

# New Digital Services from the BIPM

-

## Nuevos servicios digitales ofrecidos por le BIPM

(Bureau International des Poids et Mesures)



**B**ureau  
International des  
**P**oids et  
**M**esures

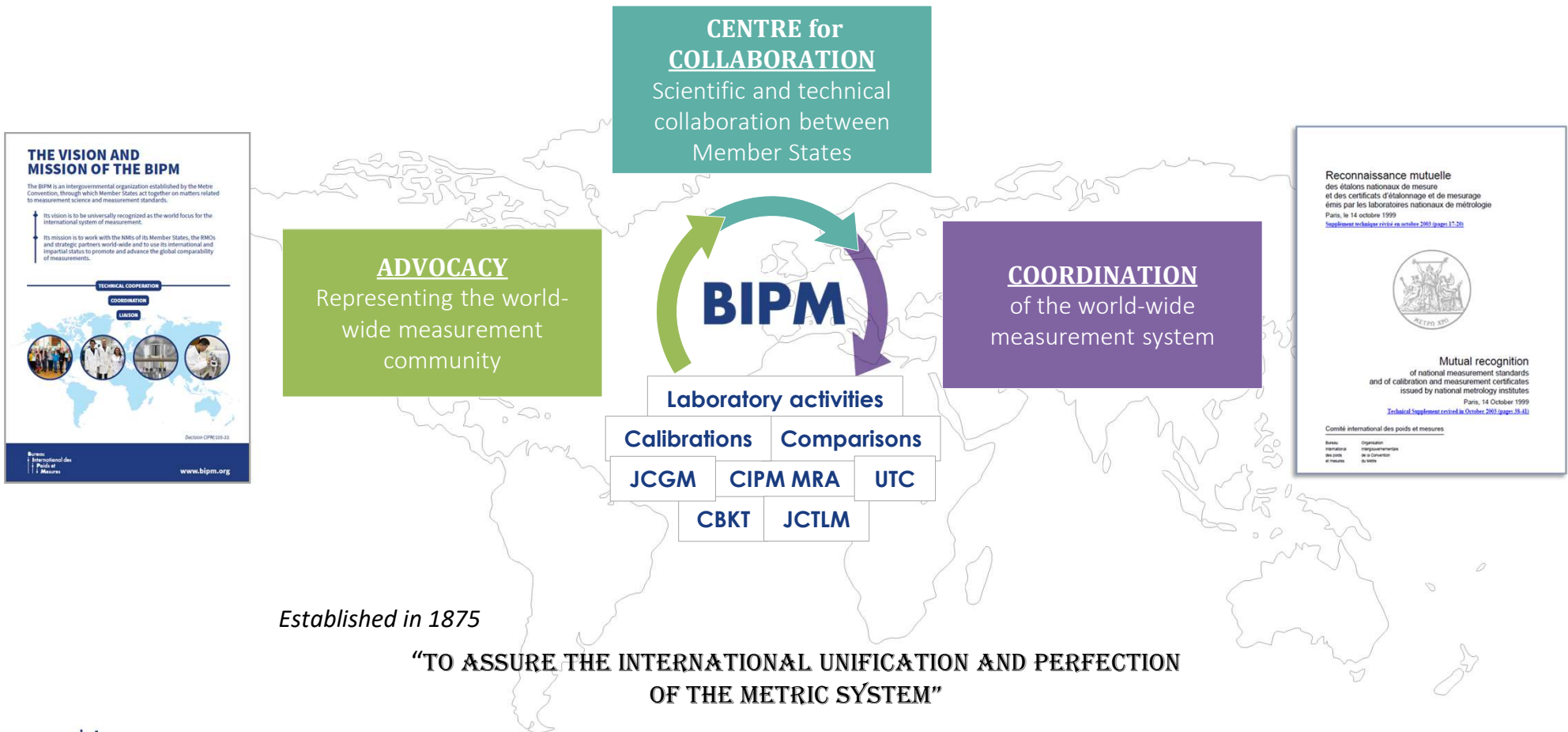
Dr Martin Milton, BIPM Director

Dr Anna Cypionka, Director International  
Liaison and Strategic Planning

November 2023

# The BIPM

... is the **intergovernmental organization established by the Metre Convention in 1875**, through which Member States act together on matters related to measurement science and measurement standards



