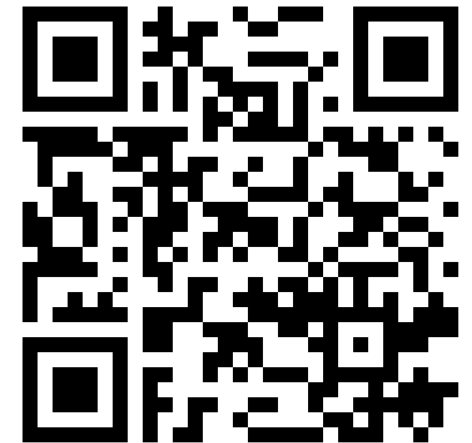


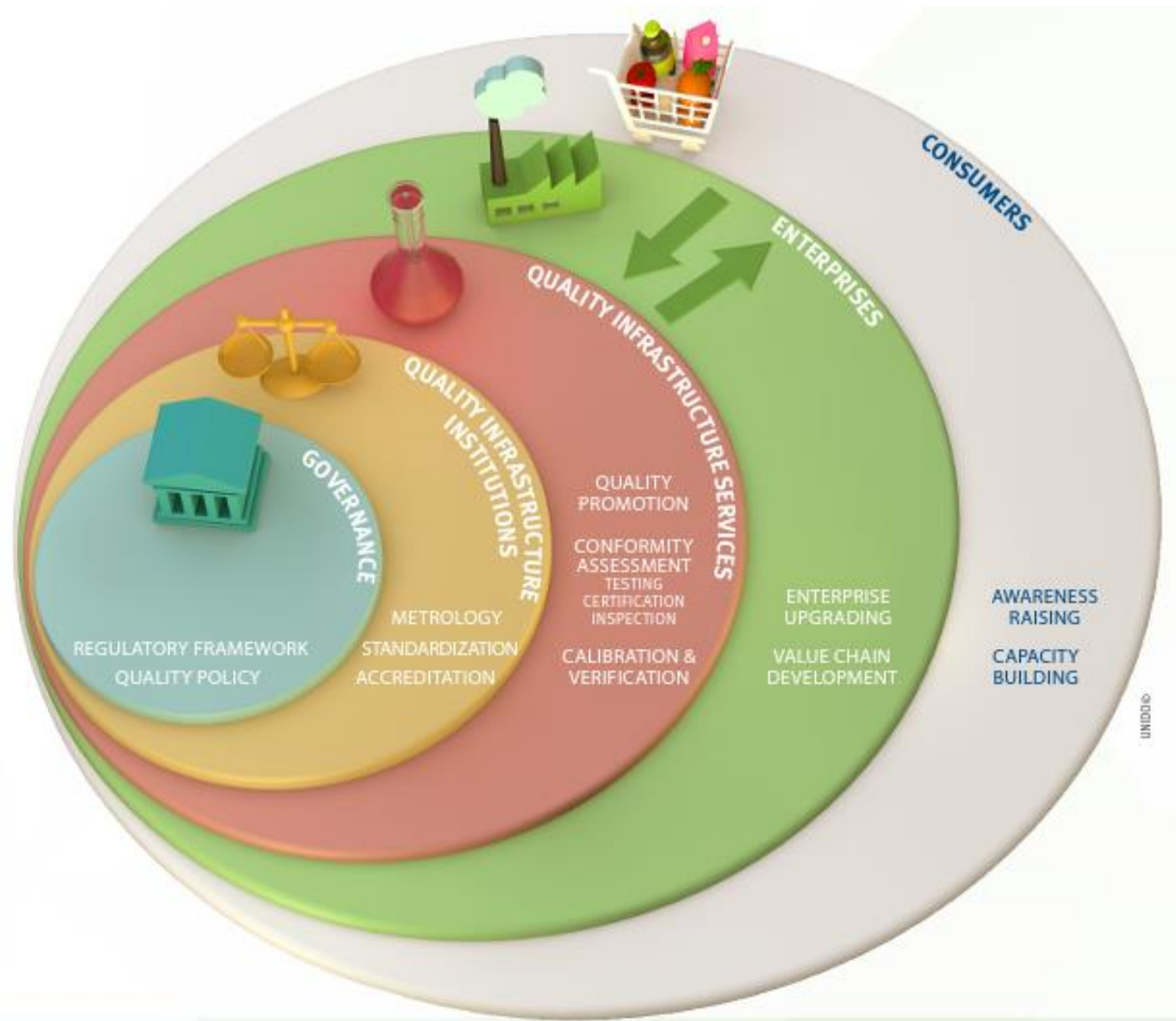
# Quality Infrastructure for Digital Transformation

2023-10-02, Hugo Gasca, CENAM



Ministério do Desenvolvimento,  
Indústria, Comércio e Serviços





# Digital Transformation

Progress	Want Music?	Want Calibration?
manual	hire musicians	manual paper certs
analog	records, tapes	automated paper certs
digitized	compact disc	PDF certs (mostly)
digitalized	tagged MP3 files	?
digitally transformed	Pandora, SiriusXM	?

