4th International DCC-Conference

2024-02-27 to 2024-02-29

Proceedings

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Agenda and Chairpersons

2024-02-27 (Tuesday)

UTC	2024-02-27 (Tuesday)	
12:00	Welcome (Carlos Galván, Cornelia Denz, Siegfried Hackel)	
12:30	#001 What is the M-layer aspect? (Blair Hall, Measurement Standards Laboratory of New Zealand (MSL))	
13:00	#002 The D-SI metadata model for an interoperable scientific and quality infrastructure (Daniel Hutzschenreuter, PTB)	
13:30	Break	
	Quality Infrastructure I (Chair: Alexis Valqui)	Interoperability Schema (Chair: Robert Hanisch)
14:00	#003 DCC2GO - Supporting the implementation of Digital Calibration Certificates in the European metrology community (Anke Keidel, PTB)	#009 Toward standardized language and structure for machine interpretable DCC's (David Balslev-Harder, DFM)
14:15	#004 Ten years of TraCIM – A celebration of modern software and data testing for digitalization (Daniel Hutzschenreuter, PTB)	#010 Proposal to improve the interoperability of the DCC (Diego Coppa, INTI)
14:30	#005 Digital Calibration Certificates within QIF, the Quality Information Framework (Jacob Brooks, UNC Charlotte)	#011 "Good Practice" conventions for DCCs for Weights and NAWIs from respective DKD working groups (Julian Haller, Sartorius)
14:45	# 006 Quality-X MVD: A Minimal Viable Dataspace For Quality Infrastructure (Mehran Monavari, BAM)	#012 Toward a measurand taxonomy for interoperable measurement data (Mark Kuster, NCSL International)
15:00	# 007 Digital Calibration Certificate in a quality infrastructure data space: a proof of concept (Tomasz Soltysinski, PTB)	#013 Harmonisation of DCCs in DKD (Thomas Krah, PTB)
15:15	# 008 Recent advances regarding machine-actionable information and data in the quality infrastructure (Talaat Al-Rahali, NMCC)	#014 DCC interoperability: a pilot study looking at implementation approaches across four Asia-Pacific NMIs (Anjali Sharma, NPLI)

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2024-02-27 (Wednesday)

UTC	2024-02-27 (Wednesday)		
12:00	#015 Special Session: Formulas in DCC (Siegfried Hackel, Aldo Adrian Garcia Gonzalez, Justin Jagieniak)		
13:00	#016 GEMIMEG-II – From Digital Calibration Certificates to Interoperable Trustchains for the IOT Landscape (Thomas Engel, Siemens)		
13:30	Break		
	Tools & Sofware I (Chair: David Balslev-Harder)	Industry Applications (Chair: Aldo Garcia)	Schema (Chair: Thomas Krah)
14:00	#017 Machine accessible storage of RefTypes with TemaTres (Muhammed Ali Demir, PTB)	#023 Serializing uncertainty to enhance traceable measurements (Blair Hall, Measurement Standards Laboratory of New Zealand (MSL))	#029 What`s New in the DCC Schema Pre-Release v3.3.0-rc.1 (Benjamin Gloger, PTB)
14:15	#018 The practicality of extracting data from a DCC – development of an interpretation and demonstration tool (Jonas Emil Vind, DTI)	#024 Rounding of results in the DCC (Christian Müller-Schöll, Mettler-Toledo)	#030 DCC conversion, schema validation and accessibility control process (Praiya Thongluang, NIMT)
14:30	#019 How to handle DCC data: the DCCSearch Tool (Gamze Söylev-Öktem, PTB)	#025 Automated Generation and Utilization of accredited temperature DCCs (Michael Melzer, BAM)	#031 Developing the DCC Ontology: A Progress Report and Methodological Insights (Moritz Jordan, PTB)
14:45	#020 Implementation of Management and Calibration Software Data Digitization and Reflections on FAIR Principles in Laboratory Routine (Igor Fernando Modesto Garcia, LABPROSAUD)	#026 Consumer-centric data mapping in temperature DCCs (Sinisa Prugovecki, LorisQ One)	#032 The Digital NIST: Update on the Digital Transformation of Reference Materials (William Dinis Camara, NIST)
15:00	#021 Case study of digital certificate using various formats suitable for the transitionperiod from paper to digital form (David Mahovský, CMI)	#027 Use case of digital calibration certificate implementation at VW Mexico (David Alberto Guevara Huerta; Cesar Luis Niño Gómez, VW Mexico)	#033 Development of digital calibration certificates for coordinate metrology applications (Katharina Janzen, PTB)
15:15	#022 Python-based development libraries and Web Applications to process array-like DCC data using a internal JSON representation (Benedikt Seeger, PTB)	#028 Machine interpretable DCC structure exemplified for pipettes (Søren Kynde, DFM)	#034 Digital Certificate of Conformity as the Key Means for the Digitalization of Certification (Tatyana Sheveleva, PTB)

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2023-02-29 (Thursday)

UTC	2024-02-27 (Thursday)		
12:00	#035 Pilot Implementation of DCC at primary acceleration laboratory at CENAM (Aldo Adrian Garcia Gonzalez, CENAM)		
12:30	#036 DCC creation and transmision using blockchain technology (Inga Urbina and Jens Leinhos, Keysight Technologies)		
13:00	#037 UN/CEFACT update on interoperable conformity data exchange in a digital quality infrastructure (Brett Hyland, NATA)		
13:30	Break		
	Tools & Sofware II (Chair: Jakob Fester)	NMI Use Cases (Chair: Diego Coppa)	Quality Infrastructure II (Chair: Jariya Buajarem)
14:00	#038 PyDCC (Andreas Tobola, Siemens)	#044 Reporting on the achievements of issuing digital calibration certificates at NMIJ, AIST (Domae Atsushi, NMIJ)	#050 Use Case “eAttestation” (Kerstin Rost, DAkkS)
14:15	#039 GEMIMEG Tool Advancements (Muhammed-Ali Demir, PTB)	#045 Interlaboratory Comparison in Ionizing Radiation Metrology: Challenges to Fair Principles and 4.0 Technology Absorption (Eric Matos Macedo, IRD/CNEN)	#051 Real or fake? - Trust is good, proof is better… (Robert Hilgers, D-Trust)
14:30	#043 Global Web platform for DCC at CENAM (Armando Lopez-Celis, Itzel Mendoza; CENAM)	#046 TUBITAK UME Digital Metrology Pilot Project and Dissemination to Turkiye (Erkan Danacı, TUBITAK)	#052 A new Era for Measurements: The DCC makes Tolerances superfluous (Christian Müller-Schöll, Mettler-Toledo)
14:45	#041 Generating a Torque Digital Calibration Certificate (DCC) according to DIN51309 using Python (Kai Mienert, PTB)	#047 An Integrated Digital Calibration System for Frequency Source Calibration at SNSU-BSN (Marizsa Rahima Indra, SNSU-BSN)	#053 Importance of open exchange of data in DCC-based calibration processes (Tuukka Mustapää, Beamex)
15:00	#042 Parameter Extraction from Digital Calibration Certificates for Sensor Data Quality Analysis (Tim Ruhland, Siemens)	#048 Recent advances regarding machine-actionable information and data in the quality infrastructure of BSTI Bangladesh (Md. Abdullah Al Mamun, BSTI)	#054 Making QI data available for research (Ulrich Harmes-Liedtke, Mesopartner and TU Berlin)
15:15		#049 Interactive Session collecting Use Cases among participants	#055 Realising the benefits of digital calibration data: a dialog between disciplines (Vashti Galpin, University of Edinburgh)
15:30	Closing Session (Chair: Carlos Galvan)		

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PTB Welcome

Presenting author: Cornelia Denz, President PTB, Germany

Presentation of Cornelia Denz

Dear Ladies and Gentlemen,

It is a great pleasure welcoming you to the 4th International Conference on the Digital Calibration Certificate - DCC number 4 - and especially, I am happy that you have joined the digital conference site of Physikalisch-Technische Bundesanstalt(PTB). The conference will be attended by more than 1000 participants. Last year, in my welcome speech on the occasion of the 3rd DCC conference, I referred to the German saying “Aller guten Dinge sind Drei” – all great things come in three. It is a great pleasure to open today the fourth edition of this extremely successful conference series.

Four is the number of wholeness and thus is more than ever an allegory to this year’s DCC conference.

Four embodies the four weeks of the month, the four elements, or the four basic states of matter. And in about four weeks we will welcome the first of the four seasons, eagerly awaited spring. Four also stands for the seldomly found four petals of the clover leaf, which is in almost all cultures believed to bring luck, since each of it symbolizes an aspect of live: hope, faith, love, and luck.

Maybe the most important metaphor today for our number 4 is the compass, with the four celestial directions marking the relevant directions of the compass itself.

A compass provides orientation, it helps to find the right path, be it the path to a goal or the path to success. Today, a compass also stands for orientation in a rapidly changing world, because the multitude of demanding technological and social challenges requires a strong moral stance - especially against war, violence and threats to democracy - on the one hand, and a scientific attitude to develop our future in the best technological way on the other.

You might also describe this situation symbolically as sailing in rough seas. For many people, a compass therefore also stands for protection, guidance, and safety. In a way, the "Digital Calibration Certificate”, the DCC, also represents such a compass: it is our guidance with respect to the upcoming challenges associated with the digital transformation in metrology and with the future of digital certificates.

Ladies and Gentlemen,

Let me illustrate this role for the digital calibration certificate with a few timely national projects that show future directions of the DCC within a full digital quality infrastructure:

First, the implementation of the DCC is strongly connected to the future of the Digital Product Passport - the DPP - one of the key elements of a future fully circular economy. While the DCC provides information on sensors or complex measuring devices, ensuring a high quality of a measurement based on traceability to international standards and thus stands for quality assurance and trust, the DPP includes the full life cycle perspective.

Second, these certificates represent important elements on industry 4.0’s goal to image machines and systems in all their processes of manufacturing, and are effectively united with the asset administration shell, ASS, which in turn is implemented into practice by the InterOpera project in which researchers and in-dustry are developing together standardized methods for ASS - and thus also for the DCC and the DPP.

Third, the national flagship project GEMIMEG, funded in its second phase by the Federal Ministry for Economic Affairs and Climate Action, brought the DCC into the focus of various areas of metrology including mechanical measurands like torque and lengths, acoustic as well as thermodynamic and electrical measurands, thereby reaching clearly its goal to create secure and robustly calibrated measurement tools for the digital transformation, and to significantly in-crease cooperation und participation of industry. Also, the national harmonization process for the DCC was intensified by the Germany Calibration Service, DKD.

Forth, the project Quality Infrastructure Digital (QI Digital), another flagship of the Federal Ministry for Economic Affairs and Climate Action, just recently finished its second Forum Conference in October 2023. It was centered around the future of digital quality certificates. Over two days, 500 enthusiastic participants including high-ranked international speakers from industry and science, from associations and politics, discussed the pressing issues of international harmonization of the digital quality infrastructure.

For me, the most important progress of Quality Infrastructure Digital is manifested by the implementation of real applications for industry. Especially sand box realizations that combine digital quality infrastructure with smart approaches in additive manufacturing, hydrogen fueling stations, and medicine instrumentation, were particularly tangible.

More and more industrial production steps are today controlled by intelligent and AI-supporting computer algorithms. The interaction of machines as well as the use of digital twins has already been established in industry 4.0.

Smart interaction between people and machines within a sustainable environment will determine the future of digitization of industry, and is often referred to as industry 5.0.

As a consequence, the quality of data and databases is becoming increasingly important in such intelligent digital applications. Digital quality documents boost the transformation of the classic quality infrastructure into the digital world, and are key elements to strengthen the German industry and economy in digital transformation.

In a changing perspective, the DCC is thus no longer a simple calibration certificate. With respect to the different types of digital quality infrastructure documents, the structure and format of DCC represents the blueprint for those Digital Quality Documents (DQDs). Thus, the DDC can be considered as a foresight instrument, thinking calibration certification in a new, integrated way.

For this vision, the current version of the DCC needs to be adapted, becoming also suitable for all other quality data document schemes. However, the needle of the compass already points clearly to the desired destination.

Dear Ladies and Gentlemen,

today, it is more important than ever to use the digital transformation as an opportunity to shape the world of tomorrow responsibly and reliably, while acting in an energy-efficient, environmentally friendly, and sustainable manner.

Since product quality and safety do not stop at the borders of nations, only an internationally shared understanding of the quality and safety of products will establish trust and promote digital innovation worldwide. Thus, an international harmonization of the digital quality infrastructure will be of utmost importance.

Also, in this area, the past year has witnessed a tremendous progress.

On the European level, the EURAMET Technical Committee on Interdisciplinary Metrology - TC-IM - has established the working group on 'Metrology for Digital Transformation' (WG M4D), and is bringing together the expertise of EURAMET Members in data management, digital processes, digital certificates, as well as in the internet of things including sensor net-works.

The working group aims to establish a continuous collaboration and exchange on digital transformation with corresponding bodies and organizations within the European quality infrastructure as well as with engaging external partner countries to promote metrological principles for data quality.

For this latter reason, The Global Project Quality Infrastructure (abbreviated GPQI) was established in 2017 on the initiative of the Federal Ministry for Economic Affairs and Climate

Protection (BMWK) with the aim to engage in international cooperation and international dialogue on the harmonization of quality infrastructures with important trading partners outside Europe such as Brazil, China, India, Indonesia and Mexico. This cooperation also extends today to Canada and the United States.

GPQI facilitates a special format of bilateral political and technical dialogue bringing together different stakeholders from different nations. As an example, recently, on November, 30th, 2023, experts from the Bureau of Indian Standards (BIS) and TÜV - the German body for technical monitoring within the quality infrastructure, came together to meet with industry representatives. They discussed the role of standards in the digitized world in order to create a safe place for industry and consumers. The need for strong cybersecurity has been identified as an increasingly relevant international issue, playing a key role in the development of solutions for a digitized, resilient, and safe digital quality infrastructure.

I also like to mention the strong role of the “Digital Transformation” Working Group of the Inter American Metrology System, SIM, which provides support to SIM Working Groups in all fields related to the digital transformation, laboratory automation, cloud technologies, digital certificates and also includes artificial intelligence, smart devices testing, big data processing, machine learning, metrology for IoT, and industry 4.0 projects.

In addition, members of this working group provide support to the national metrology institutes, as well as to local industries of SIM countries in metrological challenges that involve applications of digital transformation.

Finally, the strong activities of the newly founded Forum on Metrology and Digitalization of the CIPM, the Committee International des Poids et Mesures, focusing on harmonization in digital data quality, and emphasizing the international role of the DCC therein as an enabler of the digital transformation in metrology are also worth being highlighted here.

Dear Ladies and Gentlemen,

These four examples of international metrology are also all-encompassing in digitization, and thus also refer to the international digital quality infrastructure, or, more general, to the digital future of international metrology.

In my opinion, these four examples show impressively another meaning of the number 4: it is also referenced to as the perfect number.

The Pythagoreans believed that the Tetrad was a perfect object, since it has four corners. They were convinced that this simple object with all geometrical objects corners (or points), lines, surfaces and three-dimensional forms - symbolized God. In the Pythagorean philosophy, four parts constitute space and life by characterizing the soul: mind – opinion – science – sense.

In a way, these for features are also needed for a concise digital framework.

Therefore, I am utmost happy that this digital conference represents the international metrology community with its more than 100 countries – and I am sure that together, we are strong enough to face the challenges of international and smart digitization of industry and make it more and more perfect.

Challenges of the near future will be numerous. Let me name the measures to develop test procedures for a trustworthy and reliable artificial intelligence, but also ensuring their appropriate inclusion in advanced DCCs that may themselves be utilizing smart analyzing techniques.

Third, the inclusion of digital quality certificates into the EU New Legislative Framework Directive. This framework aims to foster international trade by strengthening accreditation, regulation, market surveillance, and quality labels of products as conformity assessments. It has transformed radically since its adoption in 2008, mainly due to the ongoing digital and green transitions.

Thus, its further development to include digital quality certificates, and develop new quality labels for upcoming smart products and complex value chains is of utmost importance to pave the way for a future secure and robust metrology within a digital world. Our aim should therefore be to incorporate the DCC into use cases and make it applicable.

And finally, as different institutions within the quality infrastructure, we have now the chance, but also the strong obligation to integrate all these needs into a unifying framework for digital data and processes. This includes software solutions for the integration and uptake of FAIR data features – being findable, accessible, interoperable, and reusable – as well as concepts and frameworks for the interoperability in a digital quality infrastructure.

These four actual challenges are the motivation for us to organize this International DCC Conference, which is held naturally as a digital event since its first launch in 2020. The aim was and still is to continuously foster an international framework to bring together stakeholders of the calibration community with those of digital certifications.

In the beginning, I was referring to the compass and how its needle indicates the right directions of development. This is also true for this DCC conference on its fourth edition. This makes it the fourth great opportunity to bring together best practice examples and current advances of the international DCC community from all over the world, but also unite all stakeholders, from NMIs over academia to the different accreditation bodies and industry representatives.

The conference will - and here the circle closes – give a clear compass for the most important challenges of today I mentioned – from reliable AI over international harmonization to methods to prevent cybersecurity.

At the end of my short glimpse on highlights and challenges of DCC, I would like to take the opportunity to express my sincere gratitude to the DCC Core Team at PTB Benjamin Gloger, Thomas Krah and Shanna Schönhals, who did all a tremendous job organizing this huge conference together with Antje Junge and Sascha Eichstädt, who mastered perfectly the technical infrastructure as well as Sigfried Hackel who passed the baton after three successful DCC conferences to the new team. I'm also grateful to the 15 active and engaged members of the International Program Committee headed by Carlos Galvan, that selected the highly attractive 55 presentation with their high expertise.

I want to close by wishing you a great conference with the big four: inspiring talks, intensive discussions, many personal interactions, and finally, innovative, forward-looking ideas – all for extraordinary digital certificates of tomorrow.

Thank you very much.

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Presentation of Siegfried Hackel

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

4th International DCC-Conference

Welcome

Siegfried Hackel

Personal remarks

- Thanks to the organizing committee:
  - Shanna Schönhals
  - Benjamin Gloger
  - Thomas Krah

  for taking on the job!
  - I will be happy to assist you further.
- Thanks also to the programme committee!

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The history of the DCC conferences

Conference	Participants	Countries
2021 (1st)	815	118
2022 (2nd)	708	85
2023 (3rd)	1146	93
2024 (4th)	942	99

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Summary of the 3rd international DCC Conference *)

Total number of presentations given: Of this:	56
• Not focussed on DCC issues:	10
• PTB presentations (incl. DCC):	15
Remain:	31
Of this: ICW Conference Hamburg 2023-04-24 to 26 • pure PDF/A3:	0
• PTB-coord. schema-based XML	27
• PTB-coord. schema-based XML in PDF/A3	4

*) Digitization versus Digitalization & Digital Transformation in the field of calibrations and their subsequent use https://doi.org/10.7795/120.20240126

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A look at the conference

- Results of the 3rd DCC conference and summary of the abstracts submitted for the 4th DCC conference:
  - The DCC is set!
- Many interesting DCC applications in the areas
  - Ontologies,
  - Taxonomies,
  - Reflections on key comparisons,
  - History analyses,
  - ...
- Many presentations from industry

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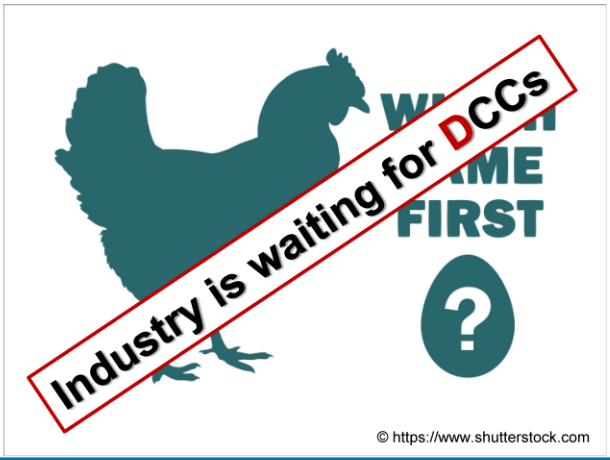
Different names and an important statement

- What is the "correct" expression?
  - Chicken or Egg Problem
  - Hen or Egg Problem



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DCC Version 3.3.0

- New release coming after the DCC conference
  - Backward compatible!
- Feedback from the community:
  - New release of D-SI (2.2.0)
  - ...
- Other feedback, e.g. for names
  - An important example (next slide):

Example: Certificate versus Report

- Names were given according to standards
- IT standards were also taken into account
  - A signed digital document is called a "certificate" there
- Feedback from the community:
  - In some countries, a certificate implies conformity
  - Calibration Report is used at the NMI there
  - In DCC: Conformity is optional ☺
- New release:
  - Digital Calibration Certificate
  - Digital Calibration Report
  - Digitaler Kalibrierschein
  - ...

Where should we publish?

- **“In which journal would you submit a publication on the DCC?”**
- TEDME word cloud (link see chat):
  - Please enter the name of your favorite journal
  - ... even if it is already visible in the word cloud
  - The software counts the entries
- TEDME is activated until the end of the first conference day
  - Then the preparation for the vote takes place
  - All registered persons receive an e-mail to vote on the preselection
- We will take up the topic again tomorrow in the plenary session.

PTB

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Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Bundesallee 100
38116 Braunschweig
Germany

More questions? Please contact:

Dir. u. Prof. Dr. Siegfried Hackel
Phone: +49 531 592-1017
E-Mail: siegfried.hackel@ptb.de

2024-02-27

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01 What is the M-layer aspect?

Presenting author: Blair Hall, Measurement Standards Laboratory of New Zealand (MSL)
Email: blair.hall@measurement.govt.nz
Additional authors: Mark Kuster mjk@ieee.org

Abstract

The International System of Units (SI) is based on the Maxwellian formalism for unit systems. However, the modern SI has evolved from a strict Maxwellian form. Its evolution reflects a need to express measurable properties that are not formally physical quantities, as well as pressure from society to accommodate some customary forms of expression.

Maxwellian unit systems facilitated exchange of physical-quantity data between scientists working with different local units of measurement. These systems allow users to easily determine conversion factors for all units from just the base-unit conversion factors. The quantities involved, however, should already be known because unit symbols alone do not identify them.

Digital representation of data should not rely on human intervention to resolve ambiguous cases, which is needed when only SI unit symbols annotate measurement data. So, a formalism that captures measured properties in sufficient detail to avoid ambiguity has been proposed, called the M-layer [1].

While conventional notation expresses the magnitude of a quantity as a number paired with a unit symbol (e.g., 10 kg), the M-layer records magnitudes as a number paired with an *aspect* and a *scale*. The M-layer scale generalises the role of conventional unit symbols in notation, while the M-layer aspect generalises the notion of different kinds of quantity (e.g., length, mass, etc.), a cornerstone of theoretical physics not included in conventional notation.

This presentation will discuss the need for the M-layer aspect and explain why it is not simply equivalent to the quantity kind. Because we wish to avoid *ad hoc* human intervention when registering and processing data, and because the evolution of measurements has outstripped SI notation as a means for representing physical data, we find the M-layer aspect essential to resolve otherwise ambiguous cases.

References

[1] B. D. Hall and M. Kuster, *Representing quantities and units in digital systems*, Measurement: Sensors **23** (2022) 100387, 2022. DOI: 10.1016/j.measen.2022.100387

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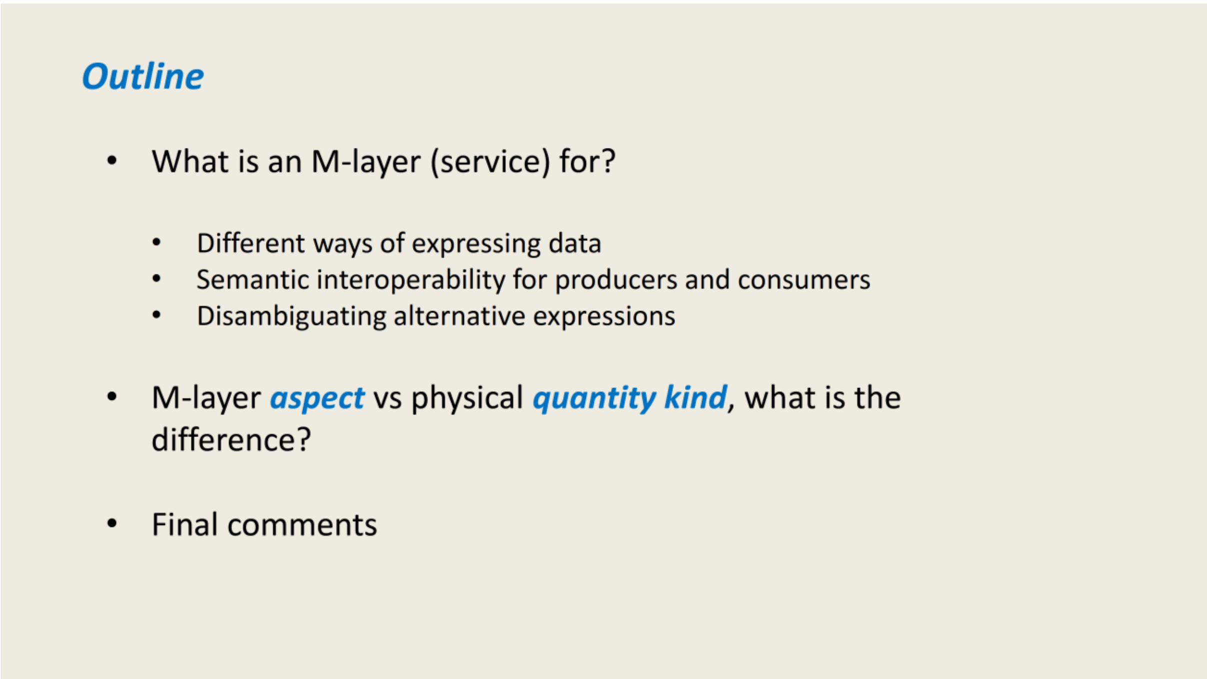
Presentation of Blair Hall



Quantity—an amount of something, but what?

"It's hot today, 30 degrees"

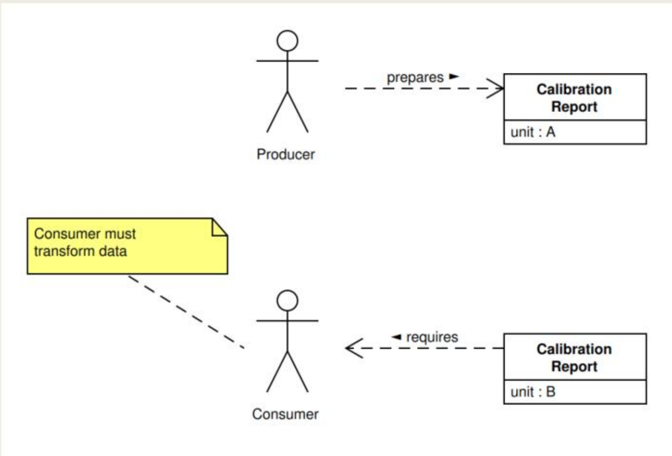
"Really!? It feels more like 90!"

Conventional units of temperature are different in the United States (degrees Fahrenheit) and Europe (degrees Celsius).

People get used to it!

Digital systems must deal with these conventions. Just as with regional differences in languages, currencies, time-of-day formats, etc.

Producers and consumers of data

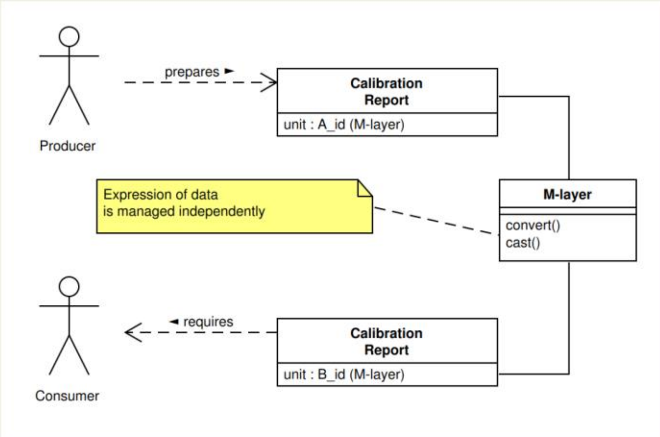


A producer cannot know the requirements of (possibly many) consumers of data

Consumers have the job of transforming the data

Repetitive work, and subject to error

Producers and consumers need help—interoperability



The form of expression is identified clearly

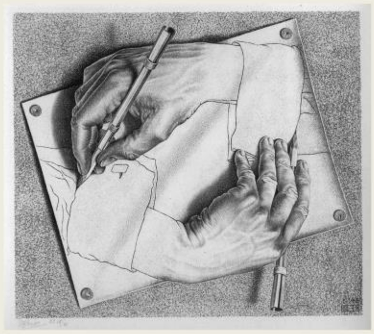
Alternative legitimate forms of expression are centrally managed

The data may be expressed according to consumer needs

"The next 700 unit-measurement checkers" [1]

"Insanity is doing the same thing over and over and expecting different results."

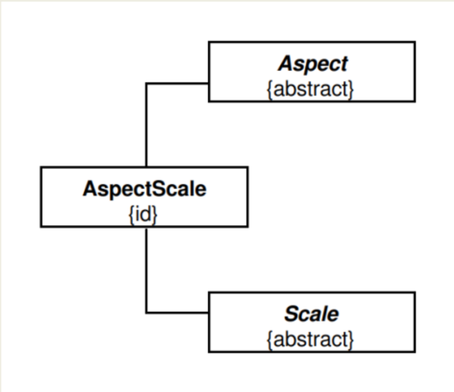
The M-layer is a conceptual model for digital systems to unambiguously represent alternative forms of expression for physical data



M. C. Escher, Drawing Hands, 1948

[1] O. Bennich-Bjoerkman and S McKeever, DOI 10.1145/3276604.3276613

M-layer has identifier pairs



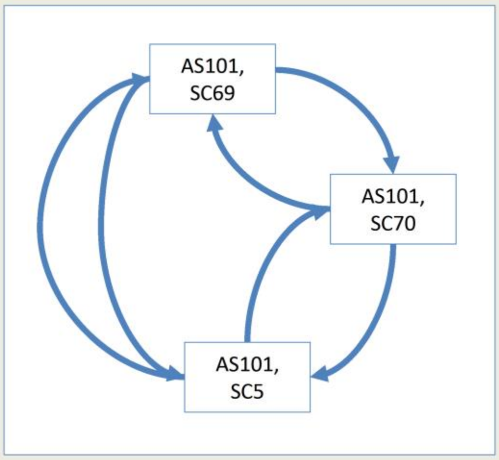
Aspect is like a quantity kind, such as mass, length, speed.

Scale is like a unit, such as kg, m, m/s.

But aspect and scale are not really quantity kinds and units, respectively.

The M-layer aspect and scale identifiers **unambiguously label alternative forms of expression.**

The M-layer maps alternative expressions



AS101 ⇔ thermodynamic temperature
SC69 ⇔ °C; SC70 ⇔ °F; SC5 ⇔ K

The M-layer holds relationships among alternative forms of expression

Nodes represent forms of expression

Edges represent transformation from one form to another

A URI prefix renders these short identifiers unique, e.g.: https://mlayer.org/AS101

Forms of expression must consider data sets

Metrological data always has a range (e.g., a data set)

Some properties remain invariant under certain types of transformation

The M-layer distinguishes between transformations that leave properties of data invariant, and other transforms

Together, aspect and scale identifier pairs label each form of expression

Temp: {15 °C, 25 °C, 30 °C}

Temp: {59.0 °F, 77.0 °F, 86.0 °F}

Means (sample): 23.33 °C and 74.0 °F

Direct transform: 23.33 °C ⇔ 74.0 °F

Ratio (max/min): 2.0 ≠ 1.46

The SI and quantity kinds

Some unit symbols in the SI are products of powers of base units

Units in this class are sufficient to express any SI quantity

However, the quantity kind is not indicated

Units are not unique identifiers of quantity

This confuses many people, so it will probably confuse machines too.

$$\mathrm{s}^{-1}$$
$$\mathrm{m}^2 \cdot \mathrm{s}^{-2}$$
$$\mathrm{kg} \cdot \mathrm{m}^2 \cdot \mathrm{s}^{-2}$$

The SI special unit names and quantity kinds

There are 22 units with special names in the SI

Used in isolation, the expressed quantity kind is indicated

Used in products of powers, ambiguity is still possible

Quantity kind (for aspect) is needed to identify legitimate transformations

$$\begin{aligned} \mathrm{Hz}\,,\ \mathrm{Bq}\,,\ (\mathrm{s}^{-1}) \\ \mathrm{Gy}\,,\ \mathrm{Sv}\,,\ (\mathrm{m}^2\cdot\mathrm{s}^{-2}) \\ \mathrm{J}\,,\ \mathrm{N}\cdot\mathrm{m}\,,\ (\mathrm{kg}\cdot\mathrm{m}^2\cdot\mathrm{s}^{-2}) \end{aligned}$$

$$\begin{aligned} 15\,\mathrm{N}\cdot\mathrm{m} &\to 15\,\mathrm{J} \quad (\text{energy}) \\ &\not\to 15\,\mathrm{J} \quad (\text{torque}) \end{aligned}$$

$$\begin{aligned} 1.5\,\mathrm{s}^{-1} &\to 1.5\,\mathrm{Hz} \quad (\text{frequency}) \\ &\not\to 1.5\,\mathrm{Hz} \quad (\text{activity}) \end{aligned}$$

What kind of quantity is that again?

Sometimes we think that a unit like **metre** MUST be a measure of **length**, but it is not always so. Units represent scaling not quantities.

Rainfall is just one example.

Same area, same volume of water, different depth

Beyond quantity kinds—the problem of temperatures

In quantity calculus, a sum or difference is only allowed between terms of the same quantity kind and then the result is of the same kind.

So, temperature difference is the same kind of quantity as temperature.

But, when transforming expressions of temperature, the distinction is necessary

Need aspects for temperature and temperature difference

Here, aspect is more specialised than quantity kind

$12\,°\mathrm{C} = ??$ $\qquad 12\,\mathrm{K} \quad \text{or} \quad 285.15\,\mathrm{K}$

Celsius temperature: $T/\mathrm{K} = t/°\mathrm{C} + 273.15$

Temperature difference: $\Delta T/\mathrm{K} = \Delta t/°\mathrm{C}$

Dimensionless ratios—are they quantities?

Quantity calculus considers 'dimensionless' quantities as pure numbers

For ratios of the same quantity, SI unit notation that shows a ratio is encouraged

The M-layer defines distinct aspects for dimensionless quantities (length-ratio, voltage-ratio, etc.)

These aspects are more specific than quantity kinds, but they are as general as possible for the ratioed quantity

$$110\,\frac{\mathrm{V}}{\mathrm{V}} \rightarrow 110 \overset{???}{\rightarrow} 110\,\frac{\mathrm{m}}{\mathrm{m}}$$

Non-linear functions

"The ratio of two quantities of the same kind and any function of that ratio, such as the logarithm of that ratio, are different quantities, although they describe the same physical situation" — ISO 80000-1:2013 (sec. 6.2)

A change of base scales (converts) data

Zero remains zero

The aspect of a logarithmic ratio is independent of the base

Here aspect is more general than quantity-kind (according to ISO 80000)

$$\log_b(x) = \log_b(e)\log_e(x)$$

so

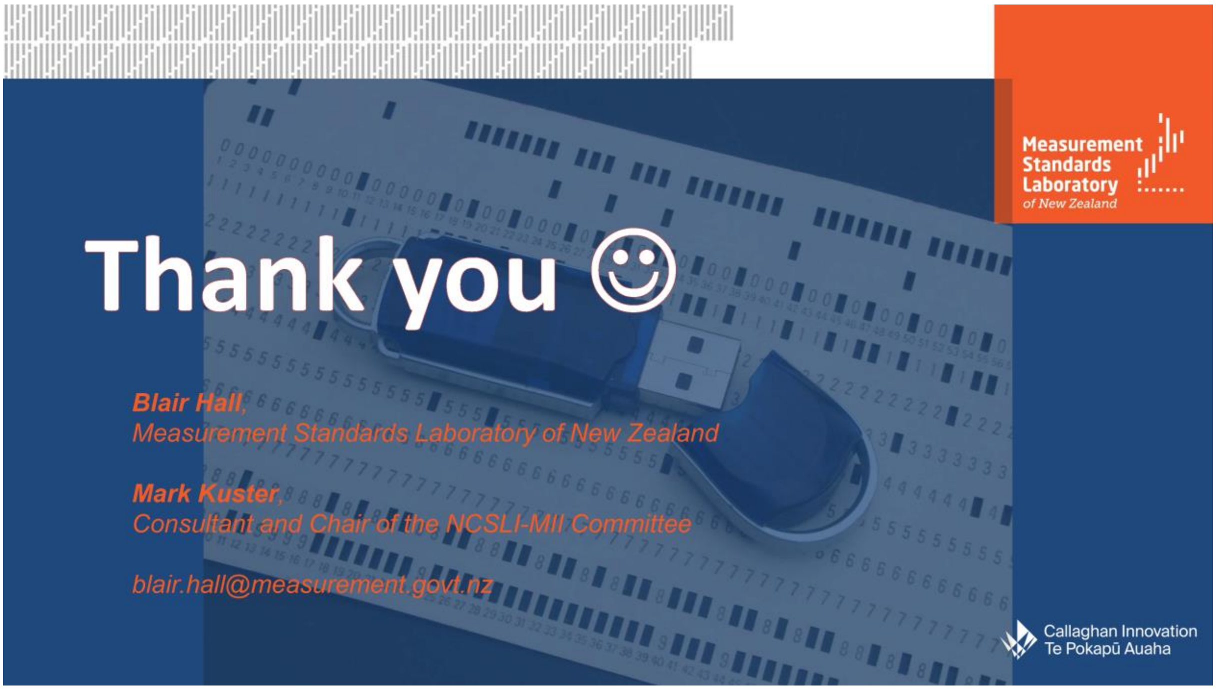
$$\log_{10}(x) = \log_{10}(e)\ \log_e(x)$$

and so

$$\log_{10}(x) = 0.434\ \log_e(x)$$

Summary

- The M-layer uses a pair of unique identifiers to label each form of expression—one is an aspect identifier, and the other is a scale identifier
- Aspect is closely related to quantity kind, but serves a different purpose
- Aspect and quantity kind are often, but not always, the same
  - Sometimes aspect is more specialised (e.g., temperature-difference and quantity ratios);
  - Sometimes aspect is more general (e.g., logarithmic ratios)
- The aspect is always the most general measurable property (quantity) needed to uniquely identify an expression format (in combination with a scale identifier)



Additional information

1. B. D. Hall and M. Kuster, *Representing quantities and units in digital systems*, Measurement: Sensors, 2022, 23, 100387. DOI:10.1016/j.measen.2022.100387

2. B. D. Hall, *The problem with 'Dimensionless Quantities'*, In Proceedings of the 10th International Conference on Model-Driven Engineering and Software Development - MODELSWARD, 2022, ISBN 978-989-758-550-0, pages 116-125. DOI: 10.5220/0010960300003119.

3. B. D. Hall, *Representing and expressing measurement data in digital systems*, Springer-Nature Computer Science, 4(2), 120 (2023). DOI:10.1007/s42979-022-01534-x

4. B. D. Hall, *Modelling expressions of physical quantities*, in: Proceedings of the 15th International Conference on Knowledge Engineering and Ontology Development (IC3K 2023) – Volume 2: pages 216 – 223, ISBN: 978-989-758-671-2; ISSN: 2184-3228; DOI: 10.5220/0000178400003598.

5. B. D. Hall, P. Saunders, and D. R. White, *Representation of scales and units for temperature and related quantities*, Temperature: Its Measurement and Control in Science and Industry, Vol 10, (in press—preprint available)

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02 The D-SI metadata model for an interoperable scientific and quality infrastructure

Presenting author: Daniel Hutzschenreuter, FB 9.4, PTB Germany
E-mail address: daniel.hutzschenreuter@ptb.de

Abstract:

Since 2021, a global community of metrology organizations and measurement laboratories is actively developing implementations of the harmonized DCC which is the XML-based format for digital certificates of calibration. The DCC uses the D-SI metadata model for universal, unambiguous, safe, and easy-to-understand metrological data at its core for the representation of quantity values with units of measurement from the International System of Units. Taking up the user experience from over two years of practical implementation work, an update of the D-SI was released by the end of 2023 which introduces additional features increasing the useability and interoperability of the format. The D-SI update is also a trailblazer for achieving the future interoperability of FAIR data and services with the SI Digital Framework that is defined and implemented by the International Committee of Weights and Measures (CIPM) and the International Bureau of Weights and Measures (BIPM). The updates of the D-SI and future developments will be presented by this contribution.

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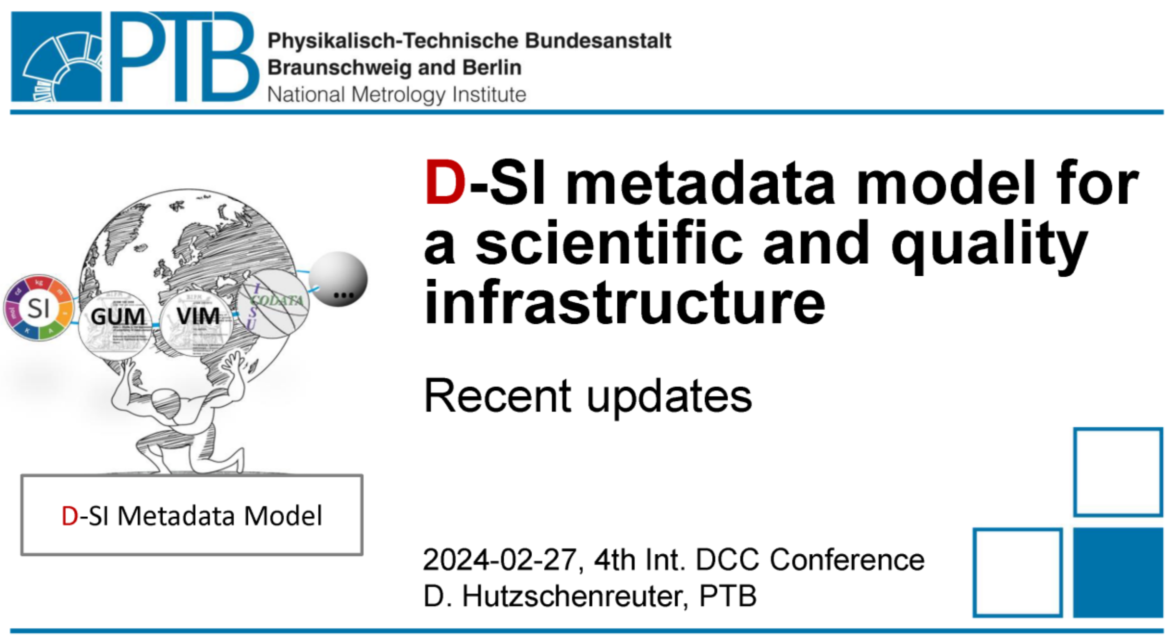
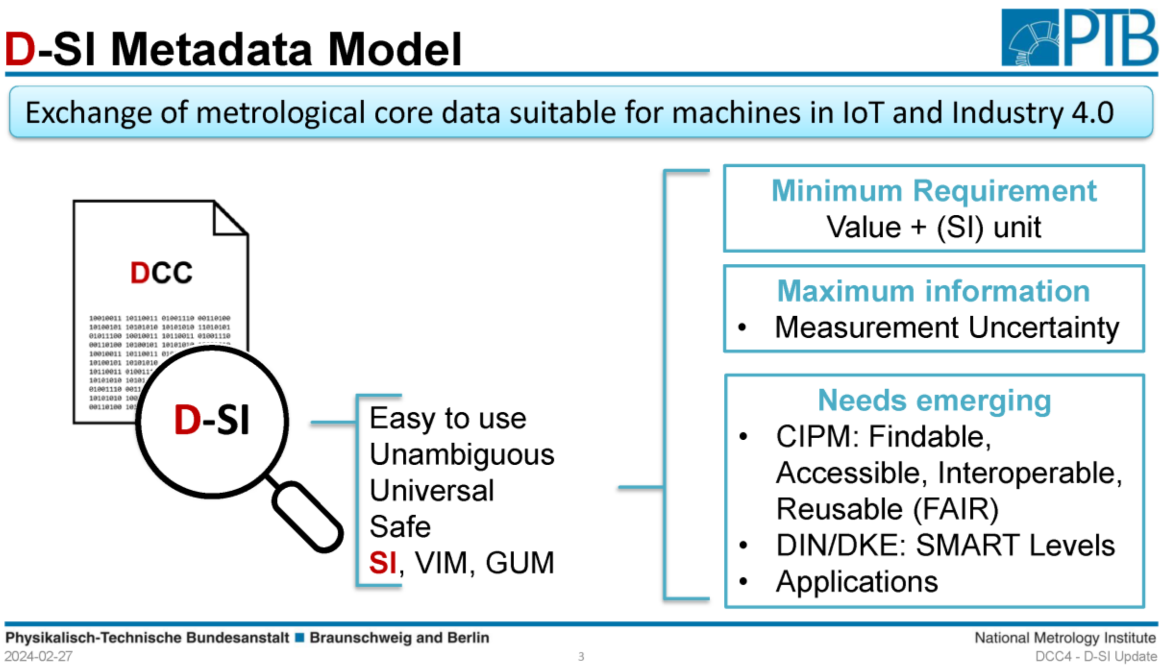
Presentation of Daniel Hutzschenreuter




D-SI Metadata Model
Exchange of metrological core data suitable for machines in IoT and Industry 4.0
DCC
D-SI
Easy to use
Unambiguous
Universal
Safe
SI, VIM, GUM
Minimum Requirement
Value + (SI) unit
Maximum information
• Measurement Uncertainty
Needs emerging
• CIPM: Findable, Accessible, Interoperable, Reusable (FAIR)
• DIN/DKE: SMART Levels
• Applications
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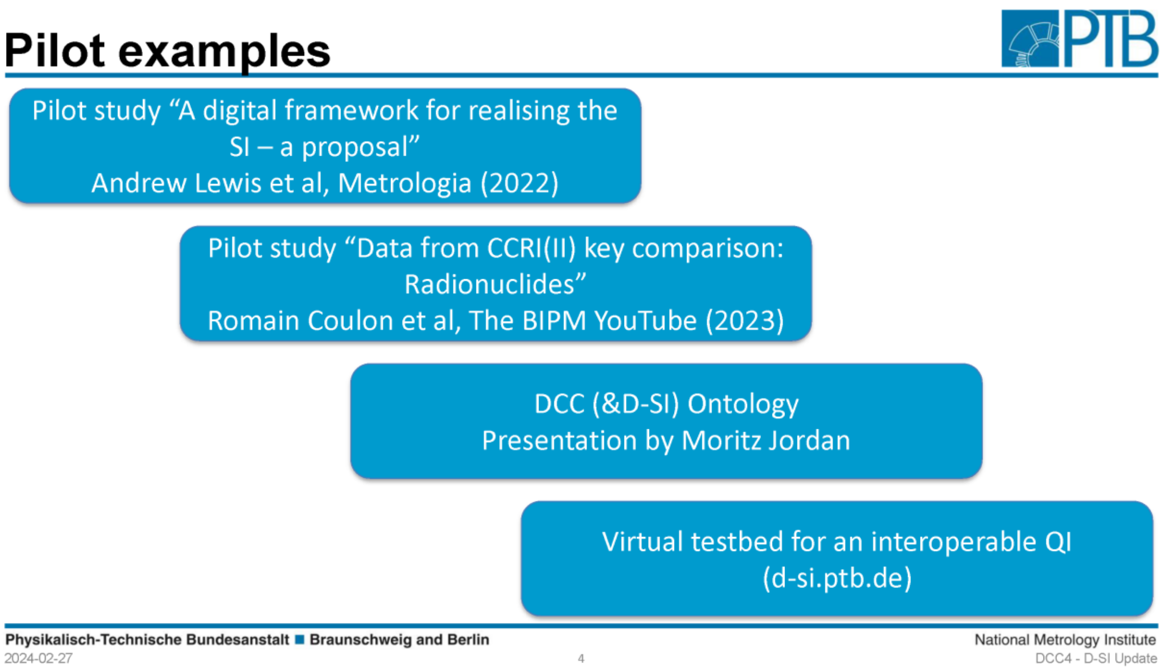
DCC4 - D-SI Update


Pilot examples
Pilot study "A digital framework for realising the SI – a proposal"
Andrew Lewis et al, Metrologia (2022)
Pilot study "Data from CCRI(II) key comparison: Radionuclides"
Romain Coulon et al, The BIPM YouTube (2023)
DCC (&D-SI) Ontology
Presentation by Moritz Jordan
Virtual testbed for an interoperable QI
(d-si.ptb.de)
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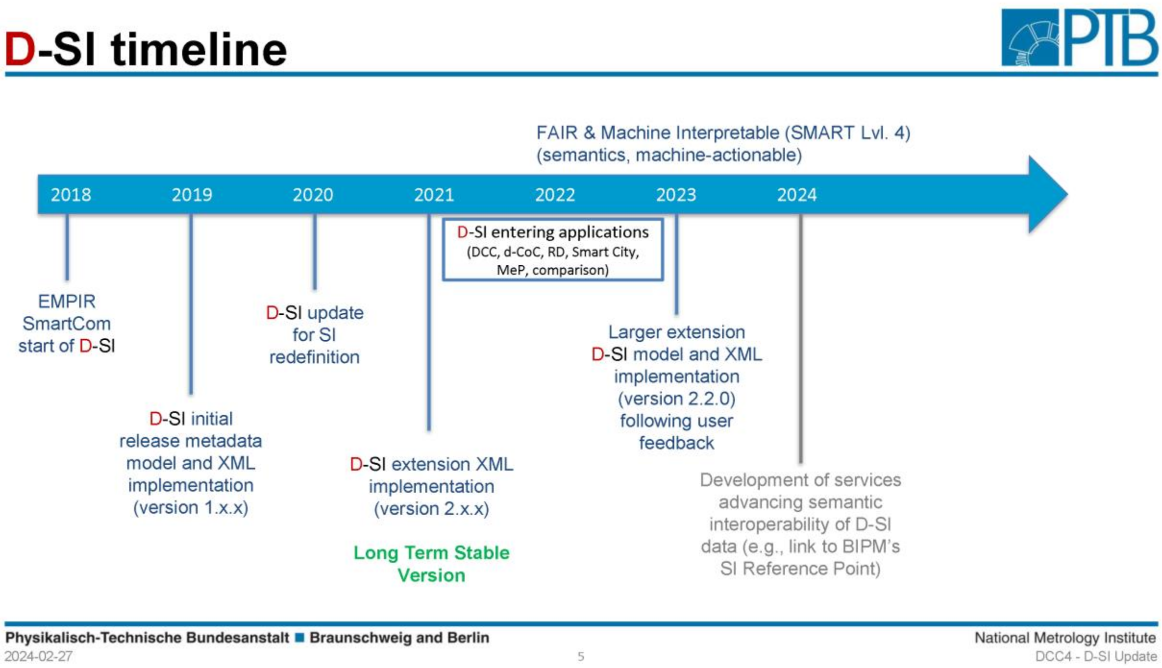
D-SI timeline
PTB
FAIR & Machine Interpretable (SMART Lvl. 4)
(semantics, machine-actionable)
2018
2019
2020
2021
2022
2023
2024
EMPIR SmartCom start of D-SI
D-SI initial release metadata model and XML implementation (version 1.x.x)
D-SI update for SI redefinition
D-SI extension XML implementation (version 2.x.x)
Long Term Stable Version
D-SI entering applications (DCC, d-CoC, RD, Smart City, MeP, comparison)
Larger extension D-SI model and XML implementation (version 2.2.0) following user feedback
Development of services advancing semantic interoperability of D-SI data (e.g., link to BIPM's SI Reference Point)
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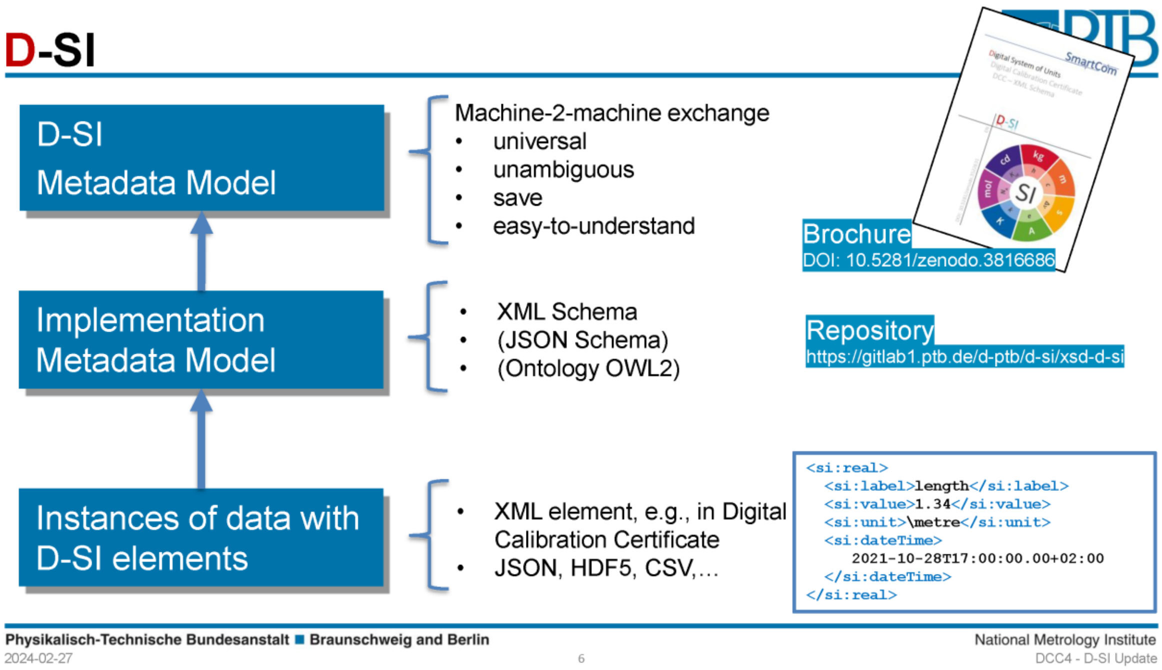
D-SI
PTB
D-SI Metadata Model
Machine-2-machine exchange
• universal
• unambiguous
• save
• easy-to-understand
Implementation Metadata Model
• XML Schema
• (JSON Schema)
• (Ontology OWL2)
Instances of data with D-SI elements
• XML element, e.g., in Digital Calibration Certificate
• JSON, HDF5, CSV,…
Brochure
DOI: 10.5281/zenodo.3816686
Repository
https://gitlab1.ptb.de/d-ptb/d-si/xsd-d-si
<si:real>
<si:label>length</si:label>
<si:value>1.34</si:value>
<si:unit>\metre</si:unit>
<si:dateTime>
2021-10-28T17:00:00.00+02:00
</si:dateTime>
</si:real>
Physikalisch-Technische Bundesanstalt ■ Braunschweig and Berlin
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D-SI scope

"Atoms"	D-SI
Real quantity value	real
Constant quantity value	constant
Complex quantity value	complex
Vector quantity value	real list complex list

"Extended"	D-SI
Univariate uncertainty	expanded uncertainty coverage interval standard uncertainty
Multivariate uncertainty	ellipsoidal region rectangular region (covariance matrix)
Generic structures	nested lists list adapter for non-SI hybrid

Latest documentation and examples
https://gitlab1.ptb.de/d-ptb/d-si/xsd-d-si

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Extensions 2023

1. Type of quantity
2. Standard measurement uncertainty
3. Element names for uncertainty
4. Disambiguating uncertainty statements
5. Voids (NaN, undefined values)
6. Significant Digit
7. Complex as XML list
8. Additional components in units
9. Preparing semantics for future
10. Sanitizing XSD

Thanks to all contributors for your valuable suggestions!