# The BIPM - Bureau international des poids et mesures

The Metre Convention was signed in Paris by 17 nations on **20 May 1875** “to assure the international unification and perfection of the metric system”



**CGPM – Conférence générale des poids et mesures**

*Official representatives of Member States*



**CIPM – Comité international des poids et mesures**

*14 then 18 members all from different nationalities and elected by the CGPM.*



**Headquarters (Scientific and technical secretariat, Sèvres, France)**



**1875**

**17 Member States**

**14 CIPM Members**

**Director + 2 Assistants**

**2022**

**64 Member States**

**18 CIPM Members**

**Director + 70 staff**

# Members and Associates (May 2023)



- 64 Member States\* and  
- 36 Associates of the CGPM  
*(States and Economies)*

*\* The official term is "States Parties to the Metre Convention"; the term "Member States" is its synonym and used for easy reference.*

251 Institutes participating in the CIPM MRA

- 97 National Metrology Institutes + 3 Ministries
  - 64 Member States
  - 36 Associates
- 4 International organizations  
*(ESA, IAEA, JRC, WMO)*
- plus 150 Designated Institutes

**1 825 comparisons**  
1152 KCs, 673 SCs

**25 863 CMCs**  
Peer-reviewed declarations



# Members and Associates (May 2023)



- 64 Member States\* and  
- 36 Associates of the CGPM  
(States and Economies)

\* The official term is "States Parties to the Metre Convention"; the term "Member States" is its synonym and used for easy reference.

251 Institutes participating in the CIPM MRA

- 97 National Metrology Institutes + 3 Ministries
  - 64 Member States
  - 36 Associates
- 4 International organizations (ESA, IAEA, JRC, WMO)
- plus 150 Designated Institutes

**1 825 comparisons**  
1152 KCs, 673 SCs

**25 863 CMCs**  
Peer-reviewed declarations

# 27<sup>th</sup> meeting of the General Conference of Weights and Measures November 2022



<https://www.bipm.org/en/committees/cg/cgpm>

## Resolution 2

### “On the global digital transformation and International System of Units”

#### Encourages

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.

# Digital Transformation

---

## One of many definitions:

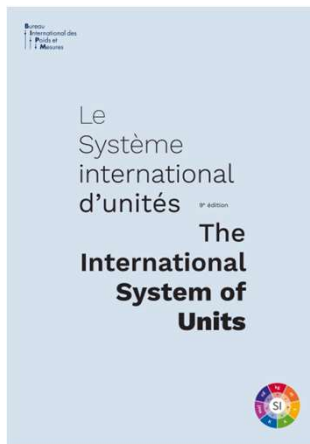
Digital transformation is the **process** that an organization applies to integrate digital technology in all areas of a business, fundamentally changing how it delivers value to customers.

## Digital Services in metrology:

- Facilitate measurement processes and the communication of results
- Save time and resources
- Improve quality of data due to automatic handling
- Address customers' needs
- Increase the “FAIRness” of data

# “A fully digital representation of the SI”

- Provide the globally accepted anchor of trust for metrology in the digital era
- Facilitate the use of digital certificates and the adoption of the FAIR principles



**pdf**  
**human readable**



**FAIR**  
**machine readable**



# The SI Digital Framework provides a fully digital representation of the SI

- Provide the globally accepted anchor of trust for metrology in the digital era
- Facilitate the use of digital certificates and the adoption of the FAIR principles

## Services underpinning the SI digital framework

### BIPM digital references

- SI Reference Point
- Measurement service categories
- Calibration and Measurement Capabilities (CMC)
- Unit interoperability service
- Vocabularies

# The SI Digital Framework provides a fully digital representation of the SI

- Provide the globally accepted anchor of trust for metrology in the digital era
- Facilitate the use of digital certificates and the adoption of the FAIR principles

## Services underpinning the SI digital framework

### BIPM digital references

- SI Reference Point
- Measurement service categories
- Calibration and Measurement Capabilities (CMC)
- Unit interoperability service
- Vocabularies

### External digital references

- ROR (NMIs)
- ORCID (Persons)
- DOI (Documents)
- InChI (Chemical Identifiers)

# The SI Digital Framework provides a fully digital representation of the SI

- Provide the globally accepted anchor of trust for metrology in the digital era
- Facilitate the use of digital certificates and the adoption of the FAIR principles

