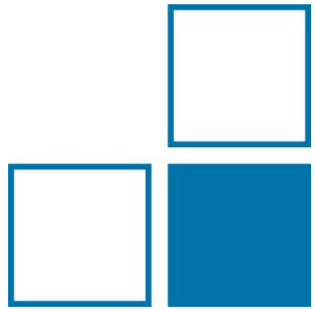
Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

Metrology for digital transformation

Lessons learned and future developments

Sascha Eichstädt



Future developments?

“When wireless is perfectly applied, ***the whole earth will be converted into a huge brain****, which in fact it is, all things being particles of a real and rhythmic whole...and the instruments through which we shall be able to do this will be amazingly simple compared with our present telephone. A man will be able to carry one in his vest pocket.”*

Nikola Tesla, 1926

“I think there's a world market for ***maybe five computers****.”*

Thomas Watson, CEO IBM, 1943

Outline

1. **Trust and confidence in data and algorithms**
2. Cyber-physical systems and IoT
3. Digital transformation in the quality infrastructure
4. EURAMET Digital Strategy

DATA

If Your Data Is Bad, Your Machine Learning Tools Are Useless

by Thomas C. Redman

APRIL 02, 2018

Summary Save Share 0 Comment Text Size Print $8.95 Buy Copies

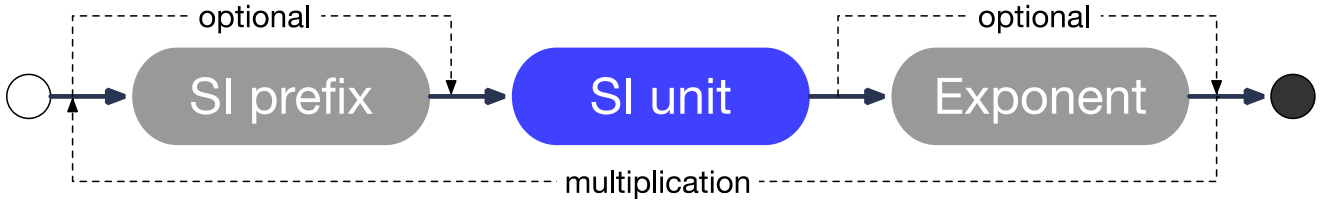
"Does your car have any idea why my car pulled it over?"

PAUL NOTH

Data without correct metadata is useless

Measurement data without units is dangerous

Trust in data: SI as basic foundation

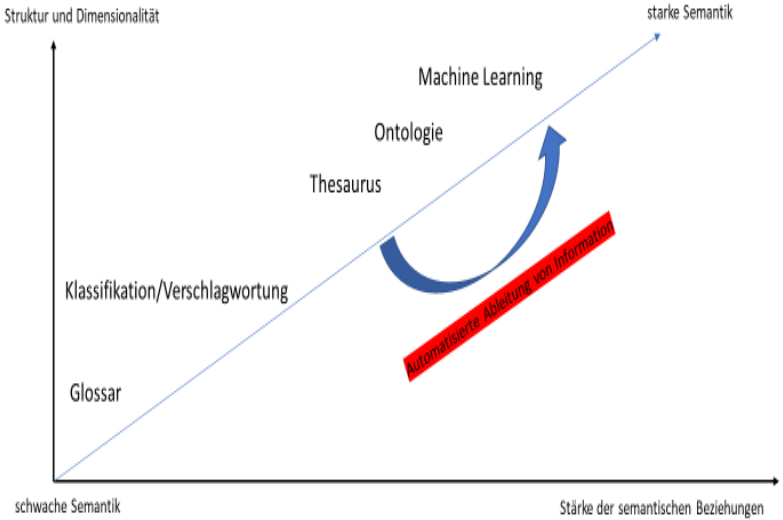


real *quantity type extended*	components (of the real quantity type)					
	label	value	unit	dateTime	expandedUnc (S)	coverageInterval (S)
Basic real with expanded measurement uncertainty						
Basic real with coverage interval (probabilistic-symmetric)						

(S) sub type — mandatory — optional

DOI: 10.5281/zenodo.3366902

Thesauri, vocabularies and ontologies



Source: based on Anna Karszpik, 2018

Controlled vocabulary for improved information retrieval for

- Communication human – human
  (e.g. dictionaries, glossaries)
- Communication human – machine
  (e.g. information retrieval in a document management system)
- Communication machine – machine
  (e.g. advanced data analyses based on semantically enriched measured data)

