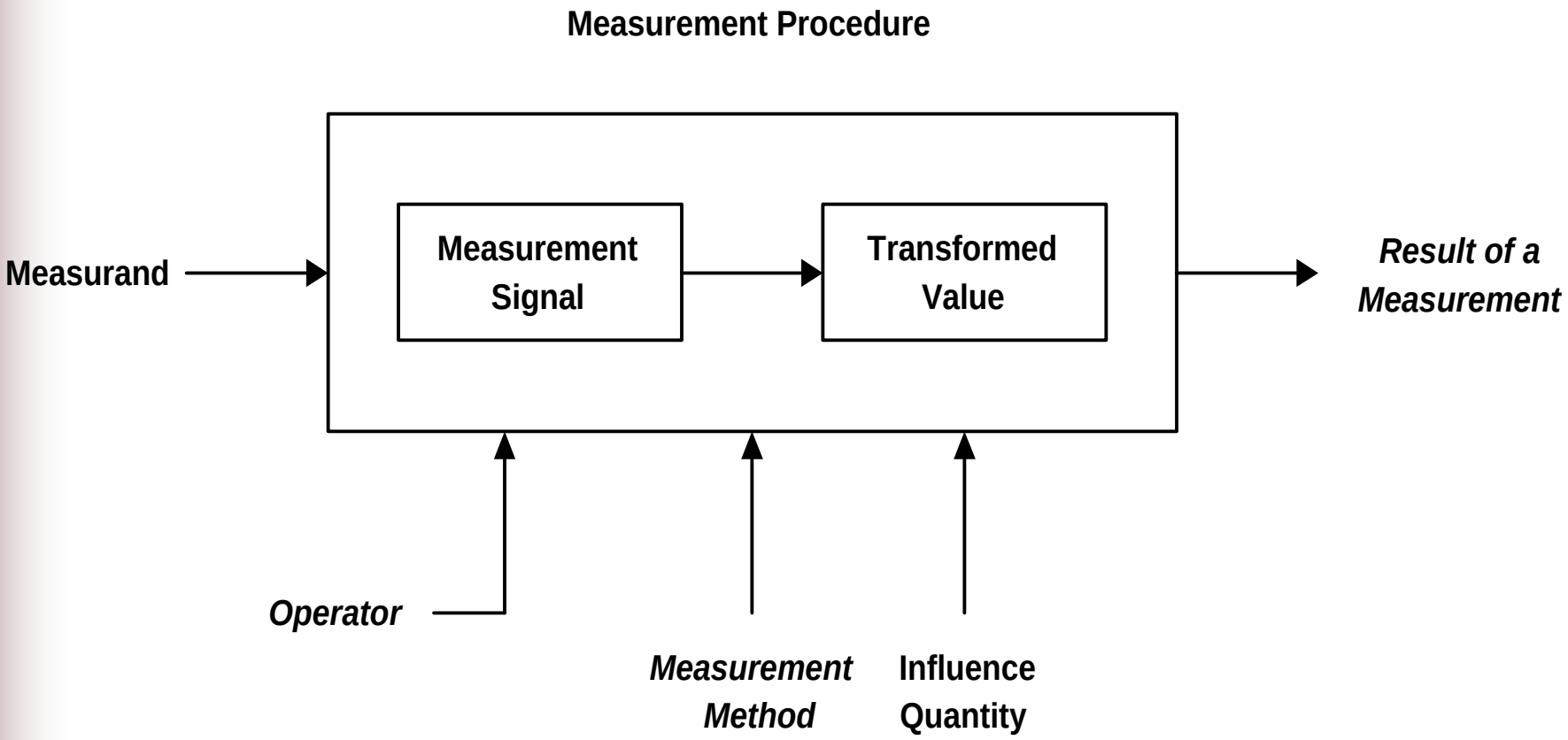
Quantities and units



Measurement foundations



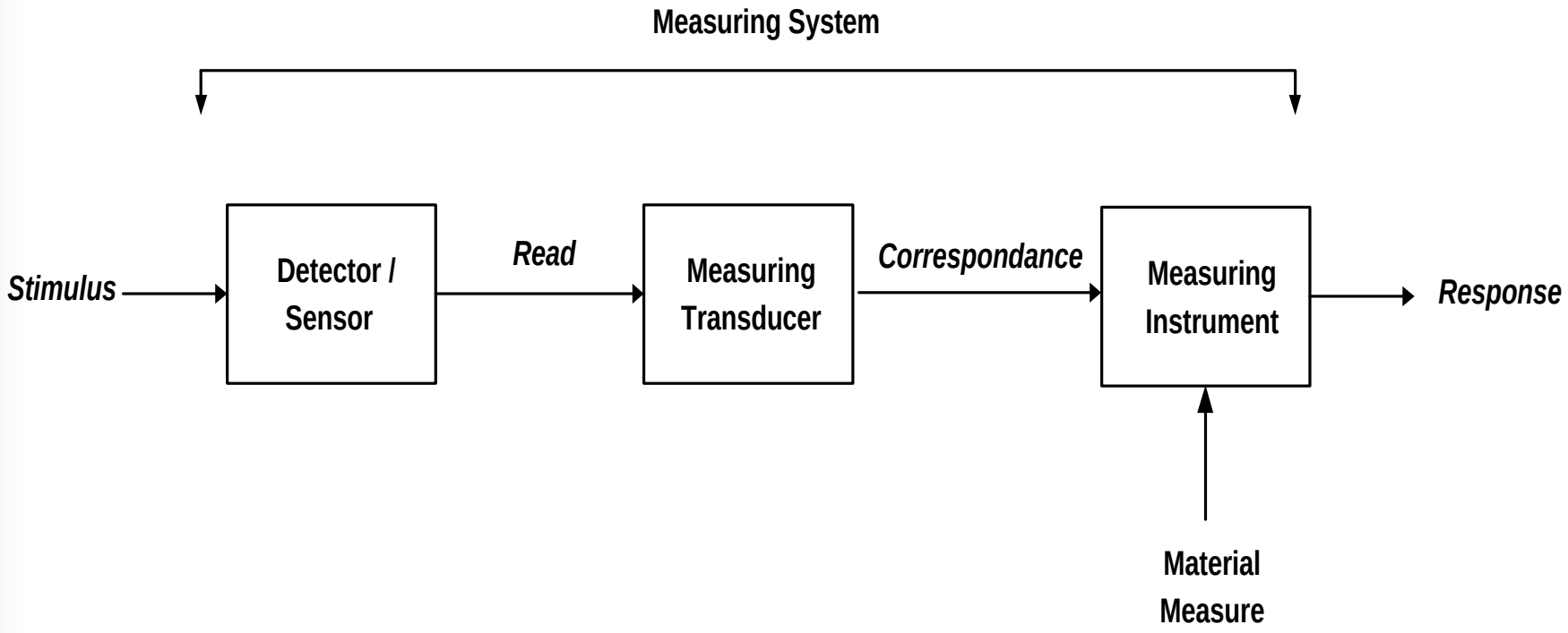
Measurement procedure



Measurement results

Types of measurement results	*Modes of verification of measurement results*	Uncertainty of measurement
Indication (of a measuring instrument) Uncorrected result Corrected result	Accuracy of measurement Repeatability (of results of measurements) Reproducibility (of results of measurements)	Experimental standard deviation Error (of measurement) Deviation Relative error Random error Systematic error Correction Correction factor

Measuring instruments



Characteristics of measuring instruments

Quantitative	*Qualitative*	*Functionality test*		Measuring Range / Working Range
		Use	*Control*	
Rated operating conditions Limiting conditions Reference conditions Instrument constant Response characteristic Sensitivity Discrimination (threshold) Resolution (of a displaying device) Dead band	Stability Transparency Drift Response time Accuracy of a measuring instrument Accuracy class (*class index*) Freedom from bias (of a measuring instrument) Repeatability (of a measuring instrument)	Error (of indication) of a measuring instrument Maximum permissible errors / Limits of permissible error Bias (of a measuring instrument) Fiducial error (of a measuring instrument)	Datum error (of a measuring instrument) Zero error (of a measuring instrument) Intrinsic error (of a measuring instrument)	Nominal Range Span Nominal Value

Measurement Standard-Etalons

(Measurement) Standard Etalon	Conservation of a (Measurement) Standard
International (Measurement) Standard National (Measurement) Standard Primary Standard Secondary Standard Reference Standard Working Standard Transfer Standard Travelling Standard	Traceability Calibration Reference Material (RM) Certified Reference Material (CRM)

Use of Metrology Concepts

- **Metrology concepts – should be used for:**
  - the evaluation of current proposals of 'metrics'
  - for improvements to current software 'metrics'
  - for the design of new software measurement instruments
- **Our models - to facilitate:**
  - Understanding of the metrology concepts
  - Facilitate their use in software engineering
  - Maturing of software measurement within Software Eng.

Conclusions and Future work

- We have proposed new models of the measurement concepts based on ISO Vocabulary in Metrology at different levels of abstraction
  - A high level model of the ISO vocabulary classification
  - Detailed models of how the individual terms fits into this high level model, and within lower levels of abstraction
- Identify which of these concepts have been discussed in the software engineering 'metrics' literature
- How these metrology concepts can help understand the current maturity status of the field of software 'metrics' and contribute to improvements

Thank you