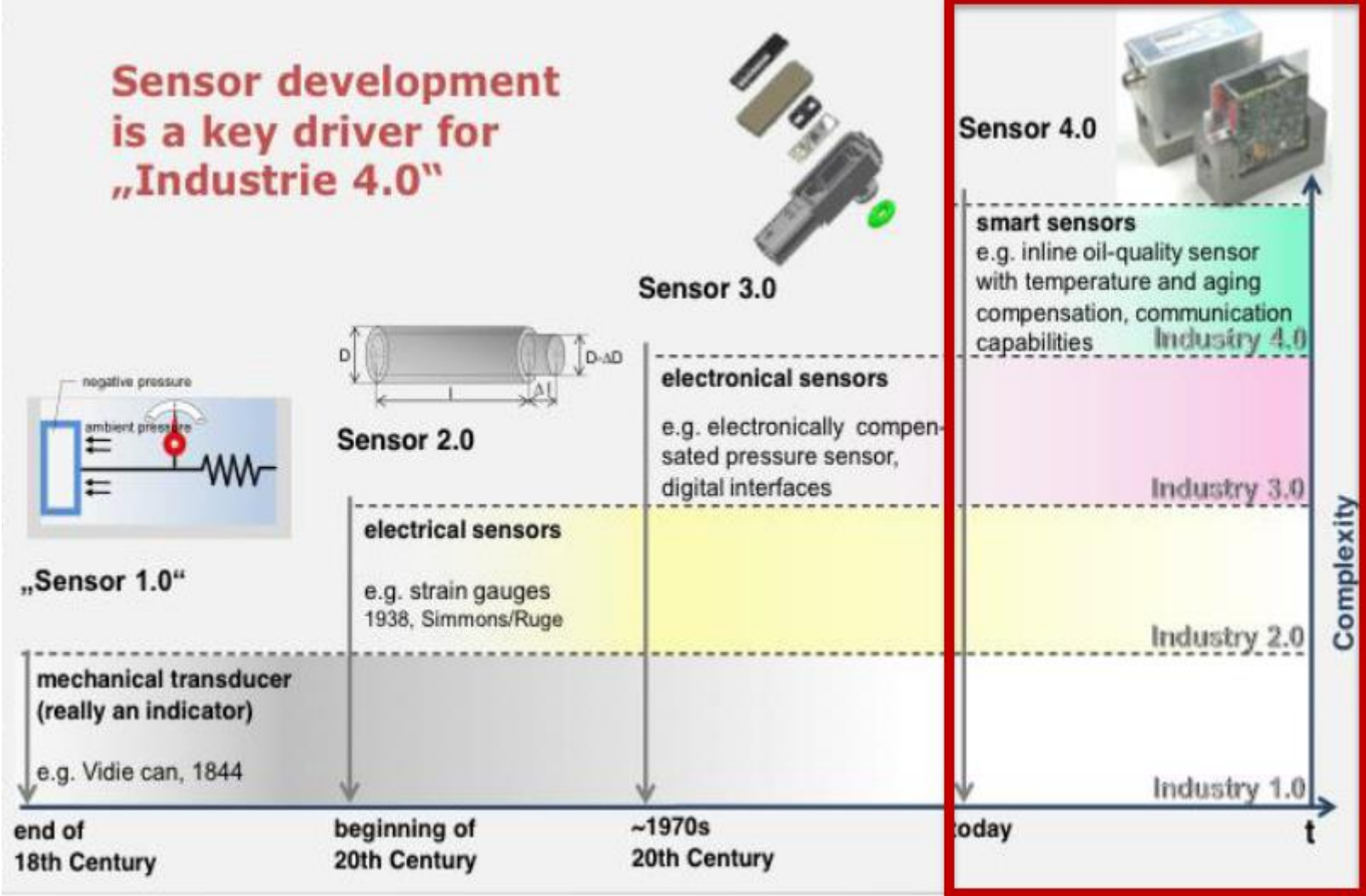
+48 file formats: WAV, AIFF, APE, WV, M4A, MPEG, SHN, WMA, MP4, ...

Spotify, Alexa, ...?

MII, DCC, ...

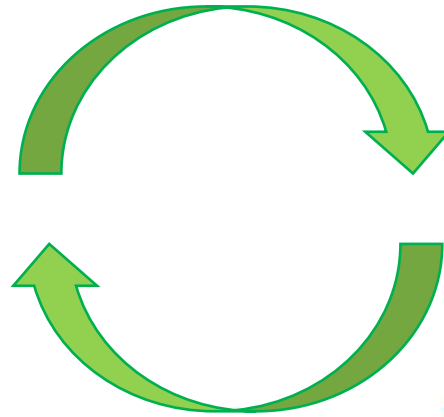
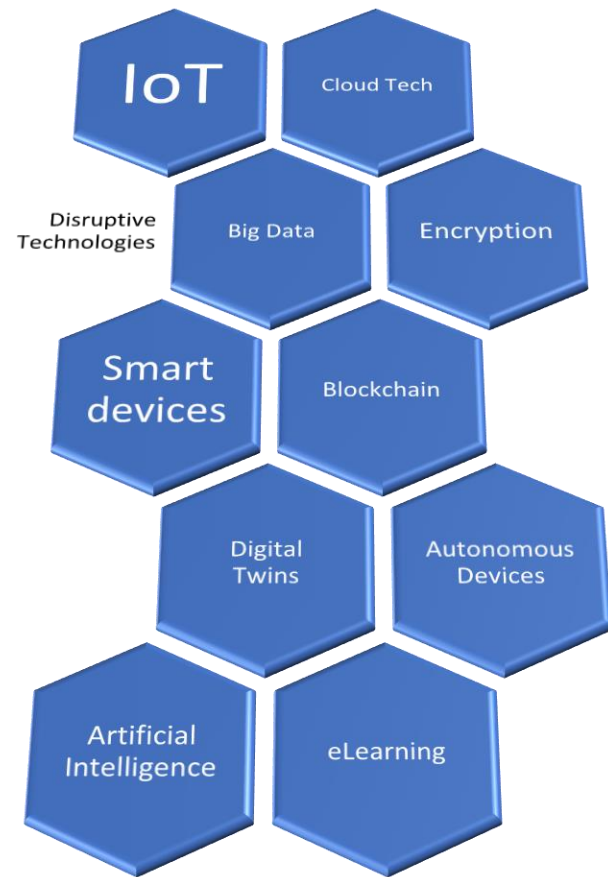
Adapted from: Mark Kuster @ 2021 NCSLI Workshop & Symposium