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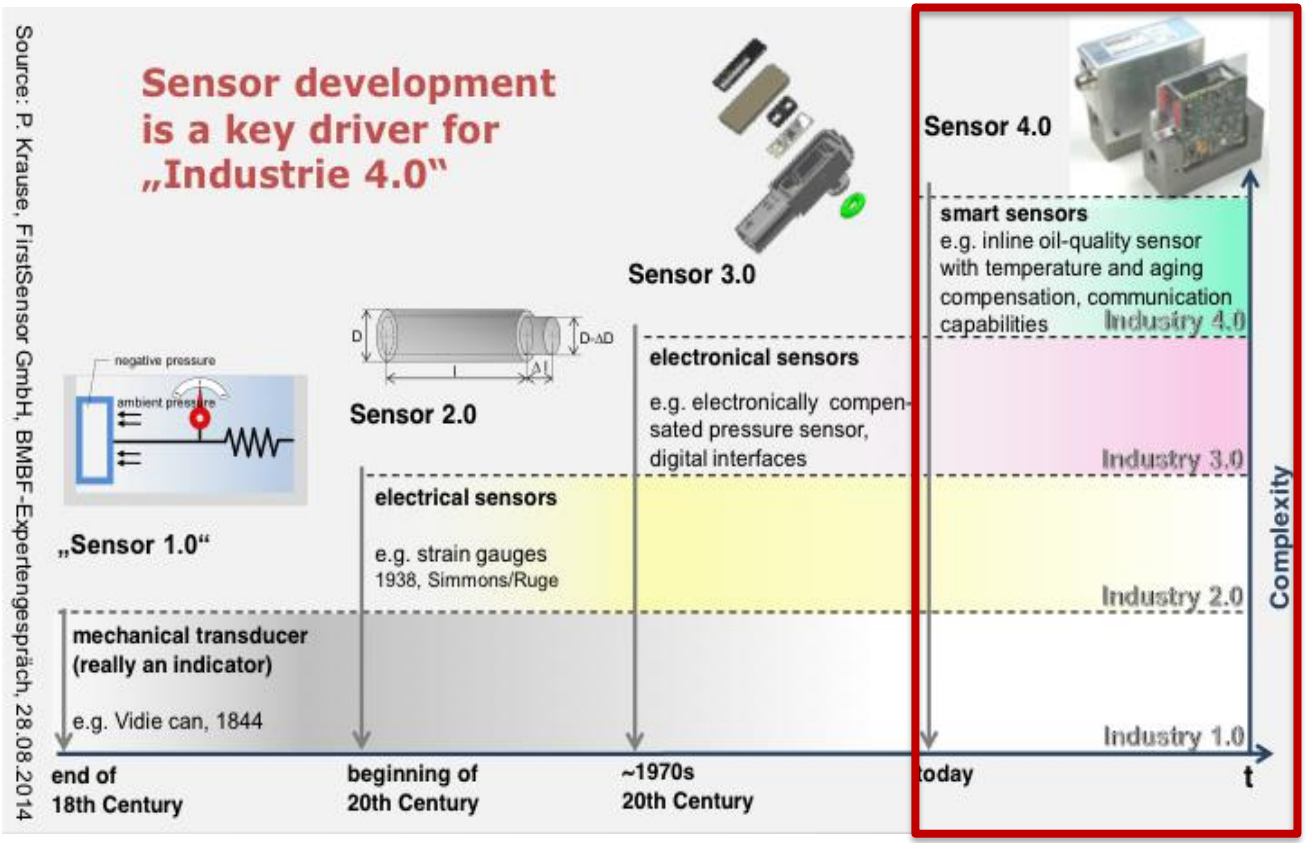
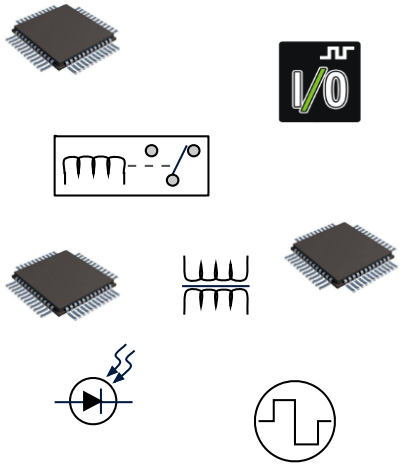