## Services underpinning the SI digital framework

### BIPM digital references

- SI Reference Point
- Measurement service categories
- Calibration and Measurement Capabilities (CMC)
- National Metrology Institutes
- Unit interoperability service

### External digital references

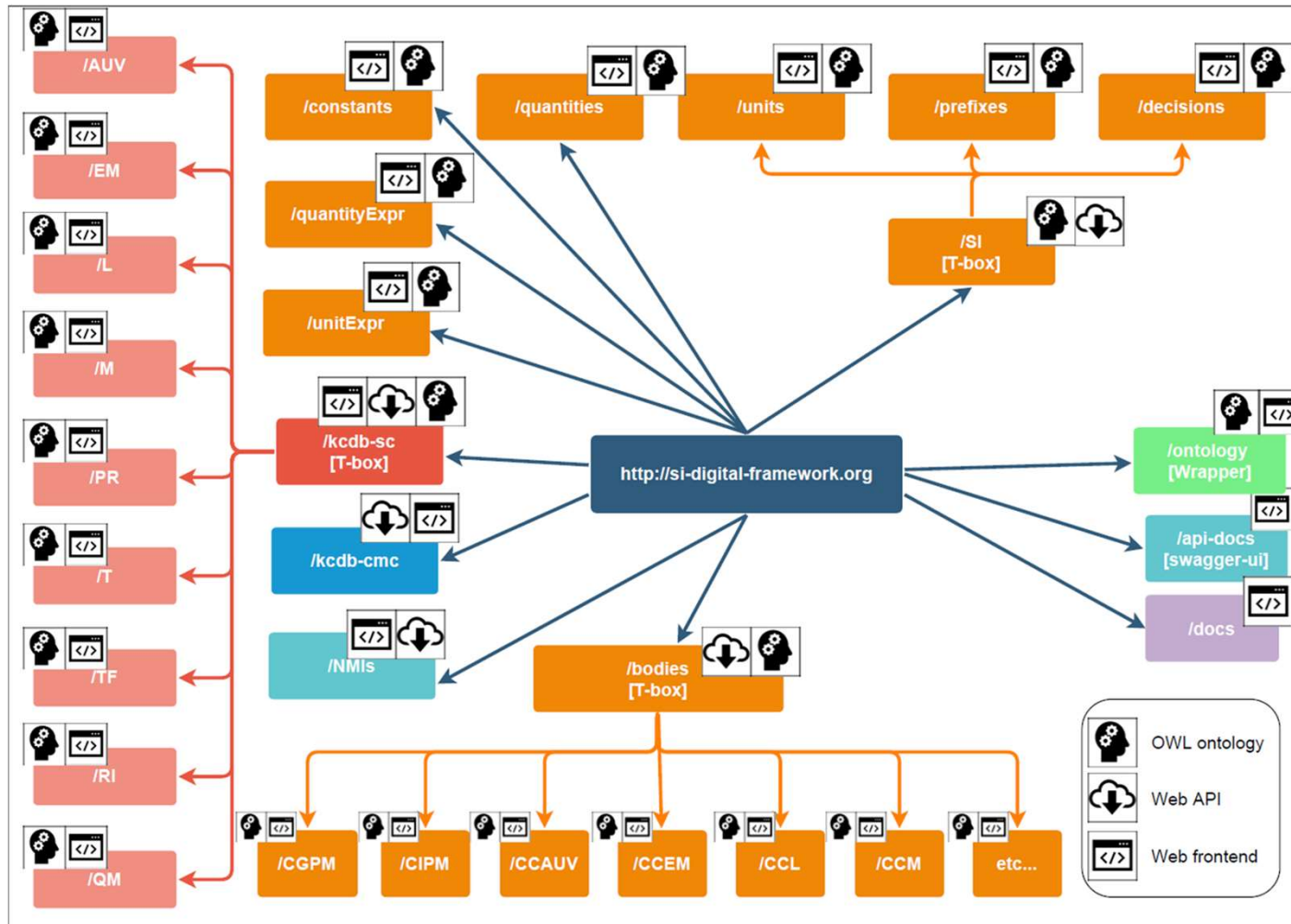
- ROR (NMI)s
- ORCID (Persons)
- DOI (Documents)
- InChI (Chemical Identifiers)

