

CIPM Vision

Transforming the International System of Units for a Digital World

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Vision

The SI Digital Framework – the network of tools, services, and applications that instantiate the Digital SI – assures that measurements are FAIR, machine-readable, machine-actionable, and support digital metrological traceability.

Mission

At its 27th meeting in 2022, the General Conference on Weights and Measures (CGPM) adopted Resolution 2 “On the global digital transformation and the International System of Units” in which it

encourages

- the CIPM to continue its outreach and engagement initiatives to ensure that the Metre Convention naturally extends its role as the globally accepted anchor of trust for metrology into the digital era,
- the CIPM to undertake the development and promotion of an SI Digital Framework, that will include the following features:
 - a globally accepted digital representation of the SI, compatible with, and useable within, digital data exchange standards and protocols, whilst maintaining compatibility with existing non-digital solutions,
 - facilitating use of digital certificates in the existing robust infrastructure for the world-wide recognition and acceptance of calibration and measurement capabilities,
 - the adoption of the FAIR principles (Findable, Accessible, Interoperable, and Reusable) for digital metrological data and metadata, ensuring that other communities recognize the critical importance of metrological traceability for measurement data, the latter being an established requisite for building trust,

invites

- National Metrology Institutes, Regional Metrology Organizations and other stakeholders to maintain and, where possible, increase their existing level of commitment and collaboration with the CIPM to continue the development, promotion and implementation of the SI Digital Framework,

- all organizations with an interest in, or activities related to, the quality infrastructure – that relies on metrology, standardization, accreditation, conformity assessment, and market surveillance – to consider joining the collaborative venture of the digital transformation to ensure that the SI Digital Framework meets the needs of all stakeholders.

Objectives

The International System of Units (SI), described in the BIPM SI Brochure, provides a coherent foundation for the representation and exchange of measurement data, enabling interoperability and reproducibility in all scientific and technological domains. The aim of the CIPM's digital initiative is to establish a framework that meets FAIR principles¹ (respecting business and privacy constraints) and allows all aspects of the international measurement system – measurement values, uncertainties, metrological traceability and provenance – to be accessed and interpreted digitally, enabling machine-to-machine communication and analysis. Metrological practice and the SI have already been established as key tools for ensuring interoperability and reusability of measurement data. The envisioned SI Digital Framework encompasses foundational (core) models for SI-based data representation, digital services and tools, and data stewardship and management activities, providing SI data and information that is transparent to (authorized) users and machines.

It is envisaged that a sustainable framework for the SI in a digital world (SI Digital Framework) supporting provenance will be composed of various data, services and tools aligned with the FAIR principles. In the nearer term, it will cover:

- Defining requirements for interoperable data and metadata models for quantities and SI units
- Digital representation of the knowledge encoded in key references: the SI Brochure, the International Vocabulary of Metrology (VIM), the Guide for the Expression of Uncertainty in Measurement (GUM), Fundamental Physical Constants, Quantities
- Establishing high-quality machine-useable open-access points to all relevant data, services and tools where their qualities are regularly controlled and verified, including the Key Comparison Database (CMC lists), JCTLM database, UTC data, *Mises en Pratique* Data
- Establishing policies for adoption of reports of structured metrological data (digital certificates, reference material reports, type approval certificates) as key for metrological traceability in metrological data
- Defining digital representation of CIPM key comparison data.

¹ See: <https://www.go-fair.org/fair-principles/>

In the longer term:

- Digital representation of measurement procedures, measurement workflows, analysis methods, provenance, and metrological traceability chains, that allows machines to access and act upon this information with little or no human intervention.
- Harmonized digital representation of CIPM and RMO key and supplementary comparison data
- Creation of a broader infrastructure to facilitate searching across metrological data sets and services
- Embedding the SI Digital Framework in cyber-physical systems, e.g., sensor networks, Internet of Things environments, autonomous systems, and establishing metrological traceability at point of measurement.

The framework will allow more information to be represented digitally, not only measurement results, but also the system being measured, how the measurements were made, and the workflow (data, models, software) associated with establishing the measurement results. The framework will increase the level of machine readability from basic capabilities to full machine-actionable knowledge representation. This machine-actionable² information will allow the provenance, metrological traceability and fitness-for-purpose of datasets to be assessed by users and machines and enable the application of knowledge reasoning, machine learning and artificial intelligence tools to be applied to create new knowledge.

Across the wider quality infrastructure it will also support digital conformity assessment, verification and standardization.

The development of the SI Digital Framework will benefit from the following activities:

- National Metrology Institutes (NMIs), the RMOs and the CIPM/BIPM engaging with the science community initiatives for FAIR data through active participation and collaboration at the national, the regional (e.g., EURAMET with the European Open Science Cloud) and international levels (e.g., the Research Data Alliance (RDA), CODATA, GO FAIR, the Allotrope Foundation, or the ISC), respectively.
- The NMIs and the CIPM/BIPM establishing mechanisms and incentives for long-term support, investments and continuous development of SI Digital Framework data, services and tools in the NMIs and the BIPM, and international data quality infrastructure, with formally established data stewardship roles, responsibilities and activities.
- Engagement and contributions of stakeholders including the signatories of the Joint Statement of Intent³ “On the digital transformation in the international scientific and quality infrastructure”.

² See <https://www.nature.com/articles/sdata201618>: „We use the phrase ‘machine actionable’ to indicate a continuum of possible states wherein a digital object provides increasingly more detailed information to an autonomously-acting, computational data explorer.”

³ See: <https://www.bipm.org/en/liaison/digital-transformation>

In summary, the SI Digital Framework is coordinated by CIPM and consists broadly of three layers:

1. **SI core representation and core data services, defined by CIPM and implemented by the BIPM:** Metadata models and digital references for measurement data elements, including values, units, types of quantities, uncertainty, and metrological traceability⁴.
2. **Data services provided by the NMIs and related organizations:** Open data formats, software tools, and services that build upon the SI core representation and core data services. Such services enable data to be ready for analysis, improve data quality and reliability, facilitate life-cycle analysis, communicate that data is fit for purpose, and improve data transparency.
3. **Applications developed and deployed in the broader metrology community and in research disciplines that rely upon the SI:** Tools and services can be utilized in domain-specific applications, including sophisticated analysis and AI/ML methods, and, through layering on the SI core representation, assure reliability and metrological traceability.

⁴ See: <https://www.bipm.org/en/bipm-workshops/dig-met>