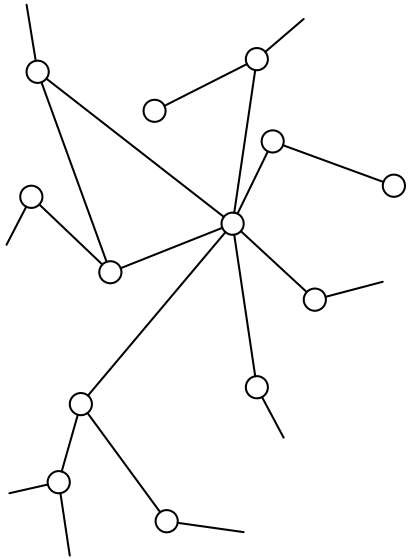
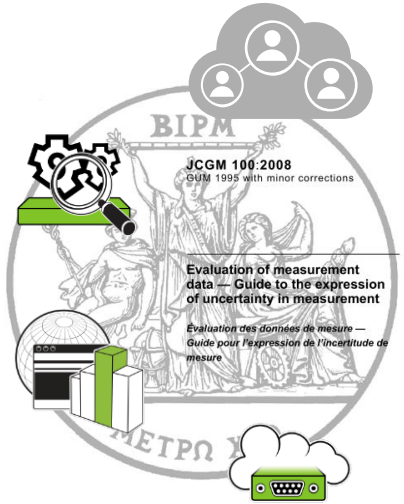
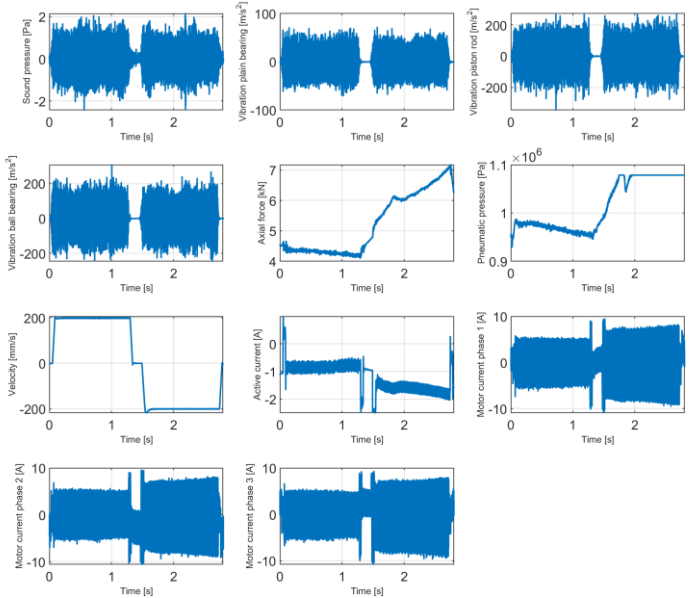
Digitalisation in measurement