### BIPM online databases

- Key Comparison Database - B
- Key Comparison Database - C
- UTC database
- JCTLM database

All human readable, through API, and machine readable using SPARQL queries

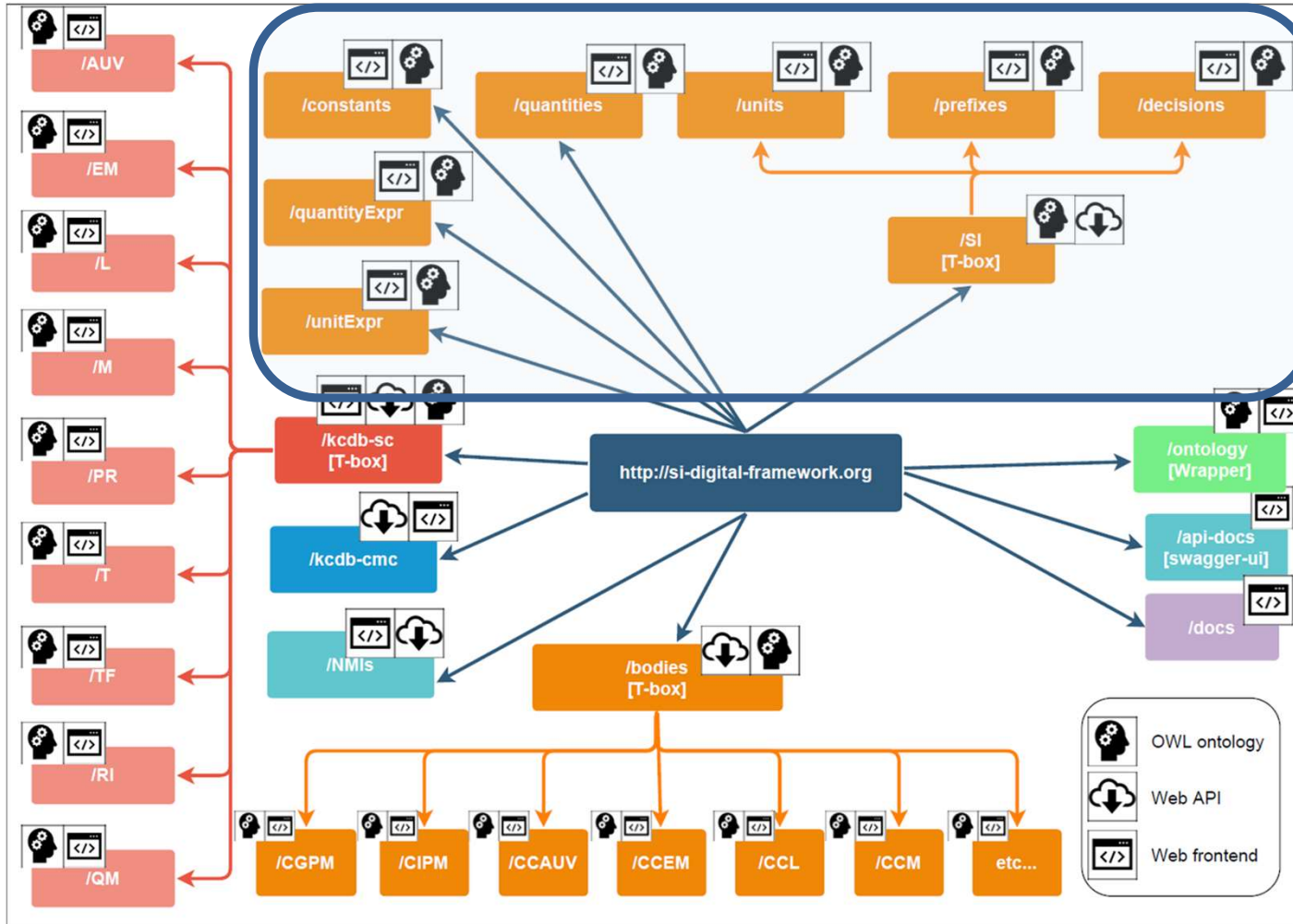
# The SI Digital Framework provides a fully digital representation of the SI



- Standardized vocabularies
- Web services for software agents
- Web interfaces for humans
- Accessible through a coherent persistent identifier scheme