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2024-02-27   8   DCC4 - D-SI Update

Extensions 2023

1. Type of quantity
2. Standard measurement uncertainty
3. Element na
4. Disambigua
5. Voids (NaN
6. Significant
7. Complex as
8. Additional c
9. Preparing s
10. Sanitizing X

optional element

Vocabular qudt.org

```
<dcc:quantity>
  <si:real>
    <si:quantityTypeQUDT>Length</si:quantityTypeQUDT>
    <si:value>1.0</si:value>
    <si:unit>\metre</si:unit>
  </si:real>
</dcc:quantity>
```

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Extensions 2023

1. Type of quantity
2. Standard measurement uncertainty
3. Element names for uncertainty
4. Disambiguating uncertain
5. Voids (NaN, undefined va
6. Significant Digit
7. Complex as XML list
8. Additional components in
9. Preparing semantics for fu
10. Sanitizing XSD

```
<dcc:quantity>
  <si:real>
    <si:value>1.00</si:value>
    <si:unit>\metre</si:unit>
    <si:measurementUncertaintyUnivariate>
      <si:standardMU>
        <si:valueStandardMU>0.10</si:valueStandardMU>
        <si:distribution>normal</si:distribution>
      </si:standardMU>
    </si:measurementUncertaintyUnivariate>
  </si:real>
</dcc:quantity>
```

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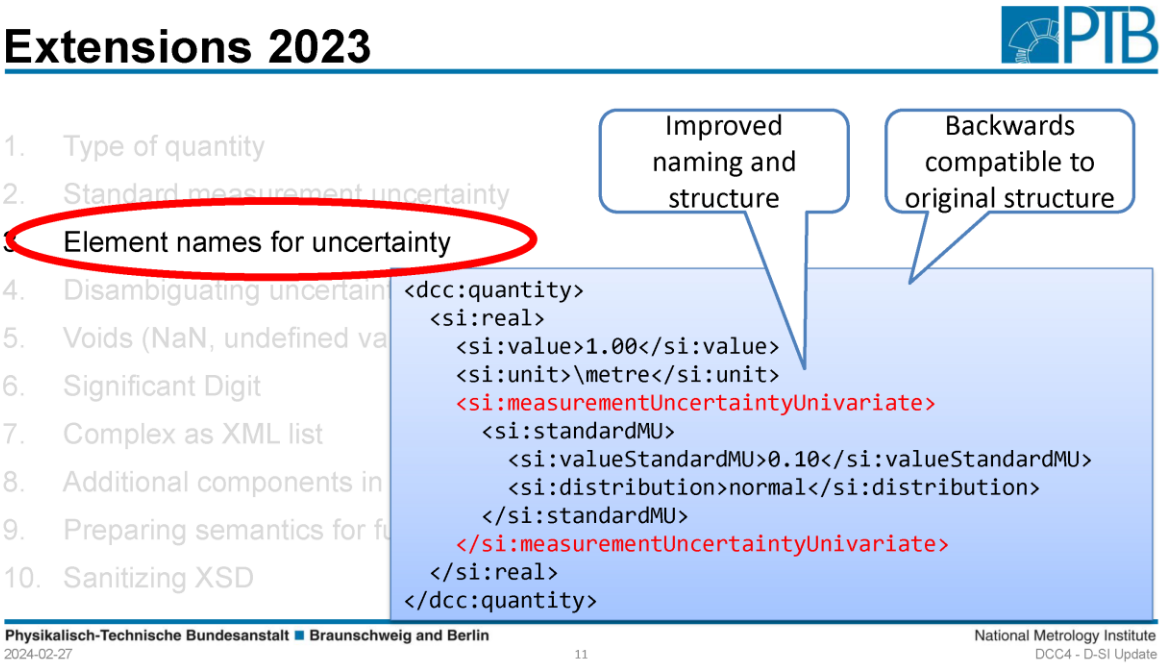
Extensions 2023
PTB
1. Type of quantity
2. Standard measurement uncertainty
3. Element names for uncertainty
4. Disambiguating uncertaint
5. Voids (NaN, undefined va
6. Significant Digit
7. Complex as XML list
8. Additional components in
9. Preparing semantics for fu
10. Sanitizing XSD
Improved naming and structure
Backwards compatible to original structure
<dcc:quantity>
<si:real>
<si:value>1.00</si:value>
<si:unit>\metre</si:unit>
<si:measurementUncertaintyUnivariate>
<si:standardMU>
<si:valueStandardMU>0.10</si:valueStandardMU>
<si:distribution>normal</si:distribution>
</si:standardMU>
</si:measurementUncertaintyUnivariate>
</si:real>
</dcc:quantity>
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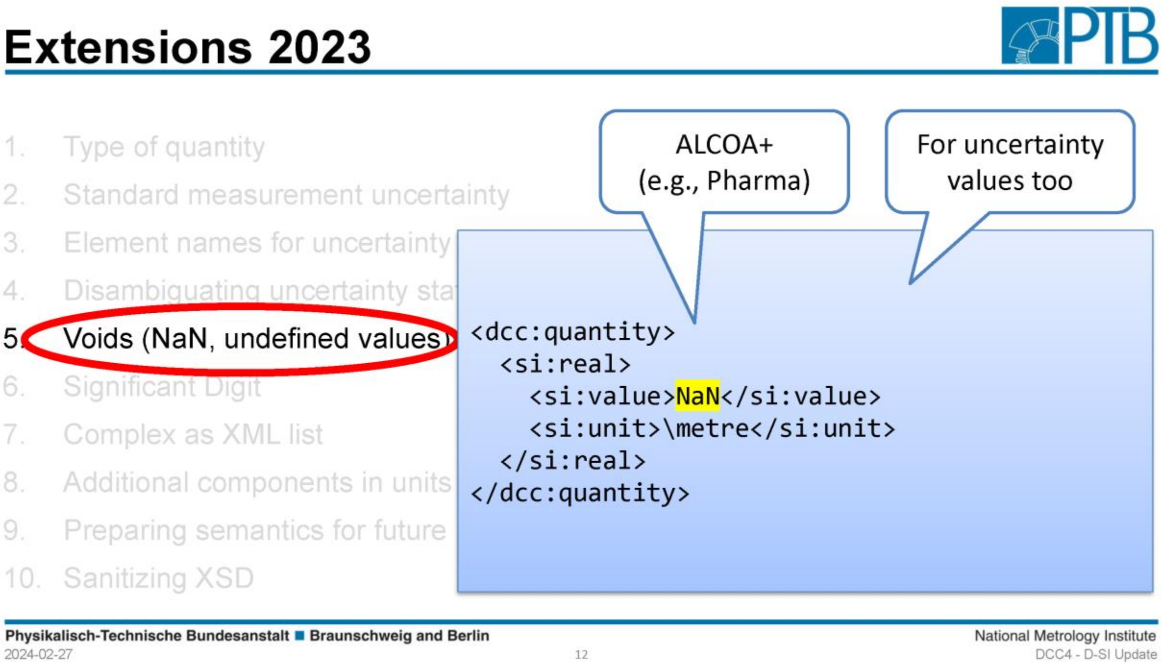
DCC4 - D-SI Update


Extensions 2023
PTB
1. Type of quantity
2. Standard measurement uncertainty
3. Element names for uncertainty
4. Disambiguating uncertainty sta
5. Voids (NaN, undefined values)
6. Significant Digit
7. Complex as XML list
8. Additional components in units
9. Preparing semantics for future
10. Sanitizing XSD
ALCOA+ (e.g., Pharma)
For uncertainty values too
<dcc:quantity>
<si:real>
<si:value>NaN</si:value>
<si:unit>\metre</si:unit>
</si:real>
</dcc:quantity>
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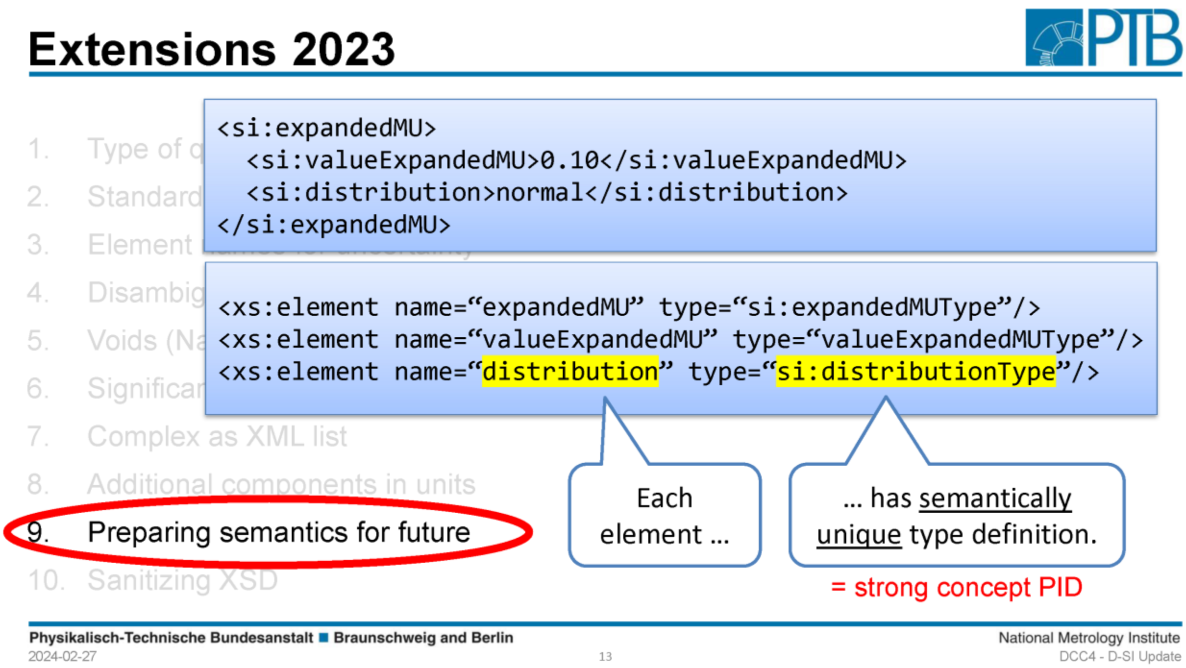
DCC4 - D-SI Update


Extensions 2023
PTB
1. Type of q
2. Standard
3. Element
4. Disambig
5. Voids (Na
6. Significar
7. Complex as XML list
8. Additional components in units
9. Preparing semantics for future
10. Sanitizing XSD
<si:expandedMU>
<si:valueExpandedMU>0.10</si:valueExpandedMU>
<si:distribution>normal</si:distribution>
</si:expandedMU>
<xs:element name="expandedMU" type="si:expandedMUType"/>
<xs:element name="valueExpandedMU" type="valueExpandedMUType"/>
<xs:element name="distribution" type="si:distributionType"/>
Each element …
… has semantically unique type definition.
= strong concept PID
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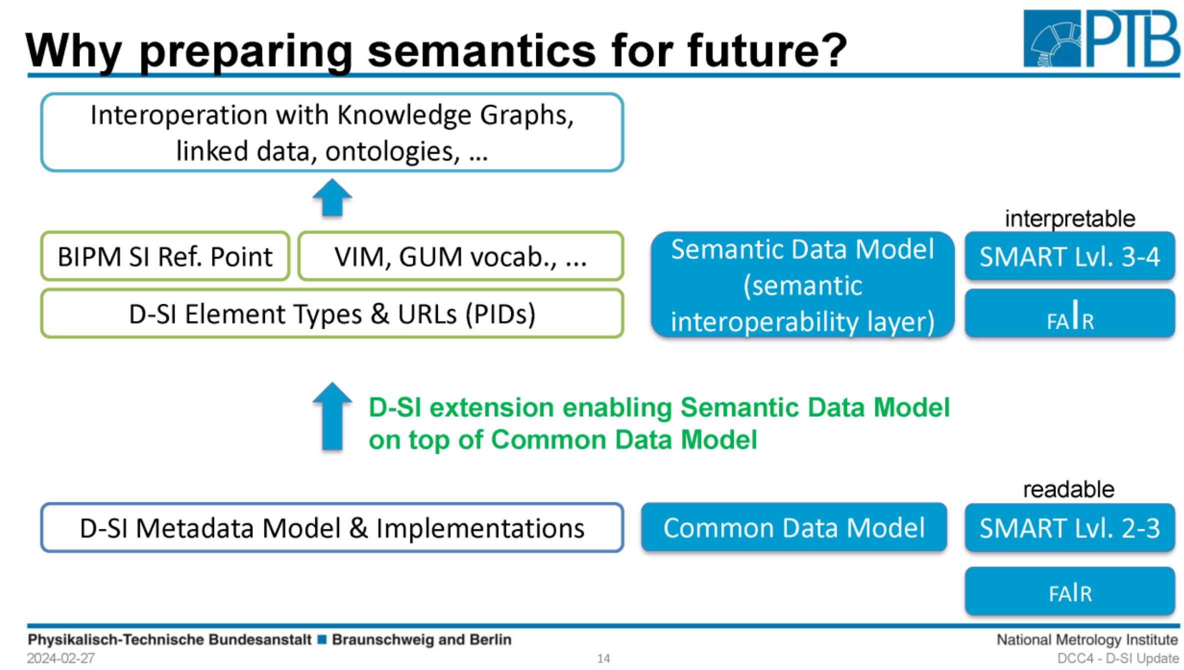
DCC4 - D-SI Update


Why preparing semantics for future?
PTB
Interoperation with Knowledge Graphs, linked data, ontologies, …
BIPM SI Ref. Point
VIM, GUM vocab., …
D-SI Element Types & URLs (PIDs)
Semantic Data Model (semantic interoperability layer)
interpretable
SMART Lvl. 3-4
FAIR
D-SI extension enabling Semantic Data Model on top of Common Data Model
D-SI Metadata Model & Implementations
Common Data Model
readable
SMART Lvl. 2-3
FAIR
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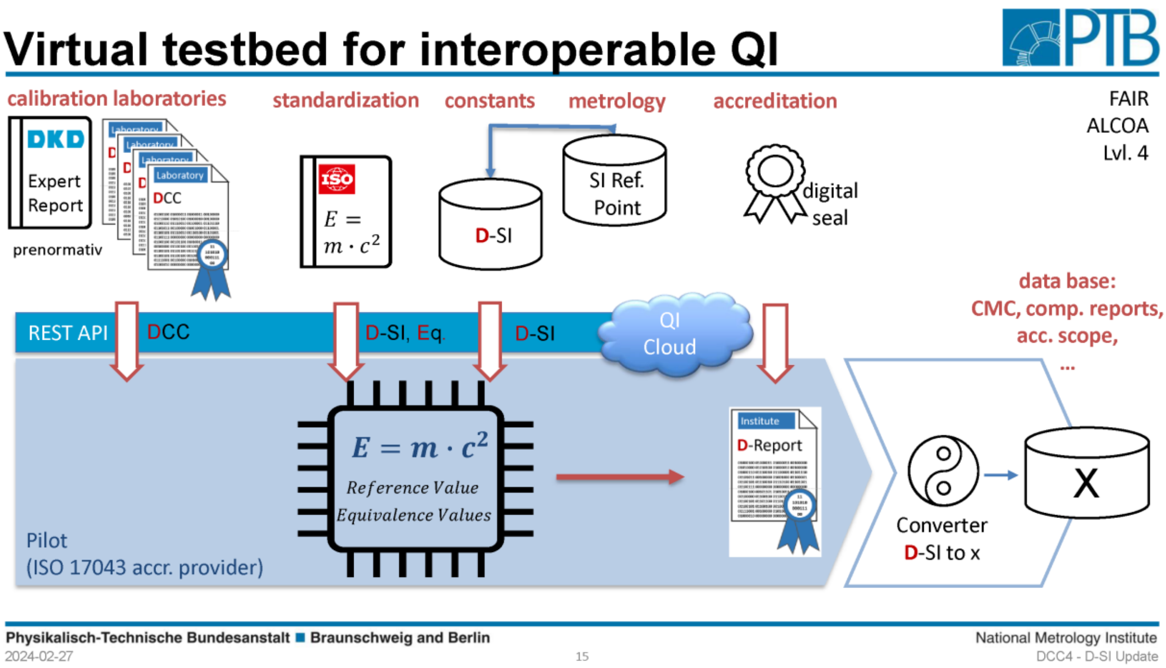
Virtual testbed for interoperable QI
PTB
calibration laboratories
standardization
constants
metrology
accreditation
FAIR
ALCOA
Lvl. 4
DKD
Expert Report
prenormativ
Laboratory
DCC
ISO
E = m · c²
SI Ref. Point
D-SI
digital seal
data base:
CMC, comp. reports, acc. scope,
...
REST API
DCC
D-SI, Eq.
D-SI
QI Cloud
E = m · c²
Reference Value
Equivalence Values
Institute
D-Report
Converter
D-SI to x
X
Pilot
(ISO 17043 accr. provider)
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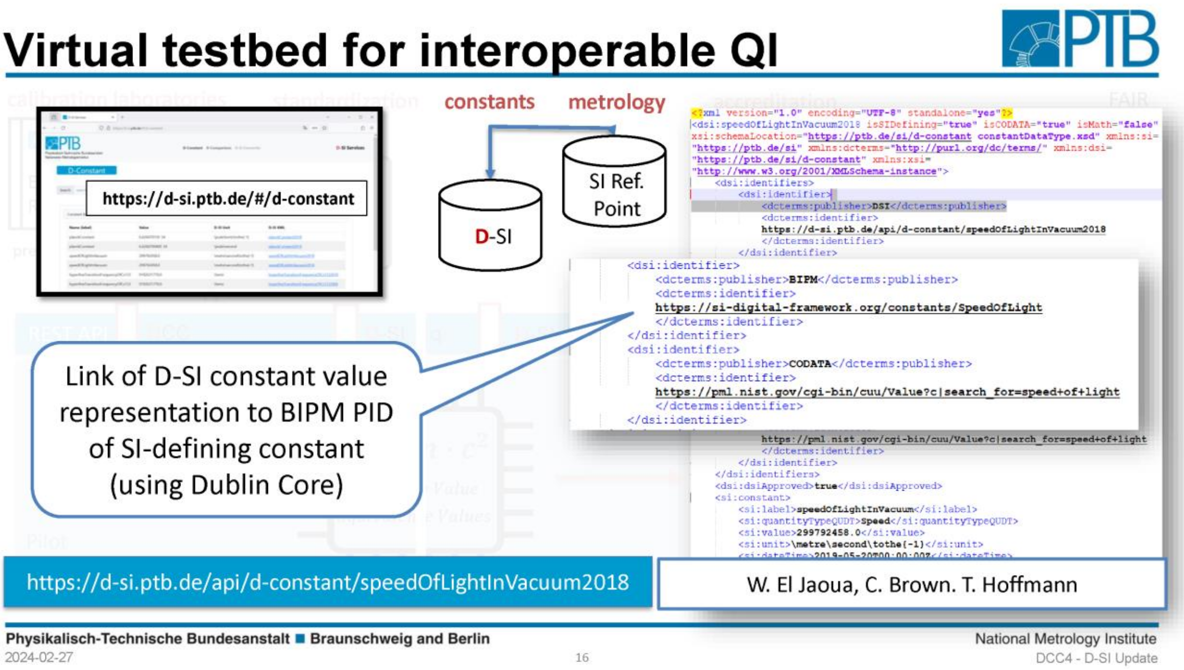
Virtual testbed for interoperable QI
PTB
constants
metrology
https://d-si.ptb.de/#/d-constant
SI Ref. Point
D-SI
<dsi:identifier>
<dcterms:publisher>BIPM</dcterms:publisher>
<dcterms:identifier>
https://si-digital-framework.org/constants/SpeedOfLight
</dcterms:identifier>
</dsi:identifier>
<dsi:identifier>
<dcterms:publisher>CODATA</dcterms:publisher>
<dcterms:identifier>
https://pml.nist.gov/cgi-bin/cuu/Value?c|search_for=speed+of+light
</dcterms:identifier>
</dsi:identifier>
Link of D-SI constant value representation to BIPM PID of SI-defining constant (using Dublin Core)
https://d-si.ptb.de/api/d-constant/speedOfLightInVacuum2018
W. El Jaoua, C. Brown. T. Hoffmann
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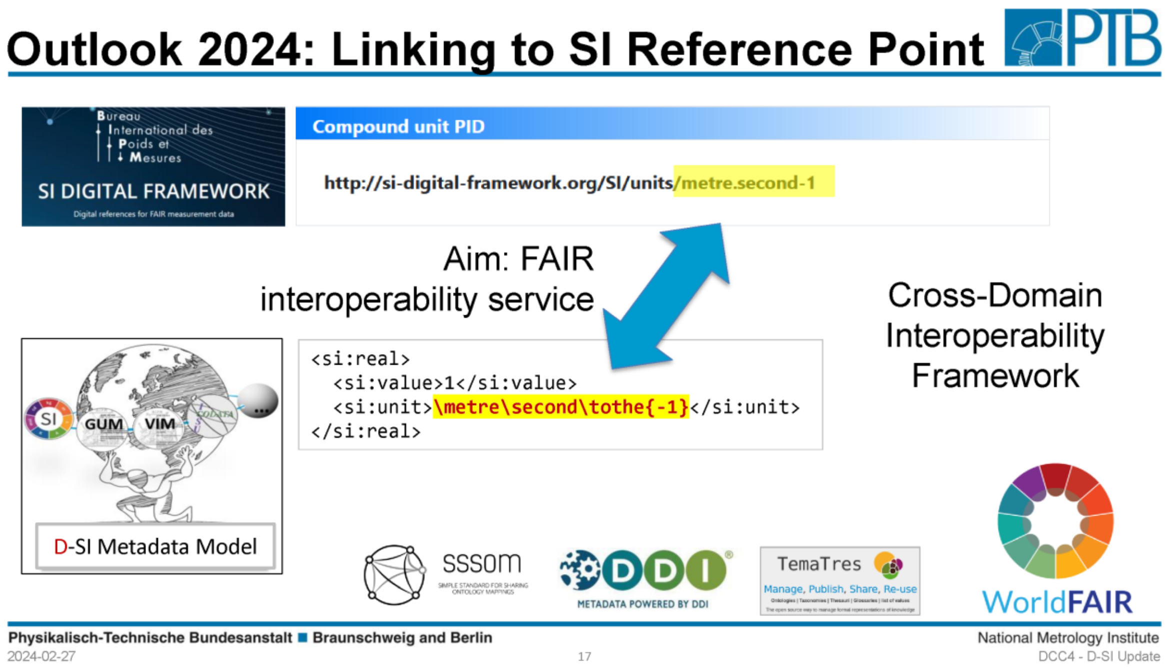
Outlook 2024: Linking to SI Reference Point
PTB
Bureau International des Poids et Mesures
SI DIGITAL FRAMEWORK
Digital references for FAIR measurement data
Compound unit PID
http://si-digital-framework.org/SI/units/metre.second-1
Aim: FAIR interoperability service
Cross-Domain Interoperability Framework
<si:real>
<si:value>1</si:value>
<si:unit>\metre\second\tothe{-1}</si:unit>
</si:real>
SI
GUM
VIM
D-SI Metadata Model
sssom
DDI
METADATA POWERED BY DDI
TemaTres
Manage, Publish, Share, Re-use
WorldFAIR
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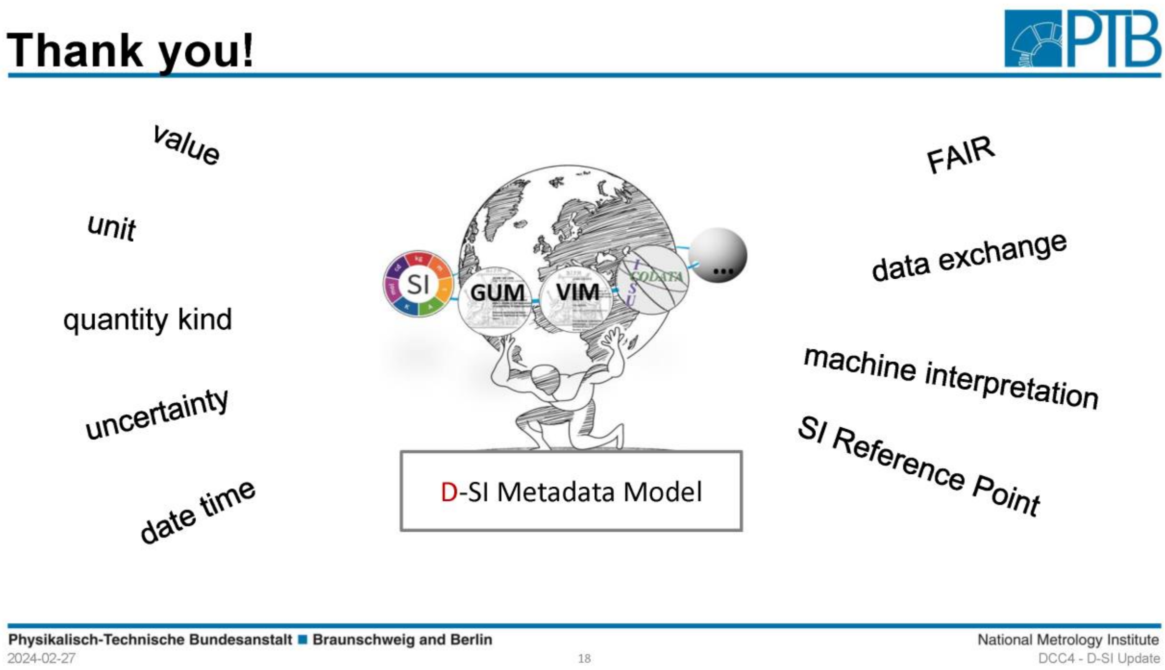
Thank you!
PTB
value
unit
quantity kind
uncertainty
date time
SI
GUM
VIM
D-SI Metadata Model
FAIR
data exchange
machine interpretation
SI Reference Point
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Daniel Hutzschenreuter

Physikalisch-Technische Bundesanstalt

Daniel.Hutzschenreuter@ptb.de
2024-02

2024-02-27

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Session "Quality Infrastructure I" (Chair: Alexis Valqui)

03 DCC2GO - Supporting the implementation of Digital Calibration Certificates in the European metrology community.

Presenting author: Anke Keidel, PTB Germany
Email: anke.keidel@ptb.de

Abstract

The outcome of this project supports the implementation of DCCs within the European metrology community, through the coordinated production and sharing of training material. The 2 main outputs from this project are (1) a DCC training compendium, and (2) a DCC starter kit.

1. The project has produced a "Freely available, DCC training compendium of basic knowledge for stakeholders with no prior knowledge of DCCs, with particular focus on the SEND community and supporting a harmonised level of basic DCC knowledge within the European metrology community," which is available at https://zenodo.org/records/8199281.

The training compendium consists of several sets of slides explaining the DCC to technical experts, management, and stakeholders of metrology organisations. The material is available for download for self-study.

2. The project produced a "Freely available and validated, Digital Calibration Certificates (DCC) starter kit for DCC implementation; containing step-by-step guidance for the creation, practical implementation and secure delivery of temperature and pressure DCCs." which is available at https://zenodo.org/records/8199700.

The DCC2GO starter kit consists of practical guidance for metrology institutes to enable them to start working with DCCs. It contains step-by-step guidance for the creation, practical implementation, and secure delivery of DCCs. Blueprints for workflows to introduce DCCs at an organisation have also been established. These workflows combine the experience obtained by the DCC2GO project members, which are all European metrology organisations that have gone through the process of introducing DCCs in the past years. The DCC starter kit is a suite of guidelines containing the following documents:

Guideline 1: How Metrology Institutes can start working with DCCs without any prior knowledge

This guideline addresses such issues as how to create a DCC, what IT infrastructure is needed and how to deal with the IT tools for handling the DCC.

Guideline 2: Collation of cryptographic tool information for DCC protection and validation

This guideline focuses on aspects of protection and secure submission of DCCs. It comprises different types of mechanisms for securing the content of DCCs such as digital signatures.

Examples: https://zenodo.org/records/8199718.

This suit of slides, data, and software provides an easy-to-follow step-by-step guideline allowing users to create and explore their first XML DCC and PDF/A-3 DCC example based on temperature calibration data. It demonstrates a quick (and dirty) approach based open access software tools.

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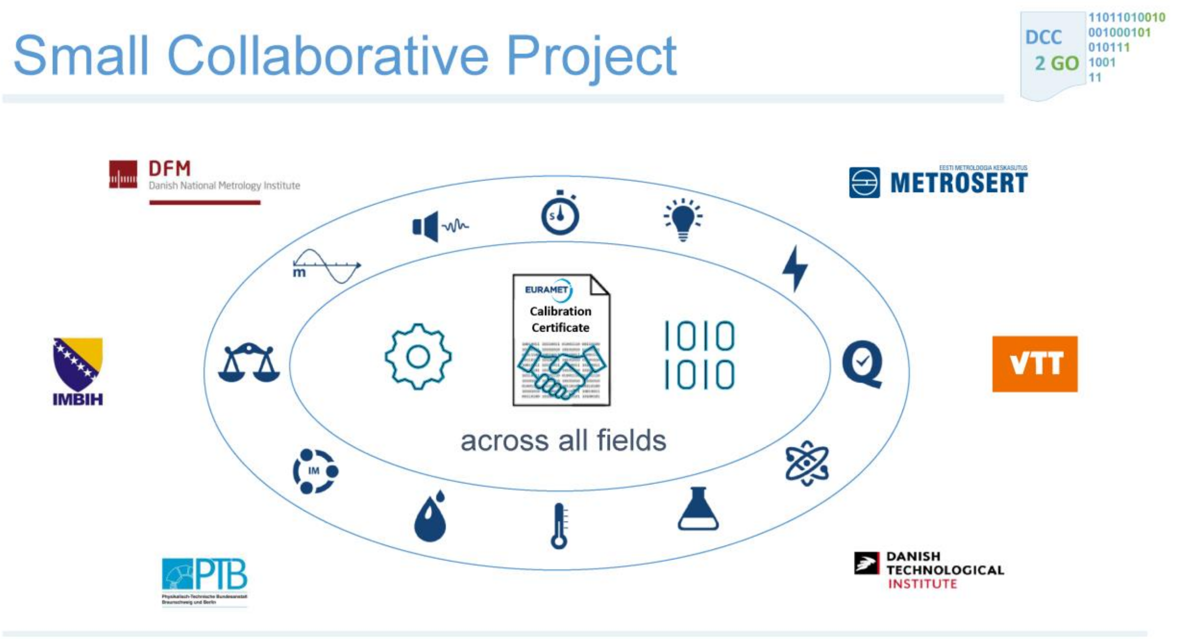
Presentation of Anke Keidel



Small Collaborative Project

For Capacity Building

✓ Project ended Oct. 2023

✓ All material freely available on https://ptb.de/dcc2go

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

Training compendium

Structured and easy-to-understand overview on DCCs

Collation of basic knowledge on DCCs relevant for:

NMIs and DIs

NMI and DI stakeholders

Starter-Kit

DCC types, their handling and available IT tools

Cryptographic tool information for DCC protection and validation

Examples

Application and validation of the DCC starter kit:

- ✓ **Step-by-step guidance for DCC creation (temperature)**
- ✓ **How-to adapt (temperature-2-pressure)**

Go forth and spread the word!

04 Ten years of TraCIM – A celebration of modern software and data testing for digitalization

Presenting author: Daniel Hutzschenreuter - Chair TraCIM eV, PTB Germany
Email: daniel.hutzschenreuter@ptb.de

Abstract:

As part of the digitalization within the scientific and quality infrastructure an increasing number of autonomous and “intelligent” operating systems for data processing are developed and used. Traditional analogue processes for testing of the accuracy of software results and the verification of the correctness and completeness of data are however barely able to keep up with the speed of new developments. Thus, platforms allowing a reliable and fast online validation of data and software by humans and automated by machines are an essential need for testing service in a digital era. The TraCIM association for improving traceability of computationally intensive metrology was established ten years ago with the mission to maintain a global standard for reliable and automated software testing under a joint TraCIM trademark. The anniversary of TraCIM celebrates recent developments. This contribution will give an overview on the current principles of testing under TraCIM which includes approaches for the verification of digital reports such as DCCs and services for testing software that are based on AI methods.

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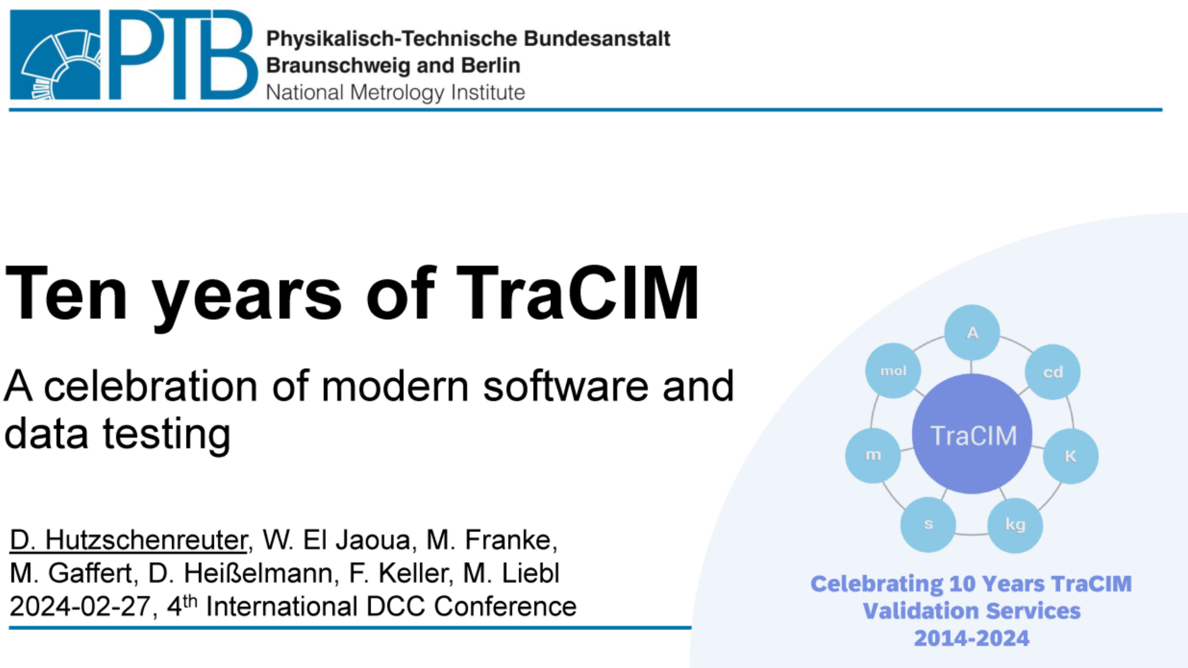
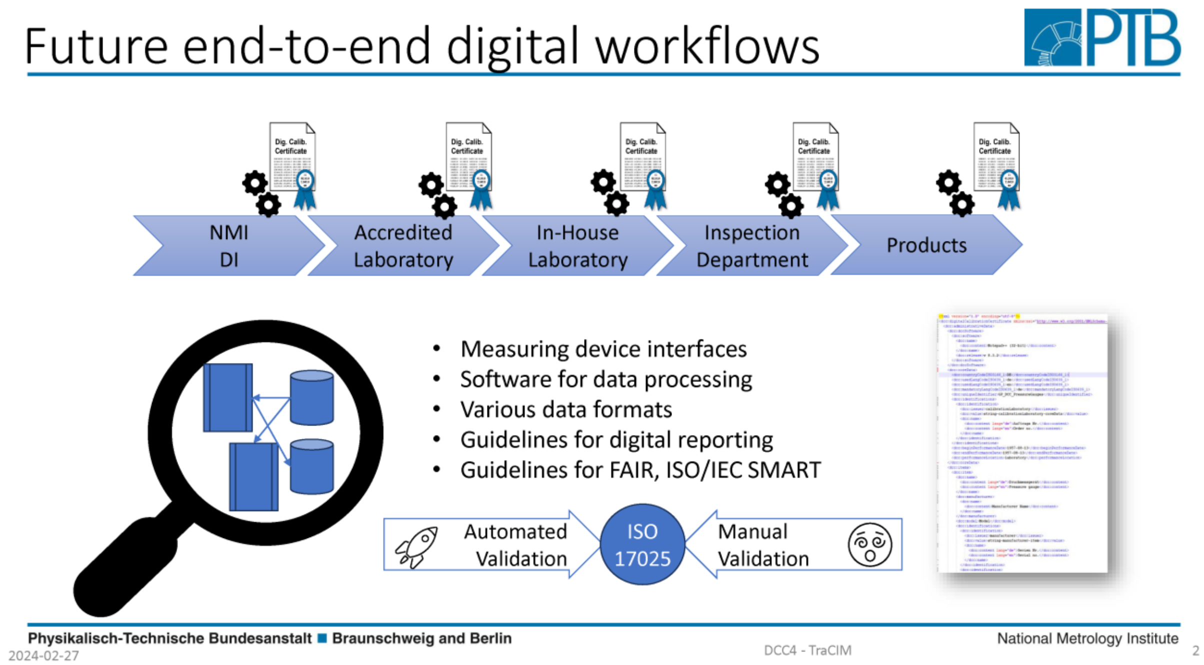
Presentation of Daniel Hutzschenreuter




Future end-to-end digital workflows
PTB
Dig. Calib. Certificate
NMI DI
Accredited Laboratory
In-House Laboratory
Inspection Department
Products
• Measuring device interfaces
• Software for data processing
• Various data formats
• Guidelines for digital reporting
• Guidelines for FAIR, ISO/IEC SMART
Automated Validation
ISO 17025
Manual Validation
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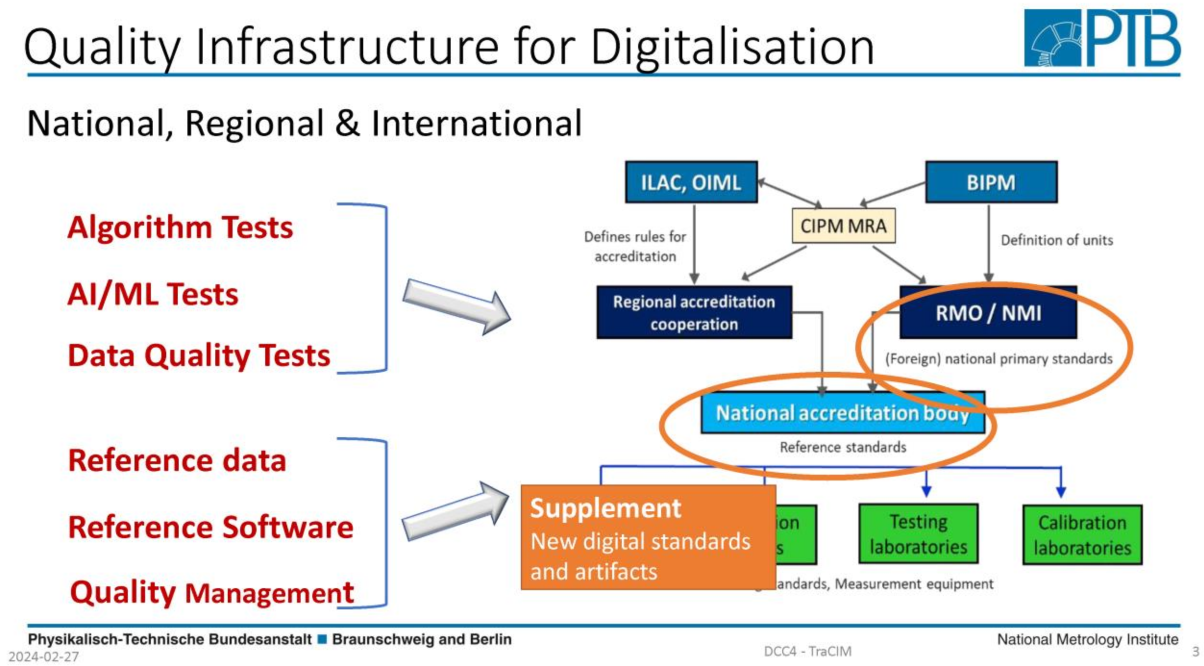
2024-02-27
DCC4 - TraCIM
National Metrology Institute
2


Quality Infrastructure for Digitalisation
PTB
National, Regional & International
Algorithm Tests
AI/ML Tests
Data Quality Tests
Reference data
Reference Software
Quality Management
ILAC, OIML
BIPM
CIPM MRA
Defines rules for accreditation
Definition of units
Regional accreditation cooperation
RMO / NMI
(Foreign) national primary standards
National accreditation body
Reference standards
Supplement
New digital standards and artifacts
Testing laboratories
Calibration laboratories
andards, Measurement equipment
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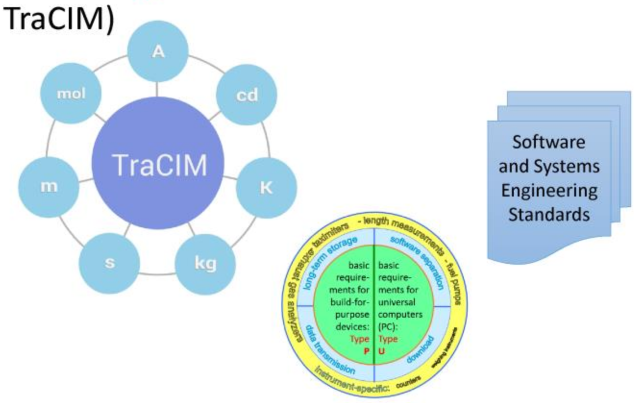
2024-02-27
DCC4 - TraCIM
National Metrology Institute
3

Standards & Services

Industrial metrology
(ISO, TraCIM)

Information Technology
(ISO/IEC 29119, 250xx)



Legal metrology
(MID, OIML, WELMEC)

TraCIM

Traceability of computationally-intensive Metrology

- **End-to-end digital service** to **validate software & data** based on **high quality** digital standards and artefacts

~ 1990: Research & reference pairs Coordinate Metrology

~ 1995: Manual PTB service test Gaussian fitting software

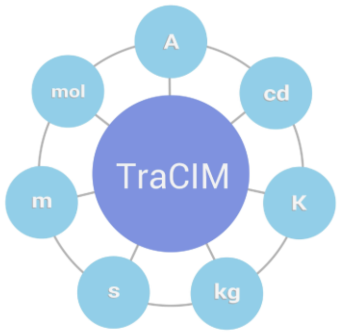
~ 2007: iMERA Plus project
~ 2012: EMRP Project TraCIM -> Online Validation Service Infrastructure

~ 2014: Foundation TraCIM association -> Quality Rules for Validation

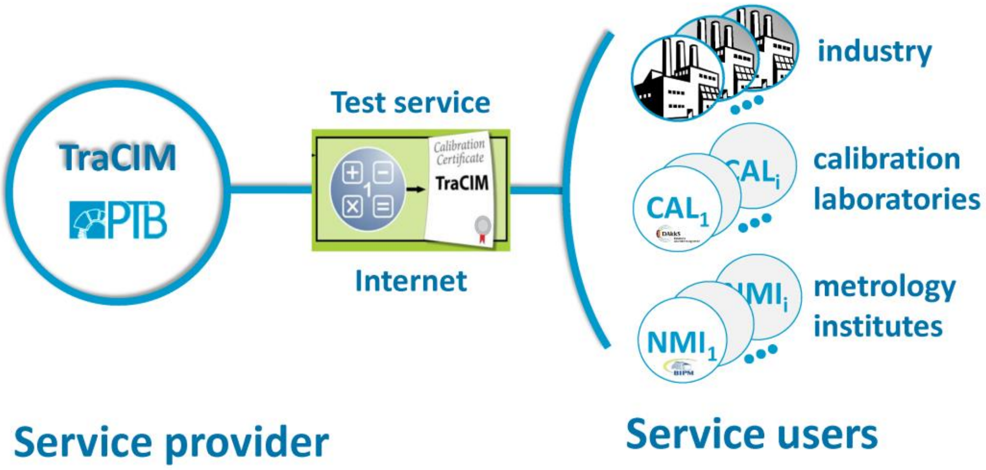
~ 2018: EMPIR Project SmartCom -> **TraCIM Data Validation for D-SI/DCC**

~ 2023: PTB Project AI-test platform -> TraCIM AI Validation medicine

~ 2025: TEF AI Matters-> TraCIM Validation of AI for industrial xCT



TraCIM Validation Service



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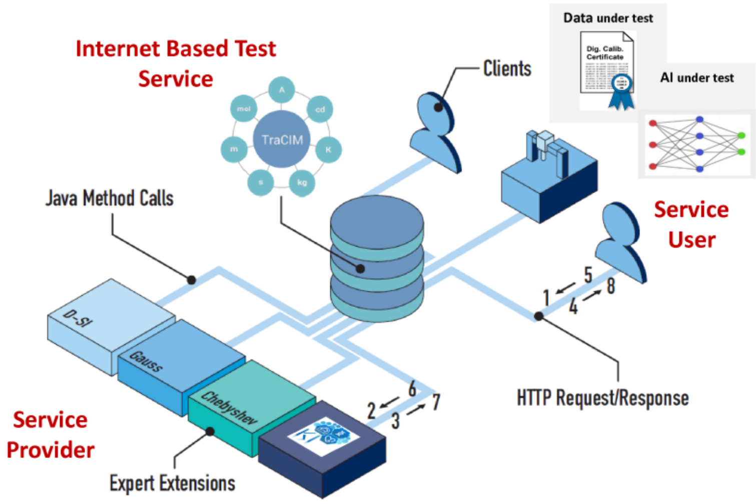
2024-02-27 DCC4 - TraCIM National Metrology Institute 6

TraCIM Service System

- Web-based, long term available services with high reliability
- Following Quality rules by metrology institutes under the TraCIM association



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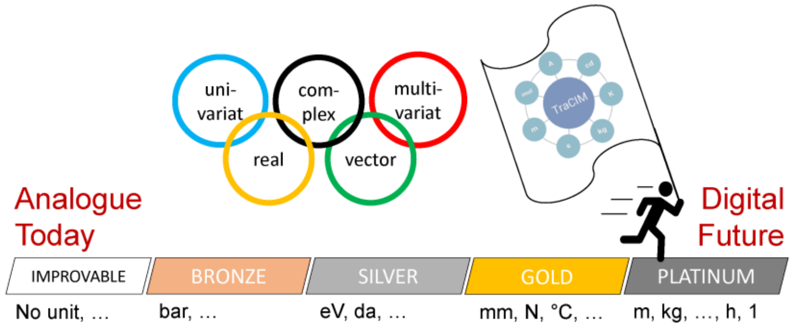
SmartCom validation for D-SI & DCC

Online validation of data formats and DCCs in digital communications



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TraCIM online validation example

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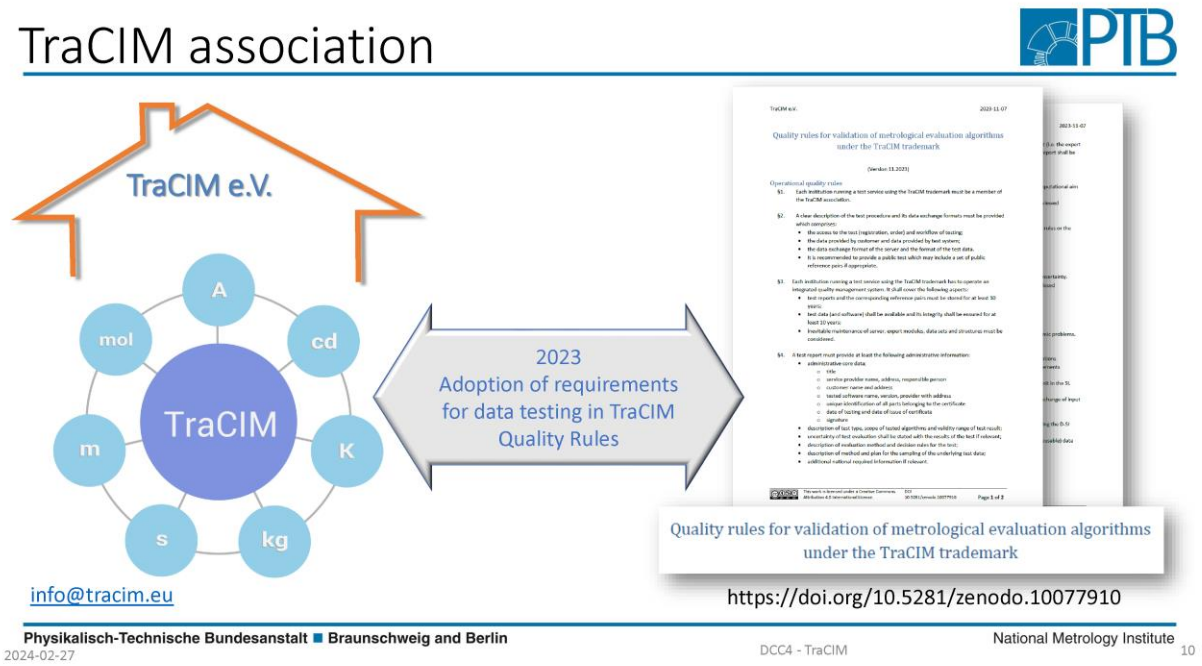
TraCIM association
PTB
TraCIM e.V.
TraCIM
A
cd
K
kg
s
m
mol
2023
Adoption of requirements
for data testing in TraCIM
Quality Rules
Quality rules for validation of metrological evaluation algorithms
under the TraCIM trademark
https://doi.org/10.5281/zenodo.10077910
info@tracim.eu
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2024-02-27
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National Metrology Institute
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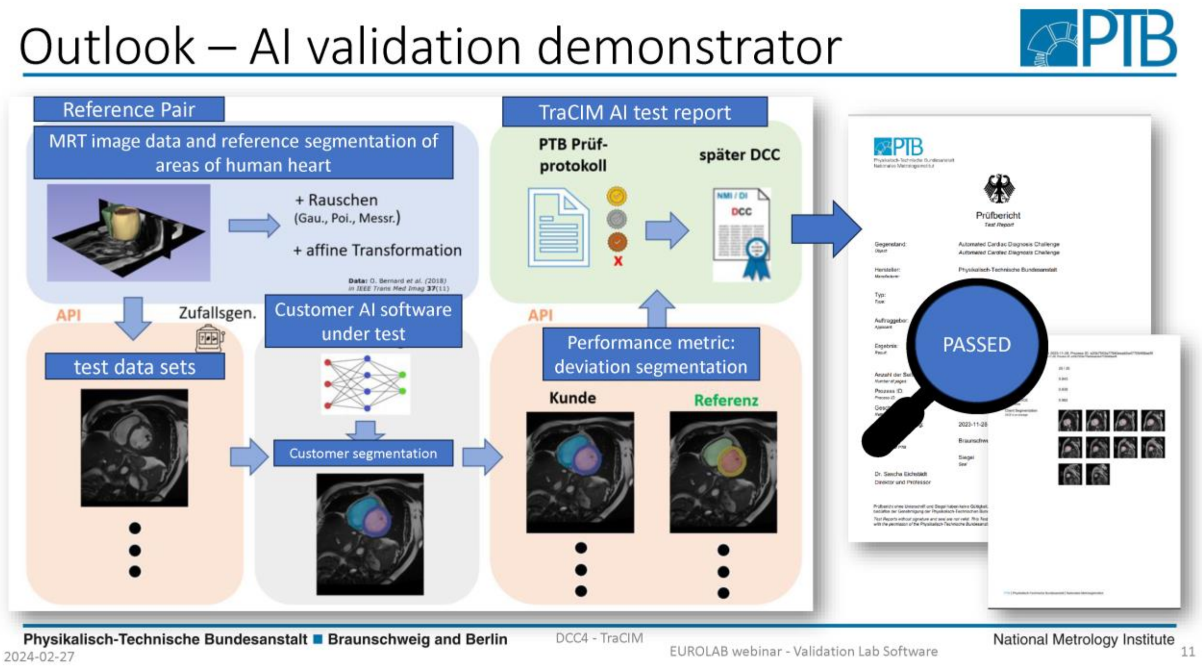
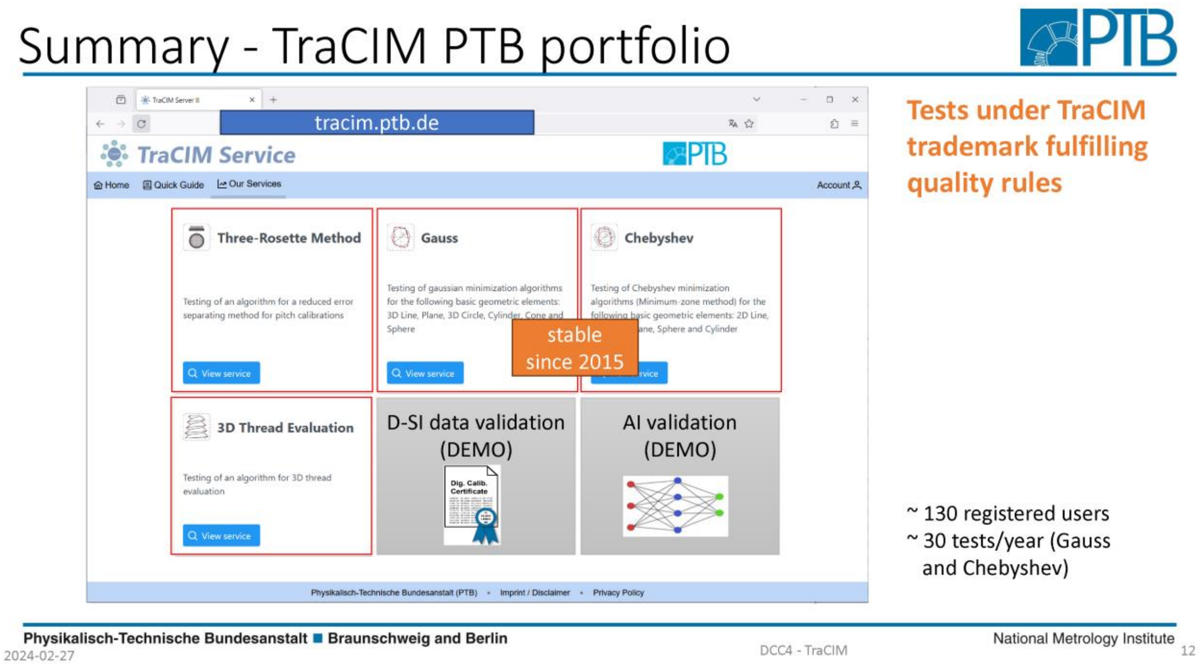

Outlook – AI validation demonstrator
PTB
Reference Pair
MRT image data and reference segmentation of
areas of human heart
+ Rauschen
(Gau., Poi., Messr.)
+ affine Transformation
API
Zufallsgen.
test data sets
Customer AI software
under test
Customer segmentation
TraCIM AI test report
PTB Prüf-
protokoll
später DCC
DCC
API
Performance metric:
deviation segmentation
Kunde
Referenz
Prüfbericht
PASSED
Physikalisch-Technische Bundesanstalt ■ Braunschweig and Berlin
2024-02-27
DCC4 - TraCIM
EUROLAB webinar - Validation Lab Software
National Metrology Institute
11



Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Bundesallee 100
38116 Braunschweig

Daniel Hutzschenreuter
Telefon: 0531 592-9420
E-Mail: daniel.hutzschenreuter@ptb.de
www.ptb.de

Stand: 02/24

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05 Digital Calibration Certificates within QIF, the Quality Information Framework

Presenting author: Jacob Brooks, UNC Charlotte, USA
Email: j.brooks@carolinarain.org

Abstract

As the digital footprint of industry grows, organization and transmission of associated data becomes increasingly critical. The Quality Information Framework, or QIF, is an XML-based structure designed to organize and transmit design and quality control data between software packages throughout a product's quality lifecycle. This standardized framework supports interoperability between previously unconnected fibers in the manufacturing digital thread.