# Digitalisation in measurement



Source: P. Krause, FirstSensor GmbH, BMBF-Expertengespräch, 28.08.2014

# M4DT & DT4M



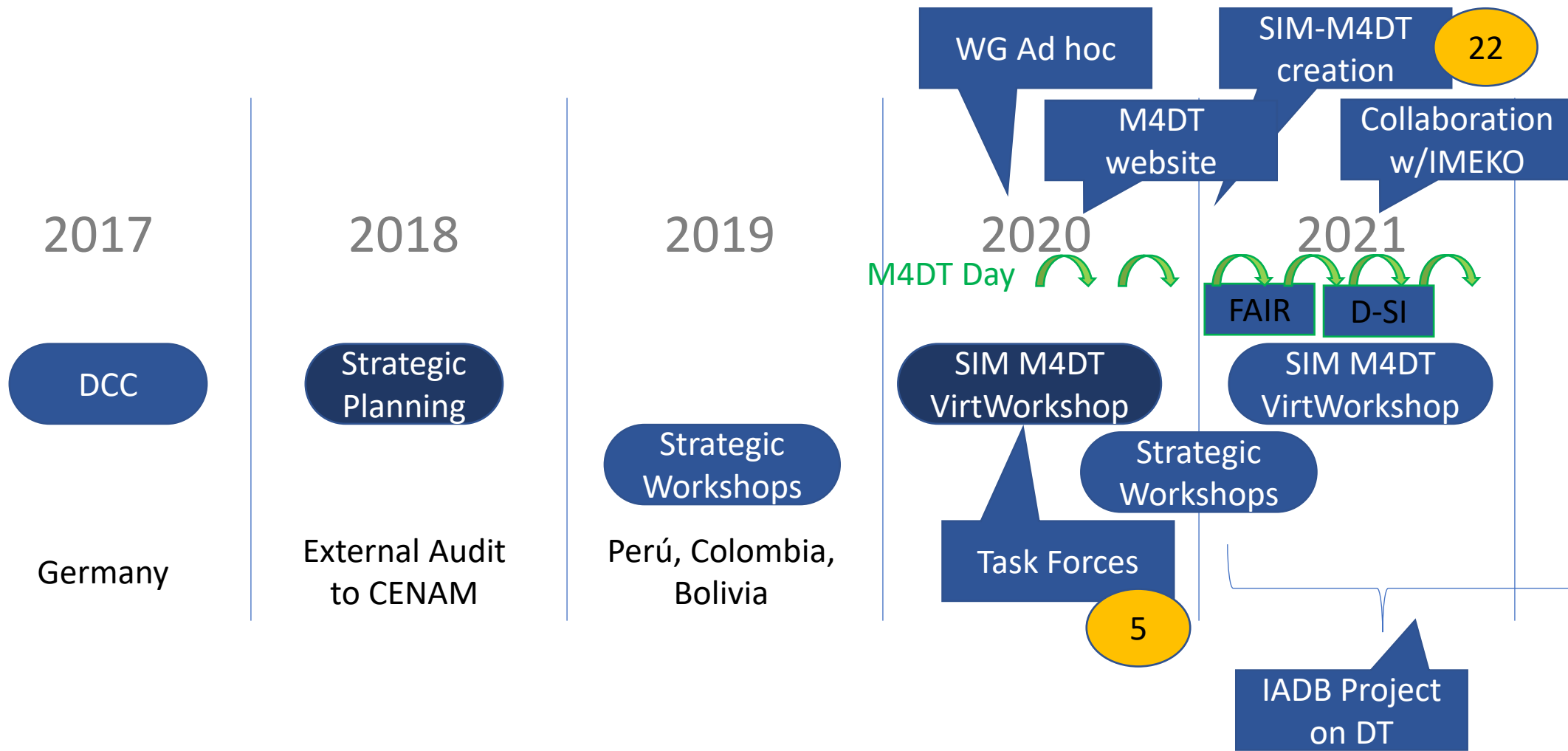
<https://www.metalmecanica.com>

[Jimb.Stanford.edu](http://Jimb.Stanford.edu)

