

Glossary of Terms

Appendix to

The draft of the Grand Vision Transforming the International System of Units
for a Digital world - version 3.4

Term	Description	Source (1)	SI Digital Framework comment
BIPM	The BIPM is an intergovernmental organization established by the Metre Convention, through which Member States act together on matters related to measurement science and measurement standards.	BIPM2	The BIPM works together with CIPM, NMIs, RMOs and strategic partners worldwide to foster relevant guidance, services and tools for metrology. With this regard, BIPM is an important partner for establishing the SI Digital Framework.
Calibration	An operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication.	VIM3 [2.39]	The SI Digital Framework aims for an adoption of digital calibration certificates as key for metrological traceability in metrological data.
CIPM	The principal task of the CIPM is to promote world-wide uniformity in units of measurement and it does this by direct action or by submitting draft resolutions to the General Conference on Weights and Measures (CGPM).	BIPM2	Discuss of work for the SI Digital Framework that member states do in common and make appropriate recommendations on strategic actions including actions of BIPM under the authority of the General Conference on Weights and Measure (CGPM).
CIPM MRA	The CIPM MRA (mutual recognition agreement) is the framework through which National Metrology Institutes demonstrate the international equivalence of their measurement standards and mutual acceptance of the calibration and measurement certificates they issue.	BIPM2	The SI Digital Framework is providing data formats, services and tools that could help to facilitate a digital transformation of the data that is exchanged by NMIs under the CIPM MRA and available from the KCDB database.

Calibration Measurement Capabilities (CMCs)	The internationally recognized Calibration and Measurement Capabilities (CMCs) of the participating institutes in the CIPM MRA.	BIPM2	CMCs provide information to users regarding the quantities, ranges, and achievable uncertainty of the participating NMI (or DI). A machine-readable provision of CMCs can help NMIs to implement provenance and traceability in digital documents.
Controlled vocabulary	See vocabulary		
Cyber-physical system	Cyber-physical systems are smart systems that include engineered interacting networks of physical and computational components.	NIST document NIST.SP.1 500-201	An area of application where interfaces and analysis tools of devices, sensors and actors would profit from harmonized SI Digital Framework data formats for exchanging measurement data.
Data model	A well-defined framework to describe and structure metadata and/or data.	GO-FAIR	The SI implicitly defines a data model for stating measurement results associated with a quantity.
Data stewardship	All activities that preserve and improve the information content, accessibility, and usability of data and metadata.	NRC 2007	
Digital twin	Digital twin refers to a digital replica of potential and actual physical assets (physical twin), processes, people, places, systems and devices that can be used for various purposes.	Wikipedia	A digital twin of an artefact would represent its calibration history and how it is used in other calibrations. Ideally, the history would be updated automatically. A digital twin of an instrument would include a comprehensive model of its response behavior as well as tracking its history.

FAIR principles	Principles aimed at improving the Findability, Accessibility, Interoperability, and Reuse of digital assets (data), particularly by computer systems operating with little or no human intervention.	Adapted from GO-FAIR	Calibration certificates can be read and understood by human beings. Can they be represented in such a way that will allow a machine/robot to determine, say, all the artefacts calibrated against a particular standard in a laboratory in the last five years?
GUM	<i>Guide to the Expression of Uncertainty in Measurement</i> (known as the GUM). The GUM comprises several documents under the auspices of the Joint Committee for Guides in Metrology (JCGM).	BIPM2/EG	Basic requirements for evaluation, representation and exchange of measurement uncertainties that need to be adopted in data formats of measurement data in the SI Digital Framework.
Internet of Things (IoT)	A system of interrelated computing devices, mechanical and digital machines provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.	Wikipedia	An area of application where interfaces and analysis tools of devices, sensors and actors would profit from harmonized SI Digital Framework data formats for exchanging measurement data.
JCTLM	The production and adoption of reference materials, reference methods and the establishment of reference laboratories are drivers for accurate patient results. The Joint Committee for Traceability in Laboratory Medicine (JCTLM) maintains a database of these higher order materials and methods.	https://www.jctlm.org/	Important database with medical data of high international relevance. Essential use-case for digital transformation of data based on the SI Digital Framework.
Key Comparison Data Base (KCDB)	The KCDB provides users with reliable quantitative information on the comparability of national metrology services under the CIPM MRA and provides the technical basis for wider agreements negotiated for international trade, commerce and regulatory affairs.	BIPM2	Important data base with metrological data of high international relevance among the NMIs regarding international comparability of national measurements. Essential use-case for digital transformation of data based on the SI Digital Framework. The KCDB lists the peer reviewed CMCs of the NMIs and Dis participating in the CIPM MRA, as well the reports of the underpinning scientific comparisons.

Knowledge representation	Either (a) a set of concepts in a controlled vocabulary, an ontology or thesaurus, or (b) a data model, i.e. a well-defined framework to describe and structure metadata or data.	RDA1/GO-FAIR	
Knowledge representation and reasoning	Representation of knowledge in a machine-readable way that enables machines to establish new, valid facts based on the knowledge represented and inference rules.	EG	If artefact A is traceable to standard S1, and S1 is traceable to standard S2 then A is traceable to standard S2.
Machine readable data Machine actionable data	Data that can be processed, at some level, by a computer/machine. The levels of machine readability depends on the complexity of the processing that is enabled, from enabling a computer to read the data and report on the data (machine readable) to enabling a computer to process, interpret, relate and infer things about data and, based on a set of rules, initiate other activities without human intervention (machine actionable).	EG	A measurement procedure may specify sets of environmental conditions (temperature, etc.) to be met before a calibration experiment can be performed. A machine-actionable version of the procedure would allow a machine/robot to read the procedure, collect the relevant sensor readings, check the conditions and then decide if the calibration can be performed.
Measurement Uncertainty	A non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand , based on the information used.	VIM3 [2.26]	The SI Digital Framework is aiming to enable machines to unambiguously understand measurement uncertainty by data formats based on the international approved and accepted requirements from the GUM.
Metadata	Information describing the characteristics of a data object including, for example, structural information describing data structures (e.g., data format, syntax, and semantics) and descriptive information describing data contents.	RDA1/NIST	Metadata provides the context and provenance to allow the dataset to be interpreted and used correctly. Instrument settings are examples of metadata.