Metrology for the factory of the future

Digital sensors and smart traceability	Reliable smart sensor networks	Confidence in smart data analysis methods
		
Dynamic, digital-only output and low-cost MEMS sensors	Synchronisation, co-calibration and sensor fusion	Measurement uncertainty in machine learning and AI

Data quality in sensor networks



- Pre-processing requires knowledge about measuring instruments and processes
- Semantic und ontologies required for automatic ML/AI
- Data quality affected by sensor errors, noise, drift, synchronisation issues, etc.

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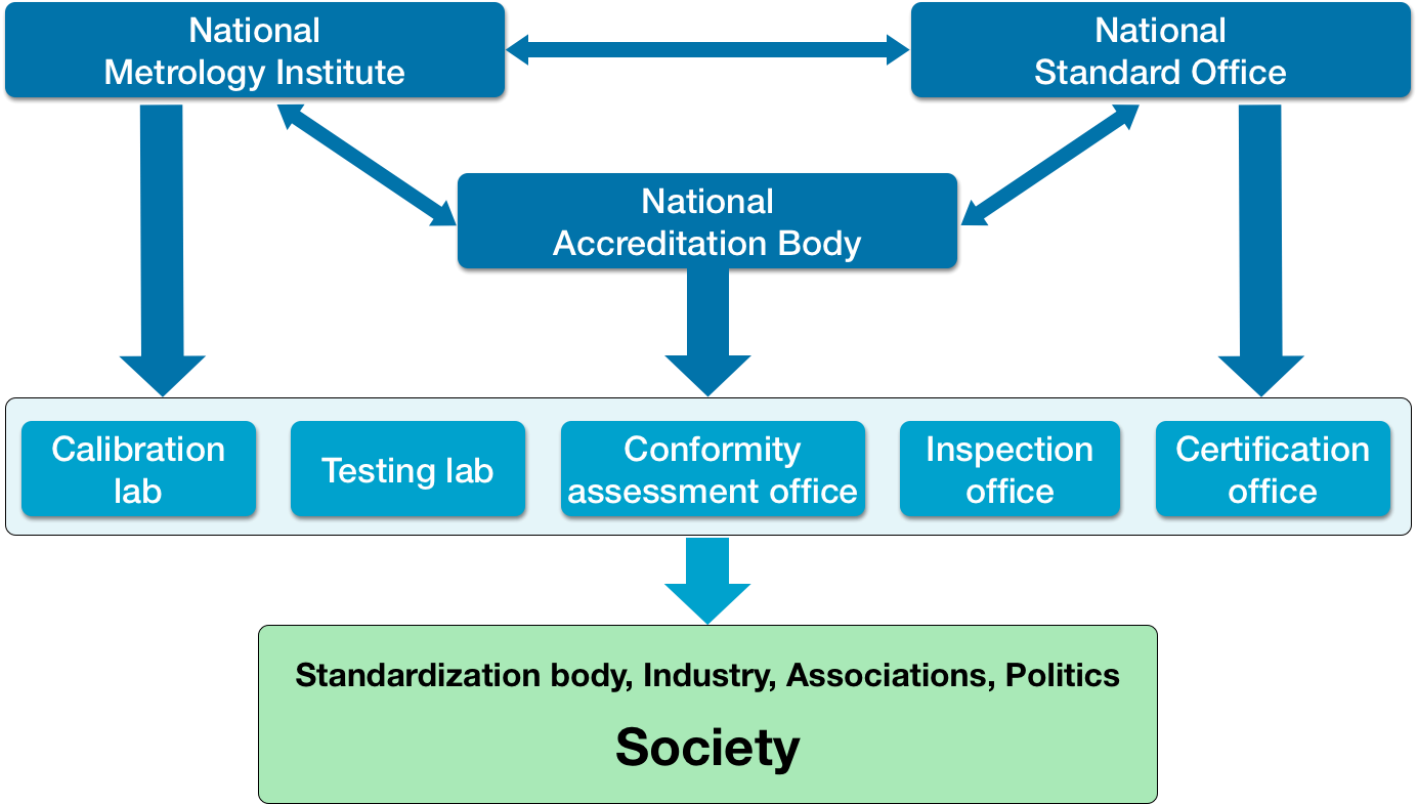
Digitalisation in the Quality Infrastructure