# The SI Digital Framework provides a fully digital representation of the SI



# The SI Digital Framework provides a fully digital representation of the SI

- Provide the globally accepted anchor of trust for metrology in the digital era
- Facilitate the use of digital certificates and the adoption of the FAIR principles

## Services underpinning the

### BIPM digital reference

- **SI Reference Point**
- Measurement service categories
- Calibration and Measurement Capabilities (CMC)
- Unit interoperability service
- Vocabularies

### SI Reference Point

- Semantically encoded reference for SI Brochure
- Definitions of units, prefixes
- References for quantities in SI Brochure (to be extended to KCDB quantities)

### Accessible through

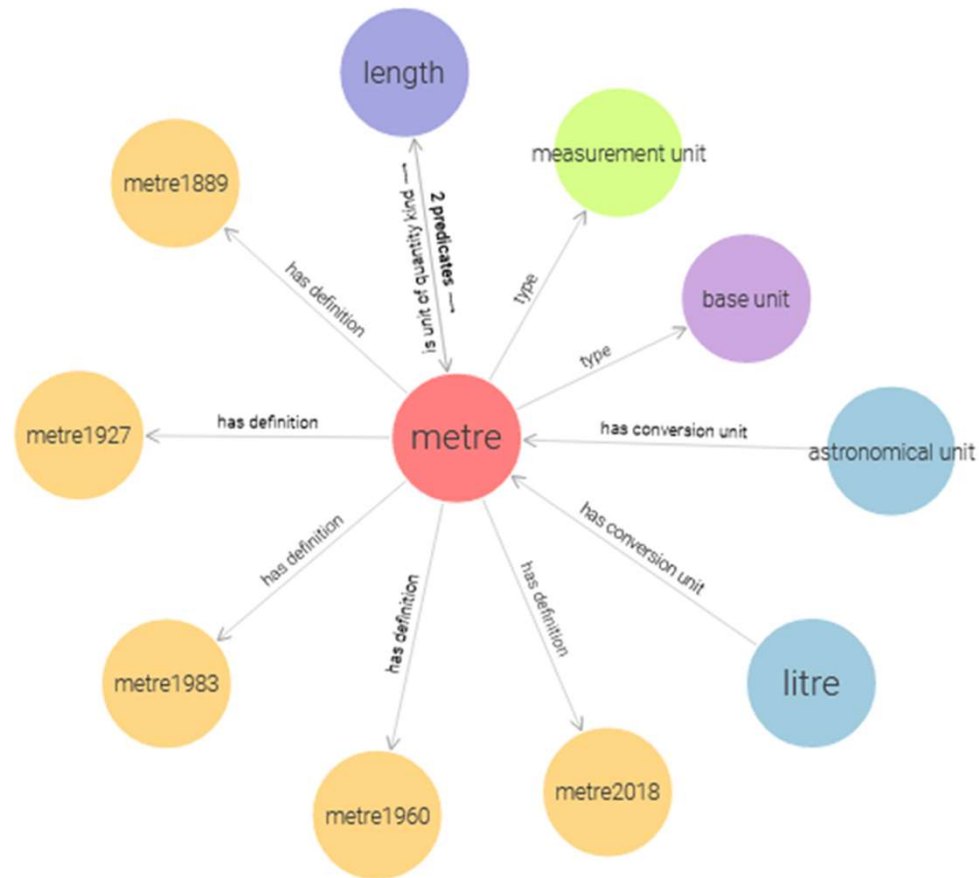
- A web browser
- API
- SPARQL queries

### Online databases

- Comparison Database - B
- Comparison Database - C
- database
- database

All human readable, through API, and machine readable using SPARQL queries

# The SI Digital Framework provides a fully digital representation of the SI



## Knowledge Graph:

Makes the information for the machine visible for a human

**SI REFERENCE POINT**

Version: 1.0, last update: 12/09/2023

**metre**

The metre, symbol **m**, is the SI unit of length. It is defined by taking the fixed numerical value of the speed of light in vacuum,  $c$ , to be 299 792 458 when expressed in the unit  $\text{m s}^{-1}$ , where the second is defined in terms of the caesium frequency  $\Delta\nu_{\text{Cs}}$ .

