

Metrology and Digital Transformation

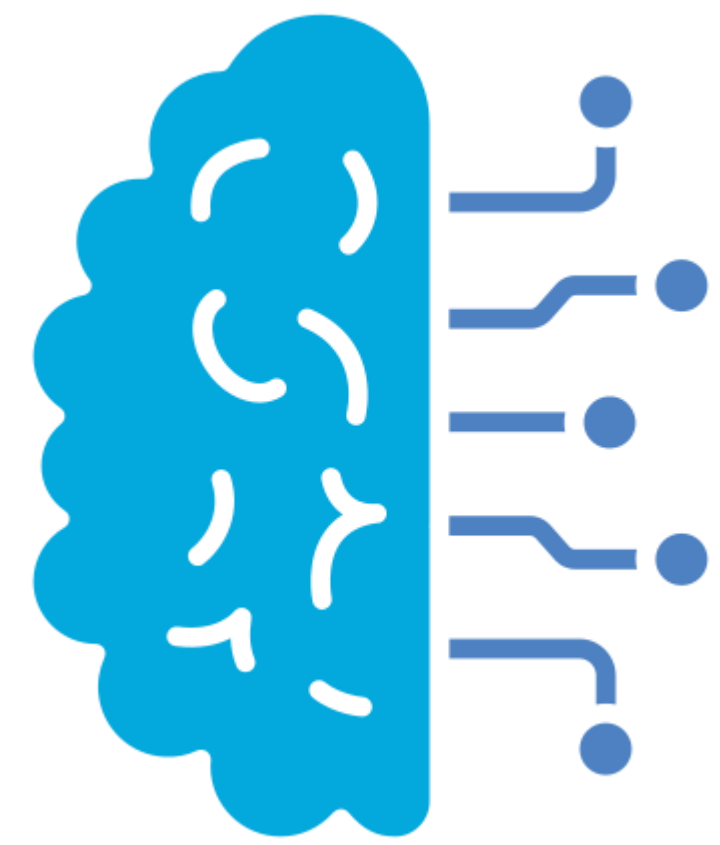


150th anniversary of the Metre Convention and the BIPM

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Metrology in the Digital Age: Challenges and Opportunities



- Metrology is undergoing a deep digital transformation.
- Enhanced innovative capabilities are needed to ensure traceability, accuracy, and quality.
- Industry 4.0 technologies, such as automation, AI, and IoT, are key to strengthening metrology.
- There is a technological gap between industry needs and the capabilities of many NMIs, limiting progress.

Digital Transformation Challenges in NMIs

Many NMIs face limitations in human resources, management, and IT systems, creating barriers to digital adoption. Gaps exist in process automation, advanced data analysis, and the integration of other digital technologies in metrology.

Key priorities include:

- Establishing robust digital architectures to support metrology processes.
- Providing specialized training in digital metrology.
- Developing harmonized global standards, guides or protocols for consistent implementation across regions.

Metrology Infrastructure for Industry 4.0: FAIR principles

The lack of adequate calibration services for advanced instruments used in Industry 4.0 represents another critical challenge to address. Modern industrial production relies on smart sensors, IoT connectivity, real-time data processing and AI, which demand a new generation of metrology solutions. Developing a metrology cloud infrastructure is essential. This infrastructure should include centralized platforms that enable the storage and, more importantly, the exploitation of measurement data in a manner that ensures it is Findable, Accessible, Interoperable, and Reusable (FAIR). Achieving this will enhance interoperability and foster collaboration among NMIs.



Global Collaboration for Digital Metrology

- High investments are needed for big data analysis, AI-driven measurements, and virtual testing technologies, but these are unaffordable for some countries.
- Metrology must evolve as a unified global system to remain relevant in the digital era.
- Innovation, cooperation, and shared standards are key to ensuring accurate, reliable, and interoperable measurement systems.
- A collaborative approach should prioritize resource optimization over isolated advancements that duplicate efforts.

Strategic Approaches for Digital Metrology

BIPM and RMOs should take a proactive role in promoting resource sharing and regional cooperation to disseminate technological advances in metrology. NMIs must develop tailored strategies for digital transformation based on their capabilities and market needs. Enterprise architecture methodologies can help identify business needs, define required capabilities, and bridge existing gaps.

The SIM region has advanced digital transformation through:

- The Working Group on Digital Transformation, which organizes the M4DT conference and other events.
- Joint developed projects, such as the CABUREK project, supported the development of Digital Calibration Certificates (DCC), digital strategies, automation, and IoT applications in NMIs.

Conclusions

1. Digital transformation is essential for metrology, but a technological gap remains between industry needs and NMIs' capabilities.
2. Limited resources and outdated systems hinder automation, data analytics, and digital adoption. Stronger digital infrastructures and global standards are needed.
3. Industry 4.0 requires advanced calibration services, smart sensors, and AI-driven solutions. A FAIR metrology cloud will boost collaboration.
4. High costs make digital transformation difficult for small countries, emphasizing the need for shared resources and cooperation.
5. BIPM, RMOs, and NMIs must lead strategic digital initiatives, using enterprise architecture to close technological gaps.
6. SIM region efforts, like M4DT and CABUREK, show progress in Digital Transformation, setting a path for others.



References

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