To maintain the traceability of measurements, manufacturers need to keep track of their measurement resources and associated calibration data. This is traditionally accomplished using Adobe PDF documents or paper calibration certificates. As quality control operations become more complex, however, the advantages of machine-interpretable calibration certificates become apparent. Calibration information can be transferred directly into gage management software packages or other measurement equipment databases without the need for manual data entry. Algorithms could then be used to automatically develop appropriate measurement strategies for given characteristics using equipment available to the user. Because QIF DCCs are designed to be processed automatically, the data can easily be translated into other machine or human readable formats. Less structured traditional calibration certificates, on the other hand, are far more difficult for a machine to process and convert.

Currently, QIF is not designed to support the transmission of all necessary calibration information. For companies that already implement the QIF framework in their manufacturing processes, adding DCC functionality will help streamline the transmission of this data, saving precious quality control time. In this project, we aim to build a DCC framework that functions seamlessly within QIF and translates easily to other DCC formats.

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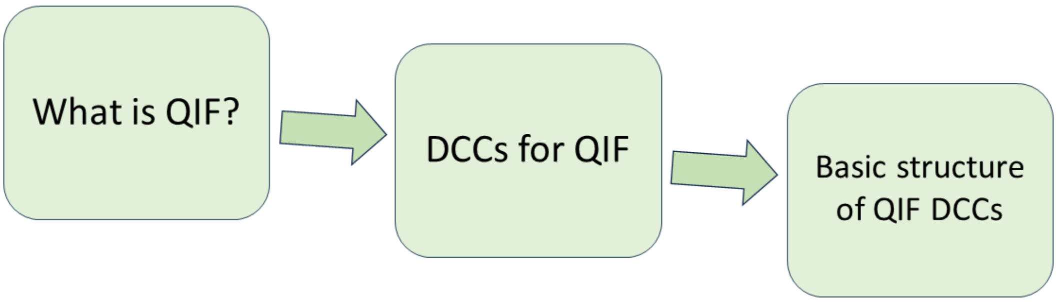
Presentation of Jacob Brooks

Digital Calibration Certificates within QIF, the Quality Information Framework

Jacob Brooks, PhD Student
Faculty advisor: Dr. Edward Morse
The University of North Carolina at Charlotte, United States
27 February 2024

CENTER FOR PRECISION METROLOGY

Presentation overview



2
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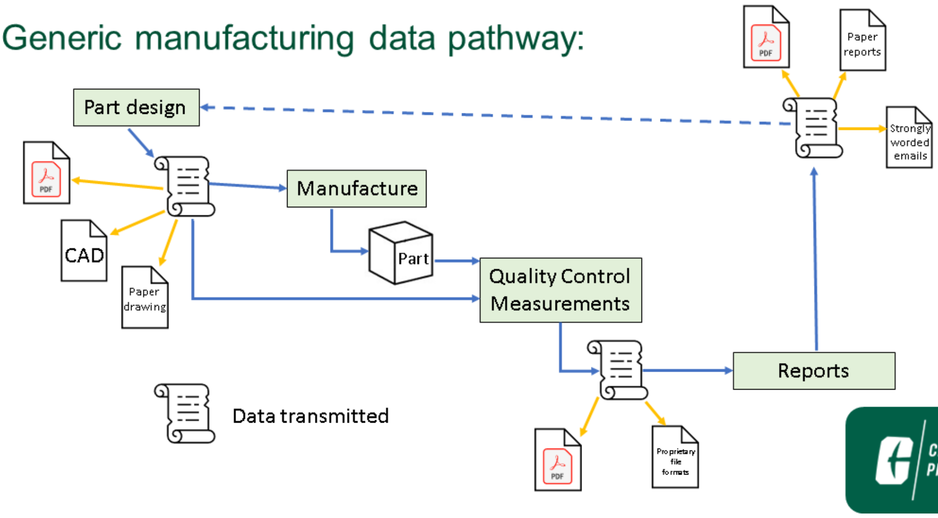
What is QIF?

- Generic manufacturing data pathway:



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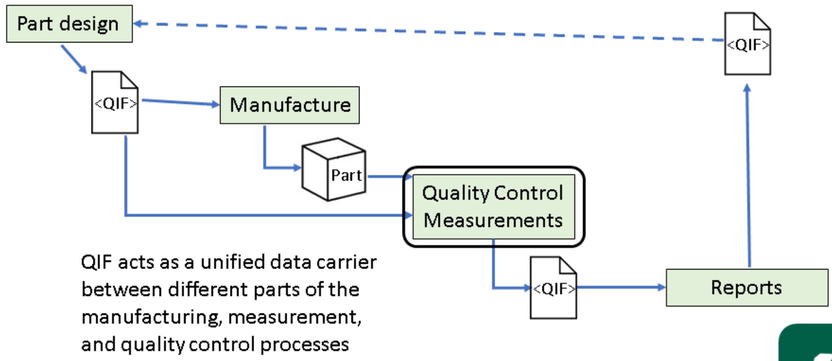
What is QIF?

- **QIF:** the **Quality Information Framework** replaces physical paper trail with unified XML format



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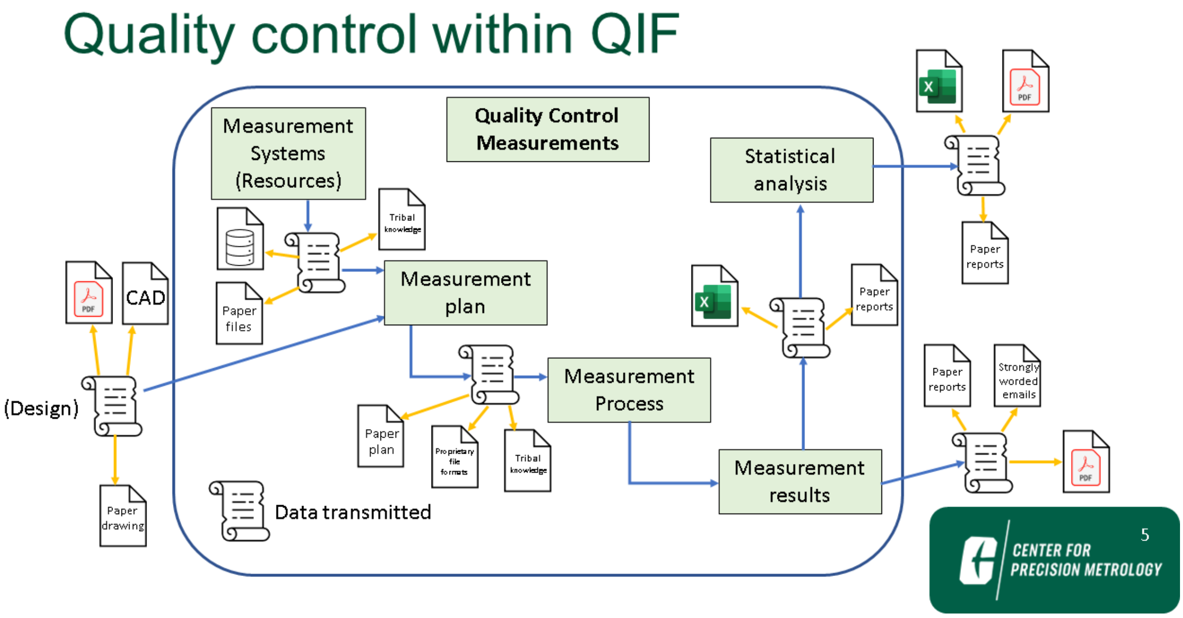
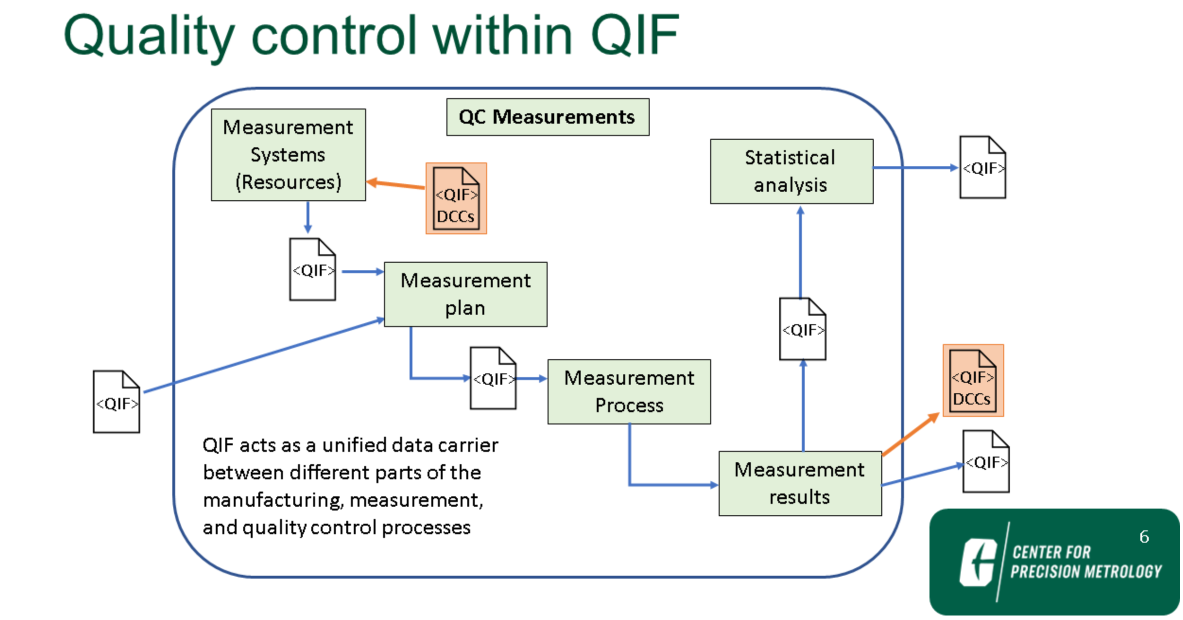

Quality control within QIF
Measurement Systems (Resources)
Quality Control Measurements
Statistical analysis
Tribal knowledge
Paper files
Measurement plan
PDF
CAD
(Design)
Paper reports
Paper plan
Proprietary file formats
Tribal knowledge
Measurement Process
Paper reports
Strongly worded emails
Measurement results
Paper drawing
Data transmitted
5
CENTER FOR PRECISION METROLOGY


Quality control within QIF
Measurement Systems (Resources)
QC Measurements
Statistical analysis
<QIF> DCCs
<QIF>
Measurement plan
<QIF>
Measurement Process
QIF acts as a unified data carrier between different parts of the manufacturing, measurement, and quality control processes
Measurement results
6
CENTER FOR PRECISION METROLOGY

QIF is currently not designed to store all necessary calibration information.

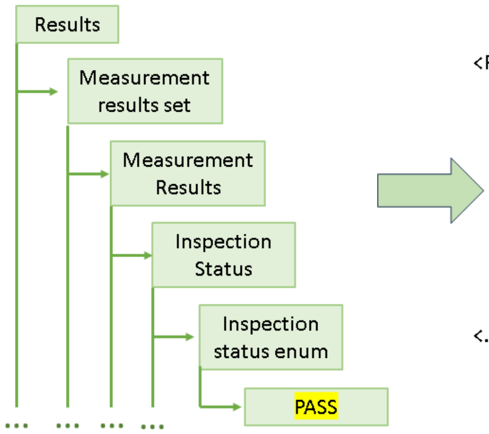
- QIF structure defined by XML “schema” files.

- QIF currently stores relevant information such as:
  - Measurement plans
  - Measurement results, reporting
  - Resources (equipment) used
  - UUIDs, time/date stamps

- However, not designed to handle *all* calibration information, certainly not all in one place

7

QIF/XML example of a “passed” measurement




```
<Results>
   <MeasurementResultsSet n=1>
      <MeasurementResults id=12345>
         <InspectionStatus>
            <InspectionStatusEnum>
               PASS
            </InspectionStatusEnum>
         <…>
      <…>
   <…>
<…>
```

8

Impetus for QIF DCCs

- Calibration certificates are intended to collect relevant information into a report documenting testing and adherence to requirements.
- To keep all this data in one place, a QIF-based DCC schema is being constructed using existing QIF XML tags and type definitions.
- This way, QIF measurement results can be easily populated into a QIF DCC, and information can easily be moved from the DCC to other places within QIF.

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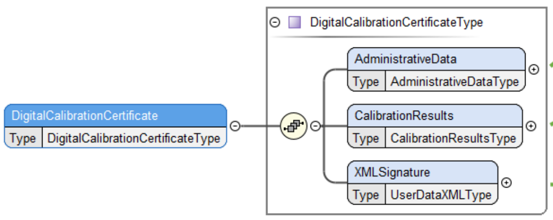
Basic structure of QIF DCCs

The QIF-style DCC will largely mirror the structure of PTB DCCs



Text statements, references, names and addresses, et cetera

Numerical measurement results with units, uncertainty, et cetera

XML signature, defined in XML-Signature Syntax and Processing W3C Recommendation

Work in progress, subject to change!

10 CENTER FOR PRECISION METROLOGY

Ongoing work

- Complete data structure to organize calibration information in conformance with ISO 17025 (Testing and Calibration Laboratories)
  - Check compatibility with standards like ISO-230, ISO-10360 series
- Create tools for reading and generating DCCs, translating between formats
  - Because the QIF DCC and PTB DCC are both based on ISO 17025, the same data will be available, making conversion straightforward

11 CENTER FOR PRECISION METROLOGY

Thank you for your time!

Please feel free to reach out for more information via email:
jbrook98@charlotte.edu

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06 Quality-X MVD: A Minimal Viable Dataspace For Quality Infrastructure

Presenting author: Mehran Monavari, Bundesanstalt für Materialforschung und -prüfung (BAM), Germany
Email: mehran.monavari@bam.de
Additional authors: Matthias Prellwitz matthias.prellwitz@bam.de, Claudia Koch claudia.koch@bam.de

Abstract

The digital transformation of quality infrastructure (QI) is a critical step towards an interconnected and efficient industrial ecosystem. The QI-Digital initiative, a collaboration between prominent German QI entities BAM, DAkkS, DIN, DKE, and PTB endeavors to revolutionize this sector by developing and piloting digital infrastructure and assets, for seamless transformation integration and interoperability of legacy QI processes.

We present our project "Quality-X MVD" a minimal viable data space for QI processes developed in collaboration with Fraunhofer ISST. Quality-X utilizes the International Data Spaces (IDS) architectural framework to facilitate issuing, tracing, verifying, and ordering digital assets for organizations, companies, and the public. Expanding on the developments of sector-specific data spaces such as Catena-X for the automotive industry and Manufacturing-X for production, Quality-X emphasizes the integration of QI processes, addressing a gap in the current data space landscape by focusing on conformity assessment mechanisms.

We demonstrate the effective implementation of QI processes within Quality-X using a case study centered on digital calibration certificates (DCC). This includes the accreditation of calibration laboratories, the generation and issuance of digital calibration certificates (DCCs), and the authentication of digital assets by end-users. This demonstrator shows that data spaces, as federated network, are inherently suited to these complex tasks. Implementing self-sovereign identities, digital wallets, and using the Eclipse Data Space Components controlled data sharing via beforehand agreed policies, Quality-X facilitates the secure creation, collection, distribution, and verification of credentials, digital assets, and meta data.

Furthermore, we discuss the potential of semantic models and semantic hubs in achieving interoperability across diverse digital assets. This interoperability is paramount for the seamless and automated interaction of various actors within the QI ecosystem, such as standardization institutes, conformity assessment bodies, and market surveillance authorities. We outline other QI processes that can be simulated in our Testbed: digital issuance and signing of certificates, tamper-proof metadata publication to neutral registries, and dynamic digital asset versioning from inception to lifecycle conclusion.

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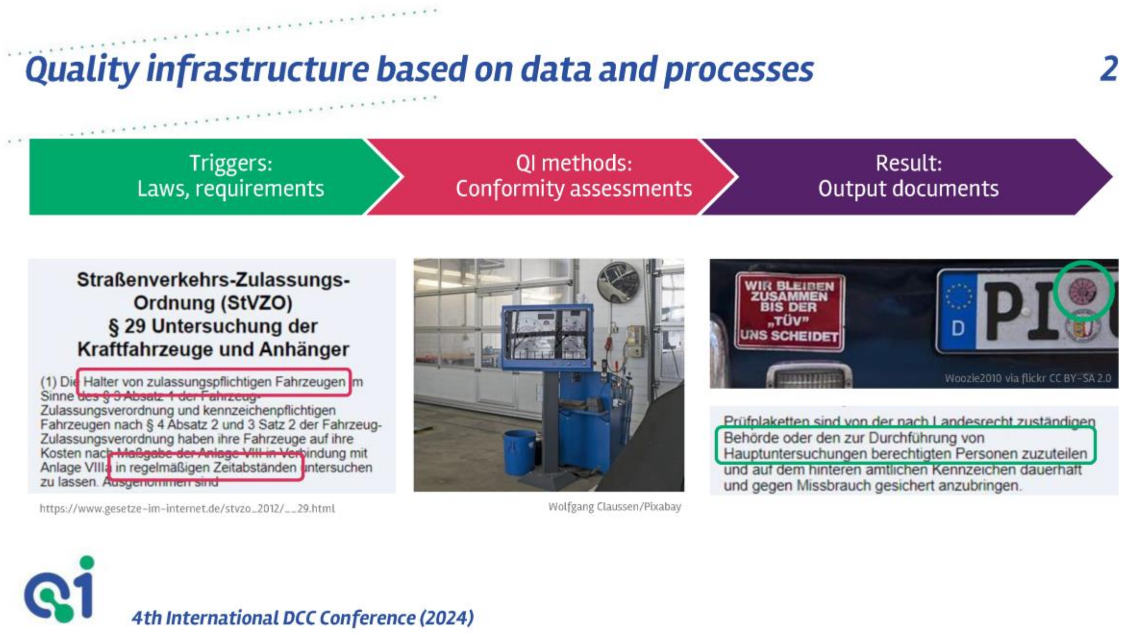
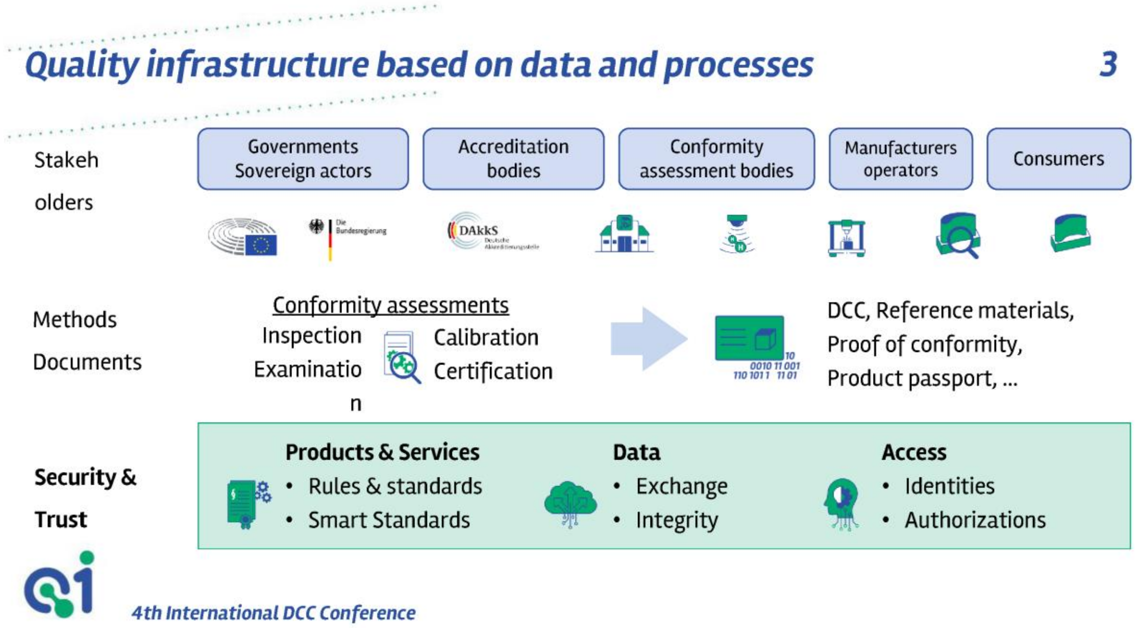
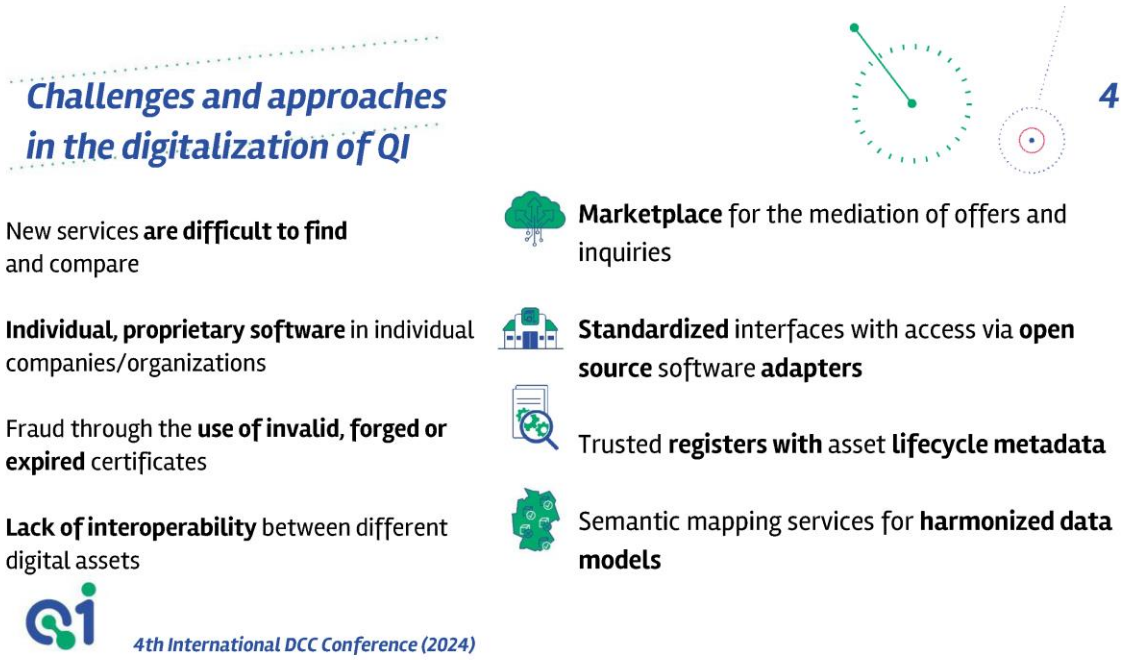
Presentation Mehran Monavari




Quality infrastructure based on data and processes
3
Stakeh
olders
Governments
Sovereign actors
Accreditation
bodies
Conformity
assessment bodies
Manufacturers
operators
Consumers
DAkkS
Methods
Documents
Conformity assessments
Inspection
Examinatio
n
Calibration
Certification
DCC, Reference materials,
Proof of conformity,
Product passport, ...
Security &
Trust
Products & Services
• Rules & standards
• Smart Standards
Data
• Exchange
• Integrity
Access
• Identities
• Authorizations
4th International DCC Conference


Challenges and approaches
in the digitalization of QI
4
New services are difficult to find
and compare
Individual, proprietary software in individual
companies/organizations
Fraud through the use of invalid, forged or
expired certificates
Lack of interoperability between different
digital assets
Marketplace for the mediation of offers and
inquiries
Standardized interfaces with access via open
source software adapters
Trusted registers with asset lifecycle metadata
Semantic mapping services for harmonized data
models
4th International DCC Conference (2024)

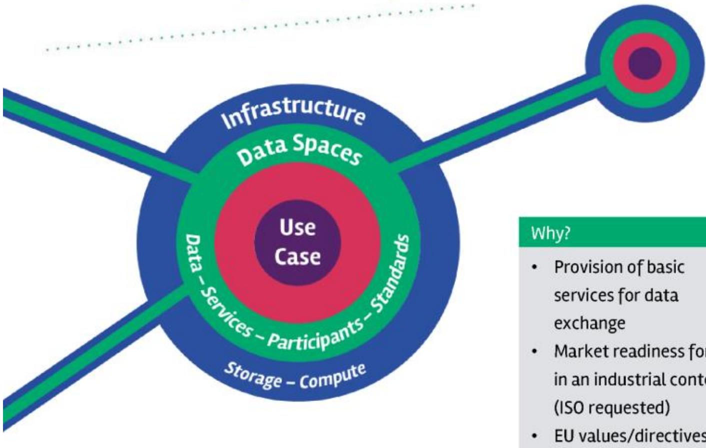
QI DIGITAL

Quality-X: A digital infrastructure for QI based on Data Spaces

www.qi-digital.de

Motivation for data spaces

6



Why?

- Provision of basic services for data exchange
- Market readiness for use in an industrial context (ISO requested)
- EU values/directives: Data/Market/AI ... Act

Values of Data Spaces and GAIA-X

Sharing: Provide and receive data securely and in a controlled manner
Sovereignty: control over your own data ensures trust and reduces leaks
Openness: promoting diversity and active participation to avoid dependencies
Interoperability: different data spaces connected by open standards for efficient networking
Transparency: Comprehensible processes, services and operating models for informed decisions
Trust: Security and data protection in the infrastructure
Governance: mechanisms are accepted by all participants
Federation: Cooperation and exchange between different providers and services

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Data Spaces
Technical building blocks

7

Data interoperability	Data sovereignty and trust	Data value creation enablers
Data models	Identity and attestation management	Data, services and offerings descriptions
Data exchange	Trust framework	Publication and discovery
Provenance and traceability	Access and usage policies enforcement	Value added services

https://dssc.eu/page/knowledge-base

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Interoperability is at the heart of data spaces

8

Technical
- Communication on a technical level through uniform standards, protocols and APIs

Semantically
- exchanged data can be interpreted in the same way everywhere.
- Semantic models, especially for digital twins, play a central role here.

Regulatory
- Being able/allowed to communicate with each other from a compliance perspective
- The basis is agreement on common regulations, such as a common legal area and standards/norms

Organizational
- Effective organization of interacting processes
- Accessibility for users

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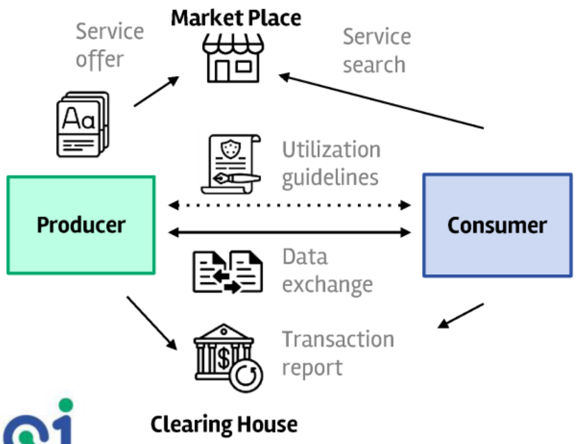
Data Spaces Interaction sequence

10



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Contributions

- Traceability of document exchange
- Guidelines (Policies)
- Legal confidence
- Exchange and verification via open, standardized software components

Advantages

Control. Data remains with the owner; Control over access
Single source of truth. Data always up to date, not uploaded to central platforms or shared multiple times
Low-threshold. Technically, anyone can participate in the ecosystem; OSS implementations
Trustworthy. Verifiable authorizations

Data usage guidelines for Data Space connectors, 21 in the standard, 9 implemented

11

#	Title	Implementation
1	Allow the Usage of the Data	provides data usage *without* any restrictions
2	Connector-restricted data usage	allows data usage for a **specific connector**
4	Interval-restricted data usage	provides data usage within a specified **time interval**
5	Duration-restricted Data Usage	allows data usage for a specified **time period**
12	Restricted Number of Usages	allows data usage for **n times**
13	Security Level Restricted Policy	allows data access only for **connectors with a specified security level**
14	Use Data and Delete it After	allows data usage within a specified time interval with the restriction to **delete it at a specified time stamp**
17	Local logging	allows data usage and sends **logs to a specified Clearing House**
18	Remote Notifications	allows data usage and **sends notification message**

https://international-data-spaces-association.github.io/DataspaceConnector/Documentation/v6/UsageControl

Quality-X: Secure, Trustworthy and Sovereign data exchange via data spaces

12

Quality-X is a federated platform for connecting institutions and easily, securely exchanging qualit related data and information.

It creates an ecosystem for quality infrastructure based on ***International Data Spaces (IDS)*** with harmonized interfaces.

Quality-X: "Standing on the shoulders of giants"

Use of building blocks from existing initiatives:
Quality-X uses elements of initiatives *such as Catena-X*, an advanced data space implementation.

Manufacturing-X, data spaces for Industry 4.0:

- Launched in spring 2023
- focuses on the improvement of production processes and supply chains through the use of GAIA-X/IDS and plans future implementations for conformity assessment.

Asset Administration Shell as the backbone:

- Data container for the virtual representation of goods (digital twin) of Industry 4.0
- different submodels with a defined structure to manage and access instructions, files or references.

Quality-X testbed based on data spaces

MANUFACTURING-X

Catena-X
Automotive Network

gaia-x

Fraunhofer
ISST

- Data Spaces (IDS architecture) is a secure and privacy-preserving infrastructure for pooling, accessing, sharing, processing and using data.
  - Enable data sovereignty (data remains with the owner)
  - Respecting intellectual property and securing business models
  - Negotiate data usage via guidelines before data transactions
- Embedding of QI processes: Connection to Data Spaces with open source Eclipse Dataspace Components (EDC).

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Technical components of an IDS and their role in the quality infrastructure

- **Broker services** could act as a **directory service** that makes it easier for participants to **find each other** and ensure secure data exchange.
- **Identity Hub** could enable the **validation and verification of** participants' **identities** and verifiable credentials could ensure **trustworthiness** and mutual recognition.
- **Clearing House** could act as a **logging service** and provide a tamper-proof **record of data exchange interactions.**
- **IDS connectors** could enable **secure data exchange** between participants and at the same time guarantee **data sovereignty** and **data protection.**
- **Semantic Hub** and **Asset Administrative Shell** enables **interoperability** between assets

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Digital quality infrastructure in data spaces

- Digitization of QI processes and documents
  - Transparent value creation networks between players

Data travels at the speed of trust

- **Trust** and **interoperability** are key factors
- Data spaces & GAIA-X
  - Federal architecture for sovereign data exchange
- Quality-X designs the weaving of QI processes and documents and documents into data spaces

Advantages

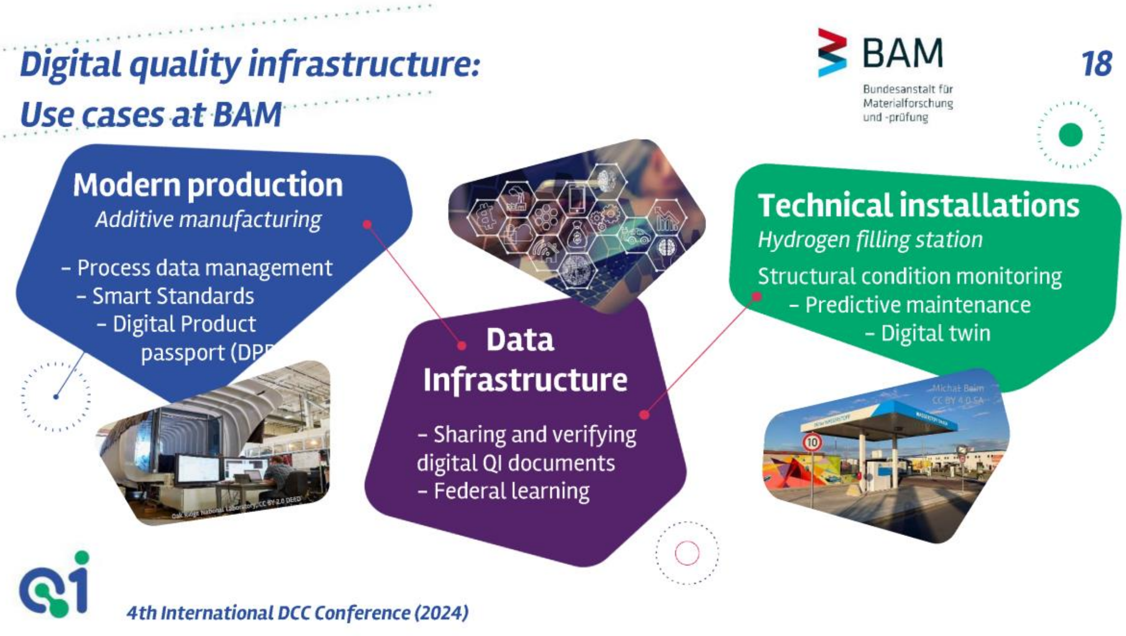
- Improved security
- Data sovereignty
- Increased transparency creates trust
- Improved efficiency through data integration
- Accelerated collaboration and innovation

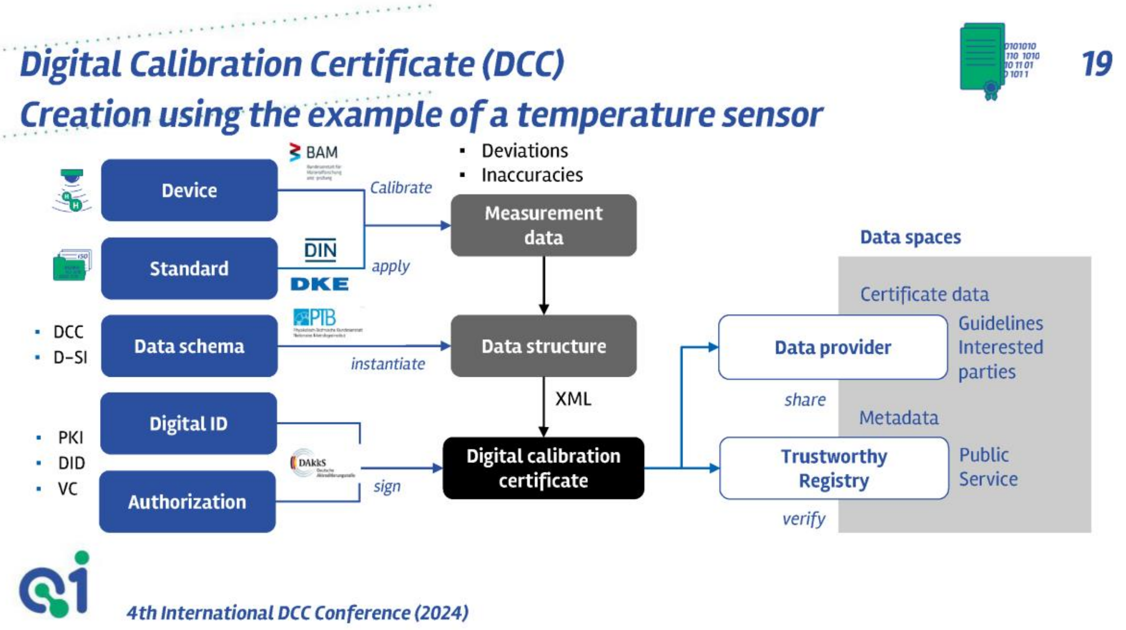
Manufacturing
Examination
Verification

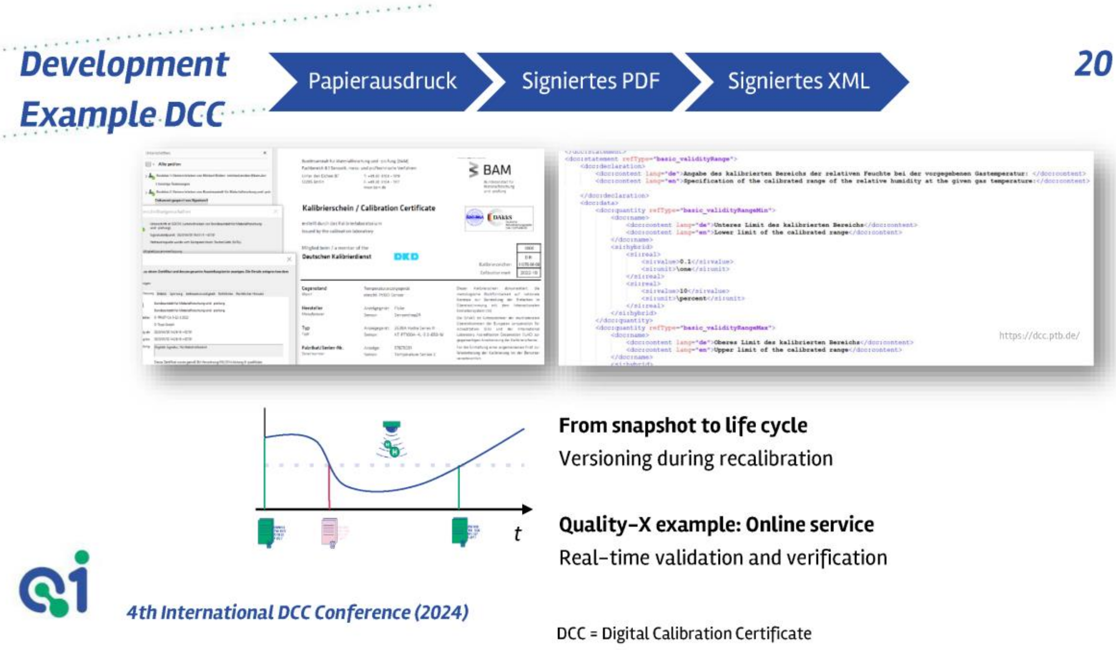
QI DIGITAL

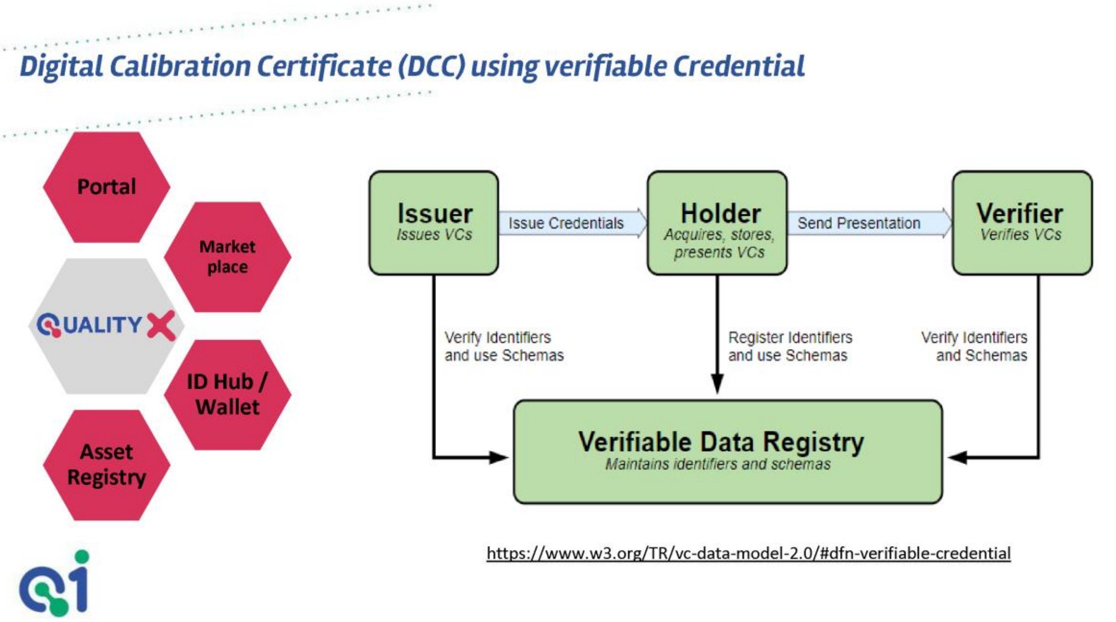
QI use cases via data spaces

www.qi-digital.de


Digital quality infrastructure:
Use cases at BAM
BAM
Bundesanstalt für Materialforschung und -prüfung
18
Modern production
Additive manufacturing
- Process data management
- Smart Standards
- Digital Product passport (DPP)
Data Infrastructure
- Sharing and verifying digital QI documents
- Federal learning
Technical installations
Hydrogen filling station
Structural condition monitoring
- Predictive maintenance
- Digital twin
4th International DCC Conference (2024)

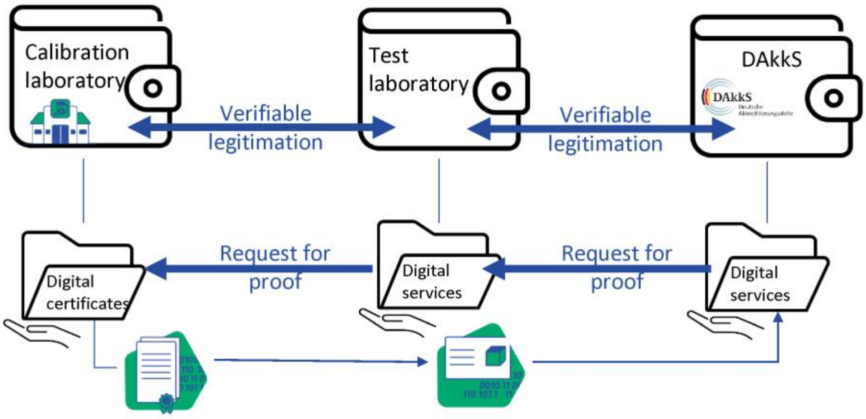

Digital Calibration Certificate (DCC)
Creation using the example of a temperature sensor
19
Device
Standard
Data schema
Digital ID
Authorization
DCC
D-SI
PKI
DID
VC
BAM
DIN
DKE
PTB
DAkkS
Calibrate
apply
instantiate
sign
Deviations
Inaccuracies
Measurement data
Data structure
XML
Digital calibration certificate
Data spaces
Certificate data
Data provider
Guidelines
Interested parties
share
Metadata
Trustworthy Registry
Public Service
verify
4th International DCC Conference (2024)


Development
Example DCC
Papierausdruck
Signiertes PDF
Signiertes XML
20
BAM
Kalibrierschein / Calibration Certificate
DKD
https://dcc.ptb.de/
t
From snapshot to life cycle
Versioning during recalibration
Quality-X example: Online service
Real-time validation and verification
4th International DCC Conference (2024)
DCC = Digital Calibration Certificate


Digital Calibration Certificate (DCC) using verifiable Credential
Portal
Market place
QUALITY X
ID Hub / Wallet
Asset Registry
Issuer
Issues VCs
Issue Credentials
Holder
Acquires, stores, presents VCs
Send Presentation
Verifier
Verifies VCs
Verify Identifiers and use Schemas
Register Identifiers and use Schemas
Verify Identifiers and Schemas
Verifiable Data Registry
Maintains identifiers and schemas
https://www.w3.org/TR/vc-data-model-2.0/#dfn-verifiable-credential

Vision: Digital proof with a high level of confidence

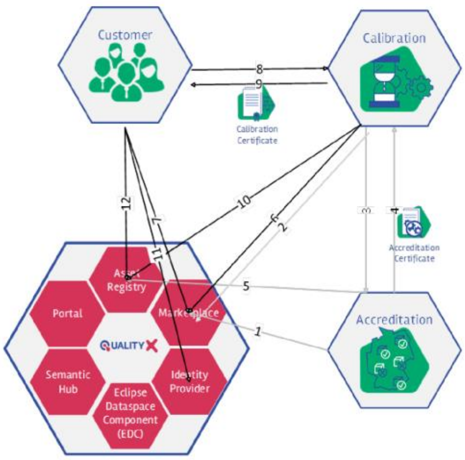
22



4th International DCC Conference (2024)

Scenario Digital Calibration Certificate (DCC)

- Participants:
  - Quality-X Central Authority (QXCA):
  - Accreditation Body: e.g. DAkkS
  - Conformity Assessment Body (CAB): e.g. BAM Calibration Lab
  - Customer of CAB
- This scenario simulates the process of issuing a digital calibration certificate by an accredited lab for a customer.
- Prerequisites:
- All participants have DID/SSI and access to the MVD via either their own node or an account on the QXCA portal



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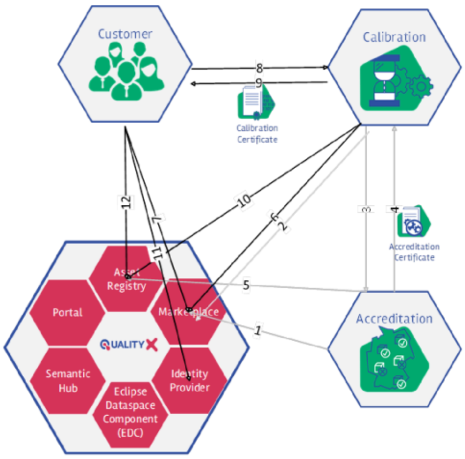
23 27.02.2024

Scenario Digital Calibration Certificate (DCC)

Part I :

1. AAC publishes its accreditation service on the **Marketplace**.
2. CAB searches for accreditation services on the Marketplace
3. CAB requests accreditation from AAC
4. AAC: issues accreditation certificate for the CAB lab
5. The accreditation certificate comes with a **verifiable credential** that can be added to the CAB ID HUB (wallet)
6. AAC registers accreditation certificate on the Asset registry with UID



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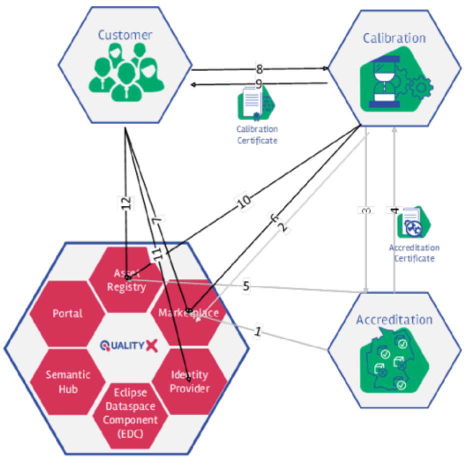
Scenario Digital Calibration Certificate (DCC)

Part II:

7. CAB: publishes its certified calibration services on the QXCA marketplace
8. The Customer: searches for certified calibration services on the marketplace
9. The Customer: purchases a calibration service from CAB
10. CAB: issues a digitally signed asset (in XML format) for the customer with a UID and using the self-signature and also issues a verifiable credential for the assets
    ## data model of the digital asset is accessible via semantic hub##
11. CAB registers the asset metadata (Creation date, expiration date, hash, dependencies) on the asset registry



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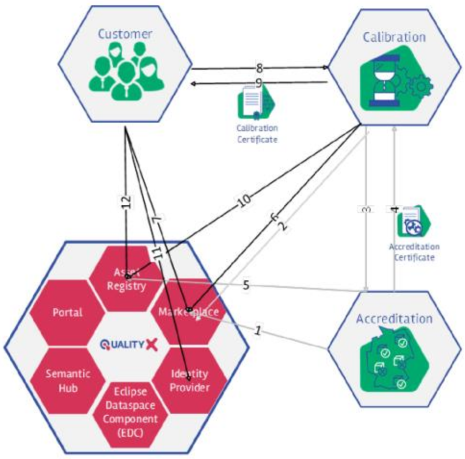
Scenario Digital Calibration Certificate (DCC)

Part III:

12. The Customer verifies the authenticity of the CAB signatures and credentials using QXCA service
13. Customer validation: The customer can look up the metadata in the asset registry for validation of the asset at a certain time or the validity of its perquisites
14. The asset data model is accessible from the Semantic Hub ensuring interoperablity



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QX Status & Roadmap

2023	• Use Case Definition: DCC Issuing • Trusted Meta Data Registry
2024	• Identity and Verifiable Credentials • Federated Learning • Quality-X Portal
2025	• Semantic Hub • Asset Administrative Shell

Quality-X Minimal Viable Data Space | DCC Conference 2024 27 27.02.2024

Contact

QUALITY INFRASTRUCTURE DIGITAL

Websites
Quality Infrastructure Digital Project
qi-digital.de/en

Quality-X development
Dr. Mehran Monavari
BAM, eScience
mehran.monavari@bam.de
linkedin.com/in/monavari/

QI Digital @ BAM
Dr. Claudia Koch
BAM, Digitalization of Quality Infrastructure
claudia.koch@bam.de
linkedin.com/in/dr-claudia-koch-a6865437

Federal Institute for Materials Research and Testing (BAM)
bam.de/qi-digital

White Paper
qrco.de/Quality-X

BAM Bundesanstalt für Materialforschung und -prüfung

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DKE

DIN

DAkkS Deutsche Akkreditierungsstelle

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07 Digital Calibration Certificate in a quality infrastructure data space: a proof of concept

Presenting author: Tomasz Sołtysiński, PTB Germany
Email: tomasz.soltysinski@ptb.de
Additional authors: Jens Niederhausen jens.niederhausen@ptb.de, Sascha Eichstädt sascha.eichstaedt@ptb.de

Abstract

Digital Calibration Certificates (DCC) contain several different information elements, structured in a way to be machine readable, to provide essential content on calibration process, technical requirements, metrological regulations and performance. In addition, specific sensitive information may be part of the information package to be shared with a DCC. Given the complexity of information, its unique and differential character comprising different aspects of metrological and industrial requirements, its trustworthy and reliable presentation constitutes a real challenge. Especially, if a state authority or a notified body claims an access to the content of a DCC it should be presented quickly, limited to defined requirements on content; in a restricted, secured and authorized way by means of automated protocols to be easily exchangeable and interoperable between involved parties.

In our work this challenge is addressed in a framework of verifiable presentations realized by applications of W3C decentralized identifiers (DID) and verifiable credentials (VC) in an international data spaces (IDS) approach. To realize a verifiable presentation of DCC content on demand, a trust and identity work package of the Gaia-X environment has been adapted. Such an open-source-based approach, utilizing the tools of Cross Federates Services developed by Gaia-X and the Eclipse Foundation demonstrates a secured, restricted and interoperable, automated framework to present only required information of interest to a state authority or any government office.

The proposed approach is easily scalable, extendable, and accessible to any authorized body and industrial partner or company. By accepting terms and conditions of the Gaia-X ecosystem, any legal participant can join the ecosystem and use the offered services exposed in a federated catalogue. Through application of DIDs, VCs, self-description and secured communication, we developed a scenario for a proof of concept, providing a use case in a metrology network. Such an approach is easily adaptable to any metrological infrastructure, especially considering a potential European Metrology Dataspace and the recently published Quality-X concept white paper. The presented use case constitutes a minimum viable product in the framework of the Gaia-X ecosystem and is directly extendable by any IDS component, including Eclipse connectors.