This definition is valid from 2019-05-20

[< Previous Definition](#)

<b>Unit</b>	<b>metre</b>
<b>Symbol</b>	<b>m</b>
<b>Quantity</b>	length
<b>Defining Constant</b>	speed of light
<b>Defining Resolution</b>	CGPM Resolution 1 (2018)
<b>Unit Type</b>	SI base unit
<b>Defining Equation</b>	$1 \text{ m} = \left( \frac{c}{299\,792\,458} \right) \text{s} = \frac{9\,192\,631\,770}{299\,792\,458} \frac{c}{\Delta\nu_{\text{Cs}}} \approx 30.663\,319 \frac{c}{\Delta\nu_{\text{Cs}}}$



# The SI Digital Framework provides a fully digital representation of the SI

- Provide the globally accepted anchor of trust for metrology in the digital era
- Facilitate the use of digital certificates and the adoption of the FAIR principles

## Services underpinning the SI digital framework

### BIPM digital references

- **SI Reference Point**
- Measurement service categories
- Calibration and Measurement Capabilities (CMC)
- Unit interoperability service
- Vocabularies

### External digital references

- Alpha-testing completed
- Initial beta-testing almost completed
- Open beta-testing: app. end of 2023
- DOI (Documents)
- InChI (Chemical Identifiers)

### BIPM online databases

- Comparison Database - B
- Comparison Database - C
- UTC database
- JCTLM database

All human readable, through API, and machine readable using SPARQL queries

# The SI Digital Framework provides a fully digital representation of the SI

- Provide the globally accepted anchor of trust for metrology in the digital era
- Facilitate the use of digital certificates and the adoption of the FAIR principles

## Services underpinning the SI digital framework

### BIPM digital references

- SI Reference Point
- Measurement service categories
- **Calibration and Measurement Capabilities (CMC)**
- Unit interoperability service
- Vocabularies

### External digital references

- ROR (NMIs)
- ORCID (Persons)

### BIPM online databases

- Key Comparison Database - B
- Key Comparison Database - C
- UTC database
- JCTLM database

Identifier you can use today!

All human readable, through API, and machine readable using SPARQL queries

# In practice: What to do first?

---

Start introducing Digital Identifiers whenever they're available!

Examples of Digital Identifiers:



# What are the advantages?

---


- ◆ Improve the FAIRness of your output
- ◆ Identify your institute/services in a machine-friendly way: certificates, data, publications
- ◆ Be ready for the machine-readable version of the KCDB



# Digital Identifiers for your Institute

**Ethiopia**  
Signatory  
National  
→ [NMIE](#)  
Addis Ababa  
Participating  
Signed by: A

**Ghana**  
Signatory  
Ghana  
→ [GS](#)  
Accra  
Participating  
Signed by: J. KIOKO (for the Managing Director, KEBS)  
\* now C

**Kenya**  
Signatory/NMI  
Kenya Bureau of Standards **ROR**   
→ [KEBS](#)  
Nairobi  
Participating in the CIPM MRA since: 21 November 2002  
Signed by: J. KIOKO (for the Managing Director, KEBS)

**Bureau International des Poids et Mesures**

# Digital Identifiers for your Service Categories

- **M/Mass-1.1.1**      Mass standard
- **M/Density-2.1.2**      Volume of a solid
  
- **EM-2.1.1**      DC resistance below or equal to 1  $\Omega$
- **EM-8.1.3**      High DC voltage ratio
  
- **RAD-2.3.1**      Activity of a radionuclide
  
- **T-3.4.1**      Liquid-in-glass thermometers





# In your calibration certificates...



Link result for humans:

**KCDB-CMC Identifier: AFRIMETS-M-ZA-00000A3W-1**

**Published in the KCDB**

Approved on 07 May 2015  
KCDB Service Category: M/Mass-1.1.1

---

**South Africa, NMISA (National Metrology Institute of South Africa)**  

Institute service identifier : NMISA/MV-1 1.1-1

Mass , Mass : **1.00E-3 g to 0.02 g**  
Mass standard  
Absolute expanded uncertainty : **2.0E-3 mg**  
Comparison in air

# In your calibration certificates...



Link result for humans:

