Report from the CIPM Forum on Metrology and Digitalization

Dr. Patrick Rourke (CCT digitalization representative), 11 April 2024

Background

In 2023, the CIPM established the Forum on Metrology and Digitalization (FORUM-MD), which grew out of the work of the CIPM Task Group on the SI Digital Framework and its Experts Group. FORUM-MD is structured like a Consultative Committee: NMIs can be Members or Observers. Digitalization representatives from each CC are Guests of FORUM-MD, not part of the NMI delegations.

The first plenary meeting of FORUM-MD was held on 7-8 March 2024, following a CIPM workshop "Towards Digital Quality Infrastructure" on 5-6 March 2024. The next FORUM-MD plenary meeting is scheduled for 17-22 February 2025.

Mission

To advise the CIPM on the SI Digital Framework and the wider implications of the global digital transformation for metrology and for the international Quality Infrastructure including:
* 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,
* providing metrological input/thinking to increase confidence in areas impacted by the digital revolution including, but not limited to, examples such as:
    o systems metrology
    o trusted AI
    o the reproducibility of research results,
* the creation of the authoritative digital reference for core SI information,
* the digital transformation of services and products offered by the BIPM,
* the implications of digital transformation on the operation of the CIPM-MRA including, but not limited to:
    o implementing the SI Digital Framework
    o digital calibration certificates
    o data integrity and authenticity (e.g., digital signatures) of data for metrology and metrological services
    o relevant services and infrastructure in digital metrology

To harmonize internal processes related to digitalization between NMIs, CCs, RMOs, and BIPM headquarters.

To act as a forum to exchange information and to create synergies and opportunities for collaboration in this field, including, but not limited to, liaison with International QI Organizations, relevant International

Organizations, international Science organizations, relevant industry associations, and further relevant stakeholders in digitalization.

Membership

FORUM-MD was led by Joachim Ullrich (PTB) through the 1st plenary meeting. Following that meeting, Cornelia Denz (PTB) became the FORUM-MD President. Georgette Macdonald (NRC) and Hector Laiz (INTI) are FORUM-MD Vice-Presidents. Gianna Panfilo is the Executive Secretary.

The following NMIs are Members of FORUM-MD:
- CENAM
- METAS
- INTI
- MSL
- NIM
- NIST
- NMIA
- NPL
- NRC
- PTB
- VNIIMS

"Towards Digital Quality Infrastructure" workshop – 5-6 March 2024

The workshop included presentations about the BIPM SI Digital Framework & SI Reference Point (now in open beta testing at https://si-digital-framework.org/), FAIR data, model-driven measurement information infrastructure, and industry perspectives on metrology digitalization. There were also two panel discussions, exploring the impact of the Digital SI on science & society and on the quality infrastructure, respectively.

The discussions often returned to the questions of what problem the Digital SI is trying to solve, what added value is brought to external stakeholders (who may already have their own digital approaches), and how to grapple with limited resources to work on digitalization. A major challenge is the present proliferation of many different schema, programming languages, implementations, formats, etc. of Digital Calibration Certificates (DCCs) and other aspects of digitalization.

An industry representative spoke of hopes that DCCs can change metrology like MP3 audio files changed the music business, and looked ahead to what the metrology equivalent of music streaming could be. A representative from the pharmaceutical industry emphasized a need for trust, verification and long-term stability of calibration data; for them, even future "self-calibrating" devices need to be verified in a rigorous traceable way, even if such is not called a traditional "calibration".

FORUM-MD plenary meeting – 7-8 March 2024

Discussion topics

The FORUM-MD Chair motivated the meeting with the need to face the digital challenge: how to guarantee high-quality and reliability of complex digitally-interlinked systems which will generate much measurement data?

Break-out focus sessions were held on four topics:
- Traceability, DCCs and DCRMs, Services and Applications – Chair: Georgette Macdonald (NRC)
- Interoperability and quality of data – Chair: Robert Hanisch (NIST)
- RMOs, Capacity Building and interaction between CCs and BIPM – Chair: Hector Laiz (INTI)
- Future Technologies – Chair: Cornelia Denz (PTB)

The respective chairs reported back to the Forum from the break-out sessions and the ensuing FORUM-MD discussion led to the decision to create 8 ad hoc Working/Task Groups and organize 2 workshops (listed below). Each ad hoc Group will meet soon to further formulate Terms of Reference and draft work plans.

There was a general desire to move quickly so that FORUM-MD and its Working/Task Groups can become fully operational as soon as possible.

Digitalization activities of other CCs

Reports were presented to FORUM-MD on the digitalization activities of the BIPM, CCs, RMOs and other organizations (ISO, OIML, CIE, CODATA, NCSLI, IMEKO). The digitalization work being undertaken by the other CCs may be of particular interest to the CCT, and is summarized below:
- **CCTF:** focusing on automation & efficient machine-readable generation of data in the continuous KC CCTF-K001.UTC; enabling API access for UTC products; developing metrological logic for the SI Reference Point.
- **CCPR:** supporting the BIPM to harmonize KCDB quantities; discussing how to bring the digital SI to stakeholder data formats; exploring digital twins to support a virtual NMI on a satellite in space, including primary realizations.
- **CCU:** supporting BIPM digitalization of the SI Brochure; developing an axiomatic system for Core Metrological Terms (CMTs), focusing on logic relationships between terms.
- **CCQM:** transforming measurement services data to enable machine interaction with data sources.
- **CCM:** developing machine-actionable comparison infrastructure, starting with a pilot study of a mass comparison that uses DCCs to transfer & analyze results; working on fully digital workflows for digital traceability at NMIs; exploring applications of digital twins to Kibble balances.
- **CCRI:** advising on the SI Digital Framework; discussing the benefits & challenges of automation, AI, etc.; working on digital traceability chain for calibrations; reference data & semantics are already in good shape with APIs.
- **CCL/CCTF/BIPM:** digitalizing the SI metre, starting from the *MeP* → API access to data in XML format on BIPM web → "digital-ready" *MeP* laser already built at NPL; helping the BIPM to sort out ambiguous CMC measurands and CMC interoperability in the KCDB.

Decision to create Working/Task Groups

8 FORUM-MD Working/Task Groups were created:

- Harmonizing DCC and DRMC – Chair: Martin Koval (CMI)
- FAIR for Metrology – Chair: Robert Hanisch (NIST)
- Metrological Semantics – Chair: Ryan White (NRC)
- Data Quality in Metrology – Chair: Mark Ballico (NMIA)
- Secure and trustworthy AI – Chair: Louise Wright (NPL)
- Coordination between RMOs – Chair: Nikola Zviagin (VNIIM)
- Coordination between CCs – Chair: Peter Blattner (METAS)
- SI-digital Framework – Chair: Anna Cypionka (BIPM)

Group membership is not yet finalized; the CC digitalization representatives will all participate in the "Coordination between CCs" Group.

At present, it is unclear whether the Groups above will be Working Groups or Task Groups. A Strategic Working Group will also be set up, composed of the FORUM-MD President, Vice-Presidents, Executive Secretary, and the Chairs of the other Working/Task Groups.

Decision to organize workshops

Two workshops will be organized:

- Metrological Traceability – organizer Frank Hartig (IMEKO/PTB)
- Complex sensor networks – organizer Cui Shan (A*STAR)