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Presentation of Tomasz Sołtysiński

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Braunschweig und Berlin
Nationales Metrologieinstitut

Digital Calibration Certificate in a quality infrastructure data space: a proof of concept

Tomasz Sołtysiński, Jens Niederhausen, Sascha Eichstädt

Metrology for digital transformation, FB 9.4, PTB

DCC Conference 2024: 4th International DCC Conference

27 February, 2024

Agenda

1. Metrology ecosystem as a Gaia-X complaint Data Space
2. Verifiable Presentation of DCC to a Public Authority in the framework of Gaia-X
3. Service folders vs federated service folder
4. Managing the credentials – Personal (PCM) an Organisational Credential Managers (OCM)
5. Minimal Gaia-X compliant viable product (G-X MVP)

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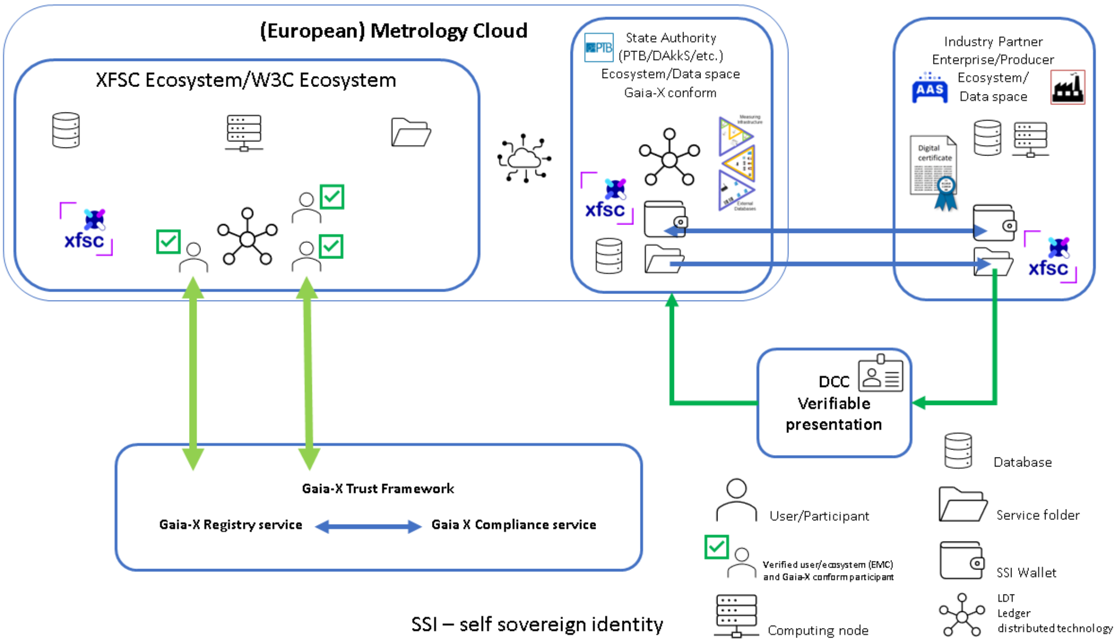
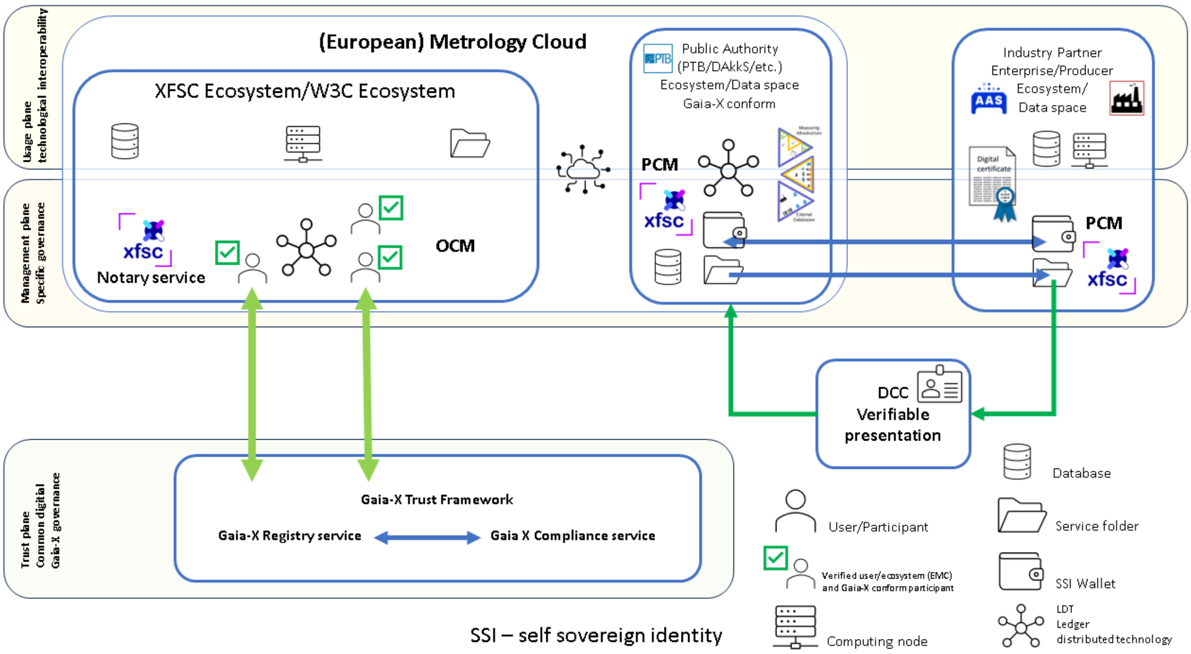
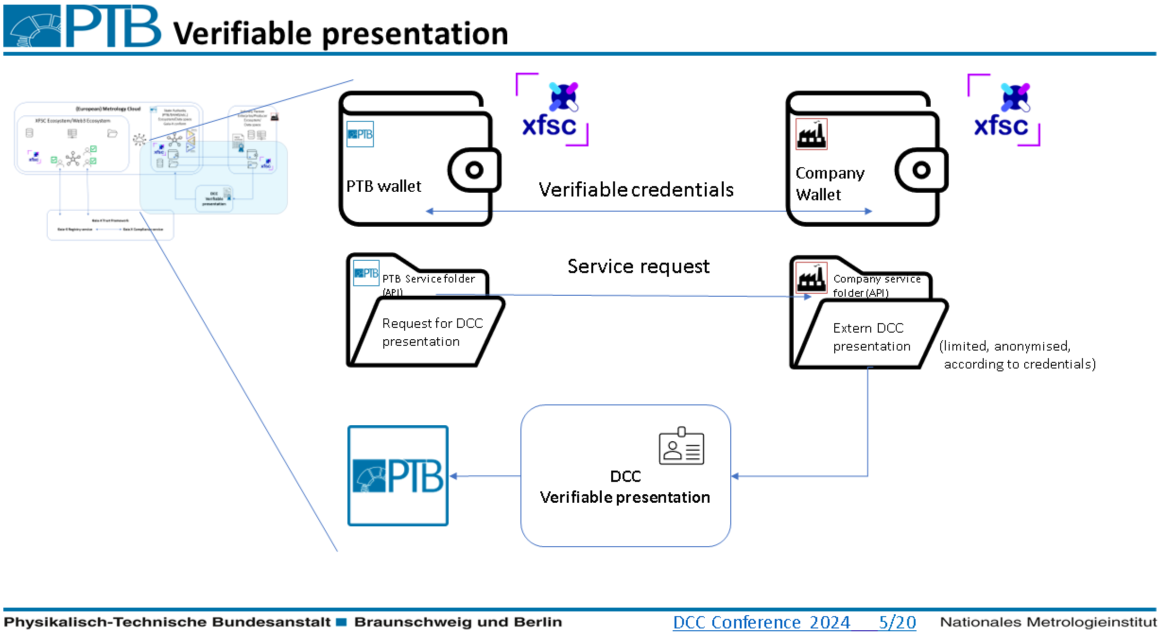

(European) Metrology Cloud
XFSC Ecosystem/W3C Ecosystem
xfsc
State Authority
(PTB/DAkkS/etc.)
Ecosystem/Data space
Gaia-X conform
xfsc
Industry Partner
Enterprise/Producer
Ecosystem/
Data space
AAS
Digital certificate
xfsc
DCC
Verifiable
presentation
Gaia-X Trust Framework
Gaia-X Registry service
Gaia X Compliance service
SSI – self sovereign identity
User/Participant
Verified user/ecosystem (EMC) and Gaia-X conform participant
Computing node
Database
Service folder
SSI Wallet
LDT
Ledger
distributed technology


Usage plane
technological interoperability
Management plane
Specific governance
Trust plane
Common digital
Gaia-X governance
(European) Metrology Cloud
XFSC Ecosystem/W3C Ecosystem
xfsc
Notary service
OCM
Public Authority
(PTB/DAkkS/etc.)
Ecosystem/Data space
Gaia-X conform
PCM
xfsc
Industry Partner
Enterprise/Producer
Ecosystem/
Data space
AAS
Digital certificate
PCM
xfsc
DCC
Verifiable
presentation
Gaia-X Trust Framework
Gaia-X Registry service
Gaia X Compliance service
SSI – self sovereign identity
User/Participant
Verified user/ecosystem (EMC) and Gaia-X conform participant
Computing node
Database
Service folder
SSI Wallet
LDT
Ledger
distributed technology


Verifiable presentation
xfsc
xfsc
PTB wallet
Verifiable credentials
Company Wallet
Service request
PTB Service folder (API)
Request for DCC presentation
Company service folder (API)
Extern DCC presentation
(limited, anonymised, according to credentials)
DCC
Verifiable presentation
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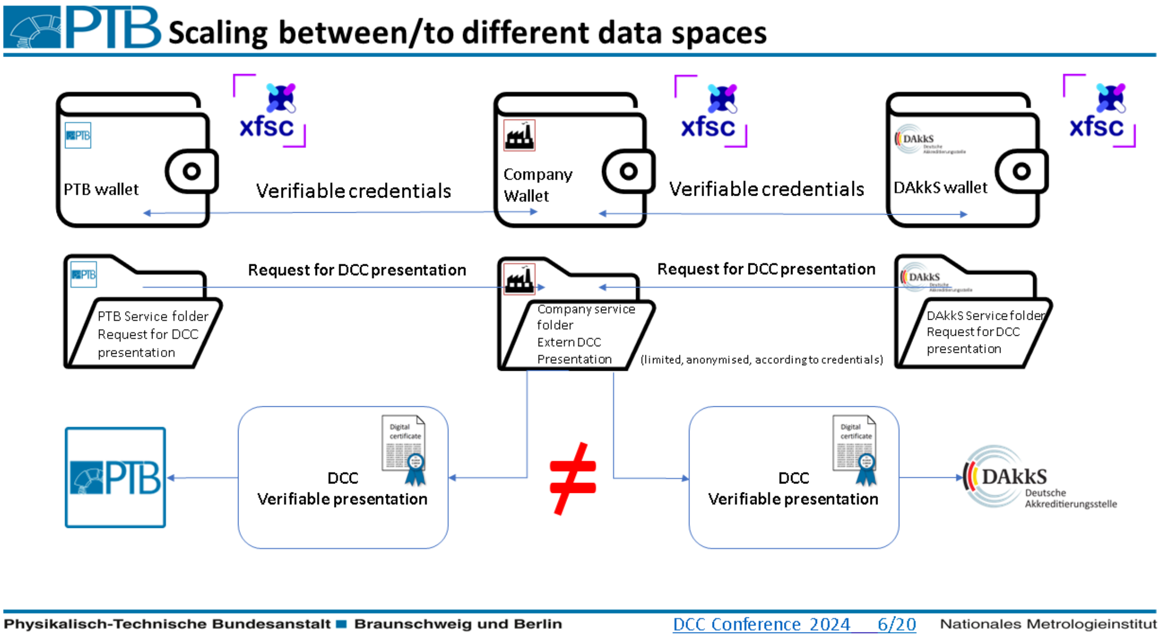
DCC Conference 2024 5/20
Nationales Metrologieinstitut


Scaling between/to different data spaces
xfsc
xfsc
xfsc
PTB wallet
Verifiable credentials
Company Wallet
Verifiable credentials
DAkkS wallet
Request for DCC presentation
Request for DCC presentation
PTB Service folder
Request for DCC presentation
Company service folder
Extern DCC Presentation
(limited, anonymised, according to credentials)
DAkkS Service folder
Request for DCC presentation
DCC
Verifiable presentation
≠
DCC
Verifiable presentation
DAkkS
Deutsche Akkreditierungsstelle
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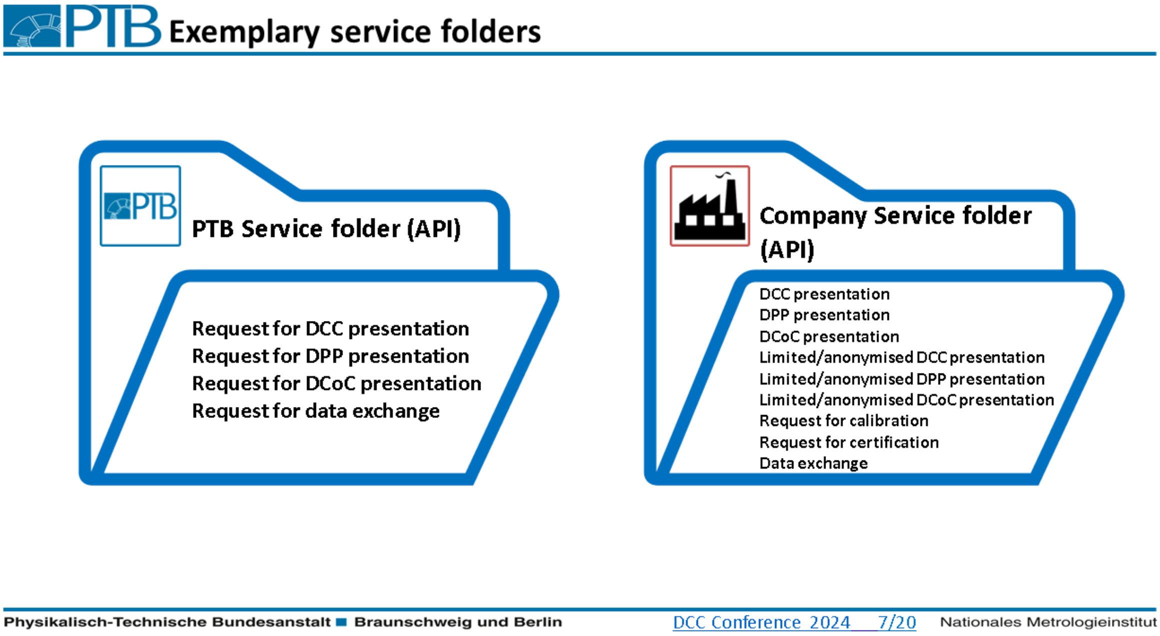
Nationales Metrologieinstitut


PTB Exemplary service folders
PTB Service folder (API)
Request for DCC presentation
Request for DPP presentation
Request for DCoC presentation
Request for data exchange
Company Service folder (API)
DCC presentation
DPP presentation
DCoC presentation
Limited/anonymised DCC presentation
Limited/anonymised DPP presentation
Limited/anonymised DCoC presentation
Request for calibration
Request for certification
Data exchange
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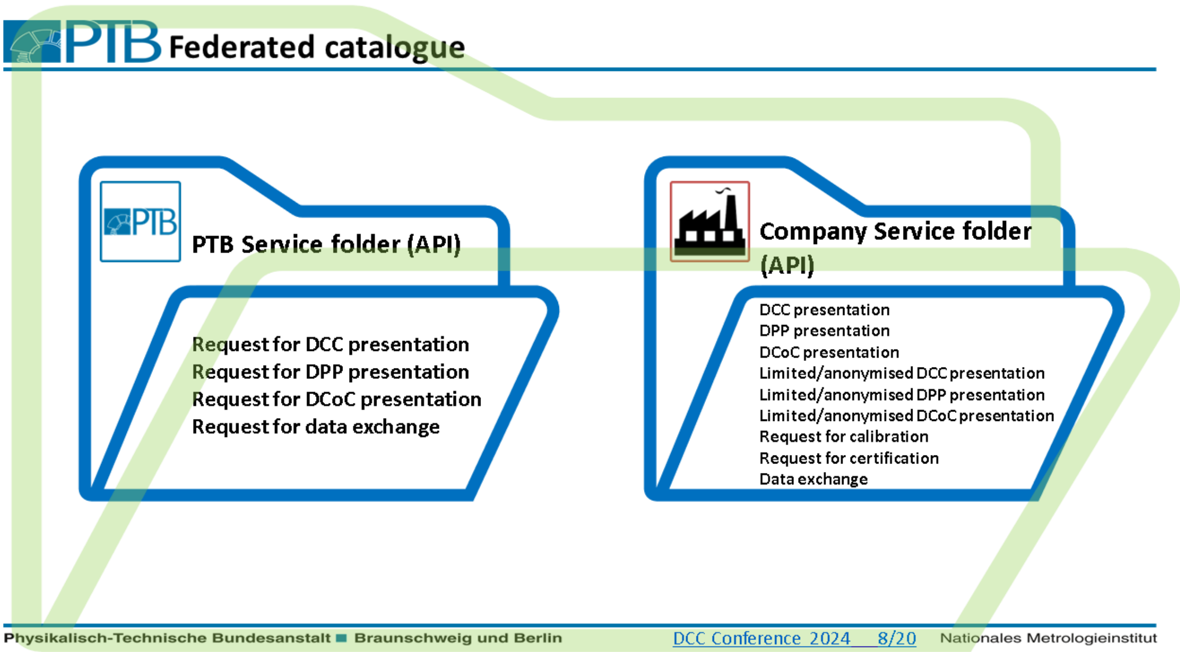
PTB Federated catalogue
PTB Service folder (API)
Request for DCC presentation
Request for DPP presentation
Request for DCoC presentation
Request for data exchange
Company Service folder (API)
DCC presentation
DPP presentation
DCoC presentation
Limited/anonymised DCC presentation
Limited/anonymised DPP presentation
Limited/anonymised DCoC presentation
Request for calibration
Request for certification
Data exchange
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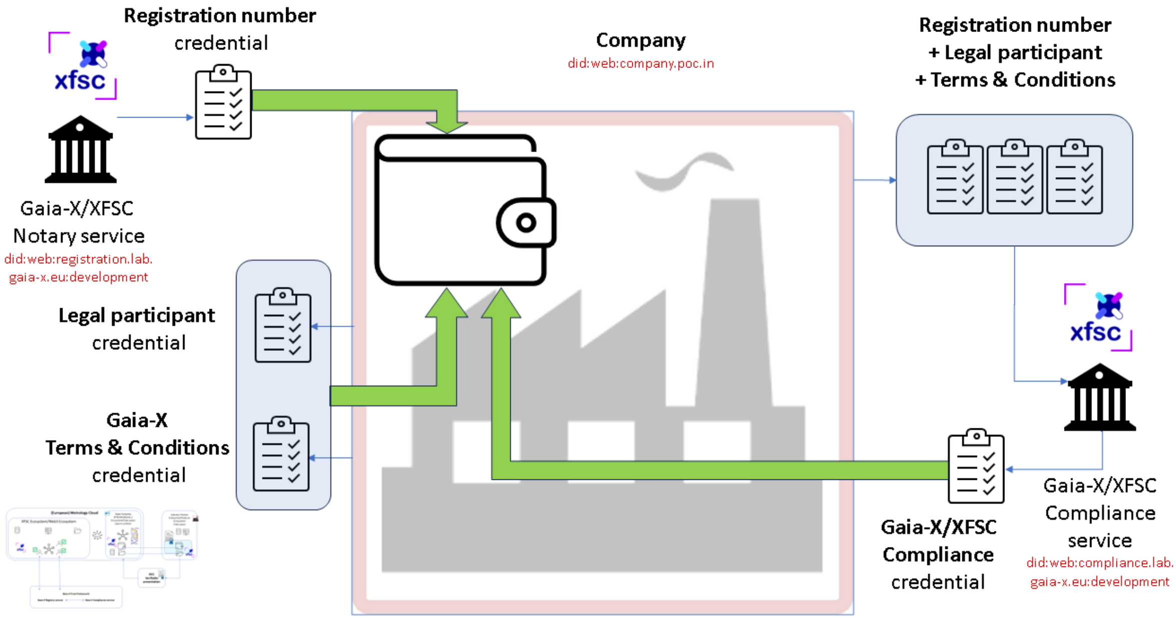
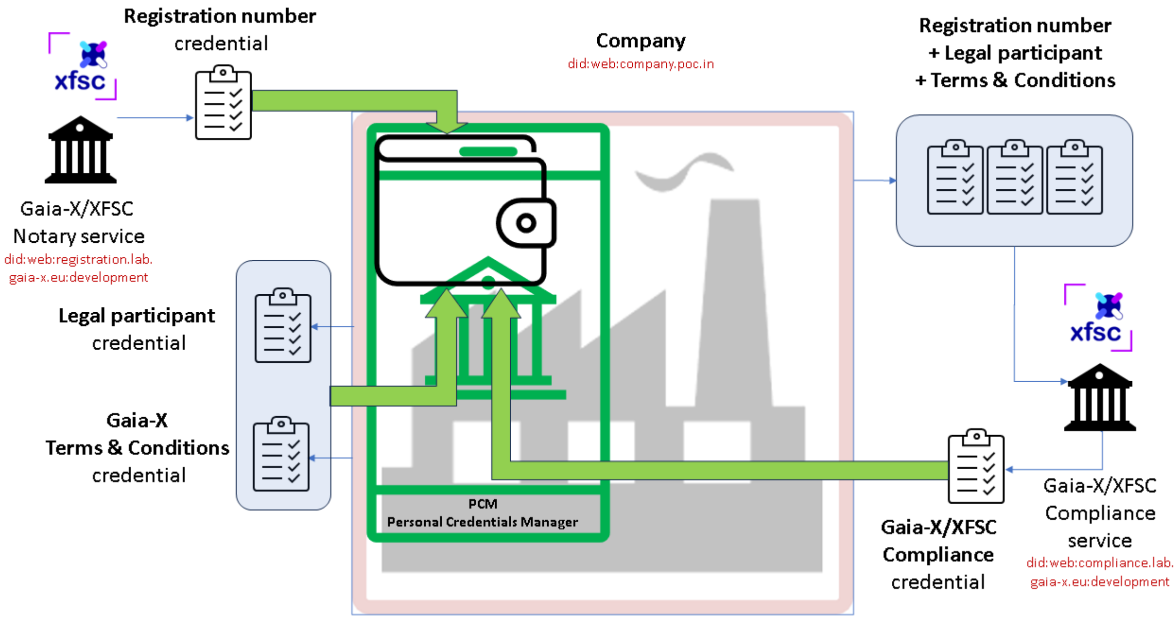
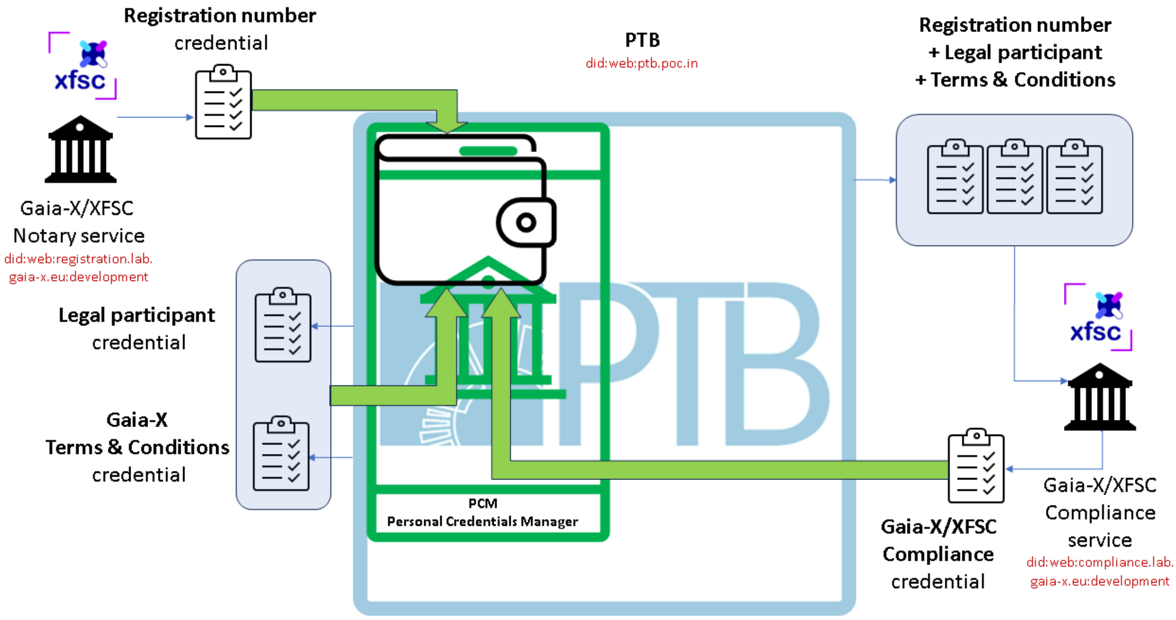
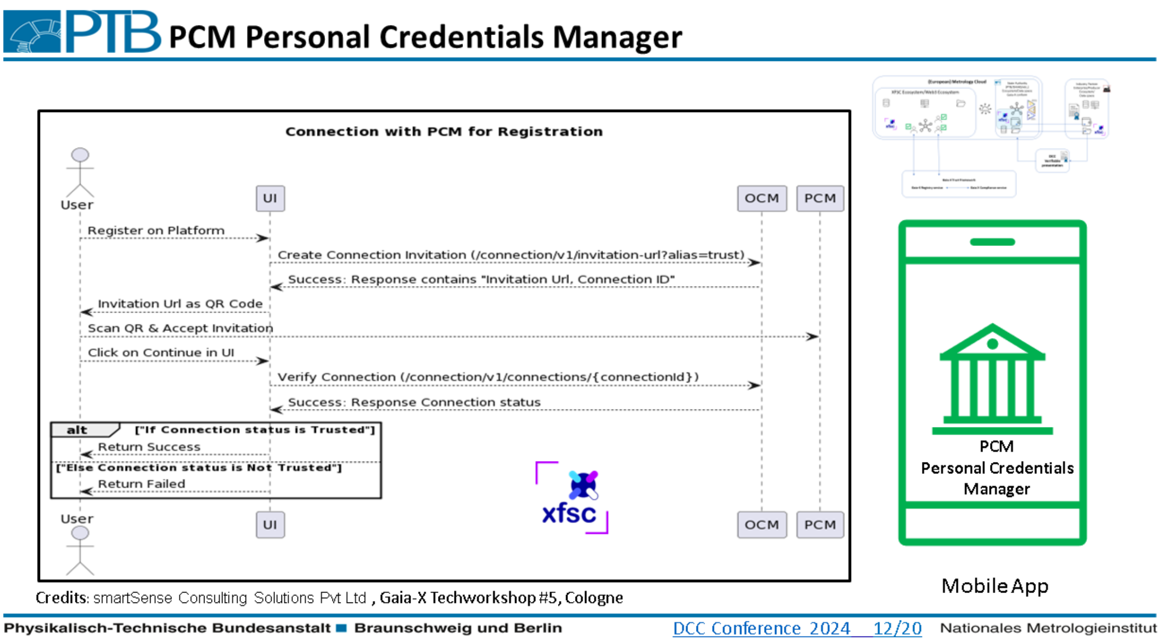

Registration number
credential
xfsc
Gaia-X/XFSC
Notary service
did:web:registration.lab.
gaia-x.eu:development
Company
did:web:company.poc.in
Registration number
+ Legal participant
+ Terms & Conditions
Legal participant
credential
Gaia-X
Terms & Conditions
credential
xfsc
Gaia-X/XFSC
Compliance
service
did:web:compliance.lab.
gaia-x.eu:development
Gaia-X/XFSC
Compliance
credential


Registration number
credential
xfsc
Gaia-X/XFSC
Notary service
did:web:registration.lab.
gaia-x.eu:development
Company
did:web:company.poc.in
Registration number
+ Legal participant
+ Terms & Conditions
Legal participant
credential
Gaia-X
Terms & Conditions
credential
PCM
Personal Credentials Manager
xfsc
Gaia-X/XFSC
Compliance
service
did:web:compliance.lab.
gaia-x.eu:development
Gaia-X/XFSC
Compliance
credential


Registration number
credential
PTB
did:web:ptb.poc.in
Registration number
+ Legal participant
+ Terms & Conditions
xfsc
Gaia-X/XFSC
Notary service
did:web:registration.lab.
gaia-x.eu:development
Legal participant
credential
Gaia-X
Terms & Conditions
credential
PCM
Personal Credentials Manager
Gaia-X/XFSC
Compliance
credential
Gaia-X/XFSC
Compliance
service
did:web:compliance.lab.
gaia-x.eu:development


PTB PCM Personal Credentials Manager
Connection with PCM for Registration
User
UI
OCM
PCM
Register on Platform
Create Connection Invitation (/connection/v1/invitation-url?alias=trust)
Success: Response contains "Invitation Url, Connection ID"
Invitation Url as QR Code
Scan QR & Accept Invitation
Click on Continue in UI
Verify Connection (/connection/v1/connections/{connectionId})
Success: Response Connection status
alt ["If Connection status is Trusted"]
Return Success
["Else Connection status is Not Trusted"]
Return Failed
xfsc
PCM
Personal Credentials
Manager
Mobile App
Credits: smartSense Consulting Solutions Pvt Ltd , Gaia-X Techworkshop #5, Cologne
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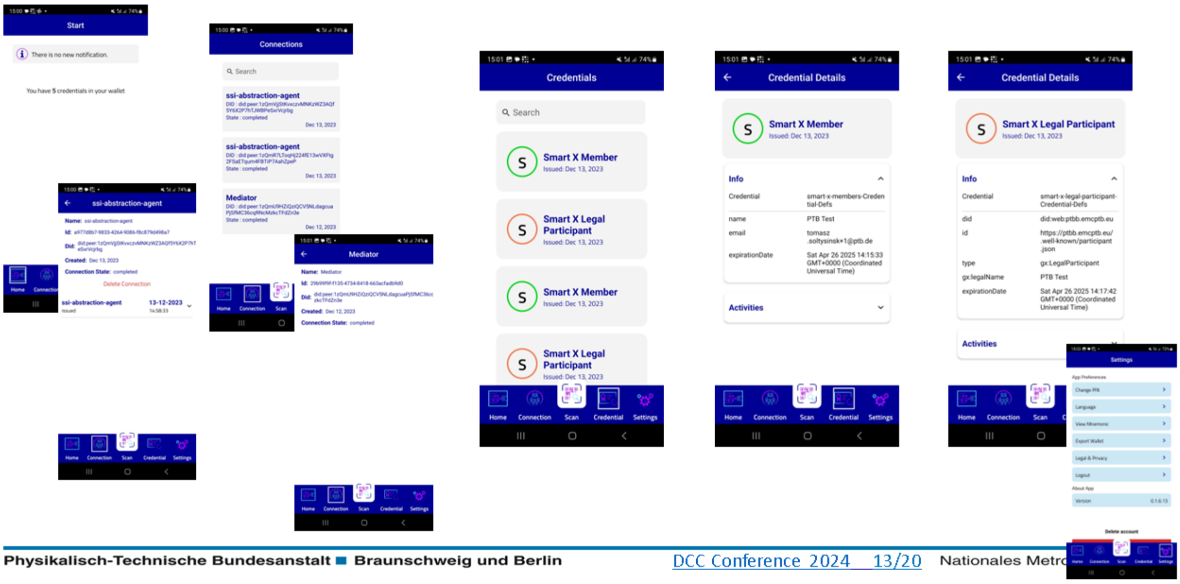
PTB PCM Personal Credentials Manager Mobile App



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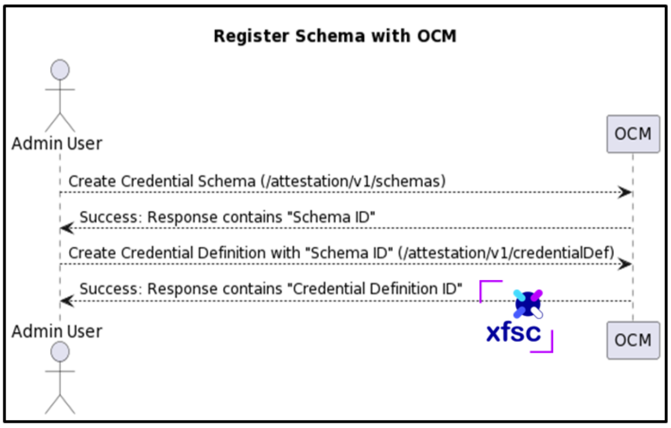
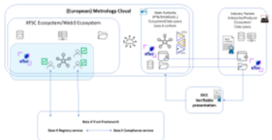
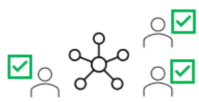
PTB OCM Organisational Credential Manager







Credits: smartSense Consulting Solutions Pvt Ltd , Gaia-X Techworkshop #5, Cologne

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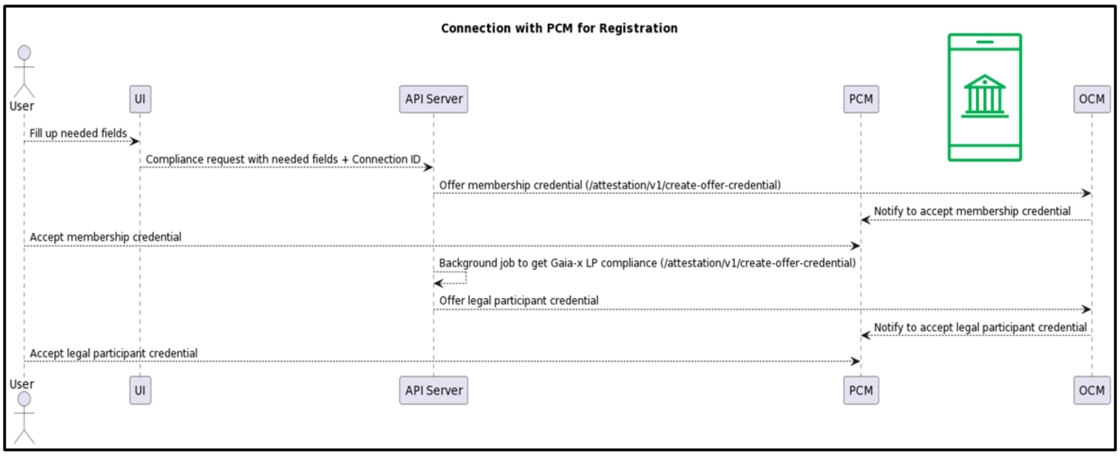
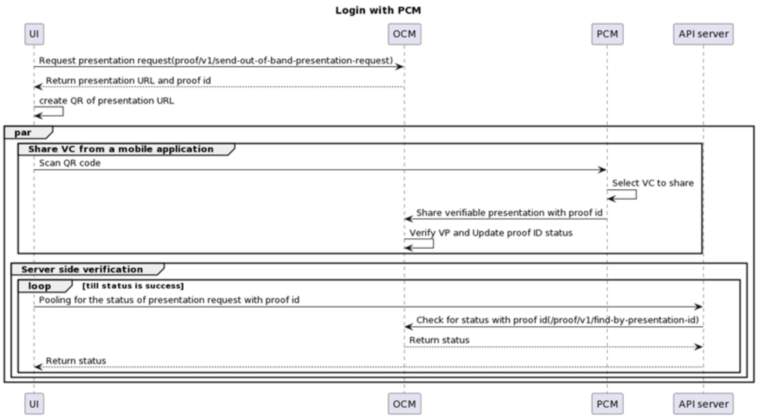
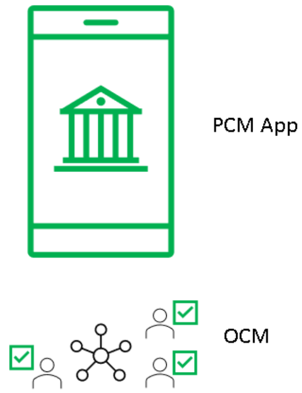
Registration through PCM to get compliant with OCM



Credits: smartSense Consulting Solutions Pvt Ltd , **Gaia-X Techworkshop #5, Cologne**

OCM compliant login with PCM





Credits: smartSense Consulting Solutions Pvt Ltd , **Gaia-X Techworkshop #5, Cologne**

Verifiable credential vs verifiable presentation

Verifiable Credential
- Credential Metadata
- Claim(s)
- Proof(s)

Verifiable Presentation
- Presentation Metadata
- Verifiable Credential(s)
- Proof(s)

- **Digital equivalents** of paper-based identity documents
- VC consist of
  - **Metadata** - Issuer, Issuance date, Expiration date, Type, Description
  - **Claims** – Statement about a subject. Ex: a company is certified and has obtained valid DCC
  - **Proof** - A digital signature by the issuer.

Collection of one or more VC

- These are context specific.
- Authorship of the whole collection can be cryptographically verified
- Allows to preset limited content, context specific according to external requst

Credits: smartSense Consulting Solutions Pvt Ltd , Gaia-X Techworkshop #5, Cologne

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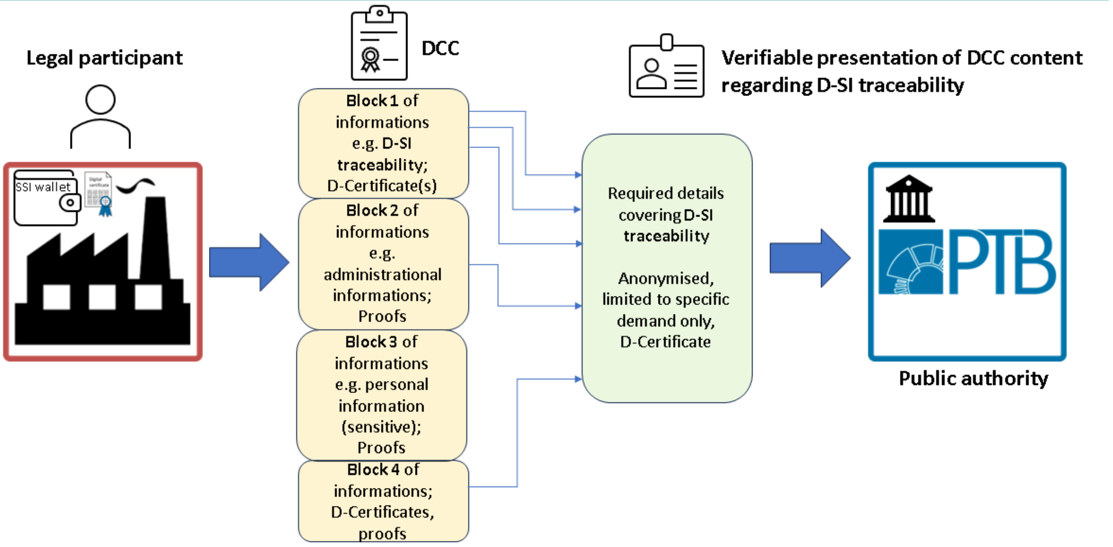
DCC verifiable presentation – Gaia-X minimal viable product



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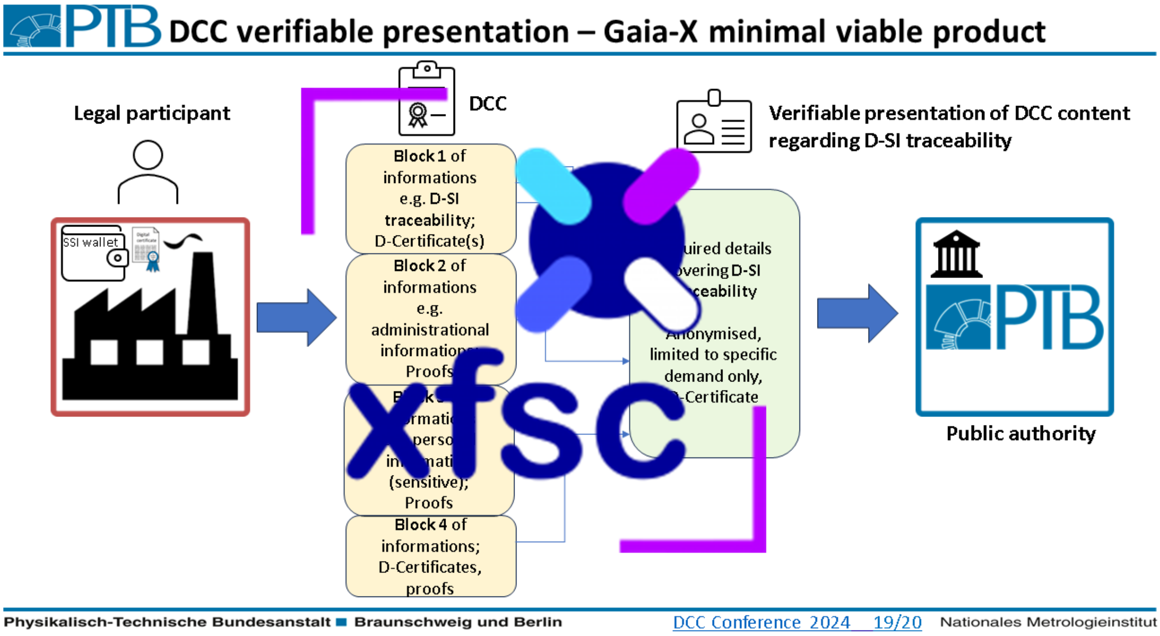

Thank you very much for your attention!

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Abbestr. 2-12
10587 Berlin

Dr.-Ing. Tomasz Sołtysiński

Phone: +49 30 348-9419
Mail: tomasz.soltysinski@ptb.de
www.ptb.de

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08 Recent advances regarding machine-actionable information and data in the quality infrastructure

Presenting author: Talaat Al-Rahali, NMCC
Email: T.rahali@saso.gov.sa
Additional authors: Fahad Atallah Al-Mahlaki fa.muhlaki@saso.gov.sa

Abstract

Introduction

The quality infrastructure (QI) is undergoing a digital transformation, empowered by advancements in machine-actionable information and data. This refers to data structured and accessible in a way that computers can readily understand and act upon, automating processes and driving efficiency. Recent developments in this area hold immense potential for streamlining and accelerating QI operations.

Benefits of machine-actionable data in QI

- Automated processes:
- Repetitive tasks like data entry and analysis can be automated, freeing up human resources for higher-level activities.
- Improved accuracy and efficiency:
- Automated workflows minimize errors and lead to faster turnaround times.
- Enhanced:
- transparency and traceability Data becomes easily accessible and traceable, strengthening accountability and trust.
- Data-driven decisions:
- Real-time insights enable stakeholders to make informed decisions based on accurate data analysis.

Examples of Application

- Manufacturing:
- Machine-readable quality certificates streamline supply chain processes and enable automated product verification.
- Metrology:
- Digital calibration reports facilitate remote instrument monitoring and automated data analysis.
- Healthcare:
- Electronic medical records and interoperable diagnostic data improve patient care and facilitate research.

Conclusion

The ongoing integration of machine-actionable data has the potential to revolutionize the QI landscape. By embracing these advancements, we can build a more efficient, transparent, and data-driven quality infrastructure for the future.

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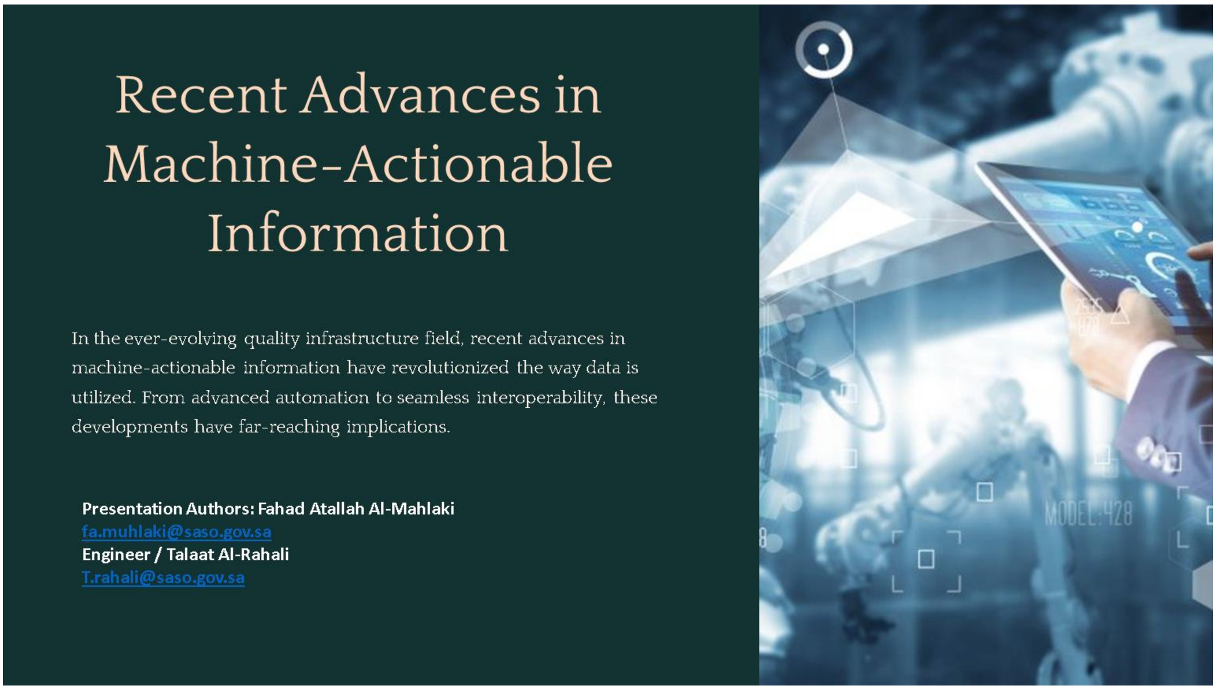
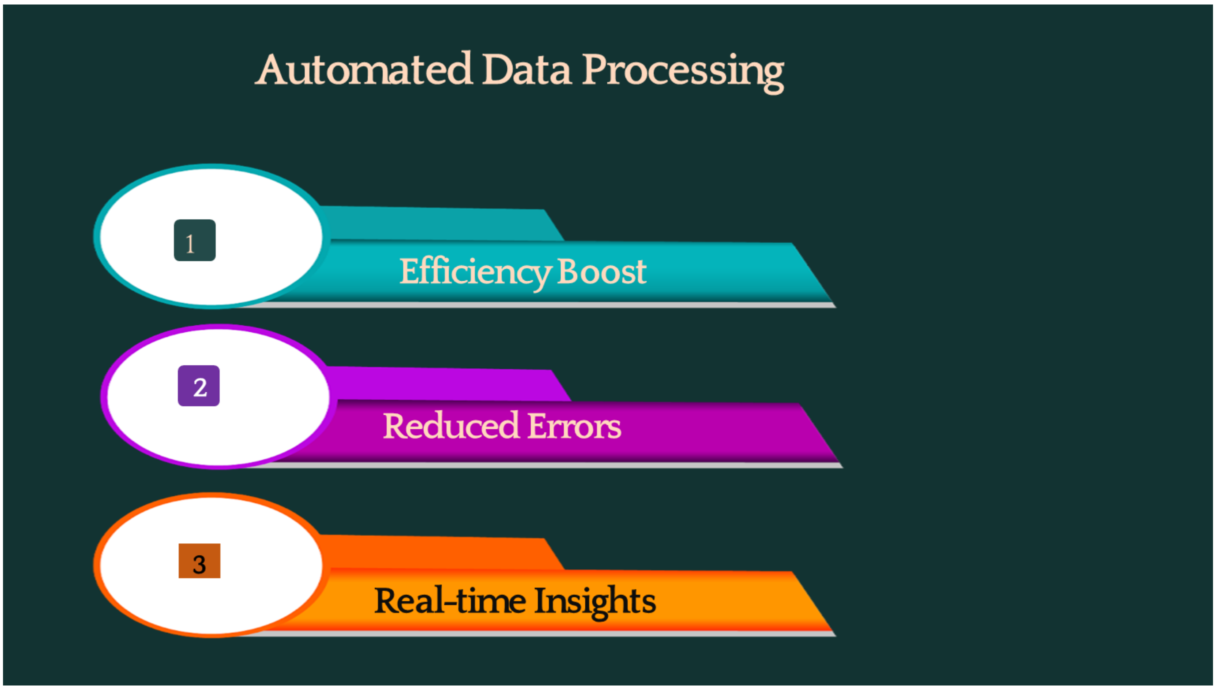
Presentation of Fahad Atallah Al-Mahlaki





Automated Data Processing

1 **Efficiency Boost**

Automated data processing streamlines operations, leading to significant efficiency gains within the quality infrastructure.

2 **Reduced Errors**

With automated processing, the potential for human error is minimized, ensuring data accuracy and reliability.

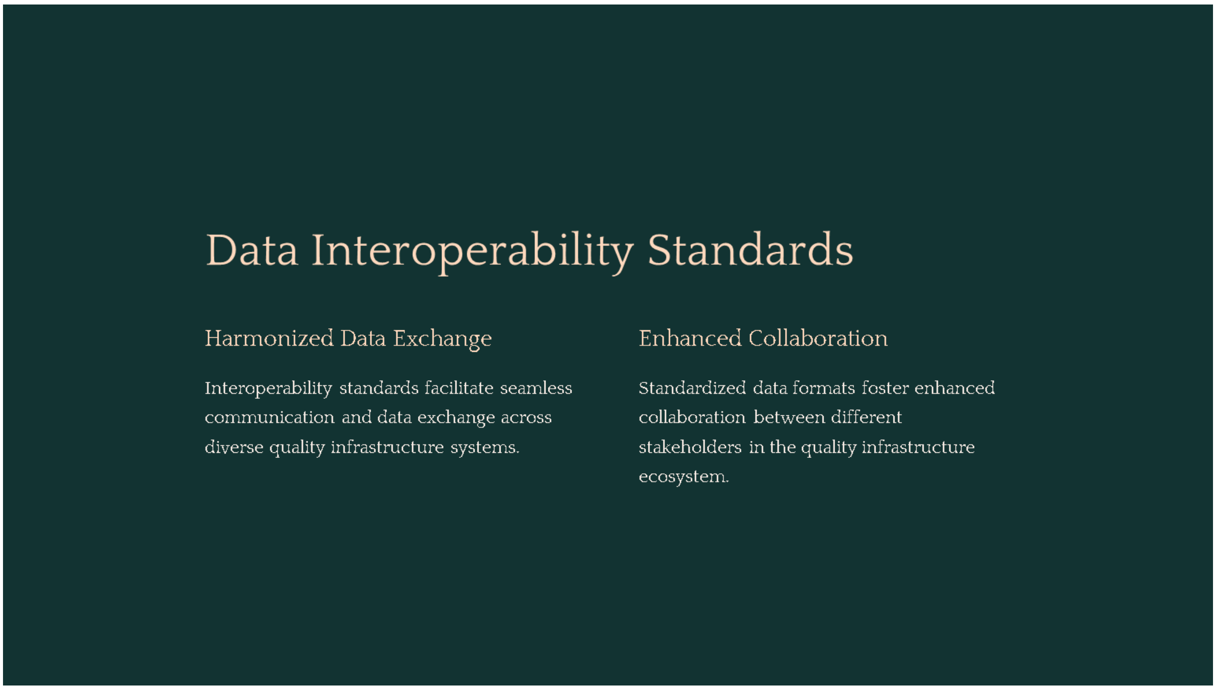
3 **Real-time Insights**

Instantaneous data processing enables real-time insights, empowering swift decision-making and problem-solving.

Data Interoperability Standards

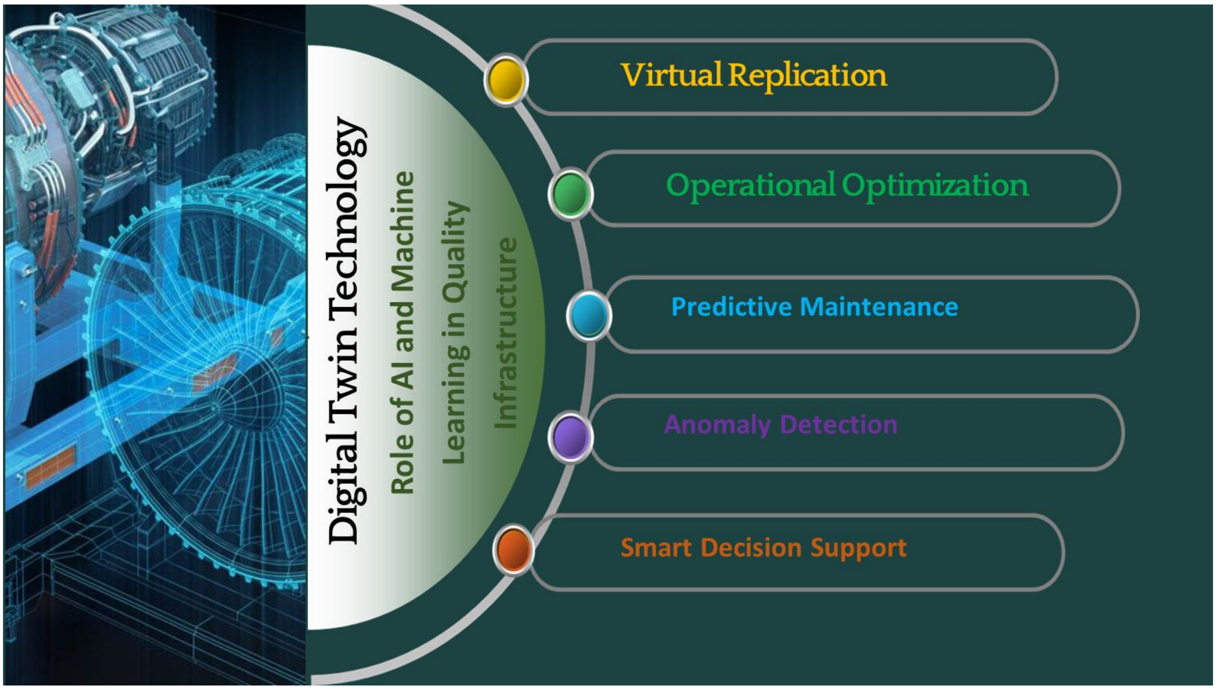
Harmonized Data Exchange

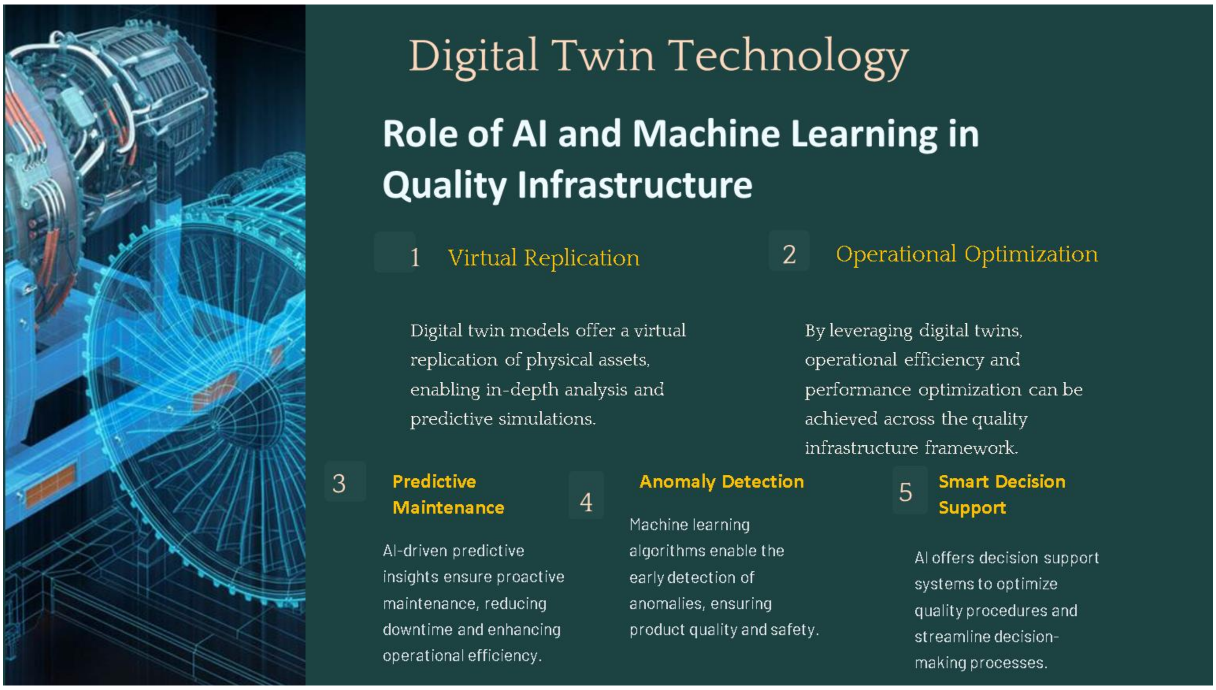
Enhanced Collaboration


Data Interoperability Standards
Harmonized Data Exchange
Interoperability standards facilitate seamless communication and data exchange across diverse quality infrastructure systems.
Enhanced Collaboration
Standardized data formats foster enhanced collaboration between different stakeholders in the quality infrastructure ecosystem.