**KCDB-CMC Identifier: AFRIMETS-M-ZA-00000A3W-1**

**Published in the KCDB**

Approved on 07 May 2015  
KCDB Service Category: M/Mass-1.1.1

---

**South Africa, NMISA (National Metrology Institute of South Africa)**  

Institute service identifier : NMISA/MV-1 1.1-1

**Mass , Mass : 1.00E-3 g to 0.02 g**  
Mass standard  
Absolute expanded uncertainty : **2.0E-3 mg**  
Comparison in air

# Digital calibration certificates...

Link result for machines:

```
{
  "versionApiKcdb": "1.0.7",
  "pageNumber": 0,
  "pageSize": 20,
  "numberOfElements": 1,
  "totalElements": 1,
  "totalPages": 1,
  "data": [
    {
      "id": 13100,
      "status": "Published",
      "statusDate": "2019-10-17",
      "kcdbCode": "AFRIMETS-M-ZA-00000A3W-1",
      "domainCode": "PHYSICS",
      "metrologyAreaLabel": "M",
      "rmo": "AFRIMETS",
      "countryValue": "South Africa",
      "nmiCode": "NMISA",
      "nmiName": "National Metrology Institute of South Africa",
      "nmiServiceCode": "NMISA/MV-1 1.1-1",
      "nmiServiceLink": null,
      "quantityValue": "Mass",
      "cmc": {
        "lowerLimit": 0.001,
        "upperLimit": 0.02,
        "unit": "g"
      },
      "cmcUncertainty": {
```

# New digital reference available for all CMCs

Recommendation JCRB/46-1 (2023) Noting the availability in the KCDB of a unique and persistent identifier for each CMC (and each version of a CMC), the JCRB recommends the use of these CMC identifiers by the participating NMIs/DIs (for example in their quality documentation) and asks the BIPM Headquarters to make available appropriate training material to encourage this.

It is thus possible for users to incorporate these unique identifiers when required, for example in quality documentation or calibration certificates to establish a machine-readable link to the KCDB.

A [Quick Start Document](#) on using Unique CMC Identifiers is available on the KCDB help page.

The BIPM is developing an Application Programming Interface to facilitate the retrieval of the CMC records for a specific identifier. This new service will be made available in the near future.



# Quick Start: CMC Identifiers

Published on the KCDB Help page.

CBKT technical exchanges include information on how to obtain the CMC identifier.

Quick start on CMC identifiers

## QUICK START: CMC IDENTIFIERS

### USE CASES

1. In its Recommendation JCRB/46-1<sup>1</sup>, the Joint Committee of Regional Metrology Organizations and the BIPM (JCRB) recommends the use by NMIs and DIs of **CMC identifiers**, for example in quality management documentation and in calibration certificates (digital or otherwise).
2. The BIPM has established a new digital service that allows a **permanent link** to be provided to the corresponding CMC.

### YOUR CMC IDENTIFIER

The identifier is automatically attributed as soon as a CMC is declared on the KCDB web platform, and is **displayed in the KCDB along with the CMC** when the CMC is published.

The CMC identifier is composed as follows, according to document CIPM MRA-G-13<sup>2</sup>:

**RMO-Area-A2-ID-V**

where

- RMO acronym of the Regional Metrology Organization through which the CMC was submitted
- Area acronym of the metrology area
- A2 ISO 3166-1 2-letter country code (or BIPM code for an international organization participating in the CIPM MRA)
- ID 8-character alphanumeric code
- V 1-character alphanumeric version value (from 1 to Z).

### PERMANENT LINK

To access a web address please use the following link including your CMC identifier:

[https://si-digital-framework.org/kcdb-cmc/"CMC identifier"](https://si-digital-framework.org/kcdb-cmc/)

(where "CMC identifier" is replaced by your CMC identifier).

To return machine-readable (JSON or XML) code (for example in a digital certificate), use:


[https://si-digital-framework.org/kcdb-cmc/"CMC identifier"?type=json](https://si-digital-framework.org/kcdb-cmc/)  
[https://si-digital-framework.org/kcdb-cmc/"CMC identifier"?type=xml](https://si-digital-framework.org/kcdb-cmc/)

[www.bipm.org/kcrtb](http://www.bipm.org/kcrtb) 1 / 2 2023-08-18

Quick start for CMC identifiers

## EXAMPLE

This calibration service is underpinned by the CMC **AFRIMETS-EM-KE-00000MUX-1**:



