FAIR for Metrology

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FAIR Principles

Wilkinson, M., Dumontier, M., Aalbersberg, I. *et al.* The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* **3**, 160018 (2016). https://doi.org/10.1038/sdata.2016.18

What is a FAIR Data Repository?

- A repository that is designed and developed with the goal of providing FAIR data services
- Important attributes of such a repository:
  - Data are described by metadata in “standard” formats/schemas
  - High-level metadata supports Findability
  - More detailed, discipline-dependent metadata support Interoperabiliy and Reusability
  - Data and metadata are fully tagged with the associated units, in a declared units representation system, in machine-readable form
  - Data are, ideally, openly accessible (no registration requirements), though may be restricted if necessary (pre-registration, usage agreements, even secure logins and encryption)
  - Data should be in open, non-proprietary formats that have broad community acceptance and use

Why Do We Want FAIR Data Repositories in Metrology?

- FAIR helps assure transparency and integrity of research
- FAIR enables reuse of data in ways beyond the original experiment, increasing the return on investment
- FAIR helps assure that researchers get credit for sharing data, through data citations and potential new collaborations
- FAIR builds public trust in the reliability of research, in helping to expose the entirety of the research record to scrutiny
- Policy directives require them
- In the metrology context, FAIR can provide a digital representation of traceability
- FAIR is transforming the practice of research globally

What is Needed to Develop a FAIR Data Repository?

- Institutional commitment
- Ideally, data that are born FAIR
- A data upload service that auto-generates standard descriptive metadata sufficient for discovery
- A file management system that allows data to be organized or structured in logical ways, such as a hierarchy
- A curation process that reviews metadata and, to the extent possible, data quality
- A process for assigning DOIs
- A robust storage platform, either Cloud-based or on-premise
- Routine data integrity checks, hash codes
- Secure backup and restore processes
- Data migration processes
- CoreTrust Seal: https://www.coretrustseal.org/

And while that all sounds complicated and expensive, the opportunity cost of not doing this is enormous

Sustainability

- Again, consider the opportunity cost
- Various models for sustainability, see Hanisch and Ember (2013)
  - WhitePaper_ICPSR_SDRDD_121113.pdf
  - https://hdl.handle.net/2027.42/136145
- FAIR data management is part of the cost of doing business
  - Telephone
  - Electricity
  - Network
  - HVAC
  - Email
- NASEM review, NIST MML: “Data are your most valuable output.”
- NIST public data repository, which is mostly FAIR, built and operating for <0.5% of overall research budget
- Collect and analyze metrics to show impact of the repository

CIPM FORUM-MD Task Groups

- CIPM Forum on Metrology and Digitalization (FORUM-MD) formed a number of task groups following its first meeting in March 2024
  - SI Digital Framework
  - Harmonizing DCC and DRMC
  - **FAIR for Metrology**
  - Metrological Semantics
  - Data Quality in Metrology
  - Secure and Trustworthy AI
- Each group wrote its Terms of Reference (charter)
- Meetings began in late Spring
- FORUM-MD meets again in February 2025 at BIPM
  - TG meetings
  - Plenary sessions
  - Signatory organizations

FAIR for Metrology Task Group

- Scope: The FAIR for Metrology (FAIRfM) Working Group will focus on the implementation of the FAIR principles[1] in a metrology context. The FAIR principles – that data should be Findable, Accessible, Interoperable, and Reusable—apply broadly to research outputs including data, software, digital certificates/reports, and services. FAIRness helps to assure reproducibility and transparency of research, aspects that are fundamental to the practice of metrology. Improving the FAIRness of metrology research results could streamline key comparisons, and inclusion of metrology-community-wide metadata standards (particularly with the inclusion of units in agreed representation systems) would help expose and increase the value of metrology research outputs to the broadest possible research community.
- The FAIRfM WG will examine several aspects of research practices in metrology and make recommendations to NMIs on steps they can take to improve FAIRness.

FAIR for Metrology Task Group

Activities: To bring to light existing practices and develop a roadmap for making metrology research outputs and measurement services as FAIR as possible.

This will be accomplished by examining the following questions, in consultation with NMIs and DIs:

1. Are your research output products currently FAIR? What barriers are there to increasing FAIRness for those outputs that are not?

2. What metadata schemas do you use for annotating research outputs? Are there standard schemas available or are you participating in standard schema developments?

3. Do your research outputs use standard units representations systems? Are you planning to link your research systems to the SI Reference Point at BIPM?

4. Are your software systems open source? Do you share your software through open repositories such as GitHub?

5. Are your measurement services FAIR? Do you already offer FAIR measurement services, e.g., by providing machine-interpretable or at least machine-readable certificates? What are your customers expecting and using in terms of FAIR services from you? What could be done to make your metrology services more FAIR?

6. Do you see your NMI delivering research outputs as FAIR Digital Objects? What would be needed for your organization to embrace FDOs? Does your NMI have a strategy or action plan to implement the FAIR principles?

7. Have you tested the FAIRness of your research outputs and measurement services? If so, what test methods are used and what metrics are produced?

FAIR for Metrology Task Group

- Assess state of FAIRness amongst the NMIs and Designated Institutes through a survey
- Survey is nearly finalized, will be distributed widely in the metrology community
- Survey results will be used to develop strategy for improving awareness and value of FAIR principles
- Will provide examples of FAIR data products and services
- Will provide guidance on how to develop and deploy FAIR data products and services
- Members:

Mark Ballico (NMI Australia)

Rodolfo Gómez (INM, Columbia)

Siegfried Hackel (PTB, Germany)

Robert Hanisch (NIST, USA, chair)

Liu Zilong (NIM, China)

Brian Maranville (NIST, USA)

Janet Miles (BIPM)

Erik Schultes (FAIR Fdn., Neth.)

Gustavo Trindade (NPL, UK)

Summary

- FAIR data repositories make sense and are worth the effort
  - Efficiency, reproducibility, reliability, robustness, transparency, confidence, traceability
  - Need not be expensive; think in terms of Total Cost of Ownership
- FAIR data repositories may contain FAIR Digital Objects (FDOs), further optimizing research capabilities and capacities
- Imagine a world of globally accessible and interoperable metrology data
  - No wasted effort in data munging, reformatting
  - Context and meaning intrinsic to the data
  - Progress toward digital traceability
  - Maximize the return on investment and the impact for research and industry