IoT Integration in Quality Monitoring
01
Real-time Monitoring
Predictive Maintenance
02
Internet of things
IOT

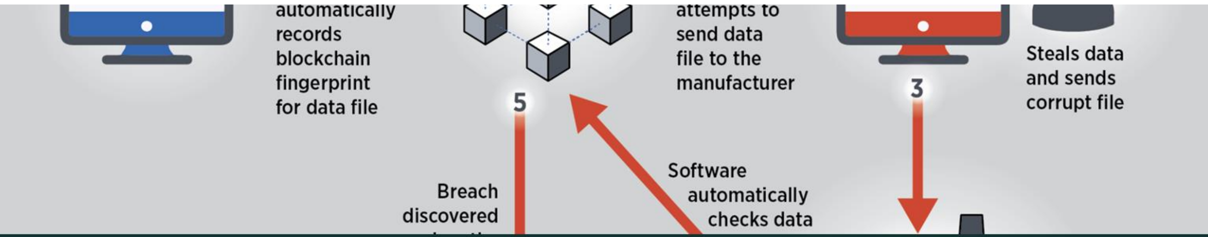

Data Privacy and Security
Stringent Privacy Protocols
Rigorous protocols ensure the protection of sensitive data within the quality infrastructure, mitigating potential security risks.
Continuous Threat Monitoring
Constant vigilance and monitoring mechanisms safeguard against evolving cyber threats and unauthorized access.

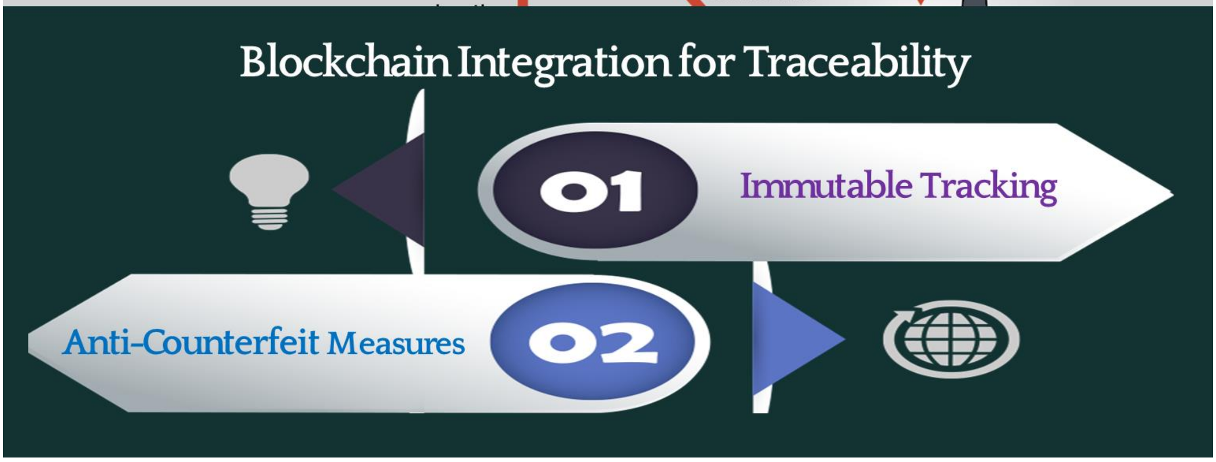

Digital Twin Technology
Role of AI and Machine
Learning in Quality
Infrastructure
Virtual Replication
Operational Optimization
Predictive Maintenance
Anomaly Detection
Smart Decision Support

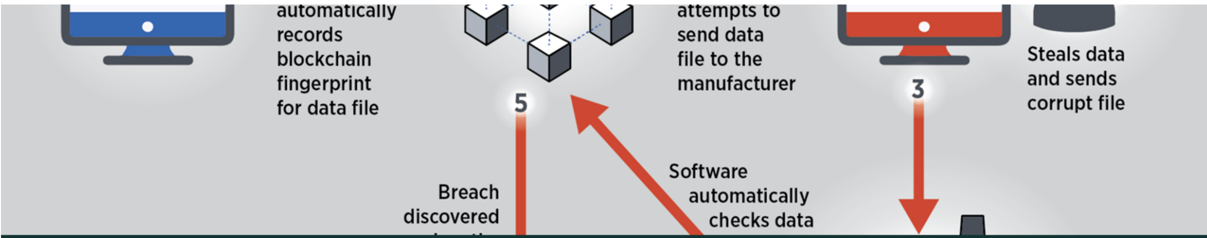

Digital Twin Technology
Role of AI and Machine Learning in Quality Infrastructure
1 Virtual Replication
Digital twin models offer a virtual replication of physical assets, enabling in-depth analysis and predictive simulations.
2 Operational Optimization
By leveraging digital twins, operational efficiency and performance optimization can be achieved across the quality infrastructure framework.
3 Predictive Maintenance
AI-driven predictive insights ensure proactive maintenance, reducing downtime and enhancing operational efficiency.
4 Anomaly Detection
Machine learning algorithms enable the early detection of anomalies, ensuring product quality and safety.
5 Smart Decision Support
AI offers decision support systems to optimize quality procedures and streamline decision-making processes.

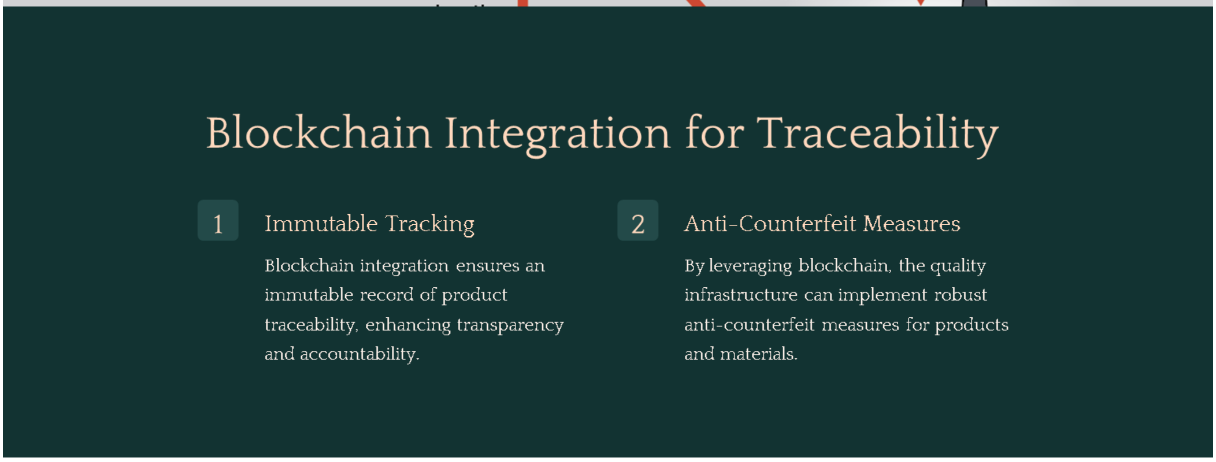

Integrating IoT for Quality Monitoring Monitoring
1 Remote Sensing
2 Real-Time Insights
3 Predictive Analytics
IOT

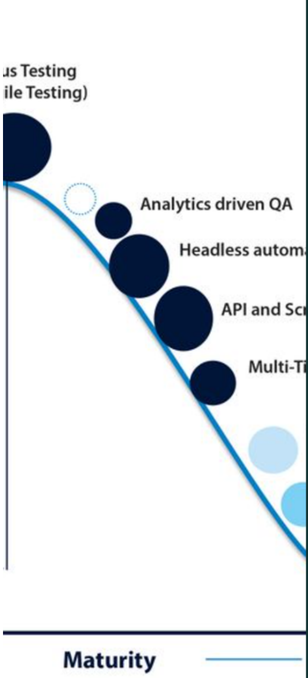

Integrating IoT for Quality Monitoring Monitoring
1
Remote Sensing
IoT sensors enable remote monitoring of quality parameters across geographically dispersed facilities.
2
Real-Time Insights
Continuous data collection provides instant insights into production processes and quality deviations.
3
Predictive Analytics
IoT data analytics predicts potential quality issues, facilitating proactive interventions for prevention.
IOT


automatically records blockchain fingerprint for data file
attempts to send data file to the manufacturer
Steals data and sends corrupt file
5
3
Breach discovered
Software automatically checks data

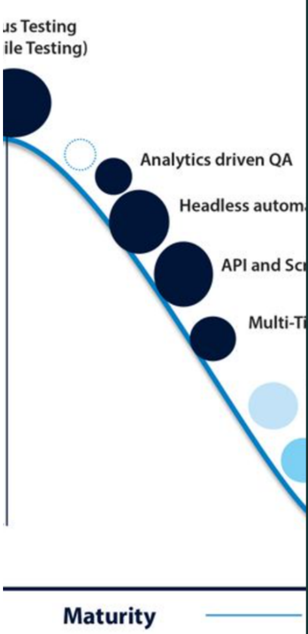

Blockchain Integration for Traceability
01
Immutable Tracking
Anti-Counterfeit Measures
02


automatically records blockchain fingerprint for data file
5
Breach discovered
attempts to send data file to the manufacturer
Software automatically checks data
3
Steals data and sends corrupt file

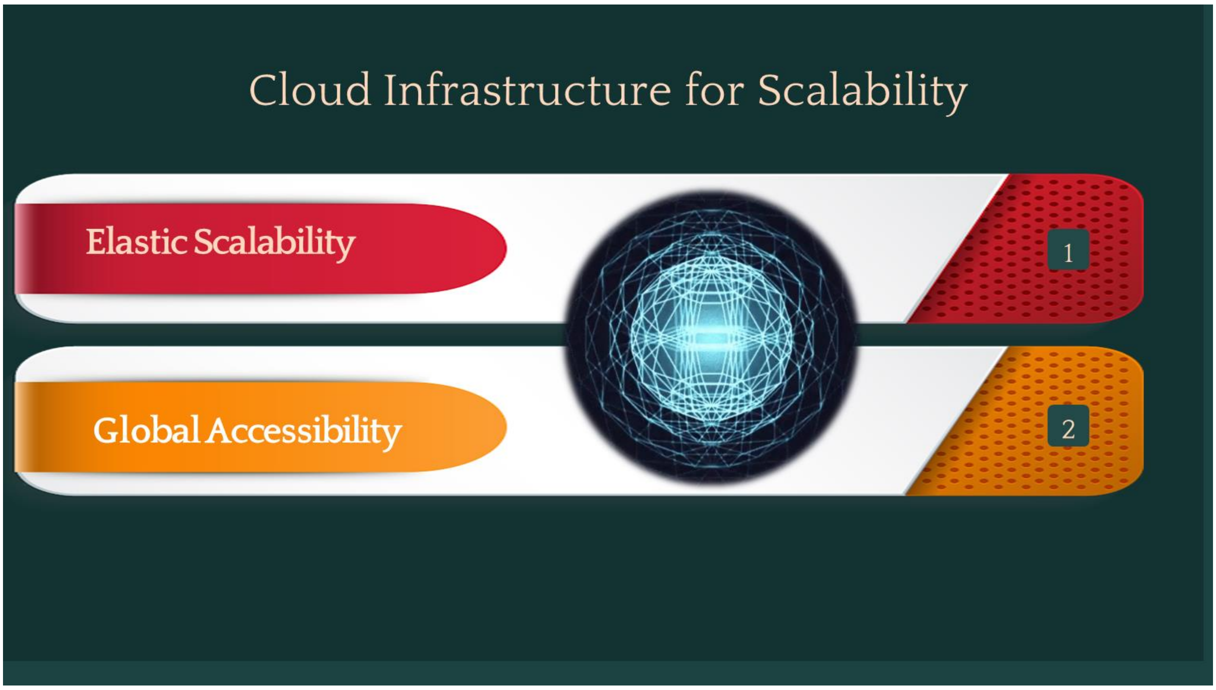

Blockchain Integration for Traceability
1
Immutable Tracking
Blockchain integration ensures an immutable record of product traceability, enhancing transparency and accountability.
2
Anti-Counterfeit Measures
By leveraging blockchain, the quality infrastructure can implement robust anti-counterfeit measures for products and materials.


Analytics driven QA
Maturity


Data Analytics and AI in Quality Assurance
1
Predictive Quality Analysis
2
Smart Decision Support


us Testing
ile Testing)
Analytics driven QA
Headless autom
API and Sc
Multi-Ti
Maturity


Data Analytics and AI in Quality Assurance
1
Predictive Quality Analysis
Data analytics and AI enable predictive quality analysis, identifying potential issues before they manifest.
2
Smart Decision Support
AI-driven analytics offer smart decision support, empowering informed and data-driven quality assurance strategies.


Cloud Infrastructure for Scalability
Elastic Scalability
1
Global Accessibility
2

Cloud Infrastructure for Scalability

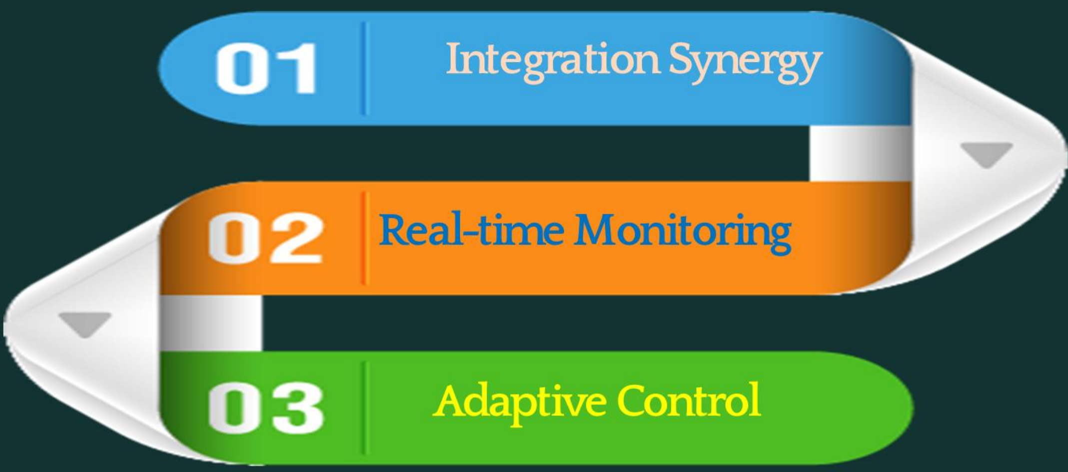
1 Elastic Scalability

Cloud infrastructure provides elastic scalability, allowing the quality infrastructure to adapt to evolving demands and volumes.

2 Global Accessibility

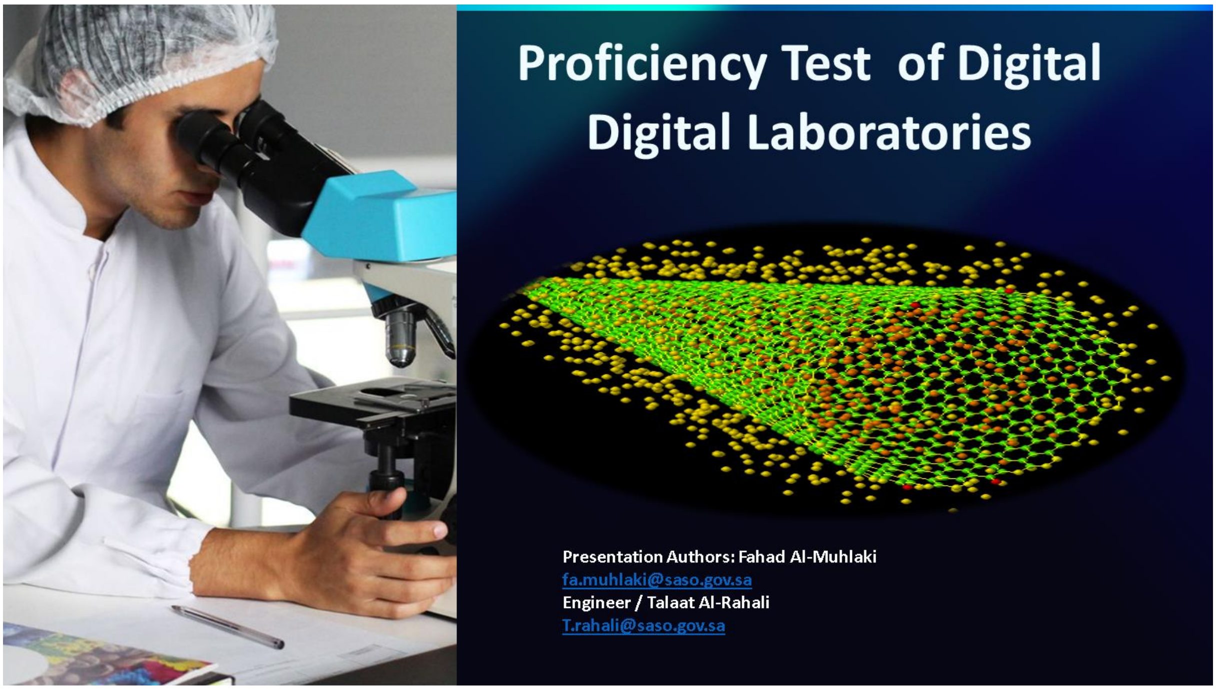
Cloud-based solutions enable global accessibility, facilitating seamless data access and collaboration across geographical boundaries.

Cyber-Physical Systems in Quality Control




Cyber-Physical Systems in Quality Control
Integration Synergy
Cyber-physical systems harmonize the integration of digital technologies with physical quality control processes, optimizing operational workflows.
Real-time Monitoring
These systems enable real-time monitoring and actionable insights, bridging the gap between virtual and physical quality assurance realms.
Adaptive Control
By leveraging cyber-physical systems, adaptive control mechanisms can be implemented, ensuring dynamic responsiveness to quality variations.


Proficiency Test of Digital Laboratories
Digital laboratories play a crucial role in quality infrastructure, leveraging machine-actionable information and data to advance efficiency and accuracy. From automated workflows to real-time analytics, these labs are transforming the way quality control is approached in various industries.
Presentation Authors: Fahad Al-Muhlaki
fa.muhlaki@saso.gov.sa
Engineer / Talaat Al-Rahali
T.rahali@saso.gov.sa



[Back to "Table of Contents" above]

Session "Interoperability Schema" (Chair: Robert Hanisch)

09 Toward standardized language and structure for machine interpretable DCC's

Presenting author: David Balslev-Harder, DFM – Danish National Metrology Institute, Denmark
Email: dbh@dfm.dk
Additional authors: Søren Kynde srk@dfm.dk

Abstract

Digital machine interpretable calibration certificates have a high potential to improve quality, management efficiency and decision making, enabled through automatic digital workflows. However, structure and nomenclature are highly important to enable reliable algorithms that can make correct interpretation of the data reported in a certificate. Simplicity of the structure is also highly relevant in order to keep maintenance costs low for middleware and DCC implementations. An overall efficiency benefit must be obtained for DCC's to have a positive impact and ideally both clients and calibration labs will experience cost benefit.

Within the EURAMET project TC-IM 1448, a working group (WG1) has been initiated to work on "Harmonising DCC structure for machine readability". Several identified needs were presented at the 3rd international conference on DCC, and over the past year these ideas have been further clarified and exemplified in form of a new xml-schema and DCC examples, covering several fields of calibration e.g. temperature, pipettes, pressure and mass. By introducing a data-frame-structure and new meta-data-tokens specified within the schema, the DCC data structures are constrained to be essentially the same across different calibration areas. These constraints set by the new schema aim toward simplifying requirements to middleware and to keep maintenance costs low.

A Graphical User Interface implemented using python and Excel is introduced as a potential production tool which enables both reading and generation of DCCs based on the presented new schema. Being able to load DCC structures into the excel tool enables excel as a viewer but also establish a workflow where client calibration request can be expressed as a DCC templates/DCR which can then be loaded directly into the interface and operate as a calibration task description for the lab. Finally, a tool for extraction specific data from a DCC is introduced, which has been requested by clients in order for them to map data into their databases.

Outline of presentation

- TC-IM 1448 WG1 on Harmonisation
- Incorporating relevant nomenclature from VIM and general basics for any calibration Metadata requirements for machine interpretability
- Metadata incorporated in a new xml-schema restricting the structure to be essentially the same for different calibration areas.
- Low middleware complexity by using data-frames and internal link-references in schema. Solution available on TC-IM 1448 GitHub
- See the implementation example in other presentation.
- DFM's work is supported by funds from The Danish Agency for Institutions and Educational Grants.

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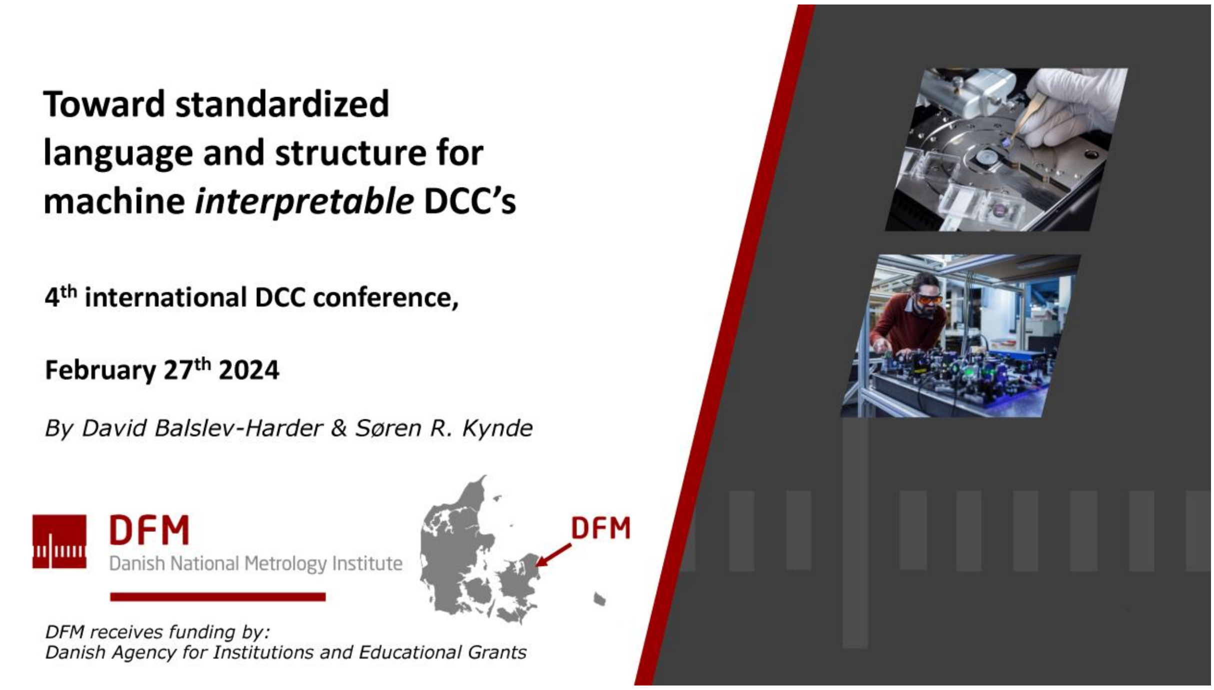
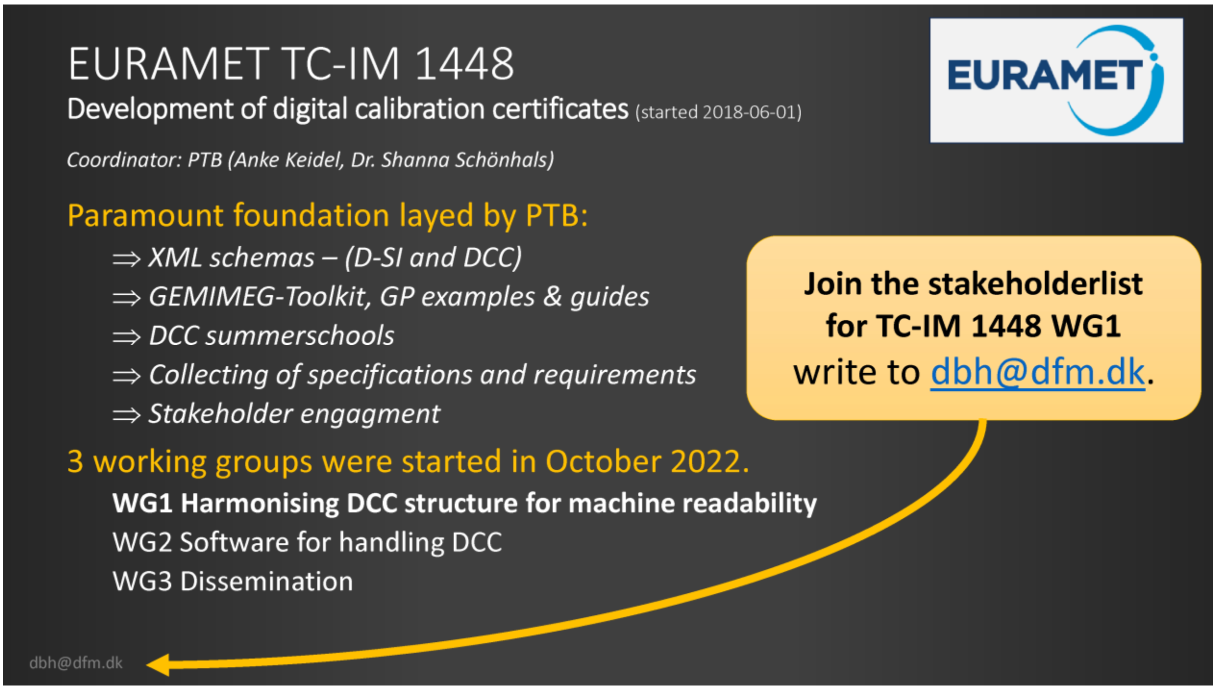
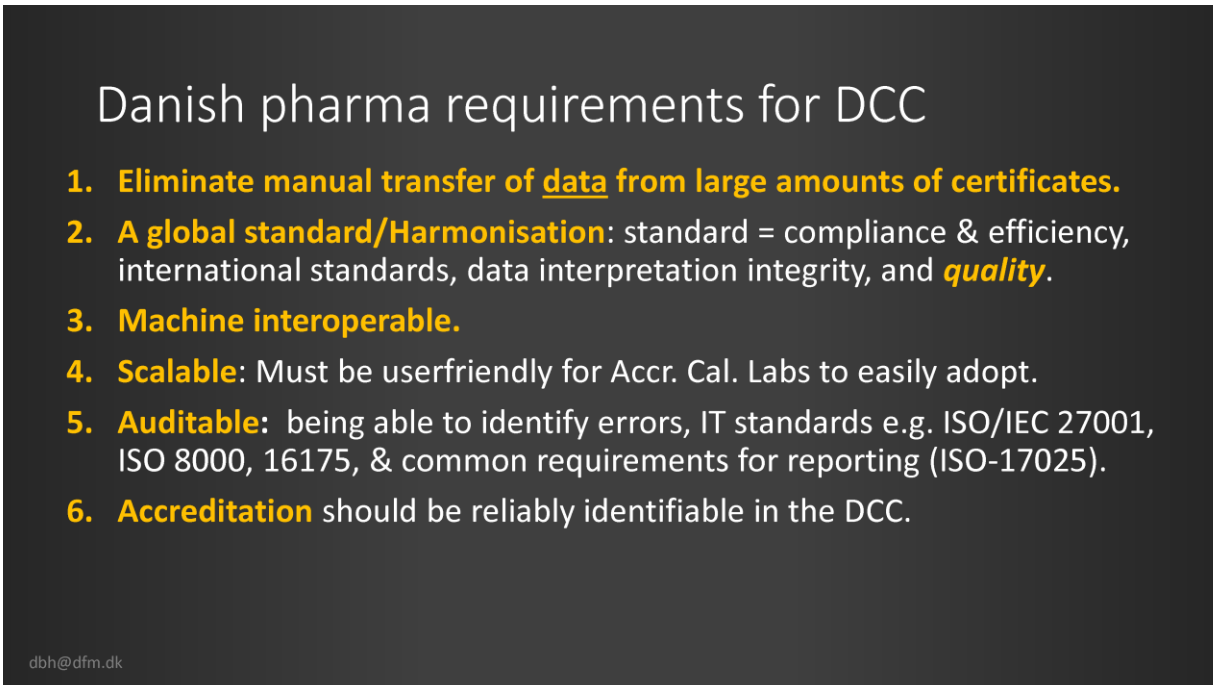
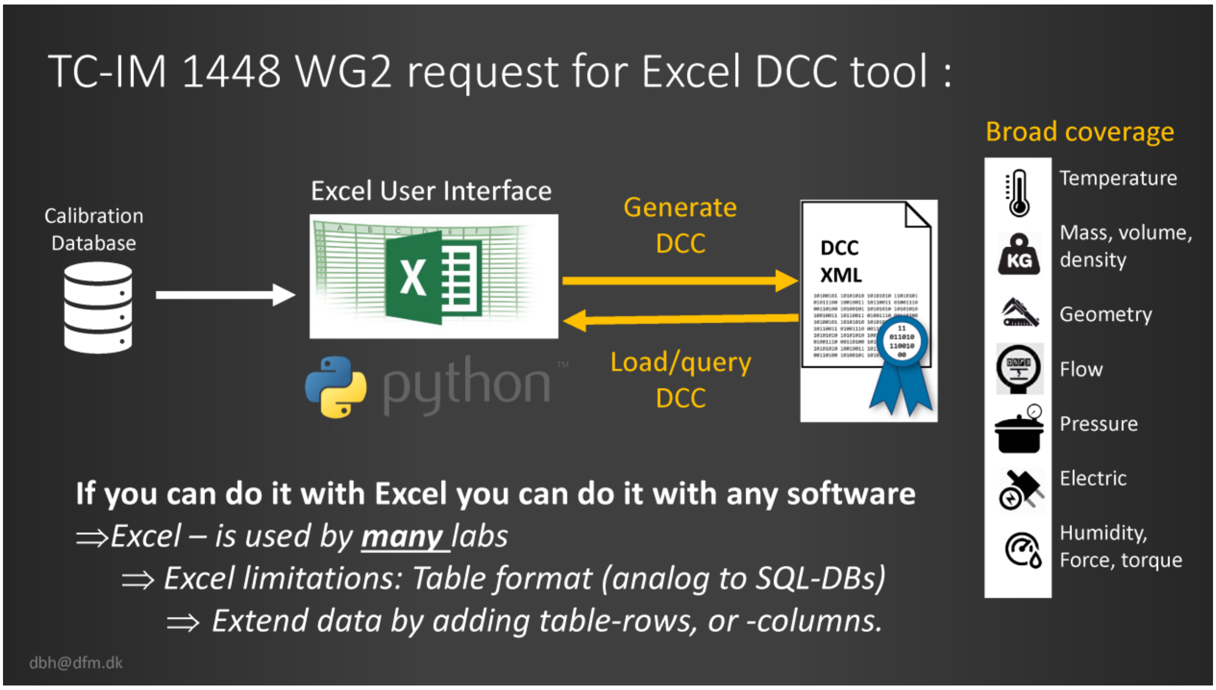
Presentation of David Balslev-Harder




EURAMET TC-IM 1448
Development of digital calibration certificates (started 2018-06-01)
Coordinator: PTB (Anke Keidel, Dr. Shanna Schönhals)
EURAMET
Paramount foundation layed by PTB:
⇒ XML schemas – (D-SI and DCC)
⇒ GEMIMEG-Toolkit, GP examples & guides
⇒ DCC summerschools
⇒ Collecting of specifications and requirements
⇒ Stakeholder engagment
Join the stakeholderlist for TC-IM 1448 WG1 write to dbh@dfm.dk.
3 working groups were started in October 2022.
WG1 Harmonising DCC structure for machine readability
WG2 Software for handling DCC
WG3 Dissemination
dbh@dfm.dk


Danish pharma requirements for DCC
1. Eliminate manual transfer of data from large amounts of certificates.
2. A global standard/Harmonisation: standard = compliance & efficiency, international standards, data interpretation integrity, and quality.
3. Machine interoperable.
4. Scalable: Must be userfriendly for Accr. Cal. Labs to easily adopt.
5. Auditable: being able to identify errors, IT standards e.g. ISO/IEC 27001, ISO 8000, 16175, & common requirements for reporting (ISO-17025).
6. Accreditation should be reliably identifiable in the DCC.
dbh@dfm.dk



Requirements for machine *interoperable* DCC (*i*DCC)

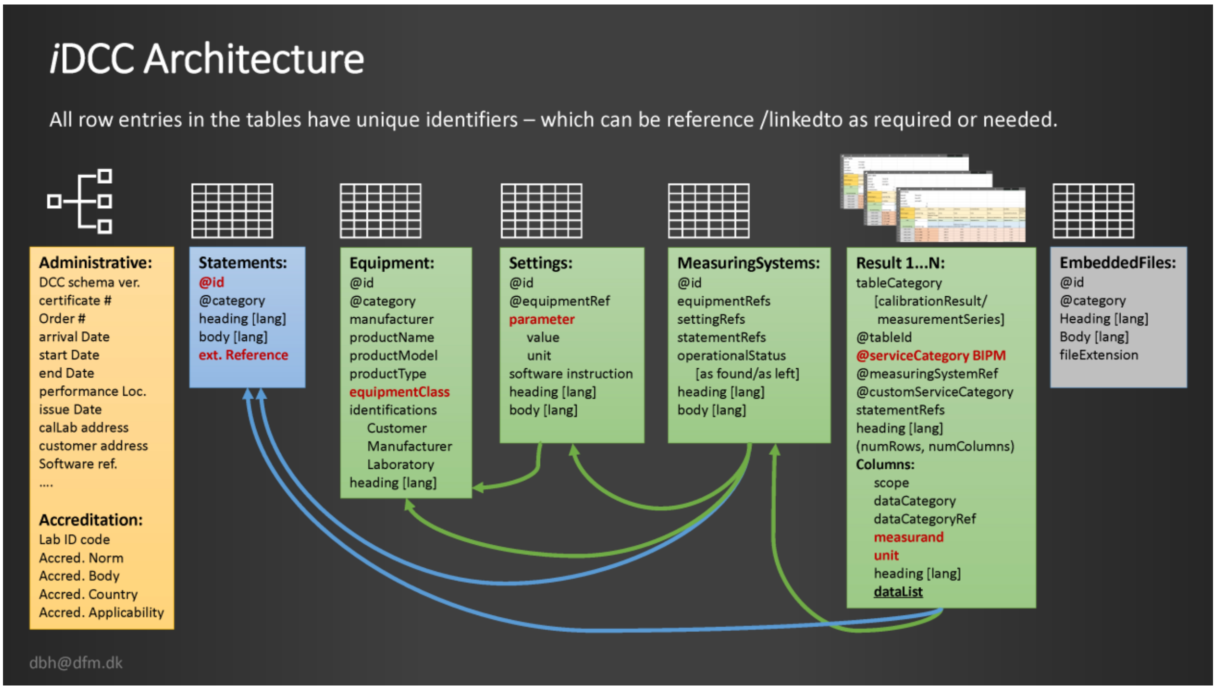
***iDCC** a Lite DCC schema version for industrial application providing:*

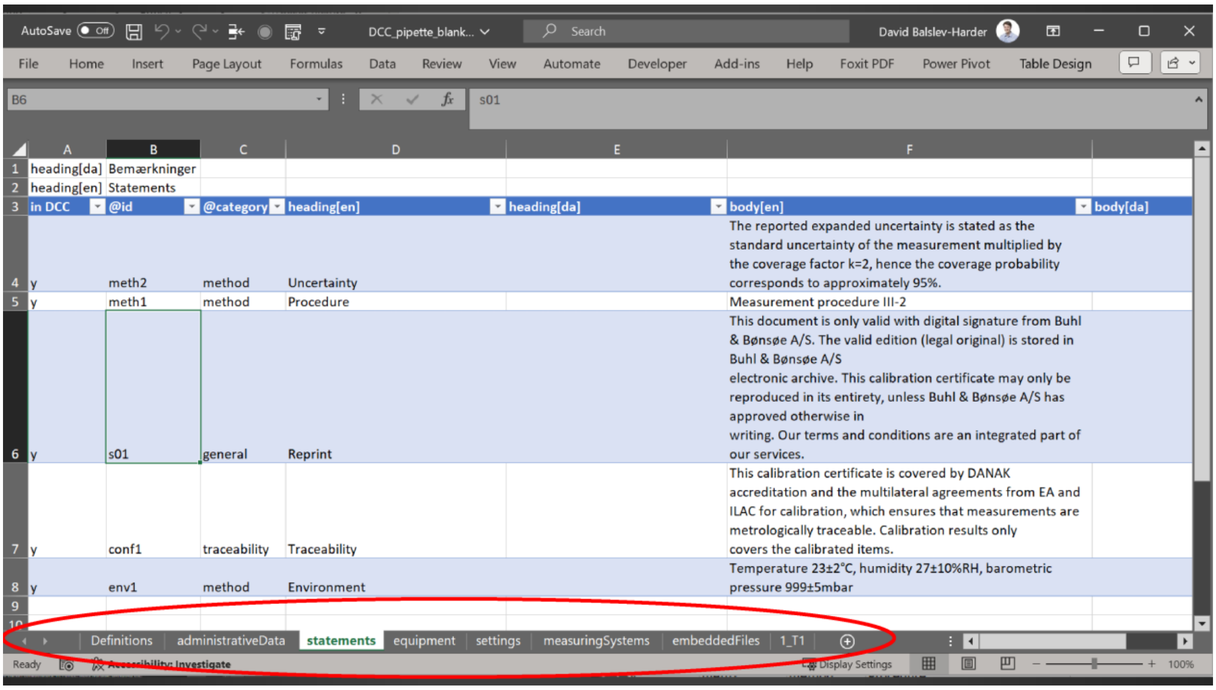
- ⇒ *General interdisciplinary algorithm for*
  - ⇒ *unique placement of data.*
  - ⇒ *finding desired data.*
- ⇒ *Reduce harmonization work to lists of words.*

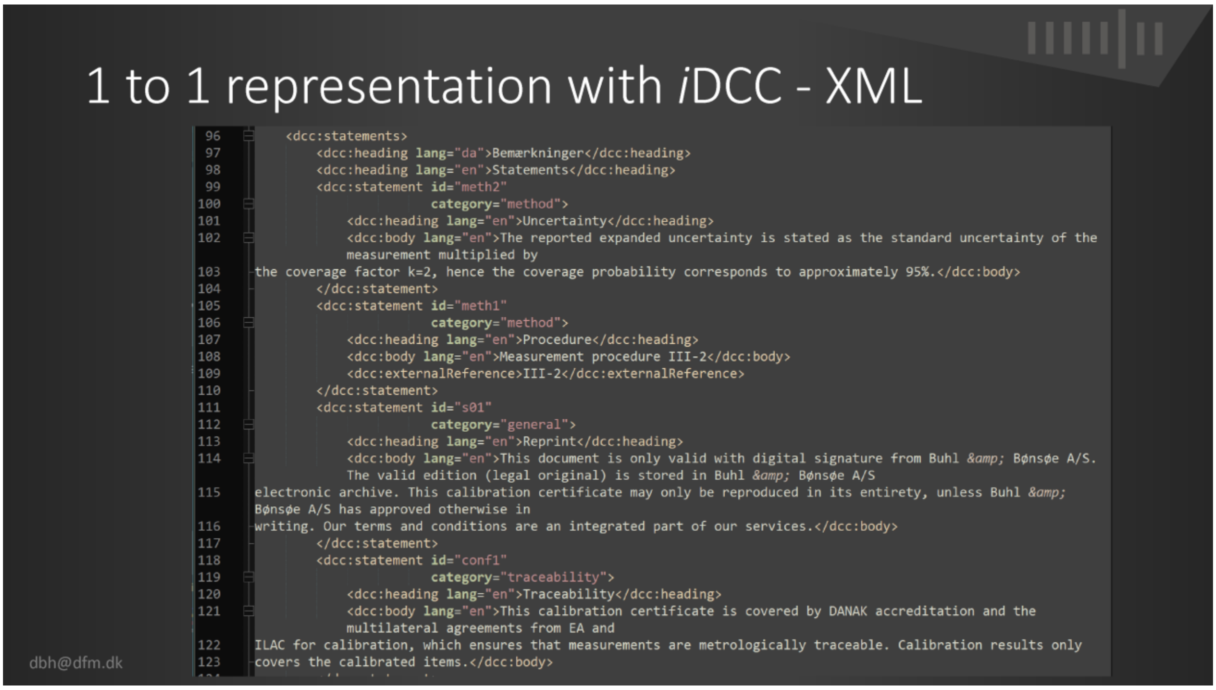
Co-creation of schema for iDCC and Middleware to help:

- ⇒ *Optimize the amount of DCC data being validated by the schema.*
- ⇒ *Schema ensures findability of data*
- ⇒ *Interpretation of the data*
- ⇒*Seamlessly able to extend for new data without consideration to tree structure.*
- ⇒ *1 to 1 correpondance between XML and Excel representation.*
  - ⇒ *Introduce a lite xml structure.*

dbh@dfm.dk


iDCC Architecture
All row entries in the tables have unique identifiers – which can be reference /linkedto as required or needed.
Administrative:
DCC schema ver.
certificate #
Order #
arrival Date
start Date
end Date
performance Loc.
issue Date
calLab address
customer address
Software ref.
....
Accreditation:
Lab ID code
Accred. Norm
Accred. Body
Accred. Country
Accred. Applicability
Statements:
@id
@category
heading [lang]
body [lang]
ext. Reference
Equipment:
@id
@category
manufacturer
productName
productModel
productType
equipmentClass
identifications
Customer
Manufacturer
Laboratory
heading [lang]
Settings:
@id
@equipmentRef
parameter
value
unit
software instruction
heading [lang]
body [lang]
MeasuringSystems:
@id
equipmentRefs
settingRefs
statementRefs
operationalStatus
[as found/as left]
heading [lang]
body [lang]
Result 1...N:
tableCategory
[calibrationResult/
measurementSeries]
@tableId
@serviceCategory BIPM
@measuringSystemRef
@customServiceCategory
statementRefs
heading [lang]
(numRows, numColumns)
Columns:
scope
dataCategory
dataCategoryRef
measurand
unit
heading [lang]
dataList
EmbeddedFiles:
@id
@category
Heading [lang]
Body [lang]
fileExtension
dbh@dfm.dk


AutoSave Off
DCC_pipette_blank...
Search
David Balslev-Harder
File Home Insert Page Layout Formulas Data Review View Automate Developer Add-ins Help Foxit PDF Power Pivot Table Design
B6
s01
heading[da] Bemærkninger
heading[en] Statements
in DCC | @id | @category | heading[en] | heading[da] | body[en] | body[da]
y | meth2 | method | Uncertainty | | The reported expanded uncertainty is stated as the standard uncertainty of the measurement multiplied by the coverage factor k=2, hence the coverage probability corresponds to approximately 95%.
y | meth1 | method | Procedure | | Measurement procedure III-2
y | s01 | general | Reprint | | This document is only valid with digital signature from Buhl & Bønsøe A/S. The valid edition (legal original) is stored in Buhl & Bønsøe A/S electronic archive. This calibration certificate may only be reproduced in its entirety, unless Buhl & Bønsøe A/S has approved otherwise in writing. Our terms and conditions are an integrated part of our services.
y | conf1 | traceability | Traceability | | This calibration certificate is covered by DANAK accreditation and the multilateral agreements from EA and ILAC for calibration, which ensures that measurements are metrologically traceable. Calibration results only covers the calibrated items.
y | env1 | method | Environment | | Temperature 23±2°C, humidity 27±10%RH, barometric pressure 999±5mbar
Definitions | administrativeData | statements | equipment | settings | measuringSystems | embeddedFiles | 1_T1
Ready
Accessibility: Investigate
Display Settings
100%


1 to 1 representation with iDCC - XML
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<dcc:heading lang="en">Statements</dcc:heading>
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<dcc:heading lang="en">Uncertainty</dcc:heading>
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the coverage factor k=2, hence the coverage probability corresponds to approximately 95%.</dcc:body>
</dcc:statement>
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</dcc:statement>
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category="general">
<dcc:heading lang="en">Reprint</dcc:heading>
<dcc:body lang="en">This document is only valid with digital signature from Buhl & Bønsøe A/S. The valid edition (legal original) is stored in Buhl & Bønsøe A/S
electronic archive. This calibration certificate may only be reproduced in its entirety, unless Buhl & Bønsøe A/S has approved otherwise in
writing. Our terms and conditions are an integrated part of our services.</dcc:body>
</dcc:statement>
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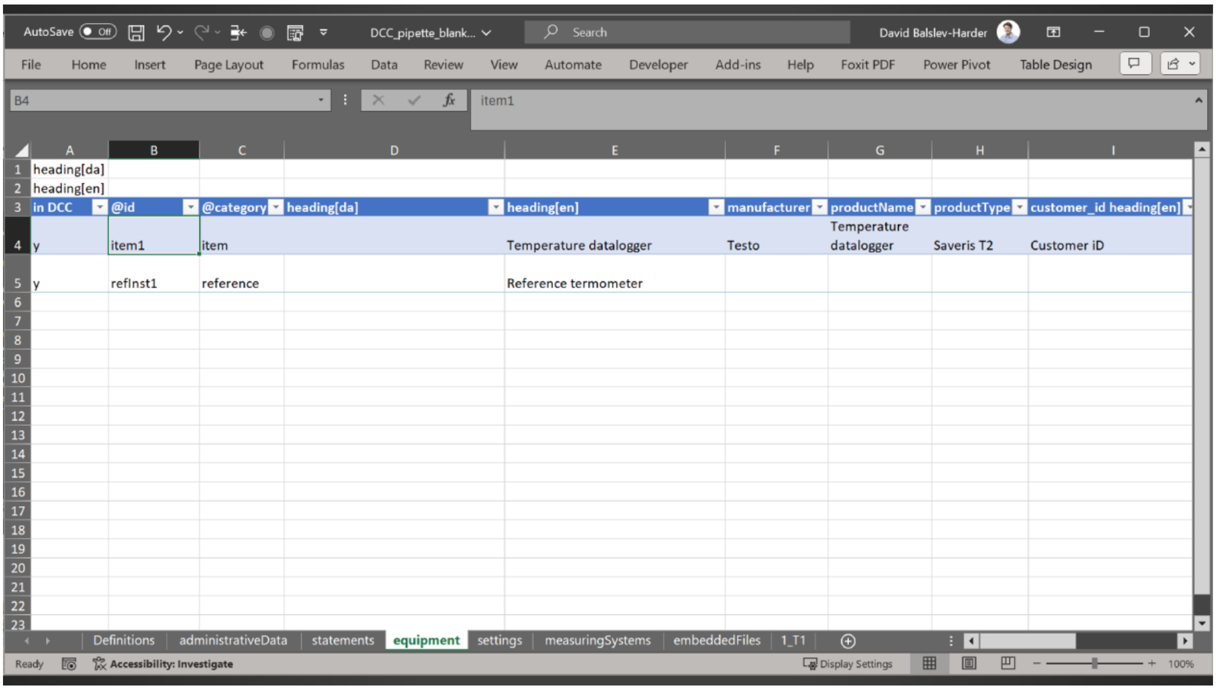
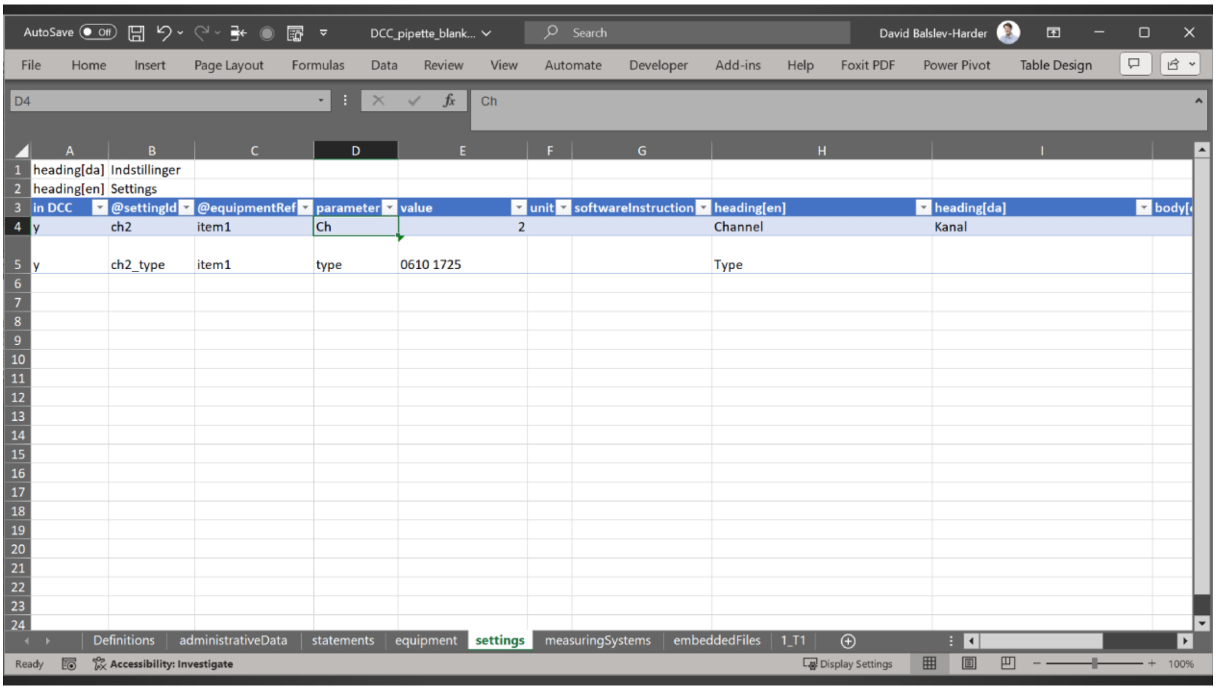
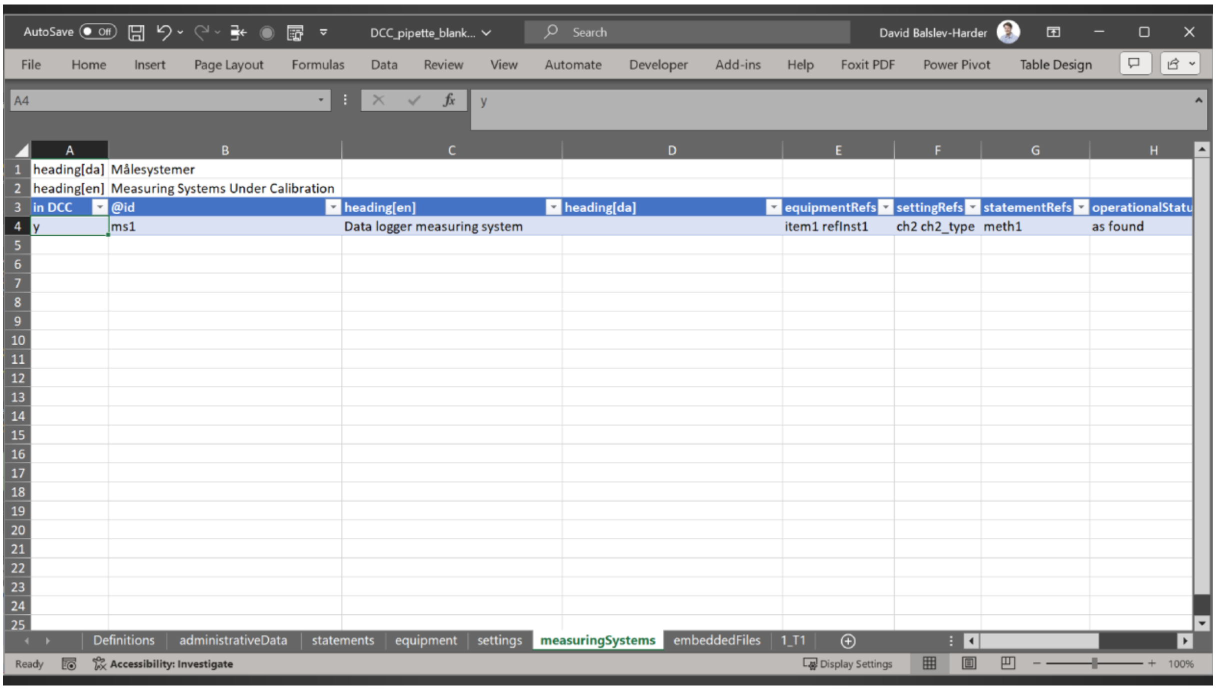
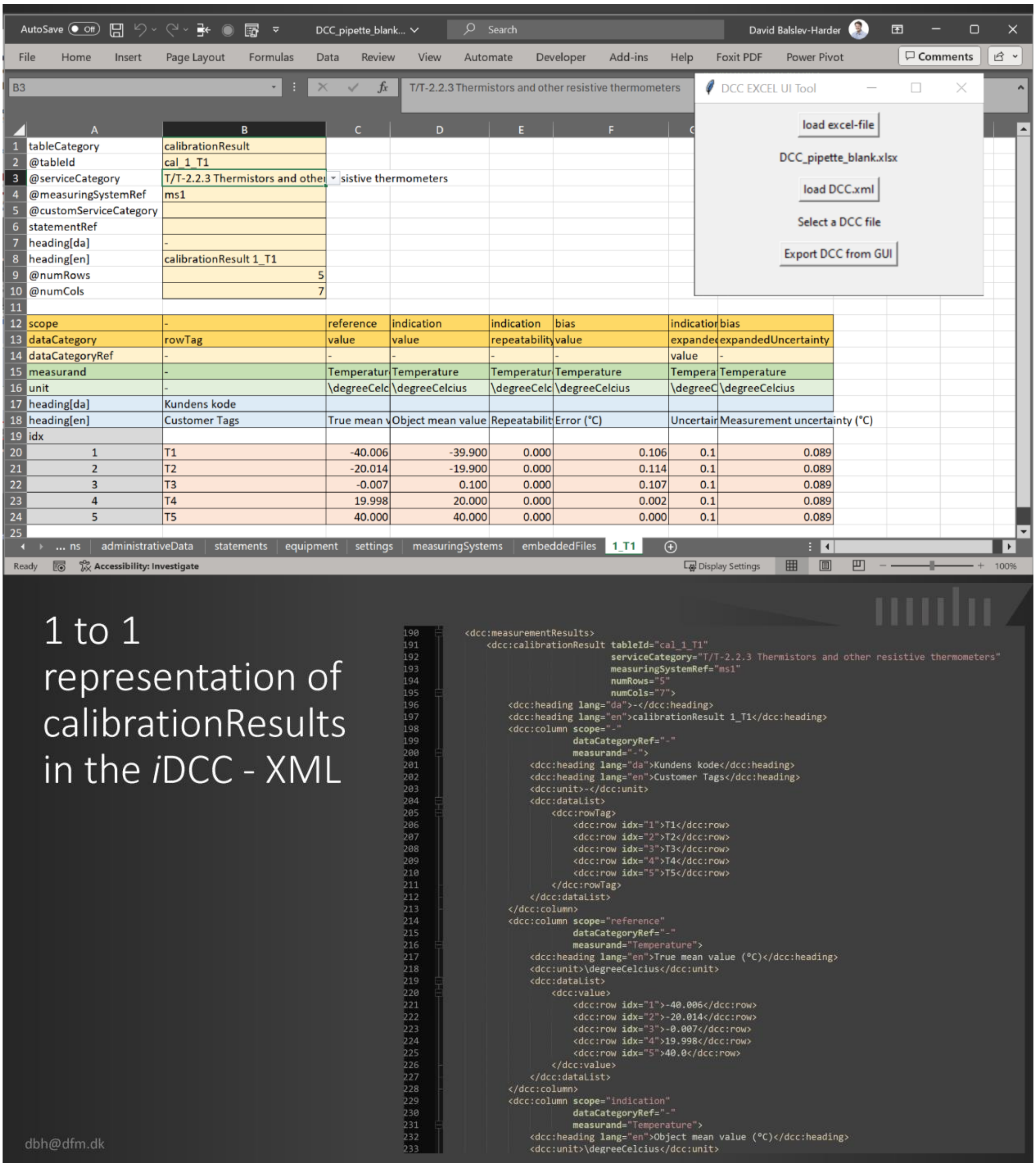
<dcc:body lang="en">This calibration certificate is covered by DANAK accreditation and the multilateral agreements from EA and
ILAC for calibration, which ensures that measurements are metrologically traceable. Calibration results only
covers the calibrated items.</dcc:body>
dbh@dfm.dk