Digitalisation in the Quality Infrastructure

Standardization body, Industry, Associations, Politics

Society

Products

- Complex devices and systems
- Embedded computing
- “Smart” features

Services

- “X as a service”
- Cloud platforms
- AI-based solutions

Regulations

- AI: ethics, confidence and trust
- Technological enforcement

Digitalisation in the Quality Infrastructure

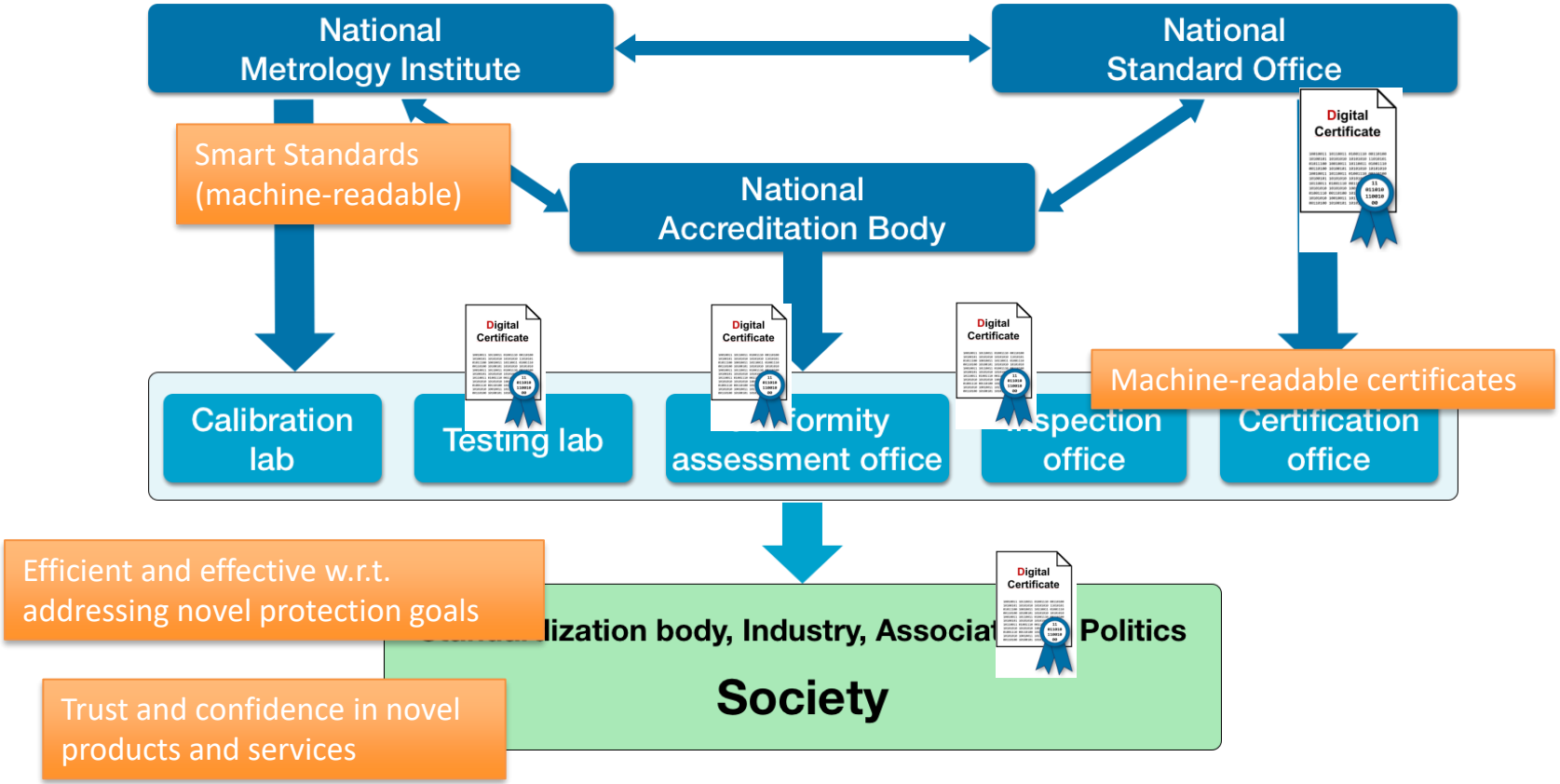
National Standard Office

- Keeping up with increasing pace of industry and society
- End-to-end collaborative, digital standardisation
- Machine-executable digital standards
- Integration into (automated) digital processes

National Accreditation Body

- Keeping up with increasing pace of industry and society
- Digital services and accreditation for novel concepts (e.g. lot size 1)
- Machine-executable digital certificates