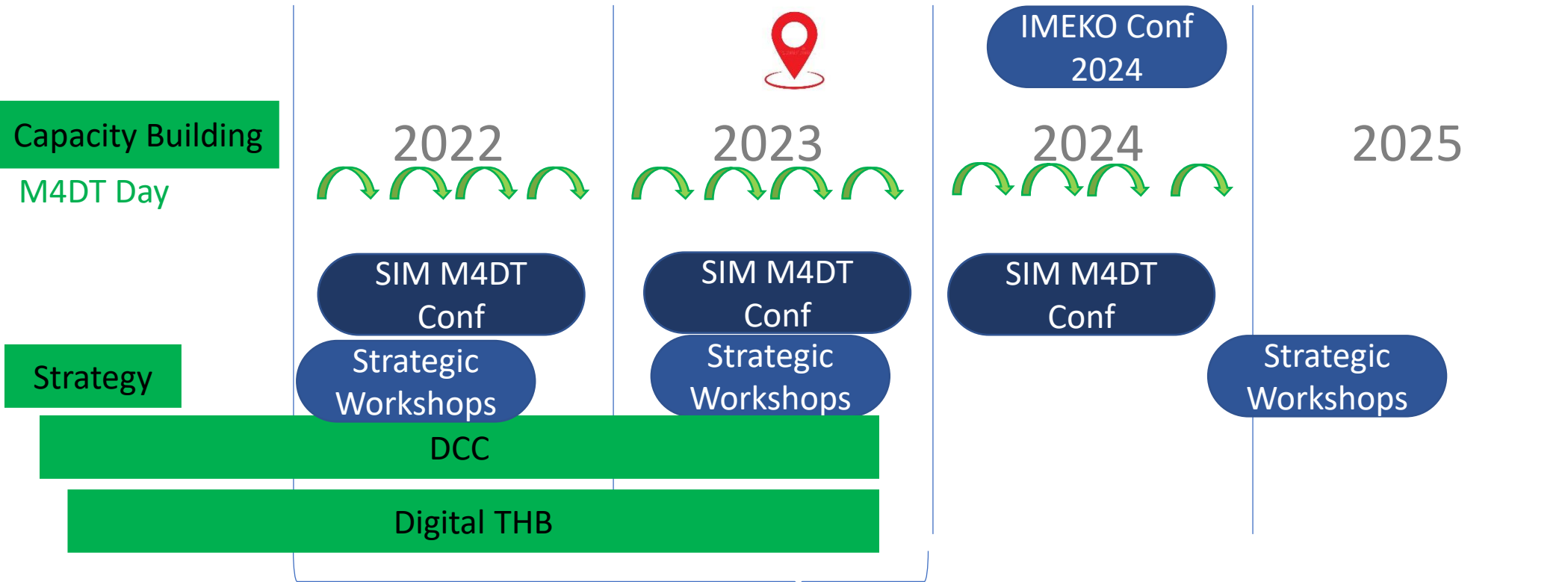
[www.nist.gov](http://www.nist.gov)