AutoSave Off
DCC_pipette_blank...
Search
David Balslev-Harder
File Home Insert Page Layout Formulas Data Review View Automate Developer Add-ins Help Foxit PDF Power Pivot Table Design
B4
item1
heading[da]
heading[en]
in DCC | @id | @category | heading[da] | heading[en] | manufacturer | productName | productType | customer_id heading[en]
y | item1 | item | | Temperature datalogger | Testo | Temperature datalogger | Saveris T2 | Customer iD
y | refInst1 | reference | | Reference termometer
Definitions administrativeData statements equipment settings measuringSystems embeddedFiles 1_T1
Ready
Accessibility: Investigate
Display Settings
100%


DCC_pipette_blank...
David Balslev-Harder
File Home Insert Page Layout Formulas Data Review View Automate Developer Add-ins Help Foxit PDF Power Pivot Table Design
D4
Ch
heading[da] Indstillinger
heading[en] Settings
in DCC @settingId @equipmentRef parameter value unit softwareInstruction heading[en] heading[da] body[
y ch2 item1 Ch 2 Channel Kanal
y ch2_type item1 type 0610 1725 Type
Definitions administrativeData statements equipment settings measuringSystems embeddedFiles 1_T1
Ready Accessibility: Investigate
Display Settings 100%


DCC_pipette_blank...
David Balslev-Harder
File Home Insert Page Layout Formulas Data Review View Automate Developer Add-ins Help Foxit PDF Power Pivot Table Design
A4
y
heading[da] Målesystemer
heading[en] Measuring Systems Under Calibration
in DCC @id heading[en] heading[da] equipmentRefs settingRefs statementRefs operationalStatu
y ms1 Data logger measuring system item1 refInst1 ch2 ch2_type meth1 as found
Definitions administrativeData statements equipment settings measuringSystems embeddedFiles 1_T1
Ready Accessibility: Investigate
Display Settings 100%


DCC EXCEL UI Tool
load excel-file
DCC_pipette_blank.xlsx
load DCC.xml
Select a DCC file
Export DCC from GUI
tableCategory calibrationResult
@tableId cal_1_T1
@serviceCategory T/T-2.2.3 Thermistors and other resistive thermometers
@measuringSystemRef ms1
@customServiceCategory
statementRef
heading[da] -
heading[en] calibrationResult 1_T1
@numRows 5
@numCols 7
scope
dataCategory
dataCategoryRef
measurand
unit
heading[da]
heading[en]
idx
1 to 1 representation of calibrationResults in the iDCC - XML
dbh@dfm.dk
<dcc:measurementResults>
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measuringSystemRef="ms1"
numRows="5"
numCols="7">
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dataCategoryRef="-"
measurand="-">
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<dcc:dataList>
<dcc:rowTag>
<dcc:row idx="1">T1</dcc:row>
<dcc:row idx="2">T2</dcc:row>
<dcc:row idx="3">T3</dcc:row>
<dcc:row idx="4">T4</dcc:row>
<dcc:row idx="5">T5</dcc:row>
</dcc:rowTag>
</dcc:dataList>
</dcc:column>
<dcc:column scope="reference"
dataCategoryRef="-"
measurand="Temperature">
<dcc:heading lang="en">True mean value (°C)</dcc:heading>
<dcc:unit>\degreeCelcius</dcc:unit>
<dcc:dataList>
<dcc:value>
<dcc:row idx="1">-40.006</dcc:row>
<dcc:row idx="2">-20.014</dcc:row>
<dcc:row idx="3">-0.007</dcc:row>
<dcc:row idx="4">19.998</dcc:row>
<dcc:row idx="5">40.0</dcc:row>
</dcc:value>
</dcc:dataList>
</dcc:column>
<dcc:column scope="indication"
dataCategoryRef="-"
measurand="Temperature">
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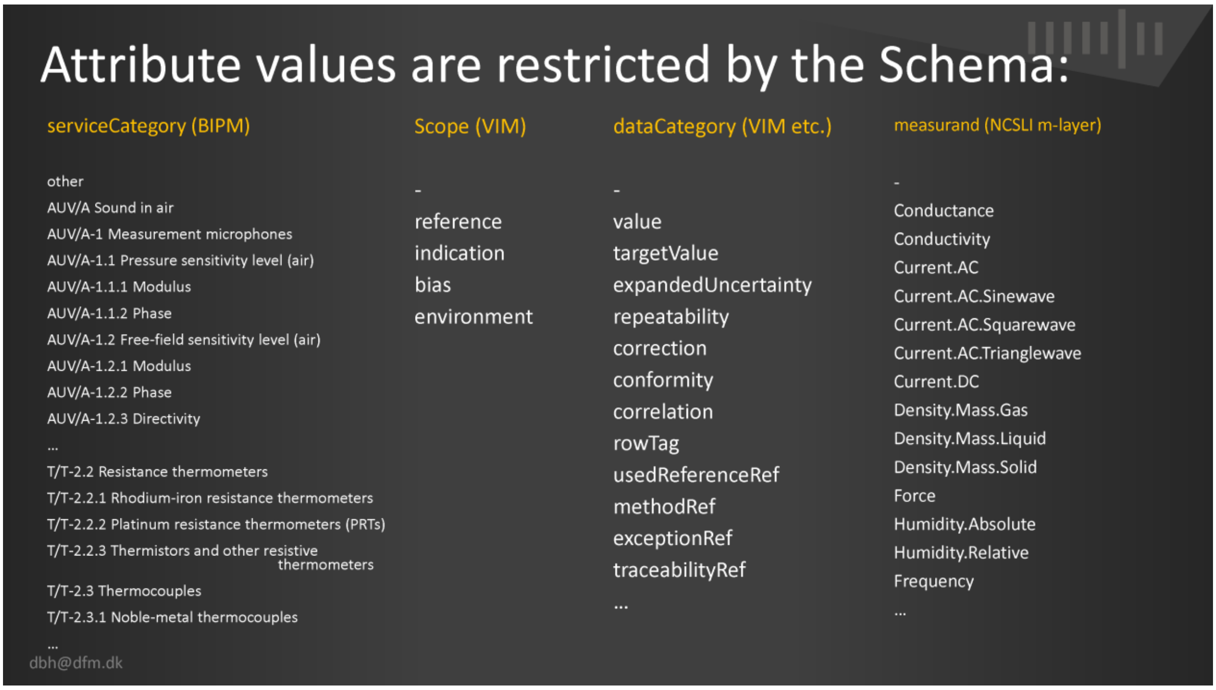
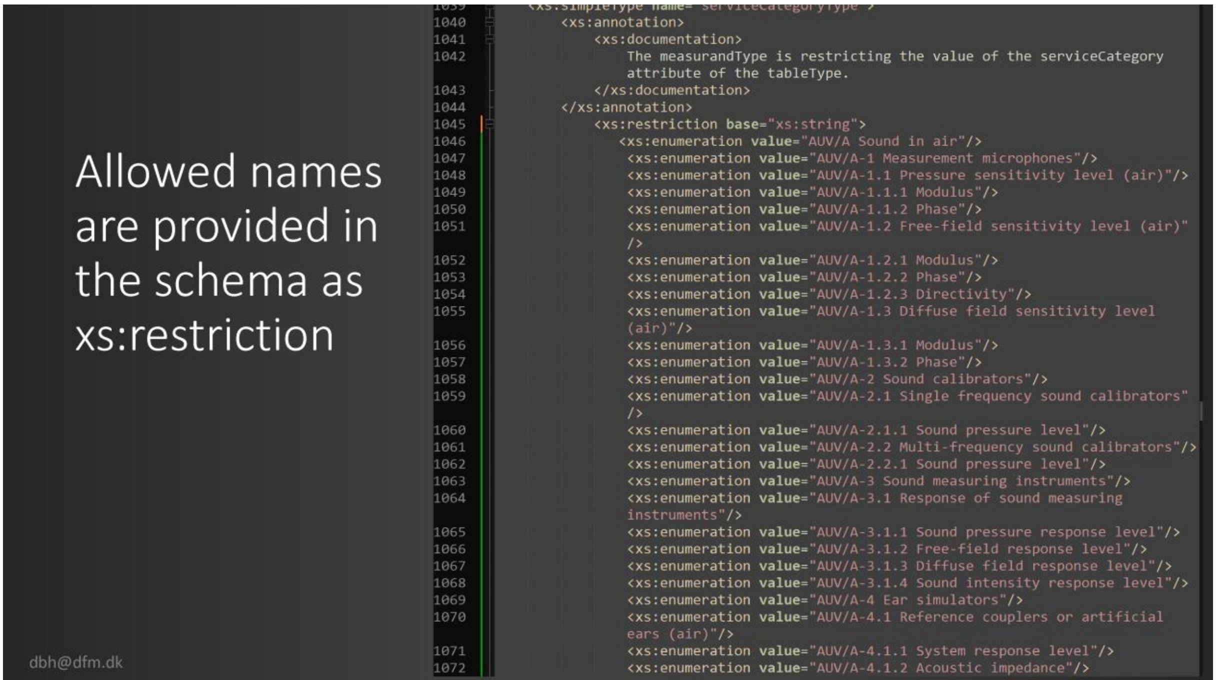
<dcc:unit>\degreeCelcius</dcc:unit>


Attribute values are restricted by the Schema:
serviceCategory (BIPM)
other
AUV/A Sound in air
AUV/A-1 Measurement microphones
AUV/A-1.1 Pressure sensitivity level (air)
AUV/A-1.1.1 Modulus
AUV/A-1.1.2 Phase
AUV/A-1.2 Free-field sensitivity level (air)
AUV/A-1.2.1 Modulus
AUV/A-1.2.2 Phase
AUV/A-1.2.3 Directivity
...
T/T-2.2 Resistance thermometers
T/T-2.2.1 Rhodium-iron resistance thermometers
T/T-2.2.2 Platinum resistance thermometers (PRTs)
T/T-2.2.3 Thermistors and other resistive thermometers
T/T-2.3 Thermocouples
T/T-2.3.1 Noble-metal thermocouples
...
Scope (VIM)
-
reference
indication
bias
environment
dataCategory (VIM etc.)
-
value
targetValue
expandedUncertainty
repeatability
correction
conformity
correlation
rowTag
usedReferenceRef
methodRef
exceptionRef
traceabilityRef
...
measurand (NCSLI m-layer)
-
Conductance
Conductivity
Current.AC
Current.AC.Sinewave
Current.AC.Squarewave
Current.AC.Trianglewave
Current.DC
Density.Mass.Gas
Density.Mass.Liquid
Density.Mass.Solid
Force
Humidity.Absolute
Humidity.Relative
Frequency
...
dbh@dfm.dk


Allowed names are provided in the schema as xs:restriction
<xs:simpleType name="scopeType">
<xs:annotation>
<xs:documentation>
The scopeType is restricting the scope attribute of the columnType.
For data columns the attribute is used to descibe the data..
For meta data columns the attribute is used to match the data column(s) that is enriched with the meta data.
* reference : Data relating to the reference equipment. E.g. measured value or uncertainty of the reference.
* indication : Data relating to the device under test. E.g. nominal value of an artefact or display value of an active instrument
* bias : Data relating to the difference item_value - reference_value.
E.g. the calibration result (bias of the item and its uncertainty.)
* environment: Influece conditions measured in the environment . E.g. laboratory temperature, pressure etc...
* Other : the content may be specified in the column name in human readable form.
* '-' : Used for meta data columns to refer to all scopes
</xs:documentation>
</xs:annotation>
<xs:restriction base="xs:string">
<xs:enumeration value="reference" />
<xs:enumeration value="indication" />
<xs:enumeration value="bias" />
<xs:enumeration value="environment" />
<xs:enumeration value="Other" />
<xs:enumeration value="-" />
</xs:restriction>
</xs:simpleType>
dbh@dfm.dk


Allowed names are provided in the schema as xs:restriction
dbh@dfm.dk
<xs:simpleType name="serviceCategoryType">
<xs:annotation>
<xs:documentation>
The measurandType is restricting the value of the serviceCategory attribute of the tableType.
</xs:documentation>
</xs:annotation>
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<xs:enumeration value="AUV/A-1 Measurement microphones"/>
<xs:enumeration value="AUV/A-1.1 Pressure sensitivity level (air)"/>
<xs:enumeration value="AUV/A-1.1.1 Modulus"/>
<xs:enumeration value="AUV/A-1.1.2 Phase"/>
<xs:enumeration value="AUV/A-1.2 Free-field sensitivity level (air)" />
<xs:enumeration value="AUV/A-1.2.1 Modulus"/>
<xs:enumeration value="AUV/A-1.2.2 Phase"/>
<xs:enumeration value="AUV/A-1.2.3 Directivity"/>
<xs:enumeration value="AUV/A-1.3 Diffuse field sensitivity level (air)"/>
<xs:enumeration value="AUV/A-1.3.1 Modulus"/>
<xs:enumeration value="AUV/A-1.3.2 Phase"/>
<xs:enumeration value="AUV/A-2 Sound calibrators"/>
<xs:enumeration value="AUV/A-2.1 Single frequency sound calibrators" />
<xs:enumeration value="AUV/A-2.1.1 Sound pressure level"/>
<xs:enumeration value="AUV/A-2.2 Multi-frequency sound calibrators"/>
<xs:enumeration value="AUV/A-2.2.1 Sound pressure level"/>
<xs:enumeration value="AUV/A-3 Sound measuring instruments"/>
<xs:enumeration value="AUV/A-3.1 Response of sound measuring instruments"/>
<xs:enumeration value="AUV/A-3.1.1 Sound pressure response level"/>
<xs:enumeration value="AUV/A-3.1.2 Free-field response level"/>
<xs:enumeration value="AUV/A-3.1.3 Diffuse field response level"/>
<xs:enumeration value="AUV/A-3.1.4 Sound intensity response level"/>
<xs:enumeration value="AUV/A-4 Ear simulators"/>
<xs:enumeration value="AUV/A-4.1 Reference couplers or artificial ears (air)"/>
<xs:enumeration value="AUV/A-4.1.1 System response level"/>
<xs:enumeration value="AUV/A-4.1.2 Acoustic impedance"/>


Allowed names are provided in the schema as xs:restriction
dbh@dfm.dk
<xs:simpleType name="dataCategoryType">
<xs:annotation>
<xs:documentation>
The dataCategoryType is restricting the value of the dataCategory attribute of the columnType.
For data columns this attribute is used to describe the data.
For meta data columns the attribute is used to match the data column(s) that is enriched with the meta data.
</xs:documentation>
</xs:annotation>
<xs:restriction base="xs:string">
<xs:enumeration value="-" />
<xs:enumeration value="value" />
<xs:enumeration value="targetValue" />
<xs:enumeration value="expandedUncertainty" />
<xs:enumeration value="repeatability" />
<xs:enumeration value="correction" />
<xs:enumeration value="conformity" />
<xs:enumeration value="correlation" />
<xs:enumeration value="rowTag" />
<xs:enumeration value="usedReferenceRef" />
<xs:enumeration value="methodRef" />
<xs:enumeration value="exceptionRef" />
<xs:enumeration value="traceabilityRef" />
<xs:enumeration value="attentionRef" />
<xs:enumeration value="commentRef" />
<xs:enumeration value="decisionRuleRef" />
<xs:enumeration value="accreditationExceptionRef" />
<xs:enumeration value="normRef" />
<xs:enumeration value="measurementSeriesRef" />
<xs:enumeration value="uncertaintyCoverageFactor_k" />
<xs:enumeration value="uncertaintyCoverageProbability" />
<xs:enumeration value="toleranceLimitLower" />
<xs:enumeration value="toleranceLimitUpper" />
<xs:enumeration value="acceptanceLimitLower" />
<xs:enumeration value="acceptanceLimitUpper" />
<xs:enumeration value="approachToTarget" />
<xs:enumeration value="other" /> <!--the content may be specified in the column name in human readable form -->
</xs:restriction>
</xs:simpleType>


Allowed names are provided in the schema as xs:restriction
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<xs:documentation>
The measurandType is restricting the value of the measurand attribute of the columnType.
For data columns this attribute is used to describe the data.
For meta data columns the attribute is used to match the data column(s) that is enriched with the meta data.
</xs:documentation>
</xs:annotation>
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<xs:enumeration value="Conductance" />
<xs:enumeration value="Conductivity" />
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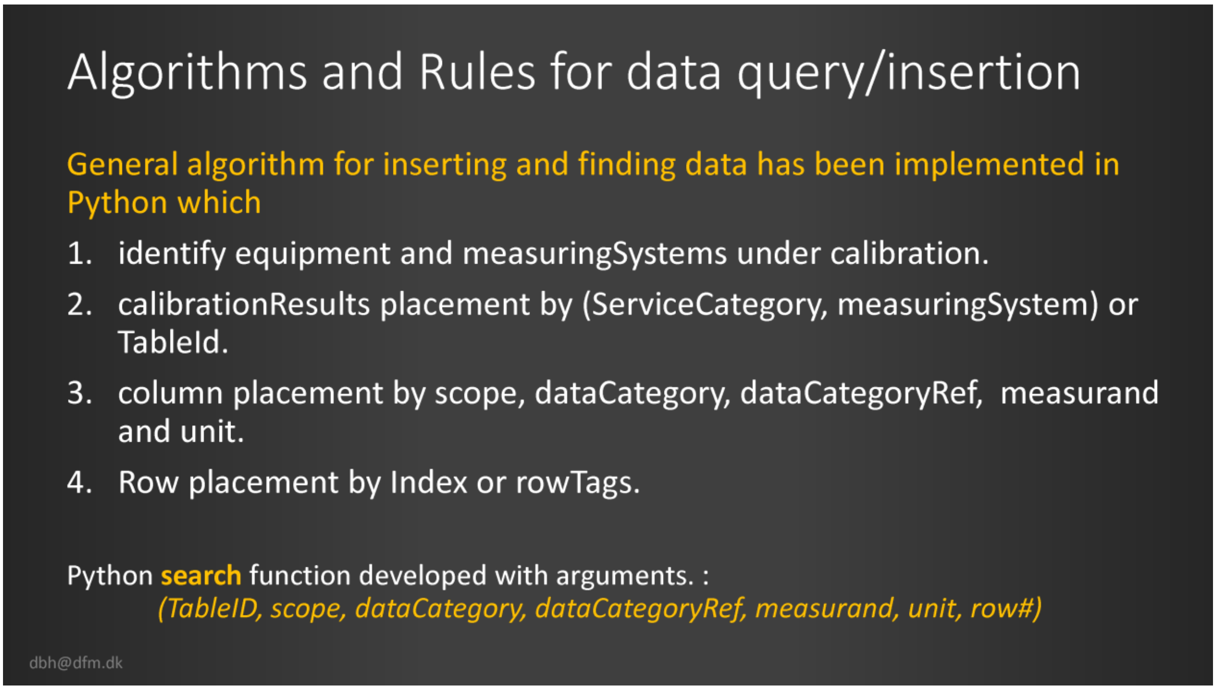
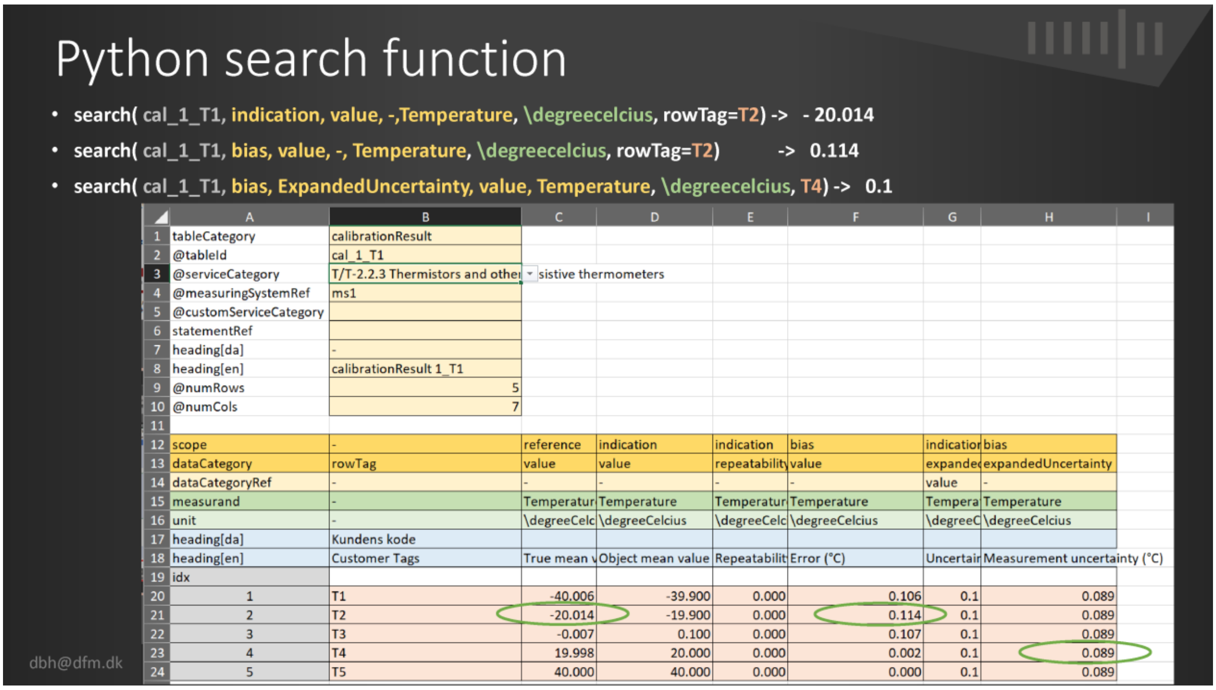
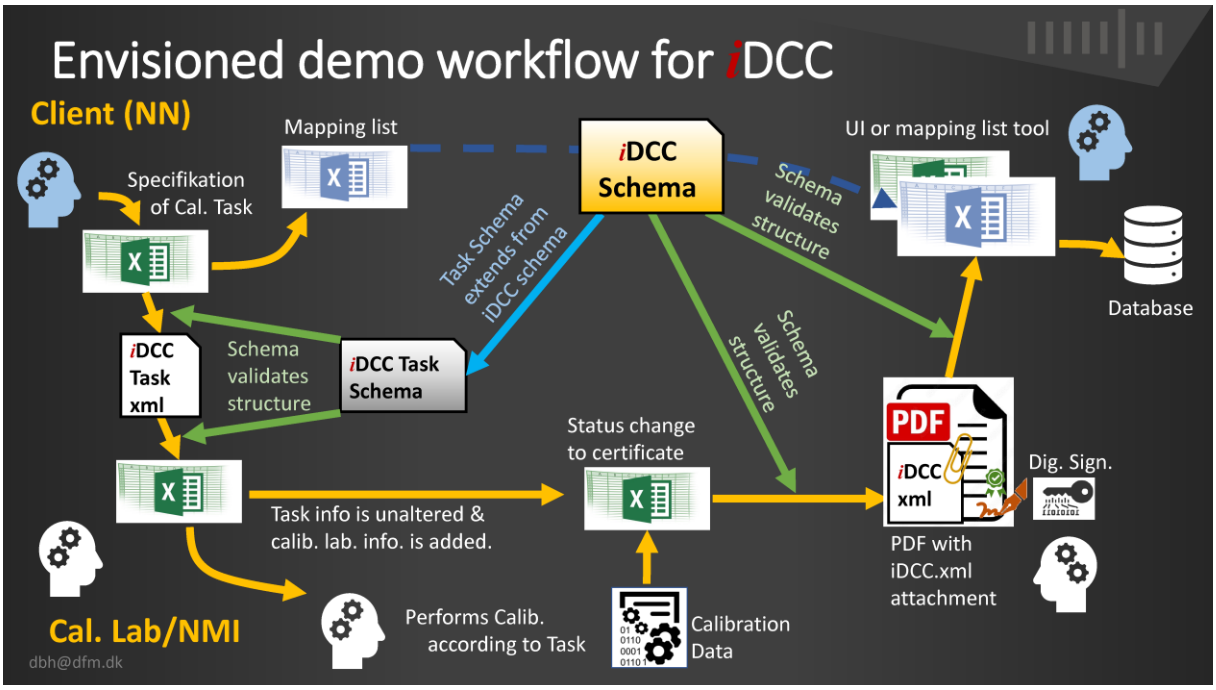
<xs:enumeration value="Current.AC.Sinewave" />
<xs:enumeration value="Current.AC.Squarewave" />
<xs:enumeration value="Current.AC.Trianglewave" />
<xs:enumeration value="Current.DC" />
<xs:enumeration value="Density.Mass.Gas" />
<xs:enumeration value="Density.Mass.Liquid" />
<xs:enumeration value="Density.Mass.Solid" />
<xs:enumeration value="Force" />
<xs:enumeration value="Frequency" />
<xs:enumeration value="Frequency.AmplitudeModulation.Rate" />
<xs:enumeration value="Frequency.FrequencyModulation.Deviation" />
<xs:enumeration value="Frequency.FrequencyModulation.Rate" />
<xs:enumeration value="Frequency.PhaseModulation.Rate" />
<xs:enumeration value="Humidity.Absolute" />
<xs:enumeration value="Impedance" />
dbh@dfm.dk


Algorithms and Rules for data query/insertion
General algorithm for inserting and finding data has been implemented in Python which
1. identify equipment and measuringSystems under calibration.
2. calibrationResults placement by (ServiceCategory, measuringSystem) or TableId.
3. column placement by scope, dataCategory, dataCategoryRef, measurand and unit.
4. Row placement by Index or rowTags.
Python search function developed with arguments. :
(TableID, scope, dataCategory, dataCategoryRef, measurand, unit, row#)
dbh@dfm.dk



	A	B	C	D	E	F	G	H	I
1	tableCategory	calibrationResult							
2	@tableId	cal_1_T1							
3	@serviceCategory	T/T-2.2.3 Thermistors and other	sistive thermometers						
4	@measuringSystemRef	ms1							
5	@customServiceCategory								
6	statementRef								
7	heading[da]	-							
8	heading[en]	calibrationResult 1_T1							
9	@numRows	5							
10	@numCols	7							
11									
12	scope	-	reference	indication	indication	bias	indicatior	bias	
13	dataCategory	rowTag	value	value	repeatability	value	expandec	expandedUncertainty	
14	dataCategoryRef	-	-	-	-	-	value	-	
15	measurand	-	Temperatur	Temperature	Temperatur	Temperature	Tempera	Temperature	
16	unit	-	\degreeCelc	\degreeCelcius	\degreeCelc	\degreeCelcius	\degreeC	\degreeCelcius	
17	heading[da]	Kundens kode							
18	heading[en]	Customer Tags	True mean v	Object mean value	Repeatabilit	Error (°C)	Uncertair	Measurement uncertainty (°C)	
19	idx								
20	1	T1	-40.006	-39.900	0.000	0.106	0.1	0.089	
21	2	T2	-20.014	-19.900	0.000	0.114	0.1	0.089	
22	3	T3	-0.007	0.100	0.000	0.107	0.1	0.089	
23	4	T4	19.998	20.000	0.000	0.002	0.1	0.089	
24	5	T5	40.000	40.000	0.000	0.000	0.1	0.089	



Implementation is available:

https://github.com/TC-IM-1448/DCC-Tables/tree/master

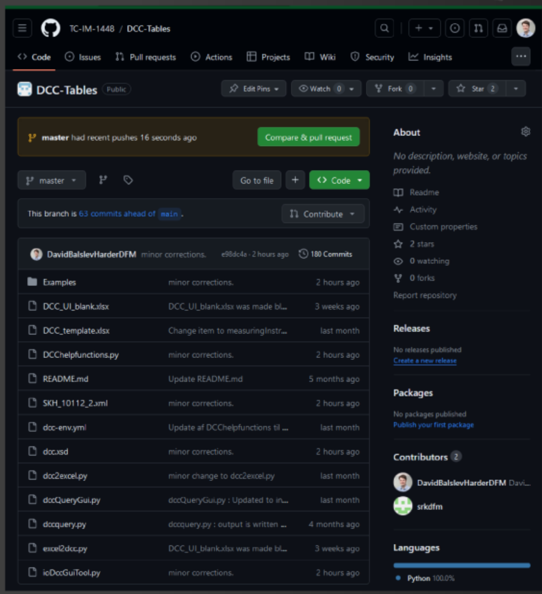
dcc.xsd - Schema file for *i*DCC.

ioDCCGuiTool.py - for interfacing with Excel.

dccQueryGui.py – for data querying into Excel.

DCChelpfunctions.py – used for validation

SKH_10112_2.xml – an iDCC validating example



dbh@dfm.dk

Thank You

Join the stakeholderlist for TC-IM 1448 WG1
Get updates on future workshops
please write to dbh@dfm.dk.

To participants in TC-IM 1448 WG1:

Zoltan Zelenka, Michael Chrubasik, Diego Coppa, Quentin Baire, Carlos Pires,
Shanna Schönhalls, Daniel Hutzschenreuter, Gamze Soeylev-oektem, Clifford Brown, Wiebke Heeren.

To International collaborators at PTB, DCC2GO project, and other fora.

To Danish collaborators, Teknologisk Institute, FORCE, Novo Nordisk, DANDIAG etc.

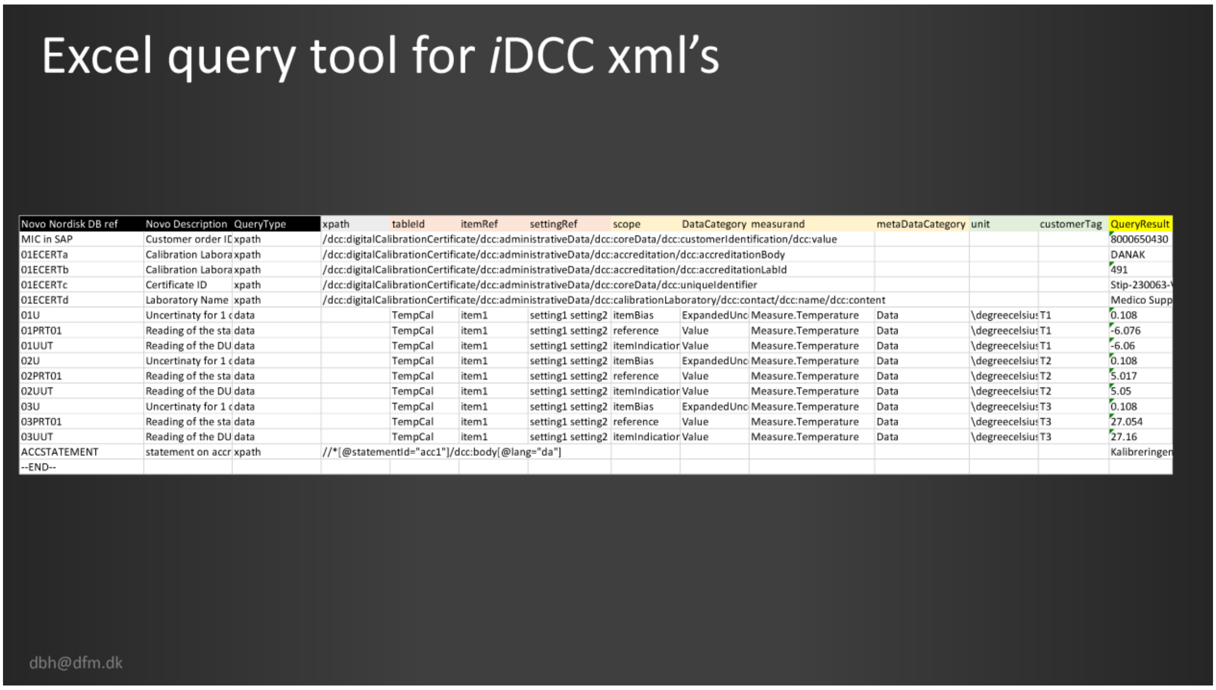
To PTB for hosting this important international DCC conference.

To audience for listening.

Contact: David Balslev-Harder (dbh@dfm.dk)

Also See Presentation #028
Machine interpretable DCC structure
exemplified for pipettes
(Søren Kynde, DFM)

dbh@dfm.dk



Novo Nordisk DB ref	Novo Description	QueryType	xpath	tableId	itemRef	settingRef	scope	DataCategory	measurand	metaDataCategory	unit	customerTag	QueryResult
MIC in SAP	Customer order ID	xpath	/dcc:digitalCalibrationCertificate/dcc:administrativeData/dcc:coreData/dcc:customerIdentification/dcc:value										8000650430
01ECERTa	Calibration Labora	xpath	/dcc:digitalCalibrationCertificate/dcc:administrativeData/dcc:accreditation/dcc:accreditationBody										DANAK
01ECERTb	Calibration Labora	xpath	/dcc:digitalCalibrationCertificate/dcc:administrativeData/dcc:accreditation/dcc:accreditationLabId										491
01ECERTc	Certificate ID	xpath	/dcc:digitalCalibrationCertificate/dcc:administrativeData/dcc:coreData/dcc:uniqueIdentifier										Stip-230063-\
01ECERTd	Laboratory Name	xpath	/dcc:digitalCalibrationCertificate/dcc:administrativeData/dcc:calibrationLaboratory/dcc:contact/dcc:name/dcc:content										Medico Supp
01U	Uncertinaty for 1 c	data		TempCal	item1	setting1 setting2	itemBias	ExpandedUnc	Measure.Temperature	Data	\degreecelsius	T1	0.108
01PRT01	Reading of the sta	data		TempCal	item1	setting1 setting2	reference	Value	Measure.Temperature	Data	\degreecelsius	T1	-6.076
01UUT	Reading of the DU	data		TempCal	item1	setting1 setting2	itemIndicatior	Value	Measure.Temperature	Data	\degreecelsius	T1	-6.06
02U	Uncertinaty for 1 c	data		TempCal	item1	setting1 setting2	itemBias	ExpandedUnc	Measure.Temperature	Data	\degreecelsius	T2	0.108
02PRT01	Reading of the sta	data		TempCal	item1	setting1 setting2	reference	Value	Measure.Temperature	Data	\degreecelsius	T2	5.017
02UUT	Reading of the DU	data		TempCal	item1	setting1 setting2	itemIndicatior	Value	Measure.Temperature	Data	\degreecelsius	T2	5.05
03U	Uncertinaty for 1 c	data		TempCal	item1	setting1 setting2	itemBias	ExpandedUnc	Measure.Temperature	Data	\degreecelsius	T3	0.108
03PRT01	Reading of the sta	data		TempCal	item1	setting1 setting2	reference	Value	Measure.Temperature	Data	\degreecelsius	T3	27.054
03UUT	Reading of the DU	data		TempCal	item1	setting1 setting2	itemIndicatior	Value	Measure.Temperature	Data	\degreecelsius	T3	27.16
ACCSTATEMENT	statement on accr	xpath	//*[@statementId="acc1"]/dcc:body[@lang="da"]										Kalibreringen
--END--													

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10 Proposal to improve the interoperability of the DCC

Presenting author: Diego Coppa, INTI Argentina
Email: dcoppa@inti.gob.ar

Abstract

The consequences of the digital transformation of metrology are the improvement of traceability and trust in measurements, the modernization of processes, and the strengthening of the entire quality infrastructure. Calibration certificates are a fundamental part of this process, and their harmonization represents the path towards digital transformation.

Focusing on the digitalization of calibration certificates, the digital transformation of metrology implies that machines are capable of interpreting metrological information written in the certificate. This interpretation can only occur through metrological communication based on state-of-the-art knowledge of a context or reference (1), and therein lies its importance.

Interpreting a calibration certificate hinges on standards. These standards, whether explicit or implicit written in the certificate, form the bedrock of traceability and the origin of transmitted information. The context of a certificate stands as a key part in its communication.

Digital calibration certificates ought to align with internationally accepted standards, with the SIRP (2) serving as the fundamental reference for crafting such certificates.

The fundamental goal of the SIRP is to furnish referential information at the BIPM level. Notable elements include services at the CC level, CMCs, fundamental constants, and metrological concepts.

This work proposes the adoption of CC Services delineated in the KCDB (3) as an integral part of the context within a Digital Calibration Certificate. Additionally, utilizing a taxonomy (4) recommended by the BIPM aims to offer a more comprehensive description of the context for humans.

1. Hall, B. D. (2023). The FAIR principle interoperability and representation of measured quantities (Version 1). Measurement Standards Laboratory of New Zealand. https://doi.org/10.5281/zenodo.10117162
2. https://www.bipm.org/documents/20126/71876713/DIG-MET-2022-MILES.pdf/f0757b30-eac0-7afc-c6ec-677a5fa092f4
3. https://www.bipm.org/en/cipm-mra/cipm-mra-documents/service-categories
4. https://www.metrology.net/mii-approved-taxonomies/

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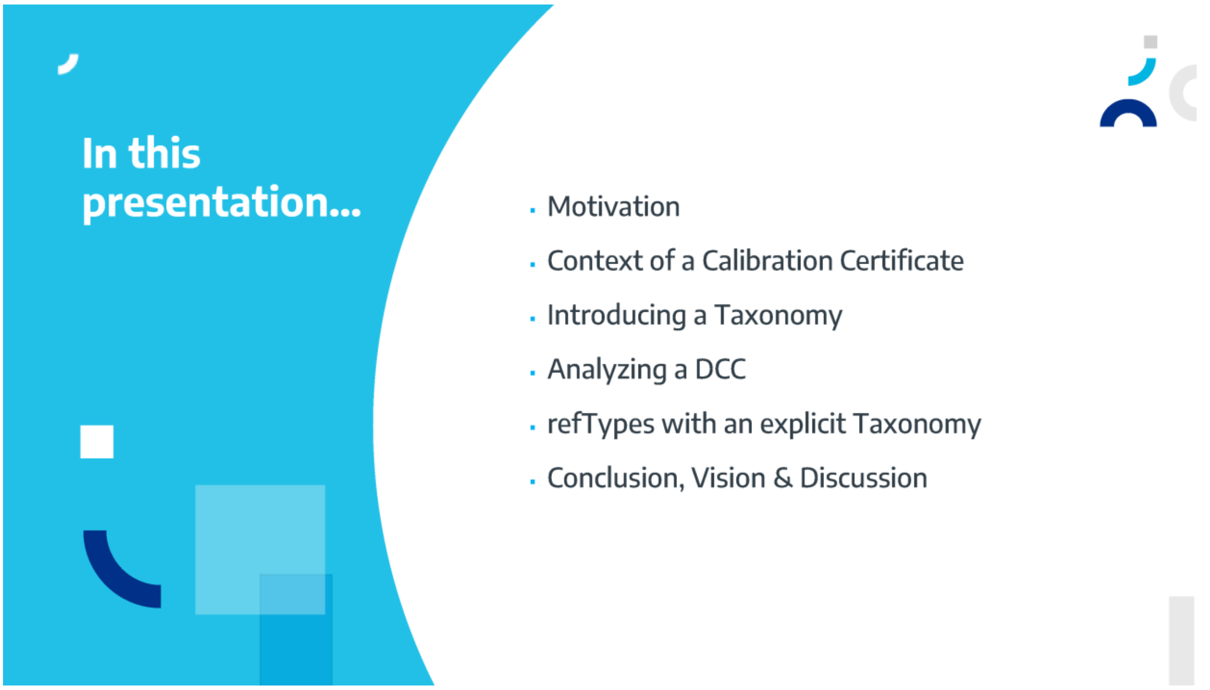
Presentation of Diego Coppa



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INTI

Motivation

Motivation

Motives, Improvements & base for the proposal

Motives

- Increase in the interoperability between Calibration Certificates.
- Facilitate the adoptability of the DCCs.
- Increase the usefulness of the Calibration Certificates.

To increase the interoperability, adoptability and usefulness the requirements will be:

- Standardization & Classification of the Certificates based on Metrological concepts.
- Have a FAIR DCC.

Basement for the development:

- Use a classification that already exists based on an actual analog and probably future digitalization of the QI documentation.
- Link the DCC to the SI Reference Point.
- Use a structurization that is already accepted by Metrological Communities.

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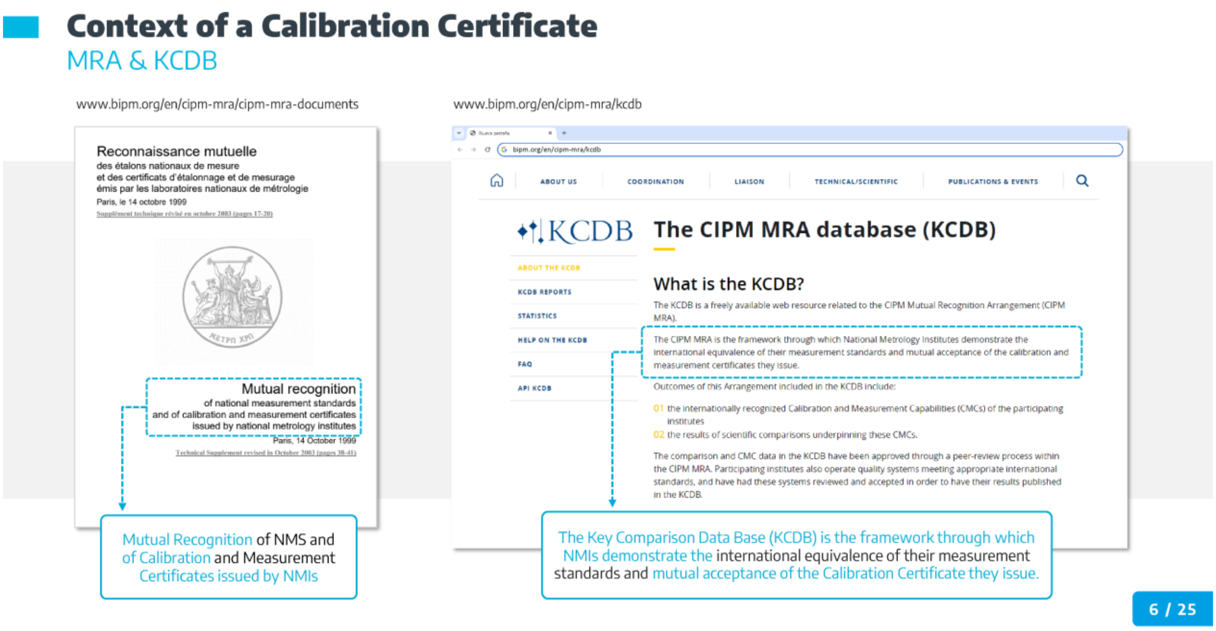
Context of a
Calibration Certificate


Context of a Calibration Certificate
MRA & KCDB
www.bipm.org/en/cipm-mra/cipm-mra-documents
Reconnaissance mutuelle
des étalons nationaux de mesure
et des certificats d'étalonnage et de mesurage
émis par les laboratoires nationaux de métrologie
Paris, le 14 octobre 1999
Mutual recognition
of national measurement standards
and of calibration and measurement certificates
issued by national metrology institutes
Paris, 14 October 1999
Mutual Recognition of NMS and of Calibration and Measurement Certificates issued by NMIs
www.bipm.org/en/cipm-mra/kcdb
KCDB
The CIPM MRA database (KCDB)
What is the KCDB?
The KCDB is a freely available web resource related to the CIPM Mutual Recognition Arrangement (CIPM MRA).
The CIPM MRA is the framework through which National Metrology Institutes demonstrate the international equivalence of their measurement standards and mutual acceptance of the calibration and measurement certificates they issue.
The Key Comparison Data Base (KCDB) is the framework through which NMIs demonstrate the international equivalence of their measurement standards and mutual acceptance of the Calibration Certificate they issue.
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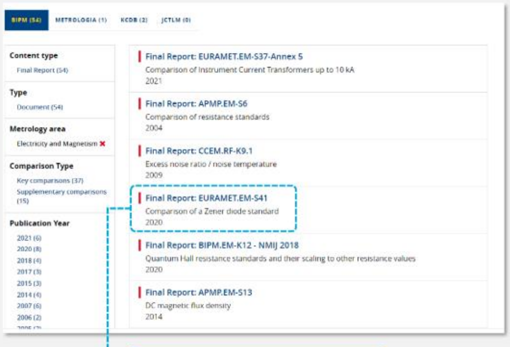
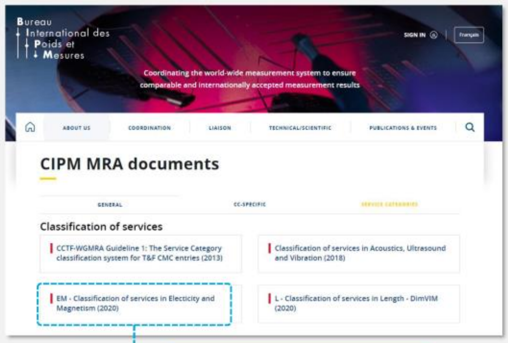
Context of a Calibration Certificate

KCDB Reports & Classification of Consultive Comitees's Services (CC Services)

www.bipm.org/kcdb/cmc/advanced-search



www.bipm.org/en/cipm-mra/cipm-mra-documents



Analog reports to support the CMCs. (Digitalization on the way)

Analog classification of CC Services (Digitalization on the way)

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Context of a Calibration Certificate

Classification of Consultive Committee's Services (CC Services)

Classification of CC Services in:

ELECTRICITY AND MAGNETISM

BRANCH: AC VOLTAGE, CURRENT, AND POWER
- **5. AC voltaje** (up to the MHz range)
  - **5.2.** AC voltaje up to 1100 V
    - **5.2.1. Sources:** multifunction calibrator.
    - **5.2.2. Meters:** AC voltmeter, multimeter, multifunction transfer standard.

