Measurement-Information Infrastructure—strategies for DX success

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Section 1

A Fresh Look

Today's Topics

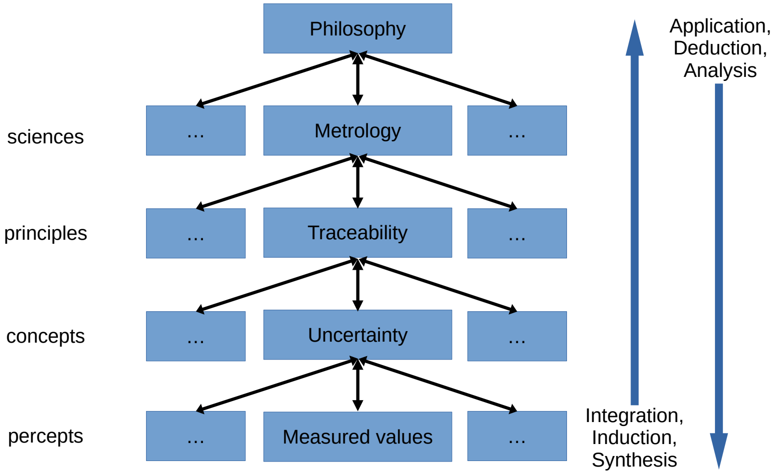
Background

- MII: structures for digitalization, digital transformation (DX)
- Many DX developments since 2013
  - Various MII milestones achieved
  - Many other efforts around the world
- Fresh look in 2023-2024 at MII strategies within the DX landscape
- Revised approach: "Conceptualize, model and implement."

Section 2

MII DX Strategy

Conceptualization—organizing models of reality into higher abstractions



- Reality exists at the bottom.
- Real-world applications succeed to the degree we have correctly conceptualized reality and applied the resulting principles.

Conceptualize, model and implement.

NCSLI's 2024 International Quality-Infrastructure Modeling Workshop
Outcomes: requirements, concerns, recommendations

Conceptualize

Reconceive processes and associated informational components across the international quality infrastructure (IQI), from the lowest to the highest level, for the digital era.

Model

Document technologically agnostic models to facilitate diverse implementations and information exchange independent of data formats.

Implement

Create and populate FAIR reference-data systems with the metadata, taxonomies and entities required to support IQI processes.

Interoperability & reusability strategy

FAIR: Digital interoperability and reusability mirrors objectivity in human communication.

Both require

- Source-independent semantic meaning and validity
- This in turn requires
  - Correct reasoning—well designed data & process models for the present and future
  - Data transformed to a standardized context—reference metadata and unique identifiers
  - Correct formulation—standardized meanings, (linked) definitions, controlled syntax
- Freedom from subjectivity:
  - Arbitrariness—undefined or free-form data fields
  - Ambiguity—multipurpose data fields, missing unique identifiers, unclear definitions
  - Out-of-context placement—essential elements falling outside the modeled framework

MII conceptualizations

Iteratively induce, test and refine abstract concepts and their models from concrete facts.

Observed Requirements		Abstract Concept
multiple scale types multiple quantity & unit systems multiple quantities per dimension varying transform applicability transcendental conversions	$\Longrightarrow$	M-layer
numerous measurands per quantity interrelated CMCs, specifications, calibrations interoperable & reusable metrology data	$\Longrightarrow$	Measurand Taxonomy
complex calibration chains (directed graph) metrological equivalence end-user measurement-decision support	$\Longrightarrow$	structured traceability (uncertainty)

MII Measurand Taxonomy

The model encapsulates

- unique identifier (taxon): `Measure.Voltage.AC`
- definition for human use (linked to an available authoritative source)
- external references for human-readable nomenclature
- parameters: measured quantity, influence quantities, operating conditions, properties

Parameters further qualify the measurand and encapsulate.