<https://www.bestreviewguide.in/metrology>

# Background



# Background

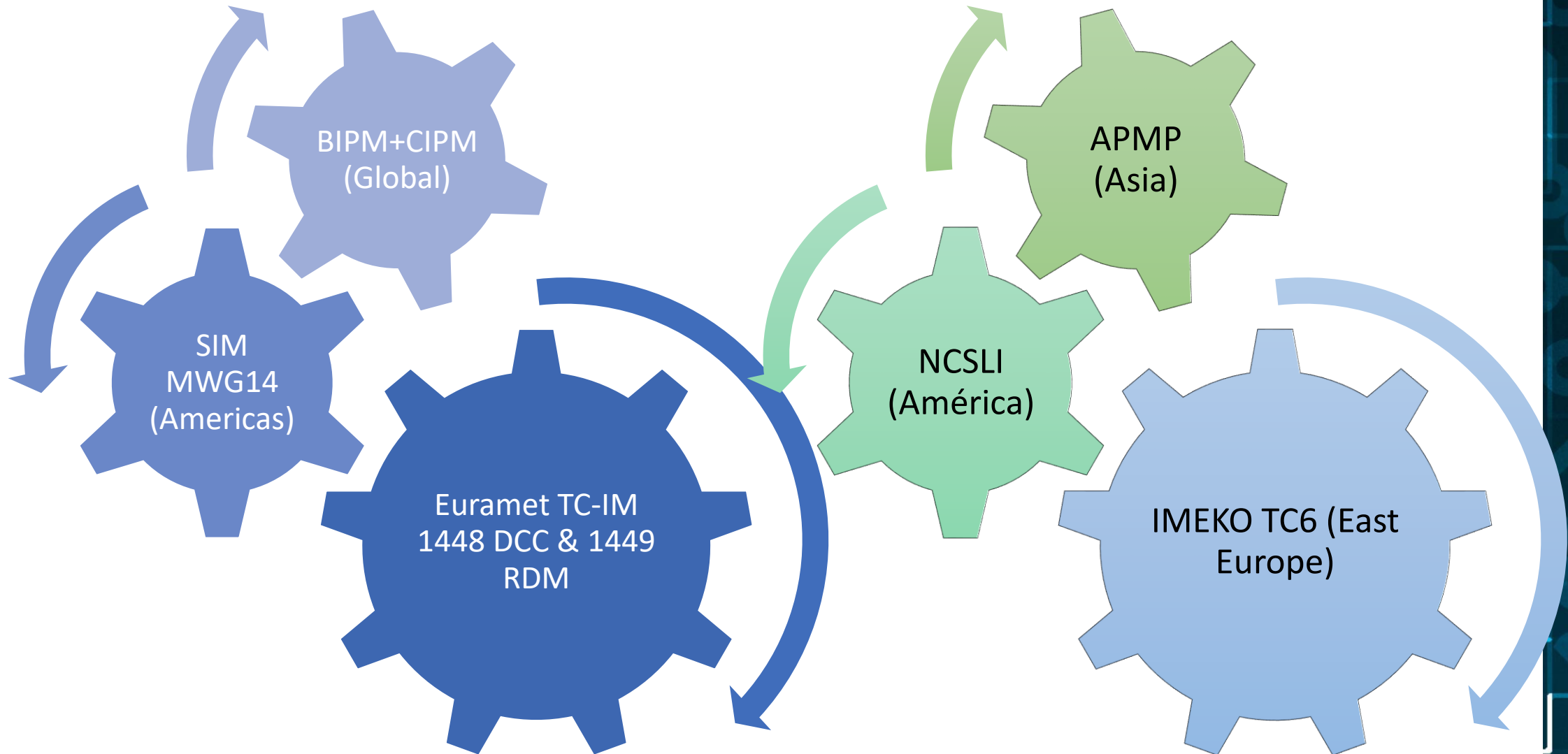


<https://www.cenam.mx/m4dt-sim>

IADB Project



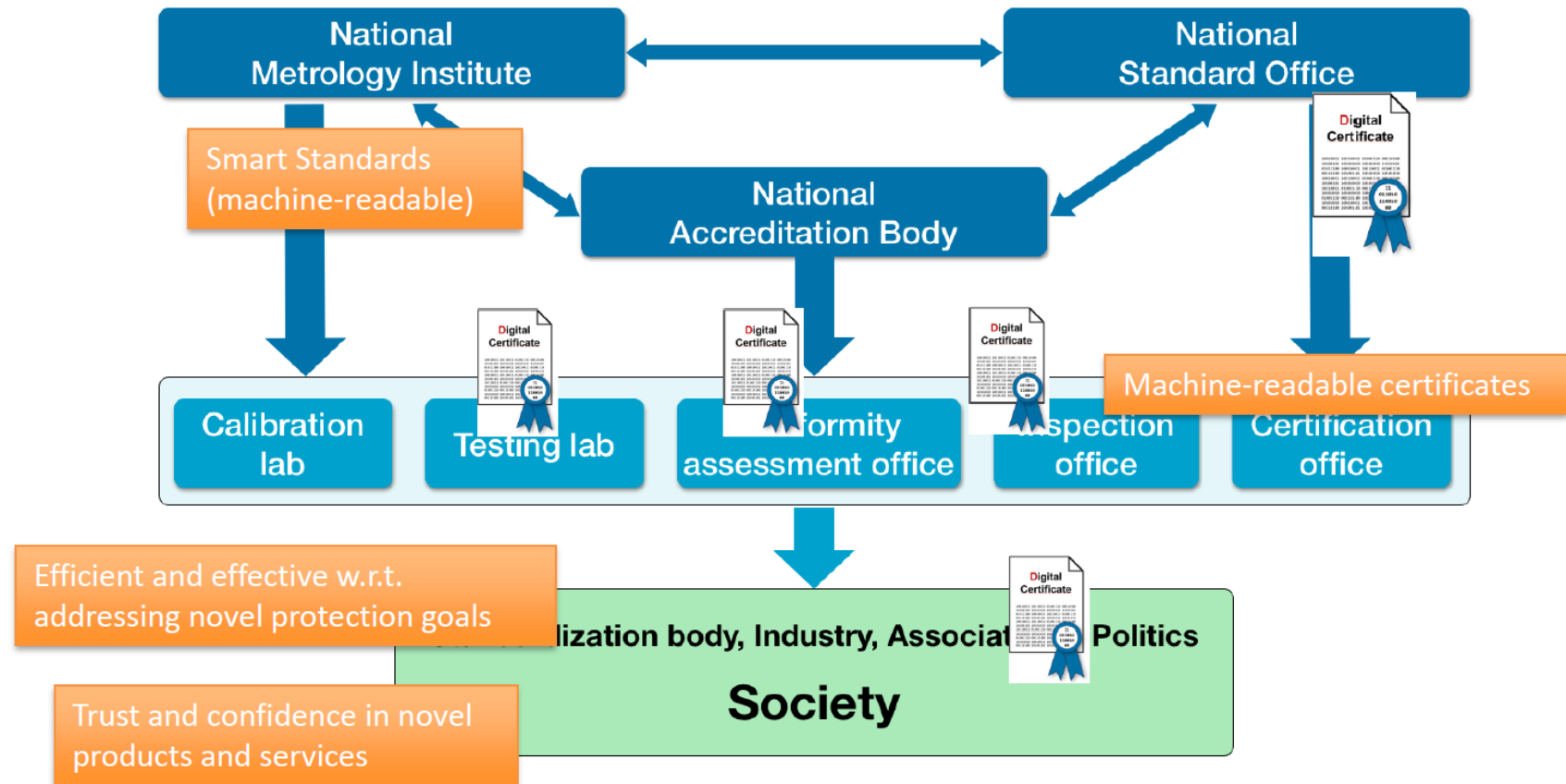