MASS AND RELATED QUANTITIES

BRANCH: FLUID FLOW
- **9. Fluid Flow**
  - **9.10. Fluid Flow**
    - **9.10.1. Liquid Flow**.
    - **9.10.2. Gas Flow**
    - **9.10.3. Quantity of Fluid**
    - **9.10.4. Flow Speed (...)**

ACOUSTICS, ULTRASOUND AND VIBRATION

BRANCH: Vibration
- **21. Linear Vibration**
  - **21.3. Acceleration measuring chain / accelerometer**
    - **21.3.1. Charge sensitivity**
    - **21.3.1.1 Modulus:** frequency
    - **21.3.1.2. Phase:** frequency

THERMOMETRY

BRANCH: TEMPERATURE
- **2. Temperature –** Items used for disseminating ITS-90 and PLTS 2000
  - **2.2. Resistance thermometers**
    - **2.2.2. Industrial platinum resistance thermometers (IPRTs).**

LENGHT

CLASS: 2. Linear Dimensions
2.4. Diameter standards

SERVICE CATEGORY	INSTRUMENT OR ARTIFACT	MEASURAND
2.4.1	external cylinder (plug, piston, pin, wire)	diameter
2.4.2	internal cylinder (ring)	diameter
2.4.3	sphere (ball)	diameter

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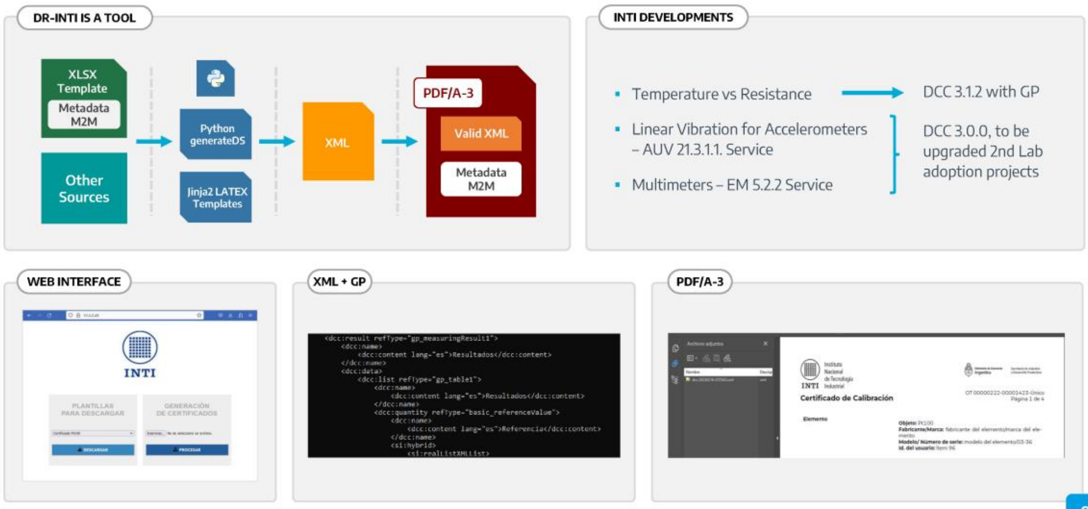
www.bipm.org/en/cipm-mra/cipm-mra-documents

Context of a Calibration Certificate

Generation of DCCs at INTI



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Context of a Calibration Certificate

CMC linked to a CC Service – EM Services – item 5.2.2 – Case of Study

Calibration and Measurement Capability (CMC)

Data Base for humans (Digitalization on the way)

	GROUP ID	SERVICE PROVIDER	INSTITUTE SERVICE CODE	COMMENTS	BRANCH	SERVICE	QUANTITY
		Argentina **INTI**	INTI/102.02.04.05.10.001		AC voltage, current, and power	AC voltage (up to the MHz range)	AC voltage (up to the MHz range): AC voltage ratio up to 1100 V, real component (or modulus)

INSTRUMENT OR ARTIFACT UNDER STUDY	INSTRUMENT TYPE OR METHOD APPLIED	VALUE CMC	EXPANDED UNCERTAINTY CMC	PARAMETERS	APPROVAL DATE
AC voltmeter, multimeter, multifunction transfer standard	AC/DC transfer	[0.06 to 1000] V	[1.0E1 to 3.0E2] µV/V Uncertainty table	Frequency : 10 Hz to 1 MHz	2013-08-06

www.bipm.org/kcdb/cmc/advanced-search

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Context of a Calibration Certificate
CMC linked to a CC Service – EM Services – item 5.2.2 – Case of Study

Calibration and Measurement Capability (CMC)

Data Base for humans (Digitalization on the way)

	GROUP ID	SERVICE PROVIDER	INSTITUTE SERVICE CODE	COMMENTS	BRANCH	SERVICE	QUANTITY
		Argentina **INTI**	INTI/102.02.04.05.10.001		AC voltage, current, and power	AC voltage (up to the MHz range)	AC voltage (up to the MHz range): AC voltage ratio up to 1100 V, real component (or modulus)

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www.bipm.org/kcdb/cmc/advanced-search

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Context of a Calibration Certificate
CMC linked to a CC Service – EM Services – item 5.2.2 – Case of Study

Calibration and Measurement Capability (CMC)

Data Base for humans (Digitalization on the way)

	GROUP ID	SERVICE PROVIDER	INSTITUTE SERVICE CODE	COMMENTS	BRANCH	SERVICE	QUANTITY
		Argentina **INTI**	INTI/102.02.04.05.10.001		AC voltage, current, and power	AC voltage (up to the MHz range)	AC voltage (up to the MHz range): AC voltage ratio up to 1100 V, real component (or modulus)

INSTRUMENT OR ARTIFACT UNDER STUDY	INSTRUMENT TYPE OR METHOD APPLIED	VALUE CMC	EXPANDED UNCERTAINTY CMC	PARAMETERS	APPROVAL DATE
AC voltmeter, multimeter, multifunction transfer standard	AC/DC transfer	[0.06 to 1000] V	[1.0E1 to 3.0E2] µV/V Uncertainty table	Frequency : 10 Hz to 1 MHz	2013-08-06

www.bipm.org/kcdb/cmc/advanced-search

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Context of a Calibration Certificate

CMC linked to a CC Service – EM Services – item 5.2.2 – Case of Study

Calibration and Measurement Capability (CMC)

Data Base for humans (Digitalization on the way)

	GROUP ID	SERVICE PROVIDER	INSTITUTE SERVICE CODE	COMMENTS	BRANCH	SERVICE	QUANTITY
		Argentina **INTI**	INTI/102.02.04.05.10.001		AC voltage, current, and power	AC voltage (up to the MHz range)	AC voltage (up to the MHz range): AC voltage ratio up to 1100 V, real component (or modulus)

INSTRUMENT OR ARTIFACT UNDER STUDY	INSTRUMENT TYPE OR METHOD APPLIED	VALUE CMC	EXPANDED UNCERTAINTY CMC	PARAMETERS	APPROVAL DATE
AC voltmeter, multimeter, multifunction transfer standard	AC/DC transfer	[0.06 to 1000] V	[1.0E1 to 3.0E2] µV/V Uncertainty table	Frequency : 10 Hz to 1 MHz	2013-08-06

www.bipm.org/kcdb/cmc/advanced-search

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Context of a Calibration Certificate

CMC linked to a CC Service – EM Services – item 5.2.2 – Case of Study

Calibration and Measurement Capability (CMC)

Data Base for humans (Digitalization on the way)

	GROUP ID	SERVICE PROVIDER	INSTITUTE SERVICE CODE	COMMENTS	BRANCH	SERVICE	QUANTITY
		Argentina **INTI**	INTI/102.02.04.05.10.001		AC voltage, current, and power	AC voltage (up to the MHz range)	AC voltage (up to the MHz range): AC voltage ratio up to 1100 V, real component (or modulus)

INSTRUMENT OR ARTIFACT UNDER STUDY	INSTRUMENT TYPE OR METHOD APPLIED	VALUE CMC	EXPANDED UNCERTAINTY CMC	PARAMETERS	APPROVAL DATE
AC voltmeter, multimeter, multifunction transfer standard	AC/DC transfer	[0.06 to 1000] V	[1.0E1 to 3.0E2] µV/V Uncertainty table	Frequency : 10 Hz to 1 MHz	2013-08-06

www.bipm.org/kcdb/cmc/advanced-search

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Context of a Calibration Certificate

AC Voltage for Multimeters – 5.2.2 Service – Case of Study

Lab #1

RANGE	NOMINAL VALUE	MODIFIER	ERROR	UNCERTAINTY K=2; 95%
0.1 V	0.1 V	0.04 kHz	0.000 04 V	0.000 020 V
0.1 V	0.1 V	1 kHz	-0.000 001 V	-0.000 010 V
0.1 V	0.1 V	20 kHz	0.000 000 V	0.000 000 V

Lab #2

RANGE	REFERENCE VALUE	MODIFIER	DEVIATION	MEASURED VALUE	UNCERTAINTY K=2; 95%	All Dev	Ut of All Dev
600 mV	60.00 mV	50 Hz	0.200 mV	60.2 mV	$1.0 \cdot 10^{-3}$	±0.9 mV	29 % pass
600 mV	540.00 mV	50 kHz	-0.30 mV	539.7 mV	$0.27 \cdot 10^{-3}$	±5.7 mV	29 % pass
600 mV	540.00 mV	500 Hz	-0.20 mV	539.8 mV	$0.27 \cdot 10^{-3}$	±5.7 mV	29 % pass

Lab #3

RANGE	NOMINAL VALUE	MODIFIER	ERROR	MEASURED VALUE	UNCERTAINTY K=2; 95%
2 V	1.000 V	10 Hz	0.000 V	1.000 V	1.2×10^{-4}
2 V	1.000 V	40 Hz	-0.003 V	0.997 V	1.4×10^{-5}
2 V	1.000 V	100 Hz	0.002 V	1.002 V	1.4×10^{-5}

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Context of a Calibration Certificate

AC Voltage for Multimeters – 5.2.2 Service – Case of Study

REQ / Set Up

Lab #1

RANGE	NOMINAL VALUE	MODIFIER	ERROR	UNCERTAINTY K=2; 95%
0.1 V	0.1 V	0.04 kHz	0.000 04 V	0.000 020 V
0.1 V	0.1 V	1 kHz	-0.000 001 V	-0.000 010 V
0.1 V	0.1 V	20 kHz	0.000 000 V	0.000 000 V

Lab #2

RANGE	REFERENCE VALUE	MODIFIER	DEVIATION	MEASURED VALUE	UNCERTAINTY K=2; 95%	All Dev	Ut of All Dev
600 mV	60.00 mV	50 Hz	0.200 mV	60.2 mV	$1.0 \cdot 10^{-3}$	±0.9 mV	29 % pass
600 mV	540.00 mV	50 kHz	-0.30 mV	539.7 mV	$0.27 \cdot 10^{-3}$	±5.7 mV	29 % pass
600 mV	540.00 mV	500 Hz	-0.20 mV	539.8 mV	$0.27 \cdot 10^{-3}$	±5.7 mV	29 % pass

Lab #3

RANGE	NOMINAL VALUE	MODIFIER	ERROR	MEASURED VALUE	UNCERTAINTY K=2; 95%
2 V	1.000 V	10 Hz	0.000 V	1.000 V	1.2×10^{-4}
2 V	1.000 V	40 Hz	-0.003 V	0.997 V	1.4×10^{-5}
2 V	1.000 V	100 Hz	0.002 V	1.002 V	1.4×10^{-5}

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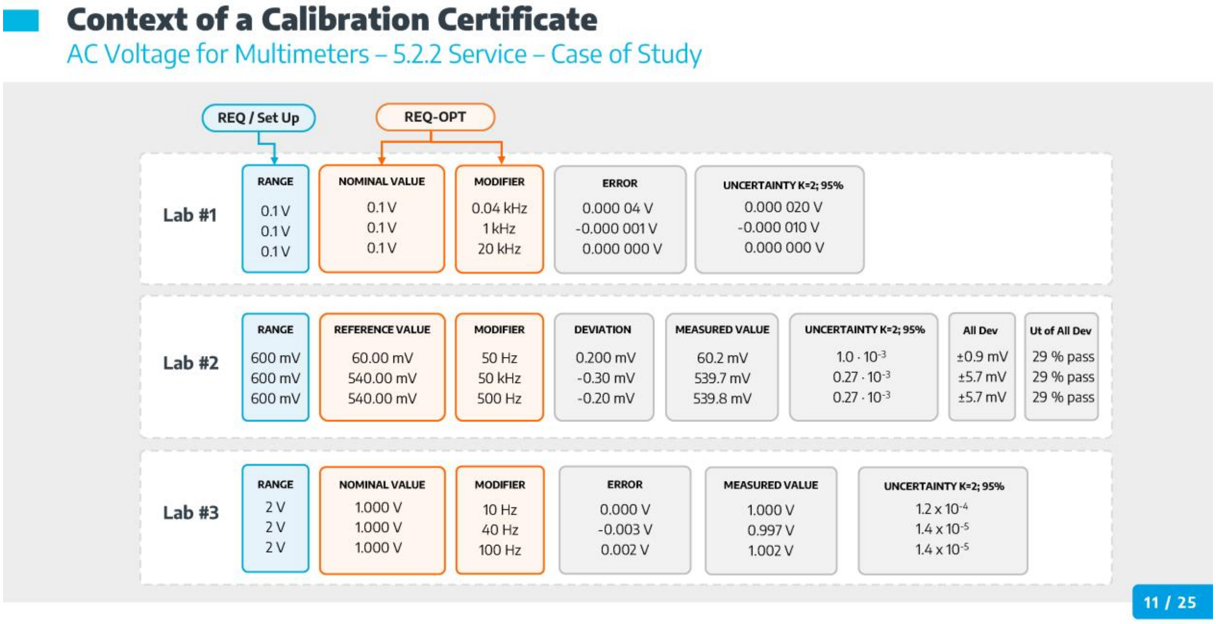
Context of a Calibration Certificate
AC Voltage for Multimeters – 5.2.2 Service – Case of Study
REQ / Set Up
REQ-OPT
Lab #1
RANGE
0.1 V
0.1 V
0.1 V
NOMINAL VALUE
0.1 V
0.1 V
0.1 V
MODIFIER
0.04 kHz
1 kHz
20 kHz
ERROR
0.000 04 V
-0.000 001 V
0.000 000 V
UNCERTAINTY K=2; 95%
0.000 020 V
-0.000 010 V
0.000 000 V
Lab #2
RANGE
600 mV
600 mV
600 mV
REFERENCE VALUE
60.00 mV
540.00 mV
540.00 mV
MODIFIER
50 Hz
50 kHz
500 Hz
DEVIATION
0.200 mV
-0.30 mV
-0.20 mV
MEASURED VALUE
60.2 mV
539.7 mV
539.8 mV
UNCERTAINTY K=2; 95%
1.0 · 10-3
0.27 · 10-3
0.27 · 10-3
All Dev
±0.9 mV
±5.7 mV
±5.7 mV
Ut of All Dev
29 % pass
29 % pass
29 % pass
Lab #3
RANGE
2 V
2 V
2 V
NOMINAL VALUE
1.000 V
1.000 V
1.000 V
MODIFIER
10 Hz
40 Hz
100 Hz
ERROR
0.000 V
-0.003 V
0.002 V
MEASURED VALUE
1.000 V
0.997 V
1.002 V
UNCERTAINTY K=2; 95%
1.2 x 10-4
1.4 x 10-5
1.4 x 10-5
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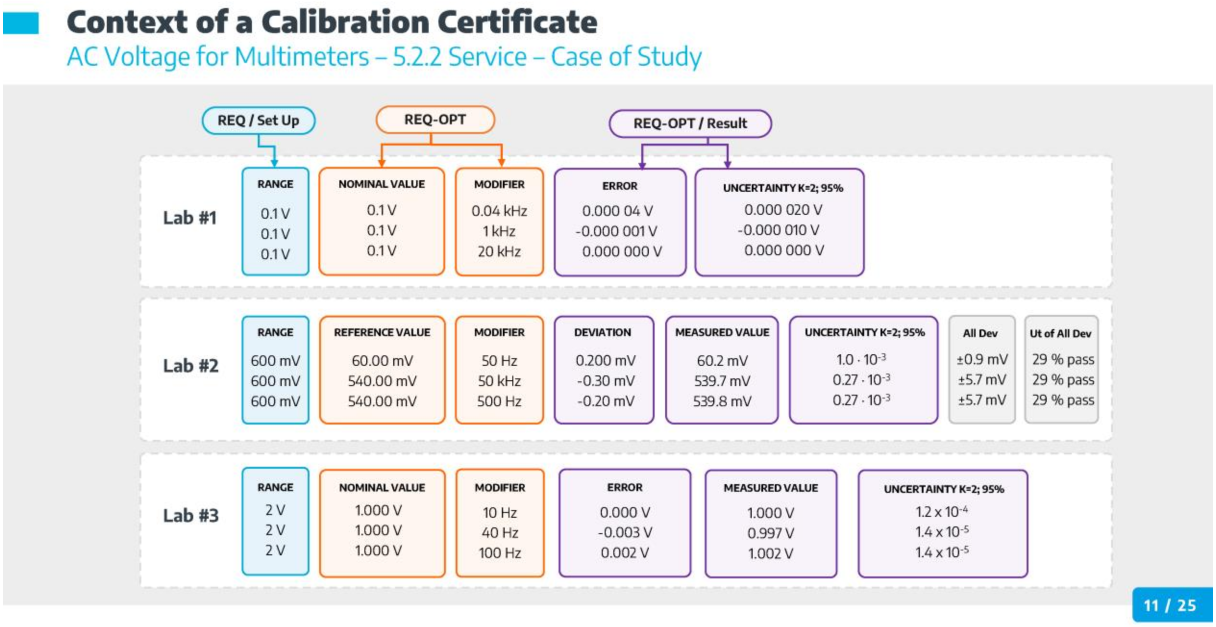
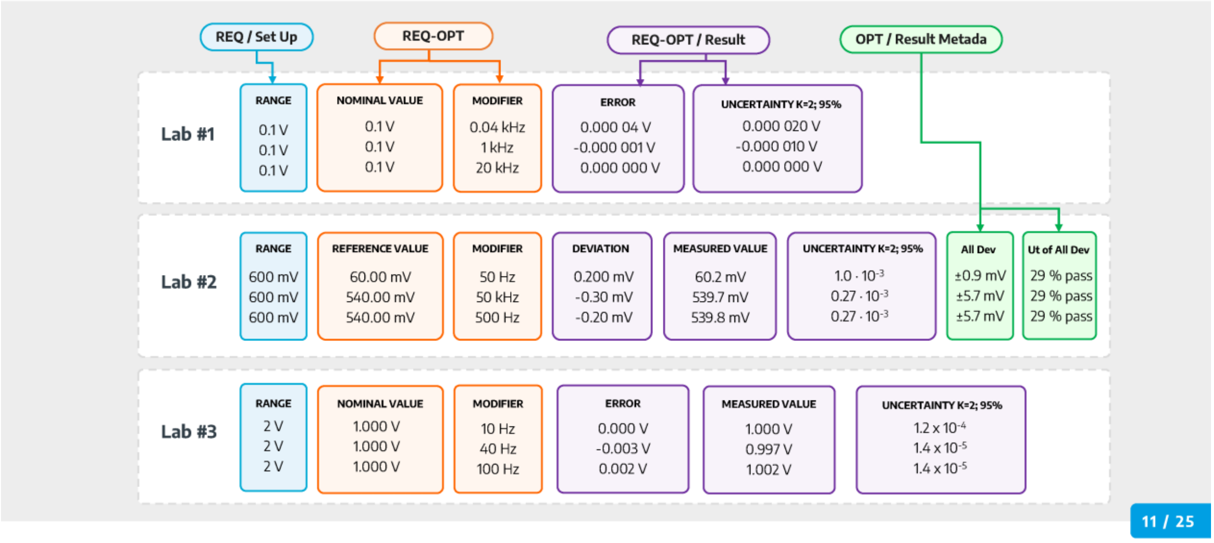

Context of a Calibration Certificate
AC Voltage for Multimeters – 5.2.2 Service – Case of Study
REQ / Set Up
REQ-OPT
REQ-OPT / Result
Lab #1
RANGE
0.1 V
0.1 V
0.1 V
NOMINAL VALUE
0.1 V
0.1 V
0.1 V
MODIFIER
0.04 kHz
1 kHz
20 kHz
ERROR
0.000 04 V
-0.000 001 V
0.000 000 V
UNCERTAINTY K=2; 95%
0.000 020 V
-0.000 010 V
0.000 000 V
Lab #2
RANGE
600 mV
600 mV
600 mV
REFERENCE VALUE
60.00 mV
540.00 mV
540.00 mV
MODIFIER
50 Hz
50 kHz
500 Hz
DEVIATION
0.200 mV
-0.30 mV
-0.20 mV
MEASURED VALUE
60.2 mV
539.7 mV
539.8 mV
UNCERTAINTY K=2; 95%
1.0 · 10-3
0.27 · 10-3
0.27 · 10-3
All Dev
±0.9 mV
±5.7 mV
±5.7 mV
Ut of All Dev
29 % pass
29 % pass
29 % pass
Lab #3
RANGE
2 V
2 V
2 V
NOMINAL VALUE
1.000 V
1.000 V
1.000 V
MODIFIER
10 Hz
40 Hz
100 Hz
ERROR
0.000 V
-0.003 V
0.002 V
MEASURED VALUE
1.000 V
0.997 V
1.002 V
UNCERTAINTY K=2; 95%
1.2 x 10-4
1.4 x 10-5
1.4 x 10-5
11 / 25

Context of a Calibration Certificate

AC Voltage for Multimeters – 5.2.2 Service – Case of Study



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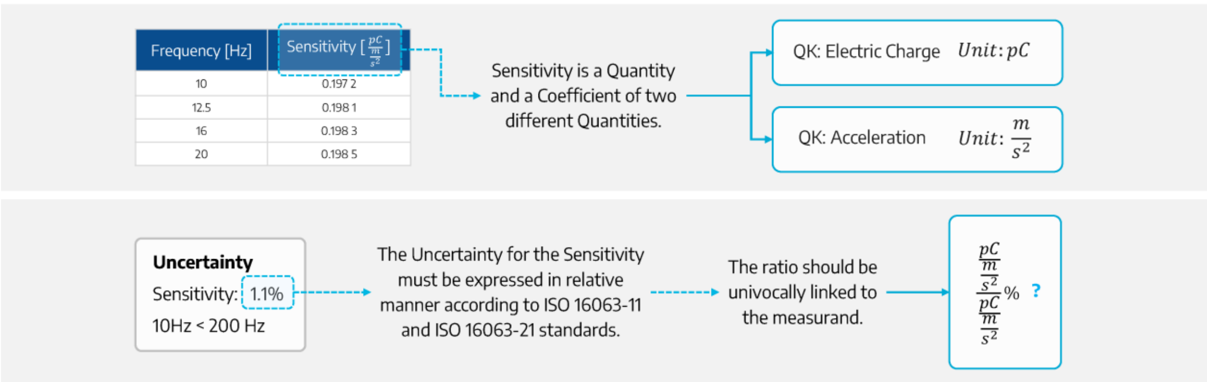
Context of a Calibration Certificate

Linear Vibration for Accelerometers– 21.3.1.1. Service – Case of Study



www.bipm.org/en/cipm-mra/cipm-mra-documents/service-categories
www.iso.org/standard/24951.html
www.iso.org/standard/27053.html

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Introducing a Taxonomy

Introducing a Taxonomy
Most relevant FAIR Principles

GO FAIR

F1. (Meta)data are assigned a globally unique and persistent identifier (PID).

F2. Data are **described with rich metadata.**

F3. **Metadata clearly and explicitly include the identifier of the data they describe.**

A2. **Metadata are accessible, even when the data are no longer available.**

I1. (Meta)data use a **formal, accessible, shared**, and broadly applicable language for knowledge **representation**.

I2. (Meta)data **use vocabularies that follow FAIR principles.**

I3. (Meta)**data include qualified references to other (meta)data.**

R1. **(Meta)data are richly described with a plurality of accurate and relevant attributes.**

Make the data/metada USEFUL

https://www.go-fair.org/

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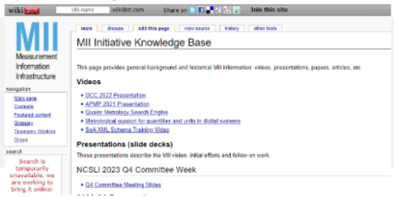
Introducing a Taxonomy

BIPM Joint Statement – NCSLI MII

https://www.bipm.org/en/liaison/digital-transformation

http://miiknowledge.wikidot.com/



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Introducing a Taxonomy

Taxon to explain a CC Service

Classification of services in electricity and magnetism

BRANCH: AC VOLTAGE, CURRENT, AND POWER

5. AC voltaje (up to the MHz range)

5.2. AC voltaje up to 1100 V

5.2.1. Sources: multifunction calibrator.

5.2.2. Meters: AC voltmeter, multimeter, multifunction transfer standard.

5.2.1. ⟶ Source.Voltage.AC — TOKENS

5.2.2. ⟶ Measure.Voltage.AC — TAXON

The Taxon is not about the method nor the procedure, is about the Measurand

TOKEN	DEFINITION
MEASURE	DUT is an equipment that measures the Quantity
SOURCE	Implies that the DUT is a generator of the Quantity
VOLTAGE	[qk] concept described in ISO 80000 or elsewhere
AC	Alternating current nature of Voltage

Example: EM/M-5.2.1 → SIRP vs. Source.Voltage.AC → taxonomy

NSCLI-141 Measurement Information Infrastructure & Automation Committee
www.metrology.net/mii-approved-taxonomies/

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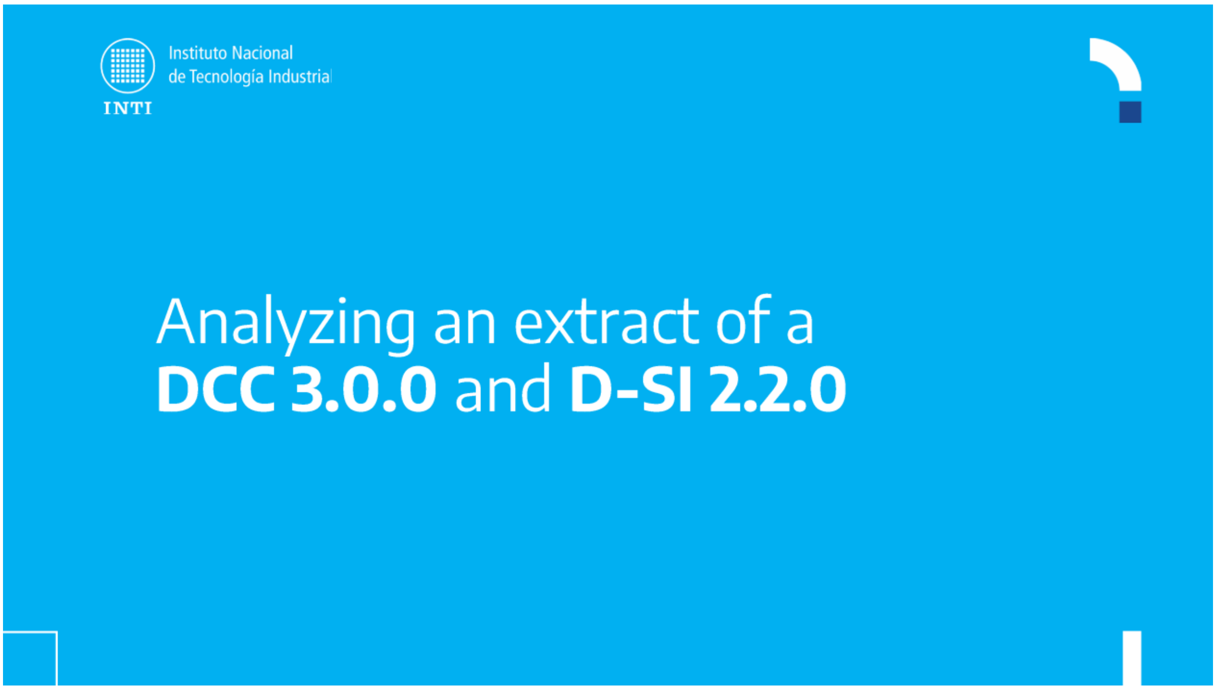
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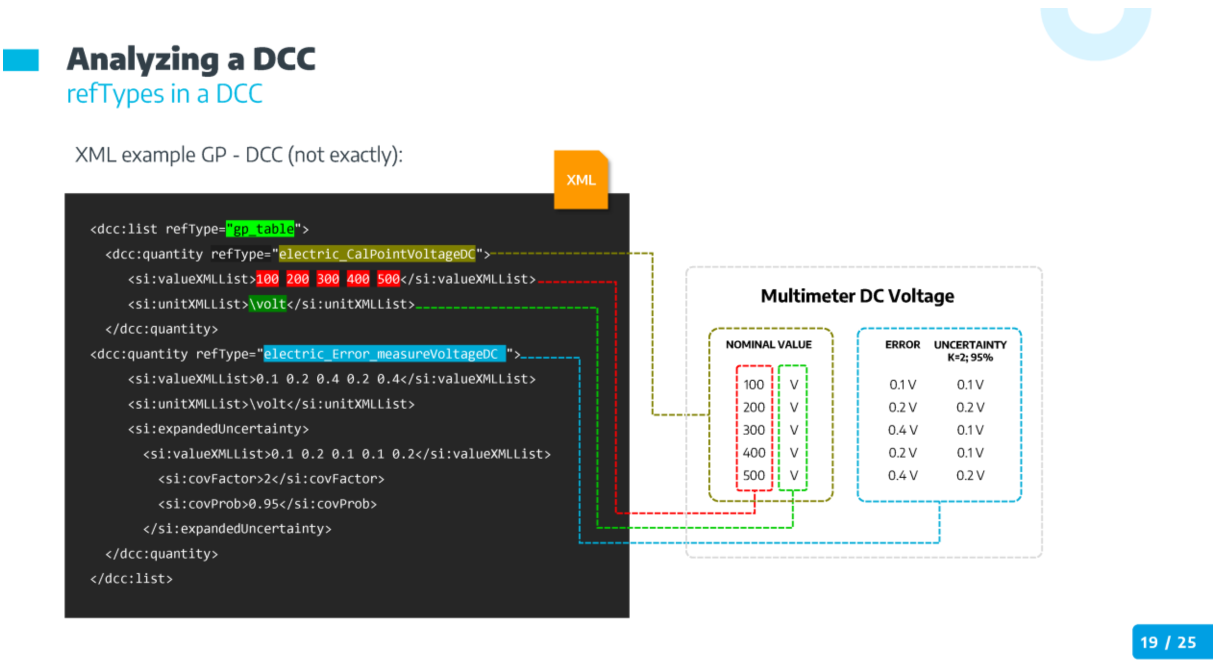
Analyzing an extract of a
DCC 3.0.0 and D-SI 2.2.0


Analyzing a DCC
refTypes in a DCC
XML example GP - DCC (not exactly):
XML
<dcc:list refType="gp_table">
<dcc:quantity refType="electric_CalPointVoltageDC">
<si:valueXMLList>100 200 300 400 500</si:valueXMLList>
<si:unitXMLList>\volt</si:unitXMLList>
</dcc:quantity>
<dcc:quantity refType="electric_Error_measureVoltageDC ">
<si:valueXMLList>0.1 0.2 0.4 0.2 0.4</si:valueXMLList>
<si:unitXMLList>\volt</si:unitXMLList>
<si:expandedUncertainty>
<si:valueXMLList>0.1 0.2 0.1 0.1 0.2</si:valueXMLList>
<si:covFactor>2</si:covFactor>
<si:covProb>0.95</si:covProb>
</si:expandedUncertainty>
</dcc:quantity>
</dcc:list>
Multimeter DC Voltage
NOMINAL VALUE
ERROR
UNCERTAINTY K=2; 95%
100 V 0.1 V 0.1 V
200 V 0.2 V 0.2 V
300 V 0.4 V 0.1 V
400 V 0.2 V 0.1 V
500 V 0.4 V 0.2 V
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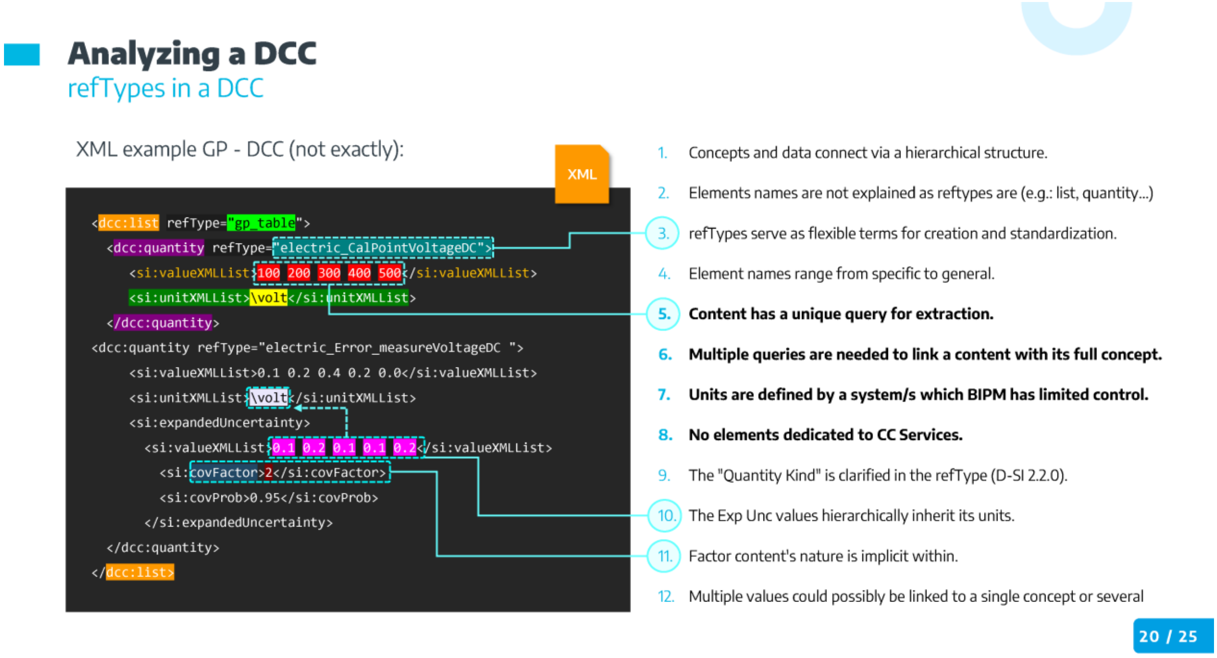
Analyzing a DCC
refTypes in a DCC
XML example GP - DCC (not exactly):
XML
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</dcc:quantity>
<dcc:quantity refType="electric_Error_measureVoltageDC ">
<si:valueXMLList>0.1 0.2 0.4 0.2 0.0</si:valueXMLList>
<si:unitXMLList>\volt</si:unitXMLList>
<si:expandedUncertainty>
<si:valueXMLList>0.1 0.2 0.1 0.1 0.2</si:valueXMLList>
<si:covFactor>2</si:covFactor>
<si:covProb>0.95</si:covProb>
</si:expandedUncertainty>
</dcc:quantity>
</dcc:list>
1. Concepts and data connect via a hierarchical structure.
2. Elements names are not explained as reftypes are (e.g.: list, quantity...)
3. refTypes serve as flexible terms for creation and standardization.
4. Element names range from specific to general.
5. Content has a unique query for extraction.
6. Multiple queries are needed to link a content with its full concept.
7. Units are defined by a system/s which BIPM has limited control.
8. No elements dedicated to CC Services.
9. The "Quantity Kind" is clarified in the refType (D-SI 2.2.0).
10. The Exp Unc values hierarchically inherit its units.
11. Factor content's nature is implicit within.
12. Multiple values could possibly be linked to a single concept or several
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refTypes with an explicit
Taxonomy

PTB DCC with Taxons

refTypes with an explicit Taxonomy

CC Services would provide a way of comparison between DCCs

XML

```
Measure.Voltage.DC->CC service EM 1.2.2 in BIPM
CalibrationPoint->Calibration Point concept
Error->Calibration Point according VIM
Voltage->Voltage according ISO 80000 or BIPM
…
<dcc:list refType="Measure.Voltage.DC">
   <dcc:quantity refType="CalibrationPoint.Voltage">
      <si:valueXMLList>100 200 300 400 500</si:valueXMLList>
      <si:unitXMLList>\volt</si:unitXMLList>
   <dcc:quantity refType="Error.Voltage">
      <si:valueXMLList>0.1 0.2 0.4 0.2 0.4</si:valueXMLList>
      <si:unitXMLList>\volt</si:unitXMLList>
      <si:expandedUncertainty>
         <si:valueXMLList>0.1 0.2 0.1 0.1 0.2</si:valueXMLList>
         <si:covFactor>2 2 2 2 2</si:covFactor>
         <si:covProb>0.95 0.95 0.95 0.95 0.95</si:covProb>
      </si:expandedUncertainty>
   </dcc:quantity>
</dcc:list>
```

Multimeter DC Voltage
CC Service EM 1.2.2

NOMINAL VALUE		ERROR	UNCERTAINTY K=2; 95%
100	V	0.1 V	0.1 V
200	V	0.2 V	0.2 V
300	V	0.4 V	0.1 V
400	V	0.2 V	0.1 V
500	V	0.4 V	0.2 V

1. "CalibrationPoint.Voltage" -> REQ
2. "Error.Voltage"-> REQ/OPT
3. "\volt" is the unit Volt according to SIUnitx

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PTB DCC with Taxons

refTypes with an explicit Taxonomy

CC Services would provide a way of comparison between DCCs

XML

```
Measure.Voltage.DC->CC service EM 1.2.2 in BIPM
CalibrationPoint->Calibration Point concept
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      <si:valueXMLList>0.1 0.2 0.4 0.2 0.4</si:valueXMLList>
      <si:unitXMLList>\volt</si:unitXMLList>
      <si:expandedUncertainty>
         <si:valueXMLList>0.1 0.2 0.1 0.1 0.2</si:valueXMLList>
         <si:covFactor>2 2 2 2 2</si:covFactor>
         <si:covProb>0.95 0.95 0.95 0.95 0.95</si:covProb>
      </si:expandedUncertainty>
   </dcc:quantity>
</dcc:list>
```

Multimeter DC Voltage
CC Service EM 1.2.2

NOMINAL VALUE		ERROR	UNCERTAINTY K=2; 95%
100	V	0.1 V	0.1 V
200	V	0.2 V	0.2 V
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400	V	0.2 V	0.1 V
500	V	0.4 V	0.2 V

1. "CalibrationPoint.Voltage" -> REQ
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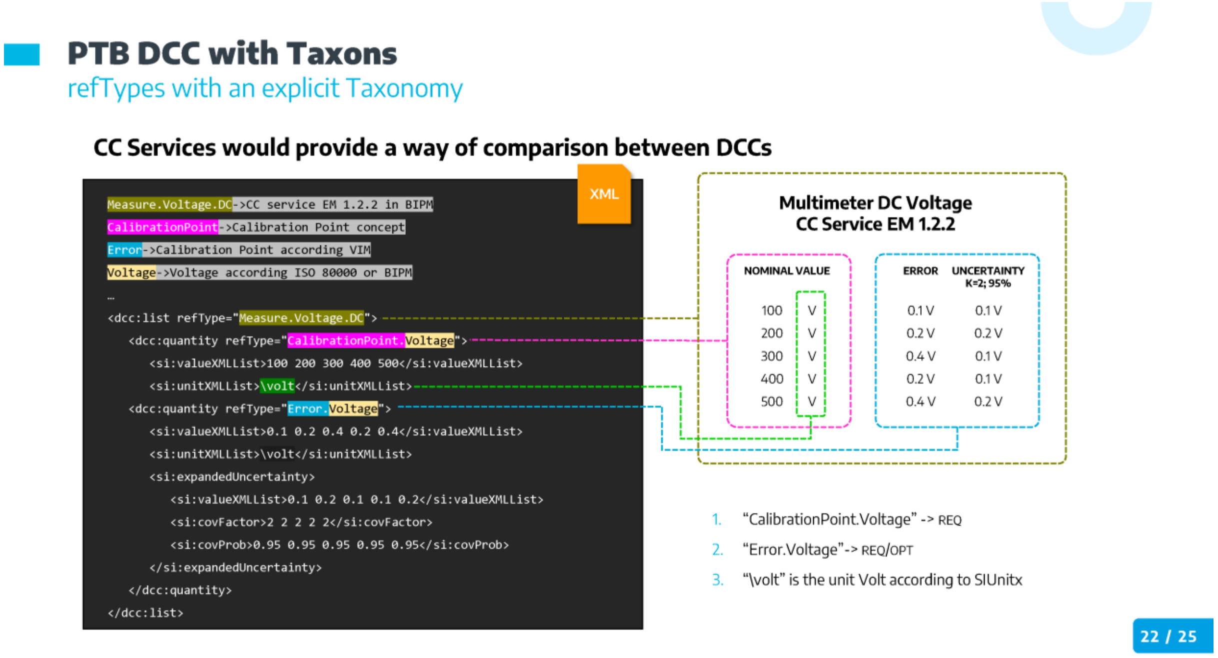
PTB DCC with Taxons
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CC Services would provide a way of comparison between DCCs
XML
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<si:unitXMLList>\volt</si:unitXMLList>
<dcc:quantity refType="Error.Voltage">
<si:valueXMLList>0.1 0.2 0.4 0.2 0.4</si:valueXMLList>
<si:unitXMLList>\volt</si:unitXMLList>
<si:expandedUncertainty>
<si:valueXMLList>0.1 0.2 0.1 0.1 0.2</si:valueXMLList>
<si:covFactor>2 2 2 2 2</si:covFactor>
<si:covProb>0.95 0.95 0.95 0.95 0.95</si:covProb>
</si:expandedUncertainty>
</dcc:quantity>
</dcc:list>
Multimeter DC Voltage
CC Service EM 1.2.2
NOMINAL VALUE
ERROR
UNCERTAINTY K=2; 95%
100 V 0.1 V 0.1 V
200 V 0.2 V 0.2 V
300 V 0.4 V 0.1 V
400 V 0.2 V 0.1 V
500 V 0.4 V 0.2 V
1. "CalibrationPoint.Voltage" -> REQ
2. "Error.Voltage"-> REQ/OPT
3. "\volt" is the unit Volt according to SIUnitx
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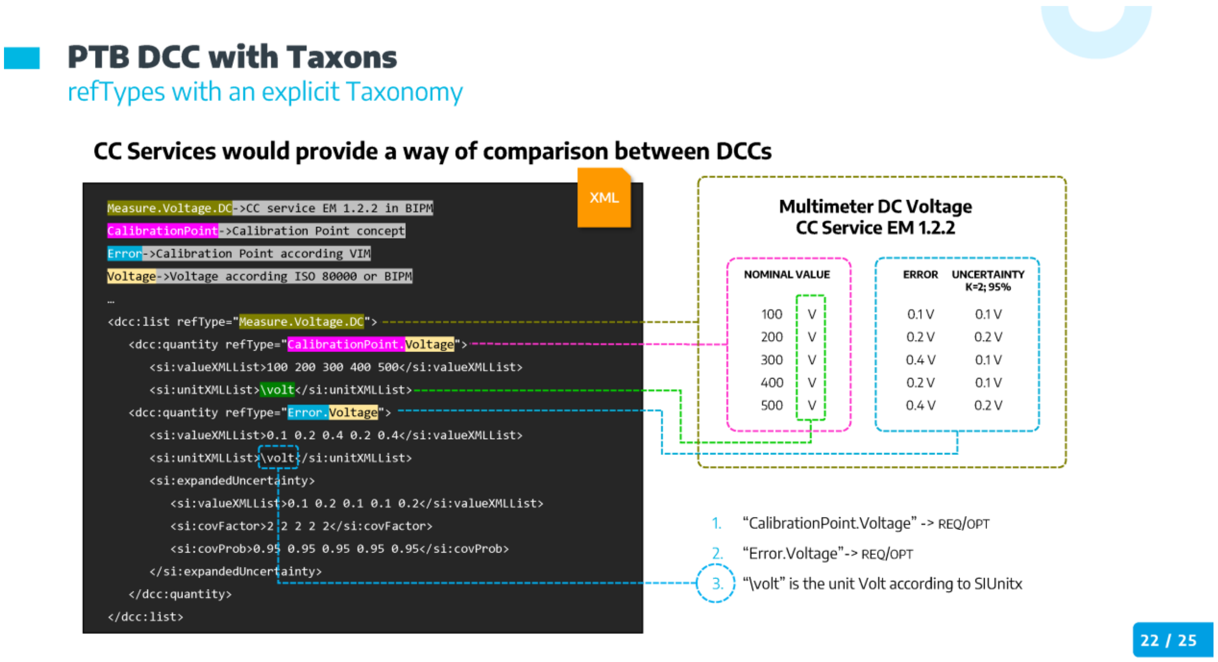
PTB DCC with Taxons
refTypes with an explicit Taxonomy
CC Services would provide a way of comparison between DCCs
XML
Measure.Voltage.DC->CC service EM 1.2.2 in BIPM
CalibrationPoint->Calibration Point concept
Error->Calibration Point according VIM
Voltage->Voltage according ISO 80000 or BIPM
…
<dcc:list refType="Measure.Voltage.DC">
<dcc:quantity refType="CalibrationPoint.Voltage">
<si:valueXMLList>100 200 300 400 500</si:valueXMLList>
<si:unitXMLList>\volt</si:unitXMLList>
<dcc:quantity refType="Error.Voltage">
<si:valueXMLList>0.1 0.2 0.4 0.2 0.4</si:valueXMLList>
<si:unitXMLList>\volt</si:unitXMLList>
<si:expandedUncertainty>
<si:valueXMLList>0.1 0.2 0.1 0.1 0.2</si:valueXMLList>
<si:covFactor>2 2 2 2 2</si:covFactor>
<si:covProb>0.95 0.95 0.95 0.95 0.95</si:covProb>
</si:expandedUncertainty>
</dcc:quantity>
</dcc:list>
Multimeter DC Voltage
CC Service EM 1.2.2
NOMINAL VALUE
ERROR
UNCERTAINTY K=2; 95%
100 V 0.1 V 0.1 V
200 V 0.2 V 0.2 V
300 V 0.4 V 0.1 V
400 V 0.2 V 0.1 V
500 V 0.4 V 0.2 V
1. "CalibrationPoint.Voltage" -> REQ/OPT
2. "Error.Voltage"-> REQ/OPT
3. "\volt" is the unit Volt according to SIUnitx
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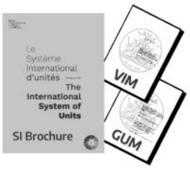
Conclusion & discussion

FAIR DCC
An envisioned Future of DCC

- KCDB services compatible
  KCDB
  - CC Services
  - CMCs
  - Key Comparison
- A FAIR DCC Object
  DCC GO FAIR
- QI Conformed and ISO/IEC 17025 Accredited



- Interoperable: M2M and interpretable for humans, easy to adopt => simple software

- Not dependent on a specific system of digital representations of units and quantities
  the Unified Code for Units of Measure — josephwright/siunitx — QUDT

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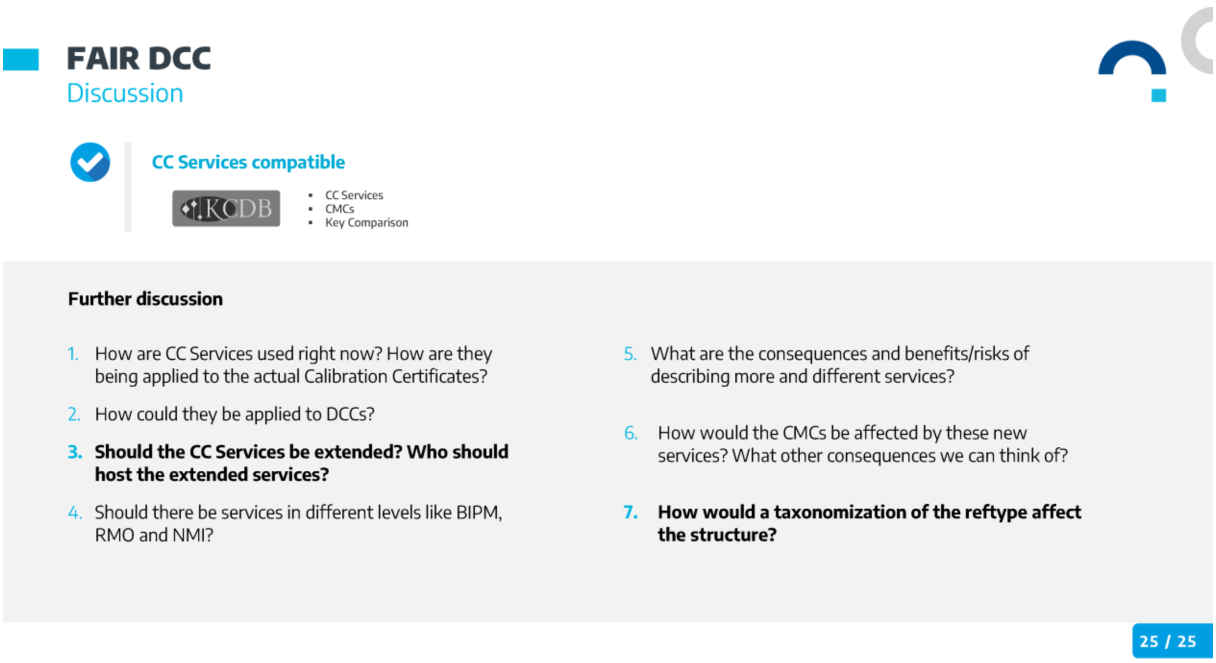

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11 Good Practice" conventions for DCCs for Weights and NAWIs from respective DKD working groups

Presenting author: Julian Haller, Sartorius Lab Instruments GmbH & Co. KG, Germany
E-mail address: julian.haller@sartorius.com

Abstract

The step from "machine readability" to "machine interpretability" undoubtedly requires harmonization and conventions to make it clear for machines, which information can be found where in a DCC. For this purpose, several working groups of the "Deutscher Kalibrierdienst" (DKD, German calibration service) are working on good practice conventions for their respective technical field. Additionally, a horizontal, cross-sectional working group has been founded.

For weights, weight sets and mass standards, the respective working group "DCC weights" had already published a "DKD expert report" in 04/2022 – to the authors' knowledge as the first respective proper documentation of good practice conventions. Meanwhile, the working group "DCC weights" has revised this expert report with respect to changes in the DCC schema and developments in the parent cross-sectional working group.

For non-automatic weighing instruments (NAWIs), another working group "DCC NAWIs" is actively developing good practice conventions and is currently in the process of publishing a similar expert report.

In this presentation, some of the work elaborated in these working groups will be shown and explained. It will further be demonstrated, how refType attributes, that allow machines to identify particular content, are properly defined and used. And finally, some similarities between the proposed structure of DCCs for weights, weight sets and for NAWIs will be shown.

Back to "Table of Contents" above

Presentation of Julian Haller

Julian Haller: "Good Practice" conventions for DCCs for Weights and NAWIs from respective DKD working groups

DKD Working Groups

- DKD: Deutscher Kalibrierdienst (German Calibration Service)
- A panel to promote the uniformity in metrology and with the aim to offer complementary technical assistance, in which PTB and accredited calibration laboratories work closely together.
- The panel's objective is to develop metrological foundations for calibrations.
- 13 Technical committees:
  - 1. Direct Current and Low Frequency
  - 2. High Frequency and Optics
  - 3. Force and Acceleration
  - 4. Length
  - 5. Temperature and Humidity
  - 6. Pressure and Vacuum
  - **7. Mass and Weighing Instruments**
  - 8. Chemical Measurands and Material Properties
  - 9. Materials Testing Machines
  - 10. Torque
  - 11. Flow Measurands
  - 12. Measurands in Laboratory Medicine
  - 13. Measurement Uncertainty

Working group „DCC Mass"

Working group „DCC Weighing Instruments"

For cross-sectional harmonisation among the technical committees, see

#013 Harmonisation of DCCs in DKD
(Thomas Krah, PTB)

2

Julian Haller: "Good Practice" conventions for DCCs for Weights and NAWIs from respective DKD working groups

DKD Working Groups

DCC Mass
G. Foyer (PTB)
A. Scheibner (PTB)
C. Müller-Schöll (Mettler-Toledo)
M. Häfner (Häfner)
S. Osang (Minebea, DKD-FA)
J. Haller (Sartorius)

DCC NAWIs
D. Knopf (PTB)
S. Hackel (PTB)
K. Fritsch (Mettler-Toledo)
M. Häfner (Häfner)
P. Straubinger (Bizerba)
S. Osang (Minebea, DKD-FA)
M. Turino (Kern)
Z. Zelenka (BEV, EURAMET TC-M)
J. Haller (Sartorius)

- Define conventions concerning structure, identification and use cases
- Final target: A guide that, if followed, ensures that any import algorithm can read in a DCC issued by any lab.

2

Julian Haller: "Good Practice" conventions for DCCs for Weights and NAWIs from respective DKD working groups

Working Group „DCC Mass"

- DKD Expert report was published in 04/2022:
  - DKD-E 7-2: Instructions on how to use the DCC schema to create a digital calibration certificate for weights

- Revised and extended expert report was published in 01/2024:
  - Adaptation to DCC schema version 3.2.1
  - Update of refType definitions with respect to current state of development
  - Guidance on reading out information

- Community-specific refTypes mass_XXX properly defined and documented in a referrable and addressable TemaTres database

- First calibration labs for mass already issue DCCs according to this expert report, others will follow soon

Scan or click on QR Code for the DKD Expert report:

2

Julian Haller: "Good Practice" conventions for DCCs for Weights and NAWIs from respective DKD working groups

„DCC Mass" – some examples

- One dcc:item element for each weight of a weight set

- refTypes for material, shape, marking, surface roughness, magnetic polarization/susceptibility

- One dcc:measurementResult element for each weight of a weight set

- One dcc:measurementResult element for each result in case of interventions (cleaning, adjustment,….)

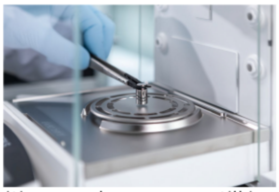
- One dcc:result element for mass values (if determined) and one dcc:result element for conventional mass values

- Denoting/identifying exchanged weights in a weight set

2

Julian Haller: "Good Practice" conventions for DCCs for Weights and NAWIs from respective DKD working groups

Working Group „DCC NAWIs"



- NAWIs are more heterogeneous than weights
- Calibrations of NAWIs allow for more options
- DKD Expert report with conventions, refType definitions and use cases still in progress
- Will hopefully be published in Q3 or Q4

2

Julian Haller: "Good Practice" conventions for DCCs for Weights and NAWIs from respective DKD working groups

Working Group „DCC NAWIs" (preliminary)

- One dcc:item element for each module (indicator, platform,...) in case of modular instruments
- refTypes for repeatability, eccentricity, scale interval, ranges,....
- One dcc:measurementResult element for each range in case of multiple range or multi-interval instruments
- One dcc:measurementResult element for each result in case of interventions (adjustment, repair,....)
- One dcc:result element for each measurement (repeatability, eccentricity, error of indication)
- Proper identification of nominal and calibrated range(s)

2

Conclusion

- Expert report "DKD-E 7-2: Instructions on how to use the DCC schema to create a digital calibration certificate for weights" available since 04/2022, revised version since 01/2024
- First calibration labs for mass already issue DCCs according to this expert report, others will follow soon

- Some more work needed for a similar expert report for NAWIs
- Expert report for DCCs for NAWIs expected for Q3 or Q4

10

Next steps

- Use the DCC for weights – feedback appreciated
- Possibly refinement of the expert report/conventions

- Finalize and publish expert report for NAWIs

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Thank you.

Dr. Julian Haller
Sartorius Lab Instruments GmbH & Co. KG
Scientist | Engineer Metrology
Phone +49 551 308 4523
Mobile +49 175 2109435
julian.haller@sartorius.com

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12 Toward a measurand taxonomy for interoperable measurement data

Presenting author: Mark Kuster, Independent Researcher, Consultant, USA, NCSL International 141 MII and Automation Committee
E-mail address: mjk@ieee.org

Abstract

In order to become machine-actionable, the DCC and other digital metrology documents require interoperable data. Solving the interoperability problem seems the most difficult aspect of FAIR data. Toward this end, the NCSL International 141 MII and Automation Committee proposed and began developing a measurand taxonomy to serve as metadata to uniquely identify measurement data in digital calibration certificates, instrument specification documents, accreditation statements, and beyond. The draft taxonomy to date covers portions of several measurement areas and service categories. The Committee would now like to extend the taxonomy to cover all published KCDB CMCs and has begun that effort for electrical and photometric metrology. This presentation reports the taxonomy development strategy and current status.

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Presentation of Mark Kuster

Section 1

Introduction

Today's Topics

1. Introduction

Today's Topics

1. Introduction
2. Motivation and Strategy

Today's Topics

1. Introduction
2. Motivation and Strategy
3. Tools and Process

Today's Topics

1. Introduction
2. Motivation and Strategy
3. Tools and Process
4. Conclusion

Current Project Contributors

- Ryan White, NRC, Canada
- Mike Schwartz, Cal Lab Solutions, USA
- Jon Bartholomew, Emirates Metrology Institute, UAE
- Steven Yang and Cliff Wong, ITC, Hong Kong
- NCSL International 141 MII and Automation Committee

Acronyms

- API—application programming interface
- BIPM—International Bureau of Weights and Measures
- CMC—calibration and measurement capability
- DCC—(PTB's) digital calibration certificate
- DCR—(PTB's) digital calibration request
- FAIR—findable, accessible, interoperable, reusable
- KCDB—key comparison database
- M-Layer—metrology information layer to support measurement systems
- NCSLI—NCSL International
- NMI—national metrology institute
- PID—persistent identifier
- PR—photometry-radiometry
- SoA—scope of accreditation

MII (measurement information infrastructure)

set of normative standards that unambiguously define data structures, taxonomies, service protocols and security for locating, communicating and sharing measurement information

Section 2

Motivation and Strategy

Motivation and Strategy

Motivation

- We want interoperability for machine-actionable measurement data.
  - Time and labor savings
  - Automatic data validation and verification
  - New productivity, services, data value and insight
  - Digital documents such as DCCs won't realize their potential otherwise.
- This requires standardized metrology metadata.
- One of least standardized data elements: measurand descriptions
  - Various DCC projects currently seek a measurand identifier.
  - Wanted: unique measurand PIDs

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Motivation and Strategy

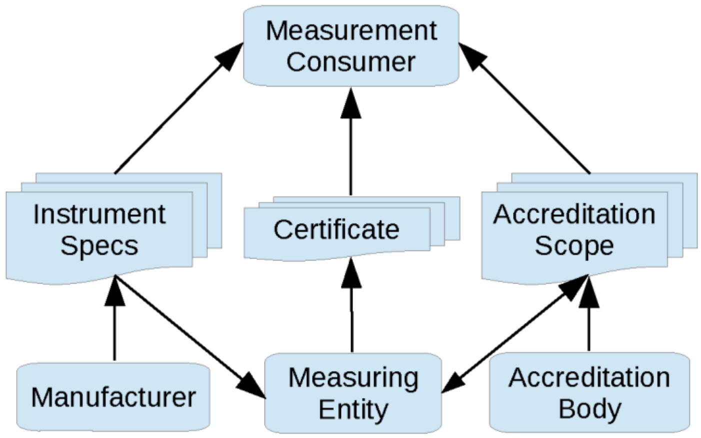
MII Proposal for Measurand Metadata

1. Standardize a measurand taxonomy.
2. Link taxons to KCDB CMC IDs.
3. Tag digital document data and service offerings with the taxons as metadata.