Digitalisation in the Quality Infrastructure



Digitalisation in the Quality Infrastructure

QI

QI Digital

Bundesministerium für Wirtschaft und Technologie

DAkkS Deutsche Akkreditierungsstelle

DIN

PTB

BAM

DKE VDE DIN

and many more

BIPM

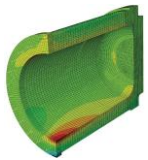
ISO

IAF International Accreditation Forum

OIML

IEC

ilac

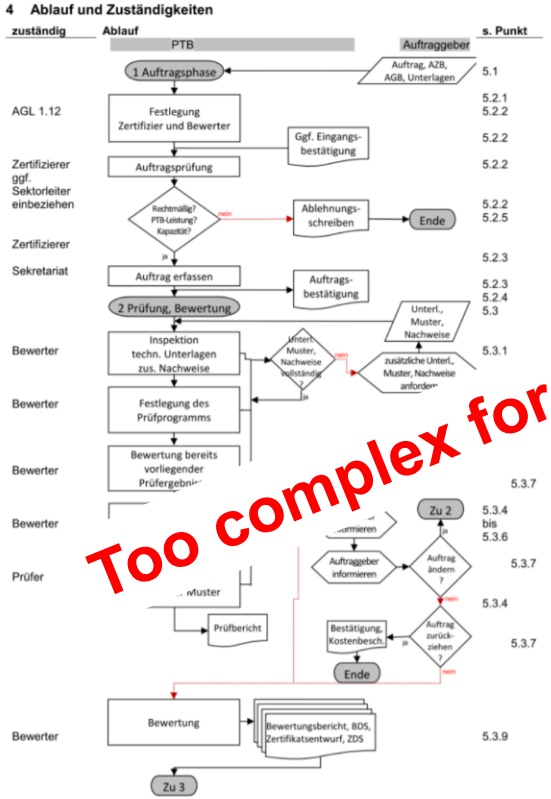


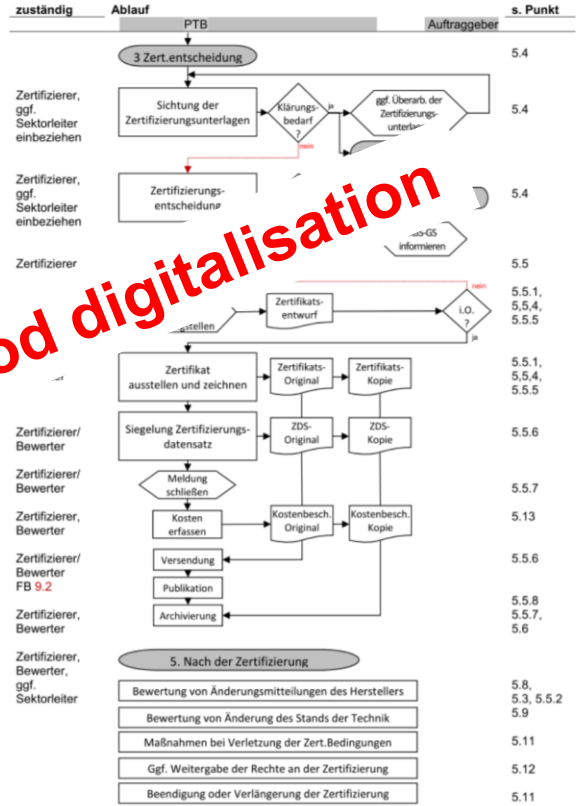
D-SI

Interoperable QI Platform („QI Cloud“)

- Shared databases and digital processes
- Interoperable and machine-readable certificates, standards and reports
- Interfaces to digital twins
- Interfaces for digital business models