# M4DT a Global Movement





# DCC Vision (2017)

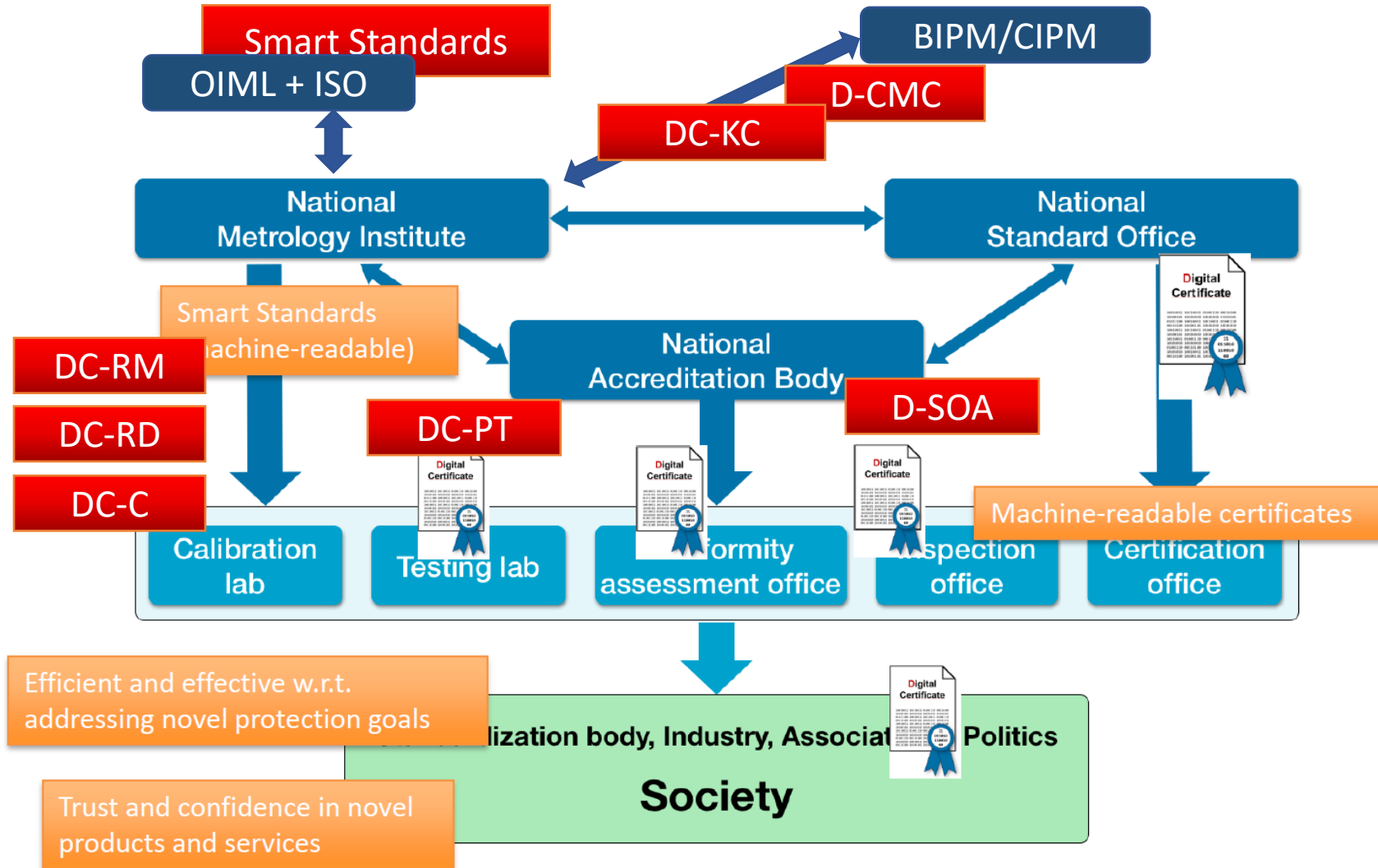
## Calibration



Source: Adaptation from Guasch et al., Quality Systems and Standards for a Competitive Edge, The World Bank, 2007 by Frank Hartig, PTB, 2017.