<sup>1</sup> <https://www.bipm.org/committees/jc/jc/b/meeting-outcomes>  
<sup>2</sup> CMCs - Calibration and Measurement Capabilities in the context of the CIPM MRA: Guidelines for their review, acceptance and maintenance (2022); CIPM MRA-G-13, <https://www.bipm.org/documents/20126/43742162/CIPM-MRA-G-13.pdf>

2023-08-18 2 / 2 [www.bipm.org/kcrtb](http://www.bipm.org/kcrtb)

# Forum on Metrology and Digitalization

---

Decision CIPM/112-38

The CIPM approved CENAM (Mexico), INTI (Argentina), METAS (Switzerland), MSL (New Zealand), NIM (China), NIST (United States), NMIA (Australia), NPL (United Kingdom), NRC (Canada), PTB (Germany), VNIIMS (Russia) as Members of the Forum on Metrology and Digitalization.

**11 Members**

The CIPM noted the expression of interest from other institutions and invited them to participate as Observers to the Forum.

**16 Observers**

The CIPM requested the BIPM Director to invite organizations from the international scientific and quality infrastructure, in particular Signatories of the Joint Statement of Intent, to participate as Liaisons to the Forum on Metrology and Digitalization.

The CIPM invited J. Ullrich to Chair the first meeting of the Forum on Metrology and Digitalization and appointed G. Macdonald as Vice-Chair.

**Kick-off Meeting: 21 November 2023**, online, registration is open!

**First Forum Meeting: 7/8 March 2024**, at the BIPM, Sèvres/ France

# The Joint Statement of Intent

## Digital Transformation

Joint Statement of Intent *On the digital transformation in the international scientific and quality infrastructure*

### Joint Statement of Intent

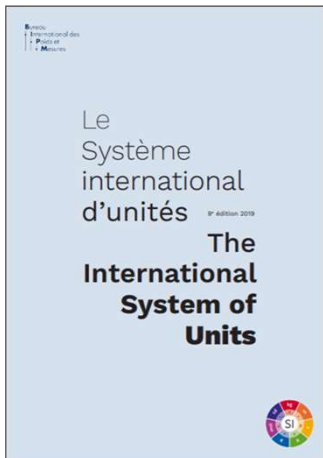
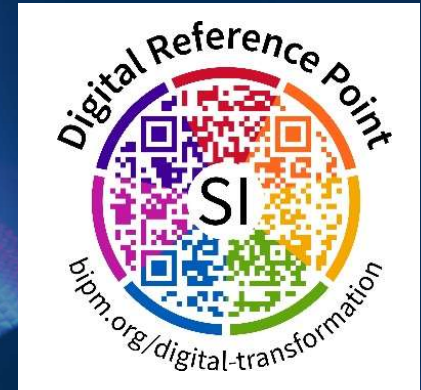
On the digital transformation in the international scientific and quality infrastructure

We the undersigned undertake to support in a way appropriate to each organisation the development, implementation, and promotion of the SI Digital Framework as part of a wider digital transformation of the international scientific and quality infrastructure.



At the BIPM we are -

- supporting open data practices by providing digital reference points and machine-accessible data,
- providing the anchor of trust for metrology data.



Accurate results  
for patient care



## The development of the SI Digital Framework has been a collaborative effort.

### Many thanks to:

- Prof Joachim Ullrich (CIPM Lead)
- The CIPM Expert Group
- NMI Partners (PTB, NIST, NPL, METAS)
- BIPM colleagues coordinated by Dr Janet Miles
- QI partners collaborating on the SI Reference Point



### The CIPM Expert Group

Daniel Hutzschenreuter	PTB, DE
Peter Blattner	METAS, CH
Stuart Chalk	U. Nth FL, US
Diego Coppa	INTI, AR
Romain Coulon	BIPM, FR
Gregor Dudle	METAS, CH
Francisco Flamenco	CENAM, MX
Alistair Forbes	NPL, UK
Blair Hall	MSL, NZ
Robert Hanisch	NIST, US
Kazu Hosaka	NMIJ/AIST, JP
Chu-Shik Kang	KRISS, KR
Janet Miles	BIPM, FR
Jeon-Seon Park	KRISS, KR
Susanne Picard	BIPM, FR
Ryan White	NRC, CA
Louise Wright	NPL, UK

**“thank you”**