- unique identifer (taxon or property name): `Frequency`
- clarifying definition
- M-layer Aspect ID
- measuring interval (range) or property list, when instantiated

MII models

The measurand model applies generally:

- CMC: measurand + recognized uncertainty
- Instrument specification: further qualified measurand + MPE (max. permissible error)
  - DCR—dig. cal. request: (altered) specification subset + business transaction data
- Calibration certificate: further qualified measurand + measurement uncertainty

The M-layer model (prototyped at `mlayer.org` courtesy of Fluke) also applies universally.

A model for structured, quantified traceability supports calibration results

- and CMC uncertainties (with worst-case estimates for some error sources)
- and instrument MPEs (with error sources from drift and operating conditions).

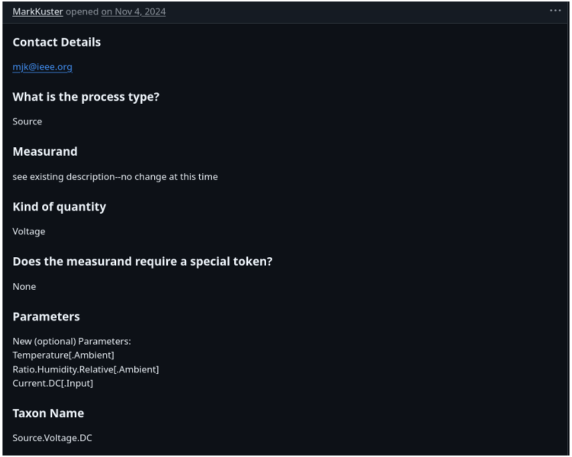
Section 3

MII Implementation

Governance

NCSLI approved an open-source license for MII documents, products.

- *Governance of NCSLI's Measurement Information Infrastructure Products*
- GitHub repositories
  - Routine operations: *GitHub Development Guide for NCSLI's MII Products*
  - Defined collaboration roles
  - Full documentation and transparency for all actions
- This combination perhaps offers a unique environment for DX efforts.



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What is the process type?

Source

Measurand

see existing description--no change at this time

Kind of quantity

Voltage

Does the measurand require a special token?

None

Parameters

New (optional) Parameters:
Temperature[.Ambient]
Ratio.Humidity.Relative[.Ambient]
Current.DC[.Input]

Taxon Name

Source.Voltage.DC

Collaboration Roles

- Users—anyone may download and use the products per the license.
- Contributors—anyone may register suggestions, contribute material or otherwise help.
- Reviewers—designated members evaluate and comment on proposed contributions.
- Committers—designated members approve and commit contributions.
- Coordinators—designated members manage validations and publish releases.

Anyone may join NCSLI and thus the NCSL International 141 MII and Automation Committee.

Market-driven implementation

- The marketplace will ultimately determine success.
- Provide the tools, leave MII application development to the market.
- Agile and model-driven development recommended
- Supply and demand: Anyone may submit a new or modified taxon.
- Scalability envisioned (as yet unproven)
- The number of contributors in approval roles should grow with market demand.
- IndySoft: Building functionality around the taxonomy and the M-layer.
- Cal Lab Solutions: Validating measurement uncertainties against accreditation scopes.

Section 4

Conclusion

DX Strategy

Summarized from the workshop report by Ryan M. White et al.

- Coordinate a standardized approach to digitalizing metrology that
  - meets the IQI's evolving requirements and
  - ensures compliance with global standards.
- Focus on agile, model-driven development and stakeholder collaboration.
- Integrate standard models to support global metrological processes.
- Facilitate flexible, user-friendly applications based on common conceptual models, taxonomies and protocols.

For success

Create, populate and use FAIR reference-data sets with well-conceptualized, modeled and implemented metadata, taxonomies, and entities to support IQI processes.

Acknowledgments

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- FORUM-MD Workshop
- Cherine Marie-Kuster

. . . and thank you for your time!

Open-source projects: https://github.com/NCSLI-MII/
General MII information: http://miiknowledge.wikidot.com/

Questions?