# SIM Integrated Vision on DT (2022)

## Digital Certificates for Metrological Services



# Levels of Digitalization

## machine-to-machine communication

<https://www.din.de/resource/blob/801106/0251eb1280a9a97e53285d42d3bf1fea/whitepaper-idis-en-data.pdf>

5 degrees of digitalization for **Smart Standards** (ISO/IEC)



Level 1

**Digital document**

Digital representation



Level 2

**Machine-readable document**

Structured document format

Software processing with high manual workload



Level 3

**Machine-readable and -executable content**

Content completely (semantically) discovered

Semantic search and selective access on content level

Earmarked information delivery across several documents



Level 4

**Machine-interpretable content**

Information models describing and explaining the content and the relationships between items of information

Self-learning analysis together with automatic validation and optimization

Value-adding services possible e.g. conformity check, question answering, predictive content supply

Fully integrated digital value chain is possible



Level 5

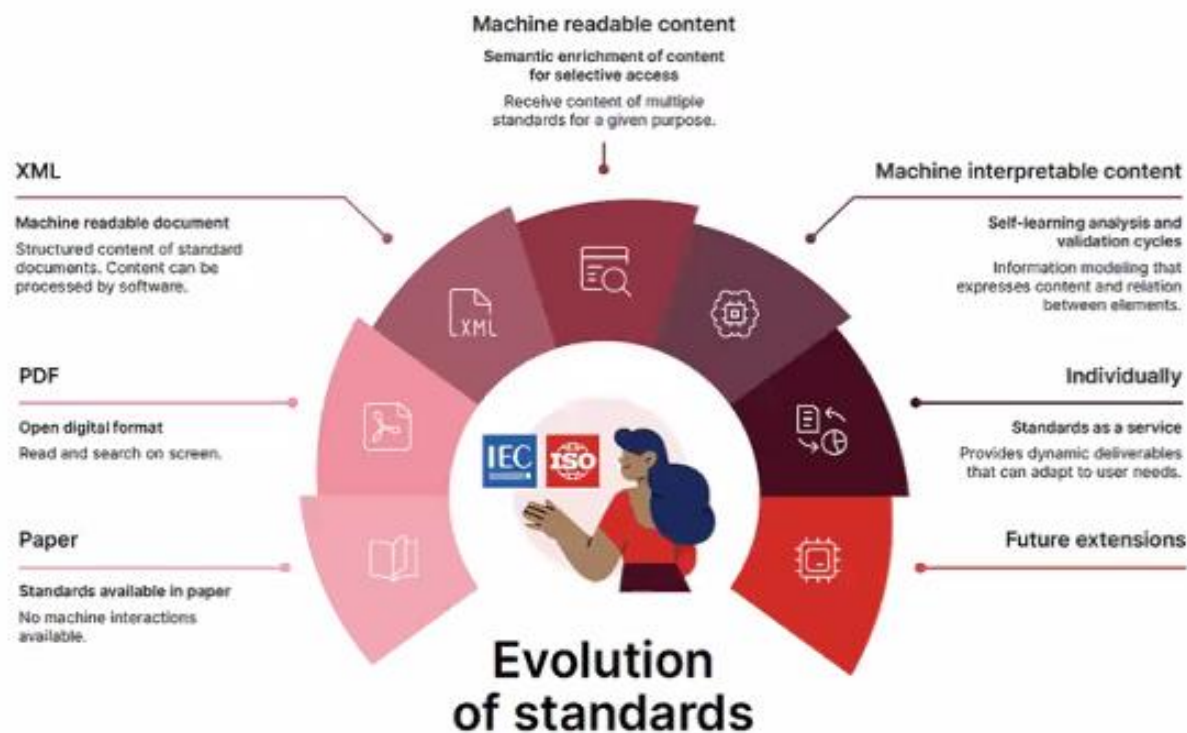
**Machine-controllable content**

The content of a standard is amended automatically and adopted by automated decision-making processes.

Digital standards are based on a system of artificial general intelligence with cognitive capabilities.

Digital standards adapt constantly to the current state of the art of technical and regulatory framework conditions.

# SMART programme timeline



## Ecosystem stakeholders:

- Members
- Technical Committees
- Academia, YPs
- Governance Groups
- Users
- Developers
- Organizations