Metrology	The science of measurement and its application.	VIM3 [2.2]	CGPM, CIPM and BIPM are the high-level organizations in the meteorological world and as an initiative under the CIPM, the SI Digital Framework is an essential key-topic for digitalization in metrology.
Metrological Traceability	A property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations , each contributing to the measurement uncertainty .	VIM3 [2.41]	The SI Digital Framework aims for an adoption of digital calibration certificates as key for traceability in metrological data.
NMI (National Metrology Institute)	A national metrology institute's (NMI) role in a country's measurement system is to conduct scientific metrology, realize base units, and maintain primary national standards. An NMI provides metrological traceability to international standards for a country, anchoring its national calibration hierarchy. For a national measurement system to be recognized internationally by the CIPM MRA, an NMI must participate in international comparisons of its measurement capabilities.	Wikipedia	Link between international harmonization of the SI Digital Framework by CIPM an alignment of standards for measurement data exchange with regional and national metrology organizations, research initiatives and laboratories in trade and industries. The NMIs forward the SI to their national quality infrastructure and in many countries, this is also affecting the digital representation of measurement based on the SI.
Ontology	A formalized set of concepts relevant to a particular area of interest, representing rich and complex knowledge about things, groups of things, and relations between things, as well as a set of constraints about the usage of its terms.	RDA1/W3C	The statement "Artefact A1 was calibrated against reference standard S2 in laboratory L3 by operator O4 using instrument I5 according to measurement procedure P6" establishes multiple relationships, e.g., between artefact A1 and standard S2.
Persistent identifier	An identifier that is guaranteed to remain valid over time. This guarantee requires an institutional commitment on the part of the publisher or maintainer of the identifier and may include a guarantee that the identifier will continue to resolve to the same resource for a specific period of time.	RDA1	Artefacts, instruments, laboratories, measurement procedures should have persistent identifiers.

Provenance information	Information about the origin and history of a resource. May include a description of the workflow that led to the resource, who generated or collected it and how it was processed.	RDA1/ GO-FAIR	Calibration certificates contain or reference, in an unstructured way, information about the artefact, the laboratory, the measurement procedure as well as the measurement results
Quantity	A property of a phenomenon, body, or substance, where the property has a magnitude that can be expressed as a number and a reference	VIM3 [1.1]	The SI Digital Framework aims to provide data formats for quantities given by a number, a SI unit as reference and uncertainty statements according to GUM.
Resource description framework (RDF)	A framework (a data model) for representing information and knowledge using atomic subject-predicate-object triples.	EG	Artefact A (subject) was calibrated using (predicate) instrument I (object)
Reuse	The act of using an existing resource for a different purpose or in a different context. This may involve republishing and creating derivatives as far as allowed under the licence specified for reuse of the resource.	RDA1	Data characterizing the property of a material for one application can be made available to the general scientific community
SI (International System of Units)	The recommended practical system of units of measurement is the International System of Units (<i>Système International d'Unités</i>), with the international abbreviation SI .	BIPM2	The SI is the system of units to be used in digital exchange of physical measurement data. A harmonized digital representation of SI units is the fundament of the SI Digital Framework.
Taxonomy	Orderly classification of things according to their relationships	RDA1/ Wikipedia	Applicable to quantities that can be measured (mass, pressure, force, etc.), classes of artefact, chemical compounds, materials, pharmaceutical products
Thesaurus	A list of subject headings or descriptors usually with a cross-reference system for use in the organization of a collection of documents for reference and retrieval	RDA1	A tool for implementing controlled vocabulary, e.g. from VIM. Could be used as the basis for transforming human -readable knowledge into machine-readable ontologies.

Vocabulary, controlled vocabulary	A set of terms or concepts that can be used in the description of a resource. This includes taxonomies, ontologies and thesauri.	RDA1	The VIM provides the basis of a controlled vocabulary for encoding the main classes and their relationships relevant to metrology.
VIM	The <i>International Vocabulary of Metrology</i> provides basic and general concepts and associated terms (known as the VIM) for metrology. It is maintained under the Joint Committee for Guides in Metrology (JCGM)	BIPM2	The availability of machine-readable implementations of the terms and concepts in VIM (controlled vocabularies) is needed to enhance the findability and interoperability of future data.
Workflow, data workflow	A sequence of processes applied to data to produce new data	Wikipedia	For example, the complete sequence of actions that converts measurement data gathered from instruments to produce a measurement result on a calibration certificate, with supporting uncertainty budget.

- (1) **RDA1** refers to the Glossary in the Research Data Alliance document *FAIR Data Maturity Model: Specification and Guidelines (2020)*. RDA1/GO-FAIR indicates that RDA1 attributes the definition to GO-FAIR, etc.
EG refers to the Expert Group.
BIPM2 refers to the information available from BIPM's web page <https://www.bipm.org>
VIM3 refers to the International vocabulary in metrology (3rd Edition): <https://jcgm.bipm.org/vim/en/index.html>.
 We added terms from the annotated VIM allowing access to the underlying meaning.