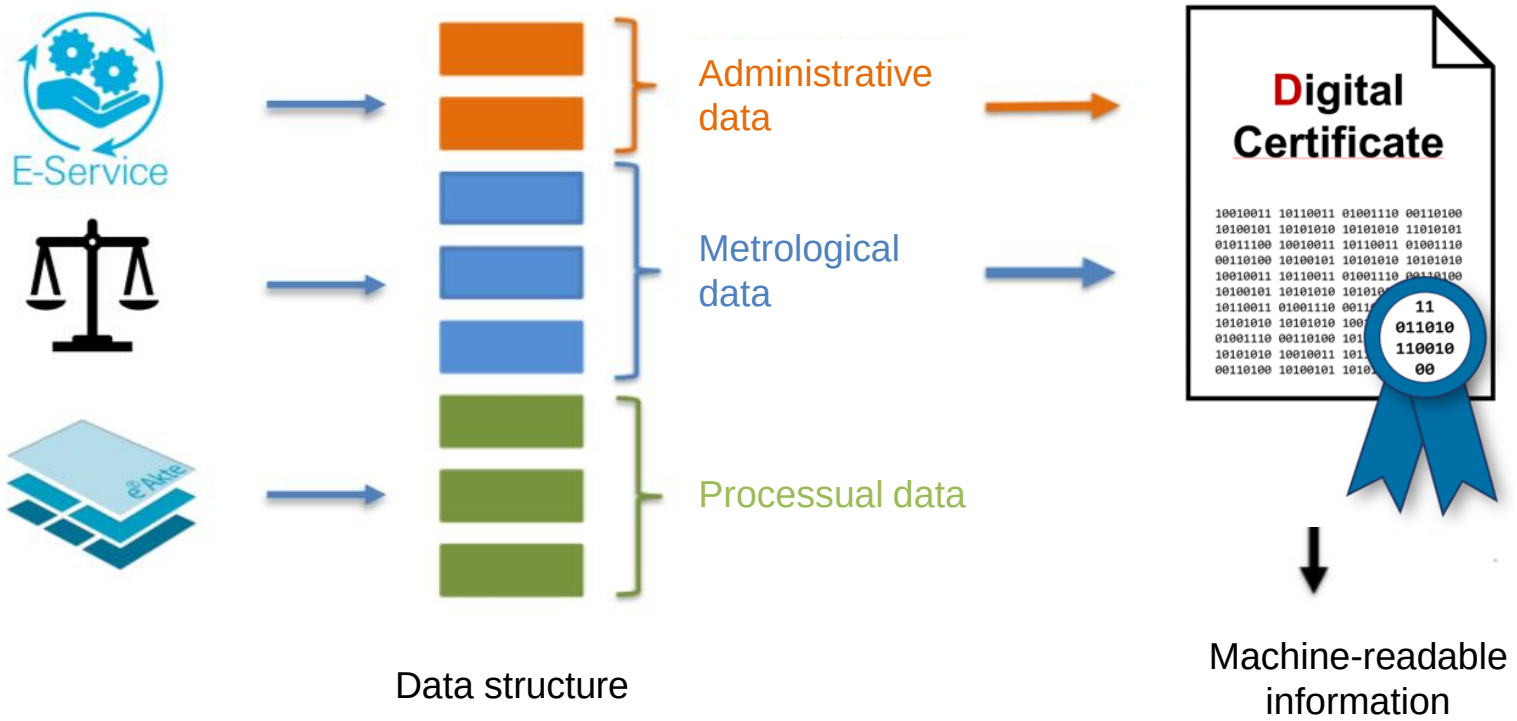
Harmonisation of processes





Too complex for good digitalisation

Building a digital certificate



PTB Digital Strategy: guiding principles

- Ensuring the uniformity of measurements in a digitised world and confidence in data and algorithms
- Metrology as anchor of trust in Open Science and data-driven research
- Holistic approach for the treatment of measuring instruments and measurement data

Outline

1. Trust and confidence in data and algorithms
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3. Digital transformation in the quality infrastructure
4. **EURAMET Digital Strategy**

Digital Strategy: mission statement

- Foster uptake of digital tools, services and processes amongst its members
- Oversee the digital transformation of metrology and industry and connect the individual developments to a harmonised approach
- Engage with external parties in relevant areas to establish metrological principles for data quality

Overall aim

EURAMET to take the lead in the digital transformation of the European quality infrastructure

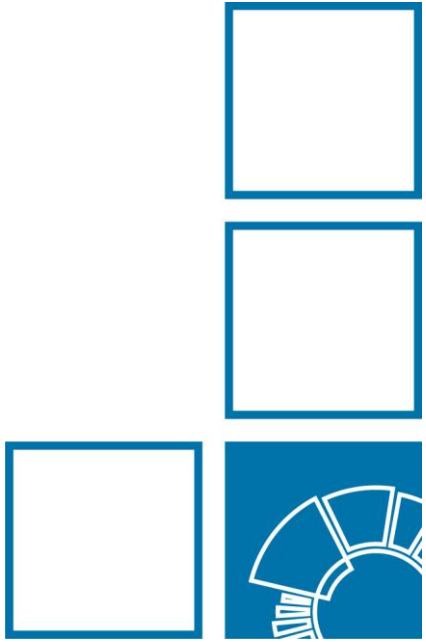
Digital strategy: implementation

- EURAMET TC-IM for coordination with WG “Metrology for digital transformation” (M4D) as “think tank”
- Dedicated projects in TC-IM for specific implementations and tasks under the coordination of WG M4D
- EURAMET TCs for field-specific expertise and developments
- EURAMET EMNs for topics driven by a clearly identified and coherent stakeholder community

Facts and figures 2020 - WG4D

“Future” topics

- End-to-end digital processes
- Machine-executable certificates and standards
- Cloud infrastructures in industrial and legal metrology
- Virtual measurements and simulations
- Digital sensors in large heterogeneous networks
- Machine learning and artificial intelligence



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