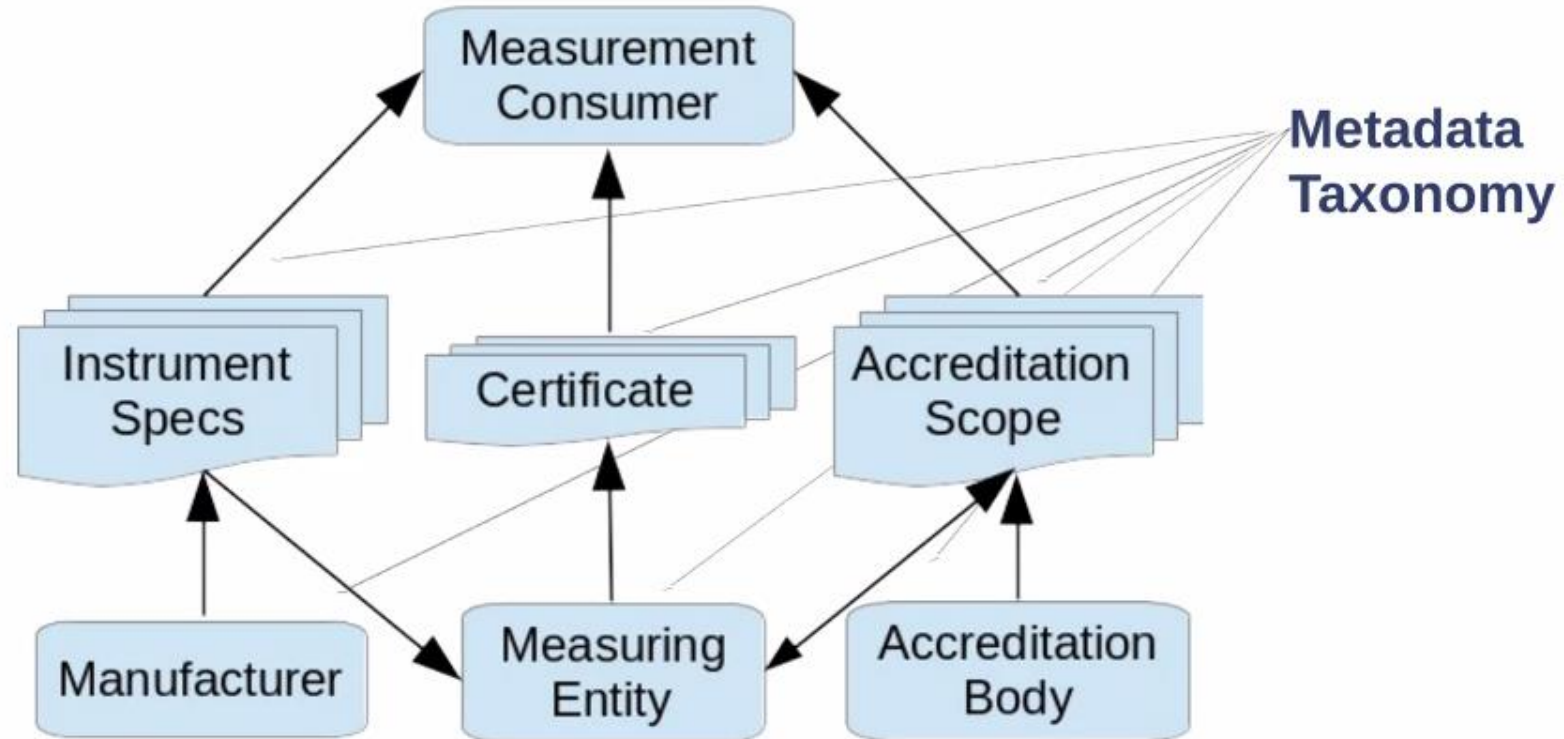
# IEC/ISO SMART Pilots landscape

IEC and ISO partnering with members are initiating pilots to test addressing market needs with SMART standards as well as assessing potential data complexities.

Pilots Sector	Pilot 1 Quality	Pilot 2 Sustainability	Pilot 3 Cybersecurity	Pilot 4 Content types (DBs+Vocab)	Pilot 5 SG12 (SIM, API)	Pilot 6 Electric Utilities	Pilot 7 Automotive	Pilot 8 PEMs devices	Pilot 9 Construction	Pilot 10 SMART authoring
Pilot Objectives	Testing Standards Complexity and Variability in the transformation to a SMART standard.			Testing foundations for SMART: Technology, Vocabulary, Terminology, & Topics		Testing Member and End-user Requirements; Roles & Responsibilities				
Member(s)	Multiple (SSC, SCC, SIS, NEN, UNI)	Multiple (SSC, SIS, ABNT, UNI)	Multiple (SSC, SIS, NEN, ABNT)	Multiple (SN, SIS, NEN, ABNT)	Multiple +BIPM	NEK	DKE	BSI	AFNOR	DIN
L-Led S-Supported	ISO (L) IEC (S)	ISO (L) IEC (S)	ISO (L) IEC (S)	ISO (L) IEC (S)	IEC (L) ISO (S)	IEC (L) ISO (S)	IEC (L) ISO (S)	IEC (L) ISO (S)	ISO (L) IEC (S)	ISO (L) IEC (S)
Standard(s)	ISO9000 ISO9001 ISO9002 ISO9004 ISO29001	ISO14001 ISO37101 ISO50001 ISO20121 IWA 42	ISO/IEC27002 ISO/IEC27011 ISO/IEC27019	ISO3166 Guide 73 Guide 2	Multiple / All +ISO/IEC80000	P1: IEC61968-4,13, IEC61970-600-2,452, 456 P2: IEC61970-302,453,501,552,IEC61970-600-1	P1: IEC62196, IEC62660	P1: IEC 60601-1,2-24 ISO13485, 14791 P2: IEC62304, 62366	ISO23386 ISO23387 ISO12006-3 ISO16739-1	ISO25119-1 ISO25119-2 ISO25119-3 ISO25119-4
IEC/ISO Use Case	UC259; UC250; UC217; UC226; UC252; UC253; UC219			UC249; UC222	Multiple / All	UC218; UC217,226; UC262; UC229;	UC262; UC217,226; UC222; UC218; UC229; 221	Modularity and Granularity	UC247; UC249; UC252; UC254; UC262; UC218; UC222	UC222, UC217,226

# The Measurement Economy

Data  
Modeling  
Principles



Source: NCSLI MII & Automation Committee.

# Advancements in the Region

- Automation of Massive Calibrations
- Continuous Monitoring of Smart-Meters
- Integrated Plataforms Customer Oriented
- Cybersecurity and Authentication of Information
- Artificial Vision in Laboratories (OCR +)
- New Metrological Services with digital component
- Digital Twins