Spec: `Source.Voltage.DC`

SoA: `Measure.Voltage.DC`

Cert: `Source.Voltage.DC`



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Solution: abstract taxon definitions customized for any context

Source.Coefficient.Voltage.Luminance

Definition: `https://cie.co.at/eilvterm/17-25-061`, `https://cie.co.at/eilvterm/17-21-050`

- **Required Parameters (instantiated with ranges)**
  - Luminance
  - SourceType {CIEA, CIED65, ..., Tungsten, TungstenDiffuser, Halogen, ...}
    - Alternatively perhaps: Temperature.Color.Correlated, e.g. CCT = 2856 K for Tungsten
  - Angle.Solid
- **Optional Parameters (instantiated with ranges)**
  - LuminanceResponsivity
  - Voltage[.Output]

Draft Taxons

Previous strategy:

- Identified and drafted taxons targeting the most common CMCs (Pareto style).
- Drew from a dataset containing 250,000 CMCs from SoAs.

Capacitance
Conductance
Conductivity
Current.AC
Current.AC.Noise.RMS
Current.AC.Sinewave
Current.AC.Sinewave.2Phase
Current.AC.Sinewave.3Phase
Current.AC.Squarewave
Current.AC.Trianglewave
Current.DC
Current.DC.Delta.Current.LoadEffect
Current.DC.Delta.Current.SourceEffect
Current.DC.OutputAndReadback
Density.Mass.Gas
Density.Mass.Liquid
Density.Mass.Solid
Energy.AC.Sinewave
Energy.AC.Sinewave.Simulated
Energy.AC.Sinewave.Simulated.2Phase
Energy.AC.Sinewave.Simulated.3Phase
Energy.DC
Energy.DC.Simulated
Force
Frequency
Frequency.AmplitudeModulation.Rate
Frequency.FrequencyModulation.Deviation
Frequency.FrequencyModulation.Rate
Frequency.PhaseModulation.Rate
Humidity.Absolute
Impedance
Inductance
Length
Length.Circumference
Length.Diameter
Length.Form.Flatness
Length.Form.Parallelism
Length.Form.Perpendicularity
Length.Form.Roughness
Length.Form.Roundness
Length.Form.Sphericity
Length.Form.Straightness.Axis
Length.Form.Straightness.Surface
Length.Radius
Mass.Apparent
Mass.Conventional
Mass.True
Phase.PhaseModulation
Phase.ReflectionFactor.RF
Phase.TransmissionFactor
PhaseNoise.SideBand
Power.AC.Sinewave
Power.AC.Sinewave.Simulated
Power.AC.Sinewave.Simulated.2Phase

Draft Taxons

Power.AC.Sinewave.Simulated.3Phase
Power.DC
Power.DC.Simulated
Power.RF.Sinewave
Pressure.Hydraulic.Static
Pressure.Pneumatic.Absolute.Static
Pressure.Pneumatic.Differential.Static
Pressure.Pneumatic.Gage.Static
Ratio.AmplitudeModulation
Ratio.AmplitudeModulation.Delta.Rate
Ratio.Density.Mass
Ratio.Distortion
Ratio.Distortion.AmplitudeModulation
Ratio.Distortion.FrequencyModulation
Ratio.Distortion.PhaseModulation
Ratio.DutyCycle
Ratio.FrequencyModulation.Delta.Rate
Ratio.Humidity.Relative
Ratio.Humidity.Specific
Ratio.PhaseModulation.Delta.Rate
Ratio.Power.ReflectionFactor.RF
Ratio.Power.RF.Sinewave.Delta.Frequency
Ratio.Power.RF.Sinewave.Delta.Power
Ratio.Power.RF.Sinewave.Harmonic
Ratio.Power.RF.Sinewave.Spur
Ratio.Power.TransmissionFactor
Ratio.PulseModulation.CWtoPulsedPower
Ratio.PulseModulation.OnOffPower
Ratio.Torque
Ratio.Voltage.AC.Ripple.OnDC
Ratio.Voltage.AC.Sinewave.Delta.Frequency
Ratio.Voltage.AC.Sinewave.Delta.Voltage
Resistance
Resistance.Insulation
Temperature
Temperature.Radiometric
Temperature.Simulated.PRT
Temperature.Simulated.RTD
Temperature.Simulated.Thermocouple
Time.Interval
Time.Period
Time.PulseWidth
Time.Transient
Time.Transition
Time.Transition.PulsedRF
Time.UTC
Torque
Torque.HydraulicPressure
Voltage.AC
Voltage.AC.NoisePeakToPeak
Voltage.AC.Ripple.OnDC
Voltage.AC.Sinewave
Voltage.AC.Sinewave.2Phase
Voltage.AC.Sinewave.3Phase
Voltage.AC.Squarewave
Voltage.AC.Trianglewave
Voltage.DC
Voltage.DC.Delta.Voltage.LoadEffect
Voltage.DC.Delta.Voltage.SourceEffect
Voltage.DC.OutputAndReadback
Voltage.DC.Segemented.Delta
Voltage.PeakToPeak
...

Current Project

BIPM would like the taxonomy linked to KCDB service categories.

- Start with one service category.
- Focus on taxon names first, though parameter sets influence the names
- Extend coverage across the KCDB.
- Extend coverage for additional measurand demand down the traceability chain
  - Derived NMI measurement services
  - Lower laboratories' accredited CMCs
  - Unaccredited CMCs

The MII taxonomy will point to the KCDB since it already exists but future digital documents and enterprise systems may point toward the taxonomy as a FAIR standardized metadata resource.

Section 3

Tools and Process

Tools

- Open-source taxonomy editor at `https://github.com/CalLabSolutions/Metrology.NET_Public`
- Project hosted on GitHub at `https://github.com/NCSLI-MII/`
- A repository to integrate quantities, units, measurands, CMCs
  - Pull data from the M-Layer and KCDB APIs
  - Link taxons to M-Layer quantities (aspects) and units (scales)
  - Link taxons to KCDB CMCs and service categories
  - Monitor coverage, find orphans, expose gaps, facilitate development

Process

First trial: photometry branch of the PR area. Steps:

1. Pull all the relevant CMC-entry data.
2. Sort and filter on service, subservice, individual service, quantity and instrument.
3. Analyze the method, units, uncertainty, comments and parameter data.
4. Supplement the data from other sources—literature, standards, etc.—as required.
5. Draft a taxon set to represent the unique measurands and their parameters.

The information assembled at BIPM through CIPM and its Consultative Committees greatly facilitates taxon creation.

Drafting 14 taxons to cover the 341 CMCs took a photometry novice approximately 6 h.
Expert reviews encouraged!

Example KCDB CMC Data

KCDB Field(s)	Data
metrologyAreaLabel	PR
branchValue, serviceValue	Photometry
subServiceValue	Luminance responsivity
individualServiceValue	Luminance meter
quantityValue	Luminance responsivity
instrument	Luminance meter
instrumentMethod	Tungsten-based source
cmc	unit: A/(cd/m^2), V/(cd/m^2), reading/(cd/m^2)
traceabilitySource	MSL cryogenic radiometer
comments	Responsivity to other types of sources can also be calibrated.
internationalStandard	
parameters	Luminance: 27 000 cd m^{-2} to 33 000 cd m^{-2}; Source Type: Illuminant A

Photometry Branch and Service Hierarchy

Sub Service	Individual Service	Quantity	Taxon(s)
Luminous intensity	Tungsten lamp	Luminous intensity	Measure.LuminousIntensity
Illuminance responsivity	Tungsten source	Illuminance responsivity	Measure.Coefficient.Voltage*.Illuminance
Luminous flux	Tungsten lamp	Luminous flux	Measure.LuminousFlux
|	LED	|	Measure.LuminousFlux
Illuminance	Tungsten lamp	Illuminance	Measure.Illuminance
Luminance	Tungsten-based source	Luminance	Measure.Luminance
			Source.Luminance
Luminance responsivity	Luminance meter	Luminance responsivity	Source.Coefficient.Voltage*.Luminance
Averaged luminous intensity	LED	Averaged luminous intensity	Measure.LuminousIntensity.LEDAveraged
Luminous exposure	General source	Luminous exposure	Measure.LuminousExposure
|	Flash photometer	Luminous exposure responsivity	Source.Coefficient.Voltage*.LuminousExposure
			Source.Coefficient.Charge.LuminousExposure

*These sub services also include ... Coefficient.Current... taxon versions (omitted for space).

Example Results

Taxon	kcdbCode
...	...
Measure.Coefficient.Voltage.Illuminance Measure.Coefficient.Current.Illuminance	EURAMET-PR-TR-000006KM-2
Measure.Coefficient.Voltage.Luminance Measure.Coefficient.Current.Luminance	SIM-PR-MX-00000GER-1
Measure.LuminousExposure	APMP-PR-CN-00000K9V-1
Measure.LuminousIntensity	AFRIMETS-PR-ZA-000006FO-1
Measure.LuminousFlux	SIM-PR-BR-0000053M-2
Measure.Illuminance	COOMET-PR-RU-00000DMG-1
...	...

Currently covered: 351 of 25868 KCDB CMCs, ≈ 1.4 %
Next: EM measurement area (4609 CMCs), reporting results at the NCSLI 2024 Conference

Section 4

Conclusion

Recommendations

Establish and use a measurand taxonomy

- Unique measurand PIDs with unlimited human-readable aliases
- Fully qualifies measurands for interoperable digital documents
- (DCCs, instrument specs-DCRs, SoAs, . . .)

Collaboration

- Available for metrologists to augment, review and critique
- Current information
  - GitHub for configuration management (submission, review, approval): https://github.com/NCSLI-MII
  - Open-source taxonomy and SoA editors: https://github.com/CalLabSolutions/Metrology.NET_Public
  - Further info: http://miiknowledge.wikidot.com/

Conclusion

Acknowledgments

Many thanks go to

- PTB and the DCC conference organizers for the kind invitation
- NCSL International for its MII support
- NCSL International Committee members for their MII development work
- Cherine-Marie Kuster

And Thank You for your time!

Collaboration opportunities? Please bring your expertise!

Questions?

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13 Harmonisation of DCCs in DKD

Presenting author: Thomas Krah, PTB Germany
E-mail address: thomas.krah@ptb.de
Additional authors: J. Haller julian.haller@sartorius.com, M. Czaske martin.czaske@ptb.de, W. Schmid wolfgang.schmid@ptb.de

Abstract

Harmonisation is one of the key elements for the DCC to become the common exchange format for calibration data. Firstly, the calibration laboratories creating DCCs need to know what information to write in each element of the DCC. More importantly, the users who process the calibration data, especially when dealing with multiple measurands, need to be able to read all the different DCCs in a simple way, without having to adapt their software for each measurand or calibration supplier. One way of harmonising the DCC could be to create a specification within a standard. This would probably be the most simple and effective way. However, it usually takes many years for a standard to become established.

In Germany, we chose the German Calibration Service (Deutscher Kalibrierdienst, DKD) with its well-established structures and the extensive knowledge of its members to speed up the process of harmonising the DCC. In 12 technical sub-committees, the members of the DKD are working on standardising the DCC within their communities. A 13th cross-sectoral sub-committee ensures that the solutions developed are consistent and do not contradict each other. All 13 sub-committees plan to publish their work in expert reports. There will hence be one guidance report for the administrative block and common elements in the results block, and 12 community specific reports.

Another important practical result of the work of the DKD sub-committees is the creation of a dictionary of the refTypes needed to improve the machine interpretability of DCCs. This dictionary will be accessible to everyone in a machine-interpretable form and will contain both community-specific refTypes defined by the 12 technical sub-committees as well as general, cross-sectional refTypes defined by the cross-sectoral sub-committee.

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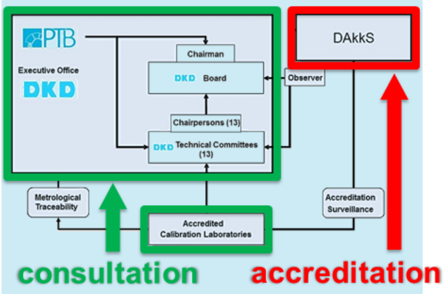
Presentation of Thomas Krah

What is the DKD?

- Abbreviation for **D**eutscher **K**alibrier**d**ienst (German Calibration Service)
- Is a board of PTB for the **technical exchange** between PTB and about 500 accredited calibration laboratories.

Structure



Tasks

- Develops calibration guidelines and good practice guides.
- Actively participates in setting international rules in the field of calibration.
- Facilitates the metrological infrastructure in the sense of the propagation of the units.
- Offers workshops and courses for the DKD members.
- Promotes interlaboratory comparisons.

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What is the DKD?

Technical committees

1. Direct Current and Low Frequency
2. High Frequency and Optics
3. Force, Acceleration and Acoustics
4. Length
5. Temperature and Humidity
6. Pressure and Vacuum
7. Mass and Weighing Instruments
8. Chemical Measurands and Material Properties
9. Materials Testing Machines
10. Torque
11. Flow Measurands
12. Measurands in Laboratory Medicine
13. Measurement Uncertainty

What are the TCs doing?

- Bring together expert knowledge from industry, calibration labs and PTB.
- Informing members about new developments in the field of calibration.
- Develop good practice in calibration based on latest state of technology.
- Preparing calibration guidelines at national level.
- Contributing to the development and evaluation of good practice technical rules for accreditation.
- **Develop harmonised concepts for the DCC.**

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Harmonisation of DCCs in DKD

Harmonisation of DCCs in DKD

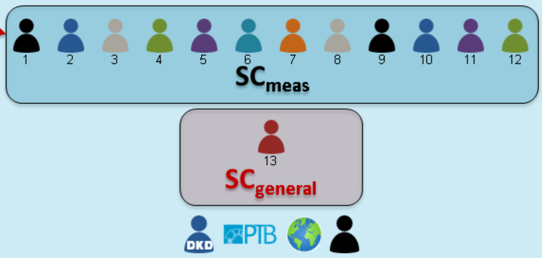
Harmonisation of DCCs in DKD

Technical committees

1. Direct Current and Low Frequency
2. High Frequency and Optics
3. Force, Acceleration and Acoustics
4. Length
5. Temperature and Humidity
6. Pressure and Vacuum
7. Mass and Weighing Instruments
8. Chemical Measurands and Material Properties
9. Materials Testing Machines
10. Torque
11. Flow Measurands
12. Measurands in Laboratory Medicine
13. Measurement Uncertainty

How is the harmonisation of DCC done?

- 1 DCC sub-committee for each technical committee.
- 12 sub-committees for measurand specific questions: **SC_{meas}**.
- 1 sub-committee for overarching questions: $SC_{general}$.



Harmonisation of DCCs in DKD

SC_{meas} vs. $SC_{general}$

Measurand specific committee

- Community specific.
- Prepare complete DCCs for each community.
- Community specific wording.
- Expert report focussed on the result block (community specific perspective).

Overarching / general committee

- For topics that apply to more than 1 technical committee.
- Prepare only code extracts wich are identical in each community.
- Define the *basic* namespace and align the community specific wordings.
- Expert report focussed on administrative block and general descriptions in the results block.

Harmonisation of DCCs in DKD

How does the $SC_{general}$ work?

- Synchronous + asynchronous.
  → Online meetings + GitLab.
- Constitudes working groups for specific questions
  (refTypes, sets, expert report, meta data).
- Creating consensus in the groups.

Output of the TCs

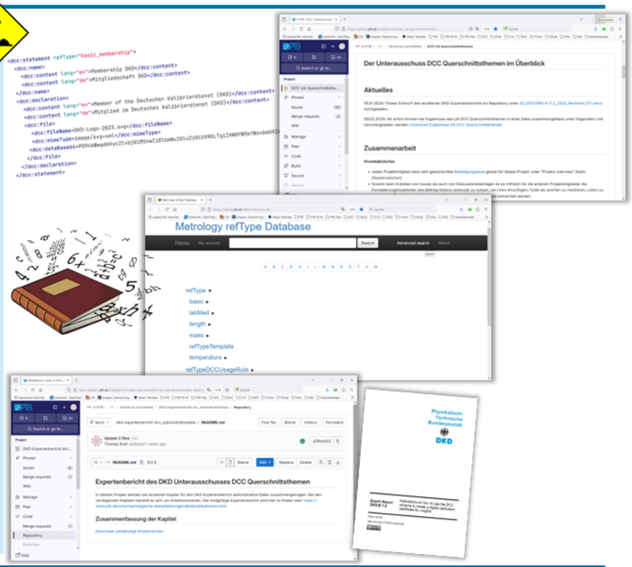
Output of the TCs

Output of the TCs: expected

- Development of DCCs for selected important measurands and measurement equipment types (Good practices / templates).
- Harmonised wording.
- Expert reports.

Output of the TCs: delivered

- Development of DCCs for selected important measurands and measurement equipment types (Good practices / templates).
  - DCC mass available.
  - Code extracts available.
  - DCC length about to be released.
- Harmonised wording.
  - Thesaurus created. RefTypes machine-interpretable and with persistent IDs
    https://digilab.ptb.de/dkd/refType/vocab/
- Expert reports.
  - Expert report mass available
    www.ptb.de/cms/en/metrological-services/dkd/publications.html
    → tab *Expert Reports*
  - Report length coming soon.
  - Report admin. block in draft version for members downloadable.



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DCC User Forum:
https://digital.ptb.de/dcc-user-forum
Wednesdays 9:00-10:00 & 16:00-17:00 CET

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Bundesallee 100
38116 Braunschweig

Dr. Thomas Krah
phone: +49 531 592-9451
E-mail: thomas.krah@ptb.de

Dr. Julian Haller
phone: +49 551 308-4523
E-Mail: julian.haller@sartorius.com

Dr. Wolfgang Schmid
phone: +49 531 592-9100
E-mail: wolfgang.schmid@ptb.de

Dr. Martin Czaske
phone: +49 531 592-8020
E-mail: martin.czaske@ptb.de

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14 DCC interoperability: a pilot study looking at implementation approaches across four Asia-Pacific NMIs

Presenting author: Anjali Sharma [1]
E-mail address: sharmars2@nplindia.org
Additional authors: Mark Ballico[2], Blair Hall[3], Pariya Thongluang[4], Cui Yuxi[5]
[1] NPL India; [2] NMI Australia; [3] MSL New Zealand; [4] NIM Thailand; [5] A*STAR Singapore

Abstract

The preparation of DCCs (Digital Calibration Certificates) is being trialed by many NMIs and there are now a variety of approaches being used to implement them with both open-source and bespoke tools. An important focus for digital transformation has been the promotion of "FAIR" principles. The most critical of these in the context of DCCs is interoperability: DCCs prepared by one NMI should be practically and robustly usable by other NMIs. Although many people have demonstrated effective creation and use of DCCs, this has been limited to use and sharing with similar or identical tools.

In this study, four NMIs from the APMP region, NPLI (India), A*STAR (Singapore), NIMT (Thailand) and NMIA (Australia) examined the interoperability of DCCs developed under the Digital Transformation Strategies of their economies. Each participant independently developed slightly different DCC approaches, consistent with their digital strategies. The NMIs prioritized issues of simplicity vs. completeness, sovereignty vs dependence, open-source vs. proprietary, roll-out vs. early-proof-of-concept. This resulted in some diversity in the DCCs although all four adopted an XML-schema-based approach.

NPLI and NMIA had adopted a PTB version 3.2.1 schema, whilst A*STAR and NIMT each adopted their own simplified XML schemas, which were designed to meet the expectations of local stakeholders. This study compared the four types of DCC and examined both direct interoperability (using nominally the same schema) and the broader agreement of fields (informing the opportunity for inter-schema conversion at a later stage).

The study was limited to administrative fields, as the NMIs had developed DCCs focusing on different measurands viz., Voltage (NPLI) , Mass (NMIA), Wavelength (NIMT) and Temperature (A*STAR), and the representation of measurement data is still at an early stage of development. Our study therefore restricted the scope to "mandatory" fields required for local legal and ISO/IEC- 17025 compliance.

Comparison of the four types of DCC revealed broad agreement on what should be regarded as "17025 mandatory" fields and how to use them, however, a number of these fields were interpreted differently. Some fields were considered essential but the legal or 17025 requirements for them was unclear, some other fields were agreed as essential (ie. currently on paper certificate) but are not mandatory under 17025.

For NPLI and NMIA DCCs, which are based on the same PTB DCC schema, we found basic interoperability. However, the resulting DCCs were somewhat fragile in practice: due to slightly different interpretations of some fields, inconsistency in what should be regarded as mandatory, and the schema's flexibility (and associated complexity).

Our study informs some key next steps towards international interoperability of DCCs.

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Presentation of Anjali Sharma

DCC interoperability: a pilot study looking at implementation approaches across four Asia-Pacific NMIs

Authors: Anjali Sharma[1], Mark Ballico[2], Blair Hall[3], Pariya Thongluang[4], Cui Yuxi[5]

NMI: 1. NPL, India 2. NMI, Australia 3. MSL, New Zealand 4. NIM, Thailand 5. A*STAR.NMC, Singapore

4th International DCC Conference
DCC for FAIR principles in the quality infrastructure

(27-29 February, 2024)

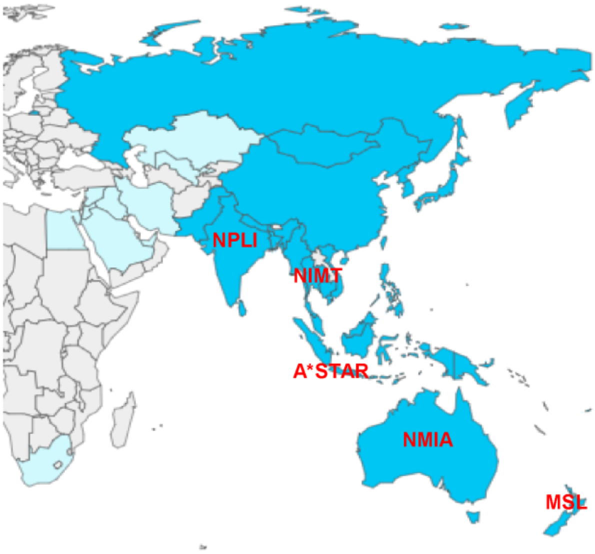
Aim & Approach

Goal: To assess interoperability of proof-of-concept approaches to DCCs.

We evaluated proof-of-concept DCC processes using a variety of XML schema established independently across 4 NMIs of the APMP, for interoperability.

We show:

- The approach taken to examine interoperability, and
- The initial lessons learned.
- Broader observations made during the study.



Heterogeneous Approaches of 4 NMIs (1/2)

More detail on each approach is given in the appendix

NMIA

Motivation: Proof of concept trial with internal users to inform large-scale DCC rollout in NMIA and Australia.

Schema: Based on PTB 3.2.1

Type of DCC: XML enhancement of existing PDF client reports.

Development Approach: External vendor, DCC reader and writer tools. POC to trial "mass" DCCs with multiple internal users.

Technology: MS Excel tool added to existing test sheets to create DCC XML from test data and CRM data and attach the XML within existing PDF report file

NPLI

Motivation: Understand PTB's DCC schema and map its fields with calibration certificate released by NPLI.

Schema: Based on PTB 3.2.1

Type of DCC: XML, JSON, and PDF/A3

Development Approach: Internal Staff

Technology: Python to parse the content into XML and convert the XML file to LATEX. Converting LATEX into DCC in PDF/A3 form

Heterogeneous Approaches of 4 NMIs (2/2)

More detail on each approach is given in the appendix

NIMT

Motivation: Implement easily understood software and an easy-to-understand schema.

Schema: NIMT schema

Type of DCC: XML and PDF

Development Approach: Internal Staff

Technology: Python and developer function in MS Excel to convert the file into XML and display in PDF form by Python coding

A*STAR.NMC

Motivation: Raise awareness and ensure easy adaptation in early stage of DCC development

Schema: NMC schema

Type of DCC: XML

Development Approach: Internal Staff

Technology: Python and Java to convert excel into DCC

Schema comparison gap-analysis

- Different metrology areas, and schemas for these areas are still being agreed internationally, so we concentrated on admin / 17025 / legally required fields.
- We examined the XML schemas for each NMI, mapped to PTB 3.2.1, ISO/IEC 17025, local CRM and existing local calibration report fields.
- We then performed a gap-analysis between the 4 schemas.

	Agree field are mandatory and interoperable using PTB 3.2.1
	We are not sure if they should be mandatory
	Agree it is mandatory but need to be fixed to be interoperable with PTB 3.2.1
	Mandatory for NMI itself, but it is not mandatory in 17025, traceability

Step 1: Mapping the schemas

- NMIA as an example.
- We have done this for each of the 4 NMIs !

	Agree is mandatory and is currently interoperable
	We are not sure if should be mandatory
	Agree it is mandatory but need to be fixed to be interoperable
	Mandatory for NMI itself, but it is not mandatory in 17025, traceability

Report field	NMIA CRM Data Tags	Typical Data	XML element	Matches PTB element name and hierarchy (yes/no)	ISO/IEC 17025 clause
Type of report	Report Title	Temperature Report	administrativeData/statements/statement/reference	Yes	7.8.2.1 Clause a
Name of cal. Lab	Lab Name and Address	National Measurement Institute	administrativeData/calibrationLaboratory/contact/name/content	Yes	7.8.2.1 Clause b
Location of cal lab	Performance Location	Brisbane	administrativeData/coredata/performanceLocation/value	Yes	7.8.2.1 Clause c
Test officer	**tmas_jobtestofficername**	Umesh Kotwal	administrativeData/respPersons/respPerson/person/name/content	Yes	N/A
Test officer phone	**tmas_jobtestofficerphone**	+61 2 8467 3868	administrativeData/respPersons/respPerson/person/phone	Yes	N/A
Test officer email	**tmas_jobtestofficeremail**	Umesh.Kotwal@measurement.gov.a	administrativeData/respPersons/respPerson/person/eMail	Yes	N/A
Address of client	**tmas_reportaddress**	33 Kingtel Place GEEBUNG QLD 4034 Australia	administrativeData/customer/location	No (PTB has multiple fields for city, postcode etc.)	7.8.2.1 Clause e
Name of client company	**tmas_reportaddressedto**	National Measurement Institute, Tra	administrativeData/customer/name/content	Yes	7.8.2.1 Clause e
DUT type	**tmas_type**	Digital thermometer	administrativeData/items/item/name/content	Yes	7.8.2.1 Clause g
DUT make	**tmas_make**	TEST MAKE	administrativeData/items/item/manufacturer/name/content	Yes	7.8.2.1 Clause g
DUT model	**tmas_model**	HD 9215	administrativeData/item/model	Yes	7.8.2.1 Clause g
DUT serial #	**tmas_serialnumberlegal**	29347, Probe S/No. 01029347	administrativeData/item/identifications/identification/value	Yes	7.8.2.1 Clause g
DUT received at NMI	**tmas_receiptdate**	1/13/2022	administrativeData/coredata/receiptDate	Yes	7.8.2.1 Clause h
start date of measurements	**tmas_teststartdate**	1/17/2022	administrativeData/coredata/beginPerformanceDate	Yes	7.8.2.1 Clause i
end date of measurements	**tmas_testenddate**	1/17/2022	administrativeData/coredata/endPerformanceDate	Yes	7.8.2.1 Clause i
NMI authorised signatory (Meas. Act.)	**tmas_nmisignatoryyominame**	Eric van der Ham	administrativeData/respPersons/respPerson/nmisignatory	No - new element	7.8.2.1 Clause o
17025 accredited signatory	**tmas_natasignatoryyominame**	Mong-Kim Ho	administrativeData/respPersons/respPerson/natasignatory	No - new element	N/A
ID number of cal. Report	**tmas_reportnumber**	RN212204	administrativeData/coredata/uniqueIdentifier	Yes	N/A
file ID of calibration records	**tmas_cbfilenumber**	CB/10/2660	administrativeData/statements/statement/NMICBFile	No - new element	17025 recordkeeping
date of issue of report	**tmas_dateofreport**	1/17/2022	administrativeData/statements/statement/date	Yes	7.8.2.1 Clause j
Test Method ID	**Test method**	TEST - EADA - 8.2.26	measurementResults/usedMethods/usedMethod/name/content	Yes	7.8.2.1 Clause f
Report Issuing Authority	**tmas_testlocationname**	National Measurement Institute	administrativeData/statements/statement/respAuthority/contact/name/content	Yes	7.8.2.1 Clause b

Step 2: Schema gap-analysis (summary)

Agreed fields with close overlap

Item of information	NMIA	NMC	NIMT	NPLI
Name of cal. Lab	PTB 3.1.2	bespoke	bespoke	
Address of client	PTB 3.1.2	bespoke	bespoke	PTB 3.1.2
Name of client company	PTB 3.1.2	bespoke	bespoke	PTB 3.1.2
DUT type/ name	PTB 3.1.2	bespoke	bespoke	PTB 3.1.2
DUT make / manufacturer	PTB 3.1.2	bespoke	bespoke	PTB 3.1.2
DUT model	PTB 3.1.2	bespoke	bespoke	PTB 3.1.2
DUT serial #	PTB 3.1.2	bespoke	bespoke	PTB 3.1.2
start date of measurements	PTB 3.1.2	bespoke	PTB 3.1.2	PTB 3.1.2
end date of measurements	PTB 3.1.2	bespoke	PTB 3.1.2	PTB 3.1.2
ID number of cal. Report	PTB 3.1.2	bespoke	PTB 3.1.2	PTB 3.1.2
date of issue of report	PTB 3.1.2	bespoke	PTB 3.1.2	
Test Method ID	PTB 3.1.2	bespoke	PTB 3.1.2	

Areas requiring harmonisation.

Item of information	NMIA	NMC	NIMT	NPLI
software used for calibration				PTB 3.1.2
version of the software used				PTB 3.1.2
country code				PTB 3.1.2
language code				PTB 3.1.2
Location of cal lab where measurements made	PTB 3.1.2			PTB 3.1.2
Calibration Department		bespoke	bespoke	
Calibration Cluster		bespoke		
calibrationLaboratoryGroup			bespoke	
Test officer	PTB 3.1.2			
Test officer phone	PTB 3.1.2			
Test officer email	PTB 3.1.2			
Client Location (NIMT: region?)		bespoke		
client email				PTB 3.1.2
DUT received date at NMI	PTB 3.1.2			
Calibration Date		bespoke		
NMI authorised signatory	bespoke			
17025 accredited signatory	bespoke			
Approval Officer		bespoke	bespoke	
Calibration Officer		bespoke	bespoke	
Scientist in charge				PTB 3.1.2
Head of Department				PTB 3.1.2
Certificate issued by				PTB 3.1.2
Type of report	PTB 3.1.2			
file ID of calibration records	bespoke		bespoke	
Report Issuing Authority	PTB 3.1.2			PTB 3.1.2
comments		bespoke		
Ambient Condition		bespoke	PTB 3.1.2	
Calibrated Range		bespoke		
traceability		bespoke	bespoke	
Type of the issuer of certificate				PTB 3.1.2
Name of issuer of certificate				PTB 3.1.2
Order number generated for the calibration				bespoke
eMail of the calibrating organisation				PTB 3.1.2
phone of the calibrating organisation				PTB 3.1.2
fax of the calibrating organisation				PTB 3.1.2
Location of the calibrating organisation				PTB 3.1.2
city of the calibrating organisation				PTB 3.1.2
countryCode of the calibrating organisation				PTB 3.1.2
postCode of the calibrating organisation				PTB 3.1.2
street of the calibrating organisation				PTB 3.1.2
website of the calibrating organisation				PTB 3.1.2

Typical "interoperability" issues

Interpretation errors:

e.g., PTB 3.2.1 address field interpreted differently (Test Method ID, Address)

Interpretation ambiguity

e.g., report date vs. testing date

Excessive flexibility.

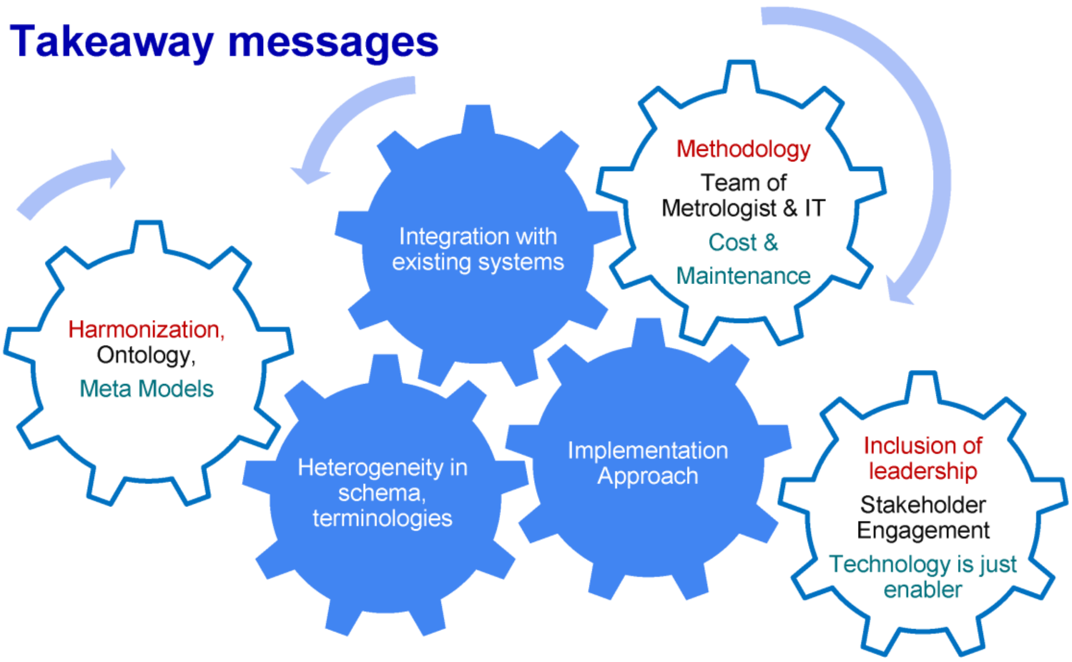
e.g., it can accommodate many roles and authorisations and many organisational structures and hierarchies. Agreement on "mandatory" roles (legal, 17025 etc) and organisational substructure elements is necessary for interoperability.

Conclusions

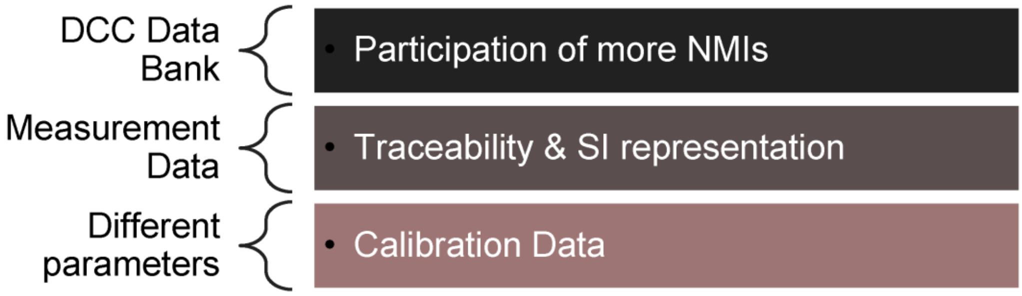
- Each team could generate and read DCCs within their own systems
- For those adopting PTB 3.2.1, there was some level of successful interoperability.
- There was broad agreement on "mandatory" fields (17025).
- We found a few common issues when comparing our schemas.
- The gap analysis revealed 4 areas to focus on

  - **Fields** should be mandatory under 17025
    - interoperable NOW if PTB 3.2.1 schema is used
  - **Fields** some NMIs see as mandatory under 17025
    - need to understand the underlying local requirements and ensure this diversity doesn't impact interoperability.
  - **Fields** should be mandatory but are currently interpreting differently
    - Most of these are semantic mismatches between the meaning of data and the label.
    - e.g., signatories vs authorisations, calibration date vs report date, etc.
  - **Fields** not mandatory in 17025, should be mandatory but need clearer definitions for smooth interoperability.
    - e.g., report number, file number (raw data record locators), comments, traceability statements

Takeaway messages



Way forward



Appendices with more details on approaches of each NMI

….not discussed today, but available in the online ppt for reference.

Motivation:

Why is each NMI engaging with DCCs?

What each NMI is trying to achieve?

Status:

Where each NMI is in executing their strategy?

Outline of DCC implementation at each NMI:

How is each NMI implementing their DCC strategy?

NMIA DCC motivation

Motivation:

- Proof of concept DCC "PTB XML in PDFA3"
- Assess issues with use of external IT providers
- Build DCC-awareness in NMIA
- Show cost/time savings from DCCs "success stories"
- Raise awareness of DCC for external users
- Inform funding and project planning for DCC rollout

Current stage

- **Proof-of-concept DCC project completed**
    - *activity currently paused*
- DCC writer and reader tools developed
- DCC enhanced "Mass" PDF certificates demonstrated
- DCC-reader trialed in multiple NMI user teams.
- Funding sought for DCC rollout
    - Integration with NMIA's CRM
    - Harden and toughen DCC tools
    - Extend DCCs to other metrology areas
    - Interoperability of DCCs

NPLI DCC Development Motivation

Motivation

- Understand PTB's DCC schema.
- Assess the viability of PTB's DCC schema implementation, taking into account the calibration certificate issued by NPLI.

Current stage

- Pilot project to trial the generation of in-house DCC Using Python to parse the content into XML and convert the XML file to LATEX. Converting LATEX into DCC in PDF/A3 form

NMC DCC Development Motivation

Motivation

- Raise awareness of DCC
- Early adaptation to the benefits of DCC
- To develop user centric system while using and generating DCC

Current stage

- Pilot project to trial the generation of in-house DCC with the aim of, reducing human error and improving efficiency and ease of adapt in the generation of reports for basic data exchange and utilization

NIMT DCC Development Motivation

Motivation

- Introduce the DCC to our staff and customer
- Surveying appropriate software to generating the DCC for NIMT's staff
- Trial implement easily understood software and an easy-to-understand schema.
- Realize the creation of cooperation between NQI organization

Current stage

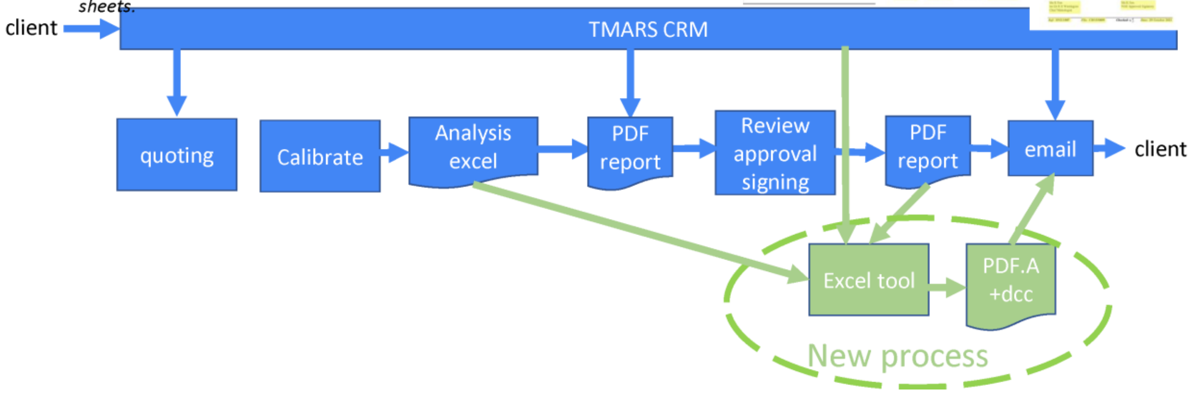
- Choosing the DCC in PDF/A3 form because it contains both machine and human readable. Moreover, this form support to add digital signature for privacy and security
- To validate schema, we collaborate with government agency
- In the future, use of external provider to design new approach to generate the DCC. The new software can convert calibration certificate to DCC in XML form that contain the digital signature and can display in PDF form.

NMIA DCC writer tool: an add-on to our existing processes

Concept:

- Implemented by external IT contractors based on PTB documentation.
- Low barrier to entry by NMI calibration teams
- Approach scalable to accredited labs
- Identified key elements in current reports that clients use.
- easily create PTB-XML and add as pdf-a into existing pdf reports
  - "17025 admin data" from existing CRM
  - Data still copy-pasted from existing data analysis sheets.

    ...automate in next project phase by modifying tool as drop-in to existing analysis sheets.



NMIA DCC reader tool: a simple add-on to client's existing spreadsheets

Concept:

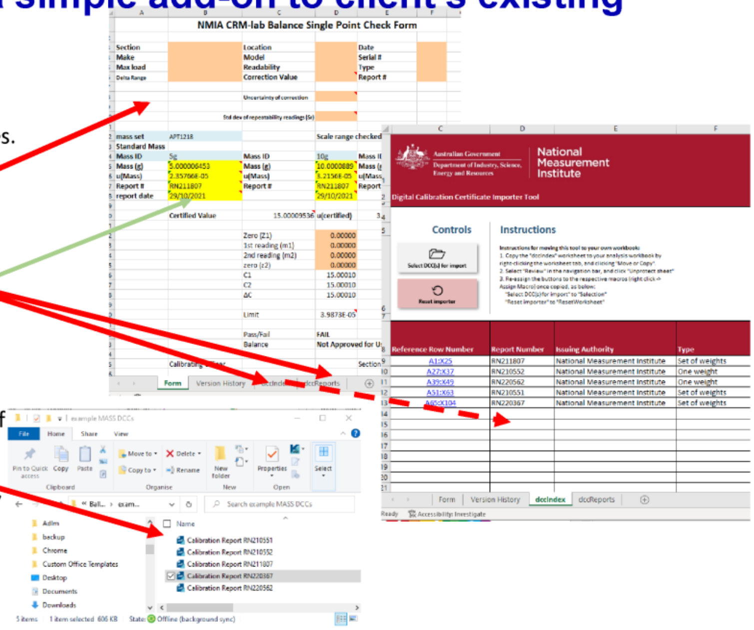
- use tech. that IT-novice lab staff can use
- Minimise rework of existing QS processes.
- Facilitate early uptake learnings.

=> Simple drop-in excel tab developed.

1. Take any client's excel sheet.
1. Add two NMIA-DCC-reader tabs
1. Replace links to calibration data in clients' sheet with excel-lookups.
1. Client points tool to directory where pdf reports are stored.

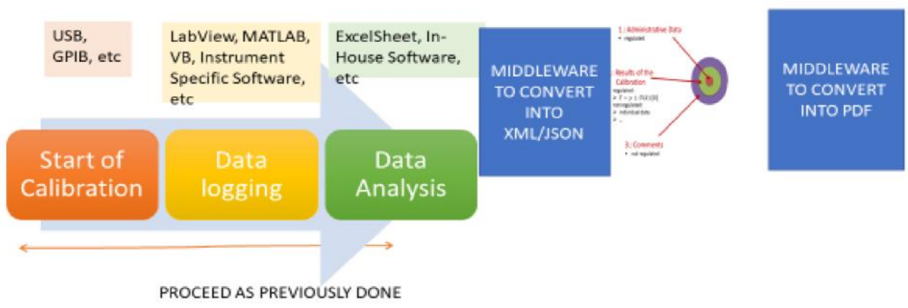
Successful proof-of-concept trial for "mass" certificates across 3 NMIA branches.

Data in new reports automatically flows through clients' existing QS processes.

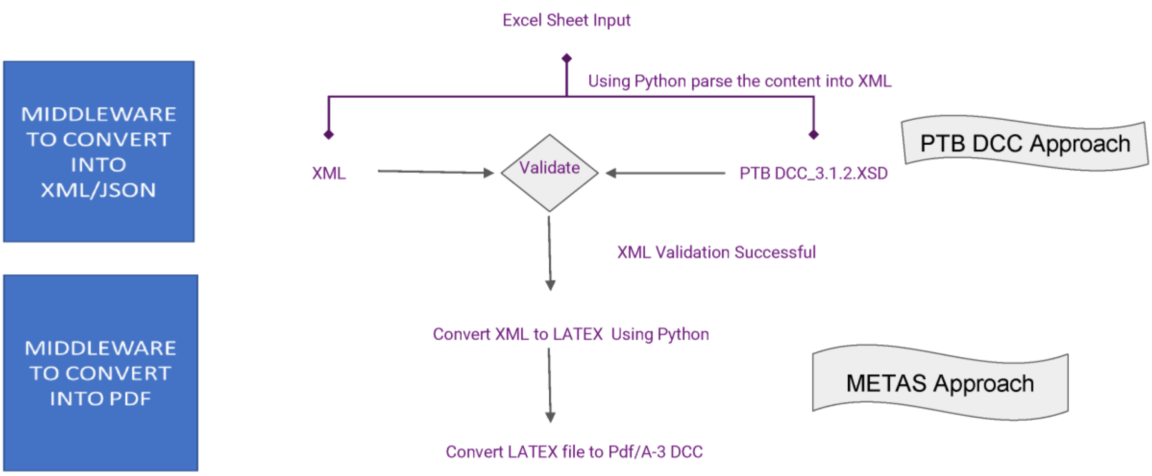


NPLI DCC Methodology

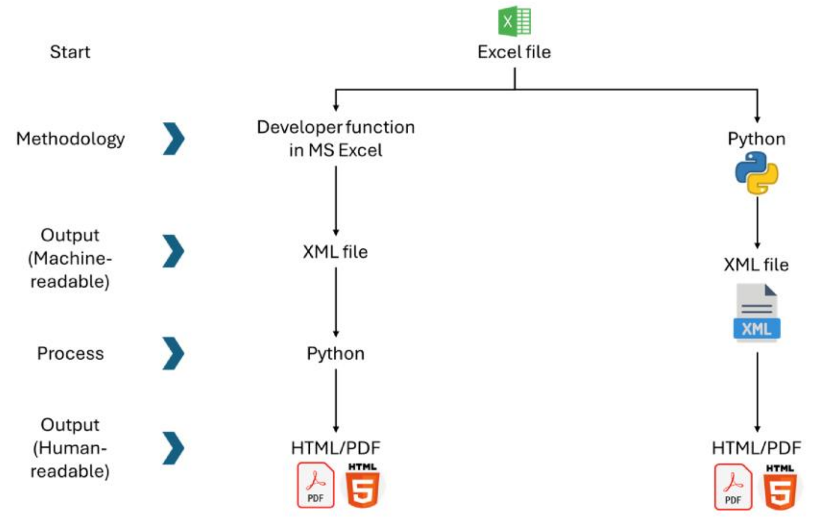
Workflow



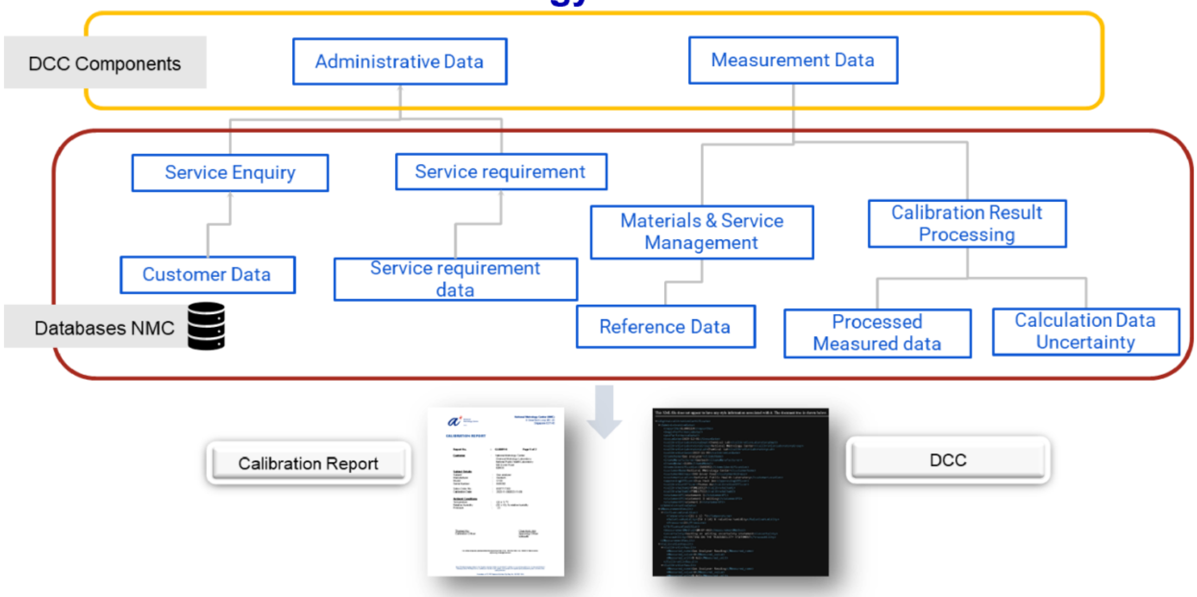
NPLI DCC Methodology



NIMT DCC Methodology



ASTAR.NMC DCC Methodology



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2024-02-27 (Wednesday)

15 Special Session: Formulas in DCC

Presenting author: Siegfried Hackel, PTB Germany
Email: siegfried.hackel@ptb.de

Abstract

Chair: Siegfried Hackel (PTB), who also gives an introduction to the problem (formatting of formulae in a human-readable form versus formulae that can be interpreted by a machine). Note on the procedure for a linear equation (f(x)=mx+b).

This is followed by a motivation lecture by Aldo Garcia (CENAM), for which this formula interpretation is needed in concrete terms (examples from acceleration for the automotive industry with the linear equation). What does this look like in the DCC?

The equations within the digital calibration certificates would help in this case the secondary calibration laboratory to offer the possibility to our customers to have more information for example coming from the calibration performed on the item where the response is represented in a linear equation, the continuous motivation when within the product testing process can reduce the verification time which is vital for metrology within the industrial sector. In addition to enabling the possibility of the development of systems that implement artificial intelligence.

A formula that is in the Content MathML, a machine-interpretable notation in the DCC, and how is it handled. What does the implementation look like and what does the solution look like? How accurate are the calculations (default 28 numbers after zero but it can be configured with higher accuracy)? This lecture highlights the three elements of the solution and will be presented by Justin Jagieniak (PTB Germany).

This is followed by an outlook by Aldo Garcia (CENAM), who then discusses the application of Content MathML in the field of temperature. The methods according to ITS90, Callendar-Van-Dusen and direct calibration (pure temperature comparison) are discussed.

Another use case is in temperature, where the equations will serve not only for our customers in the part of knowing the response of the calibration item using different methods such as ITS90, Callendar-Van-Dusen or a calibration by comparison but in expressing the uncertainties and that these are related, this is an aspect that the industry is looking for.

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Presentation of Siegfried Hackel (PTB)

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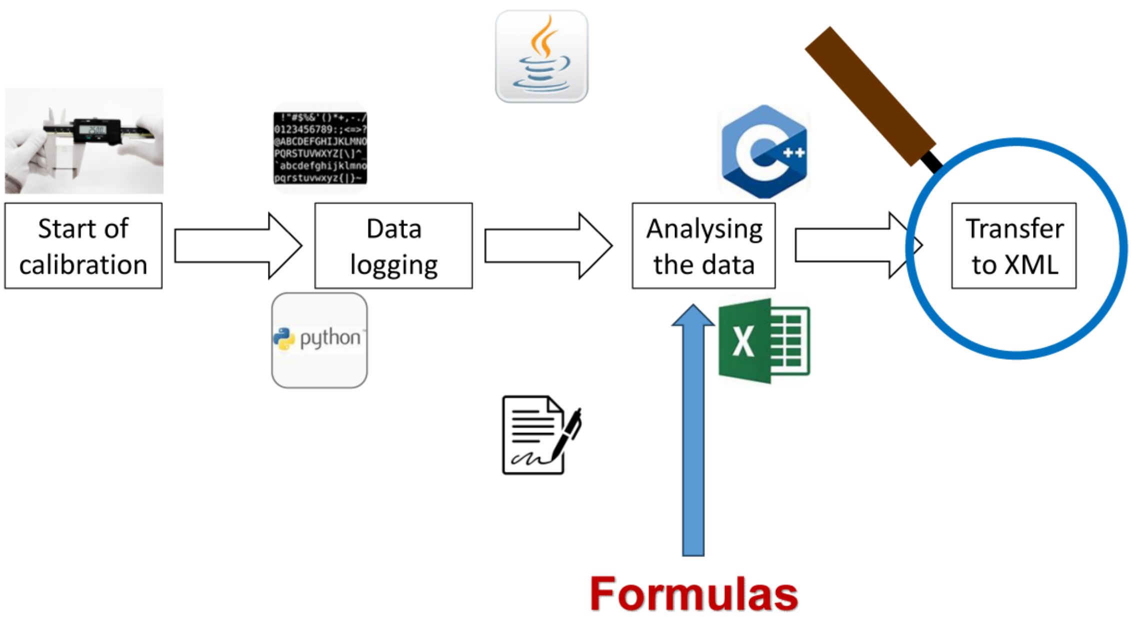
Braunschweig und Berlin
Nationales Metrologieinstitut

Formulas in DCC

https://www.ptb.de/dcc

Siegfried Hackel

Workflow



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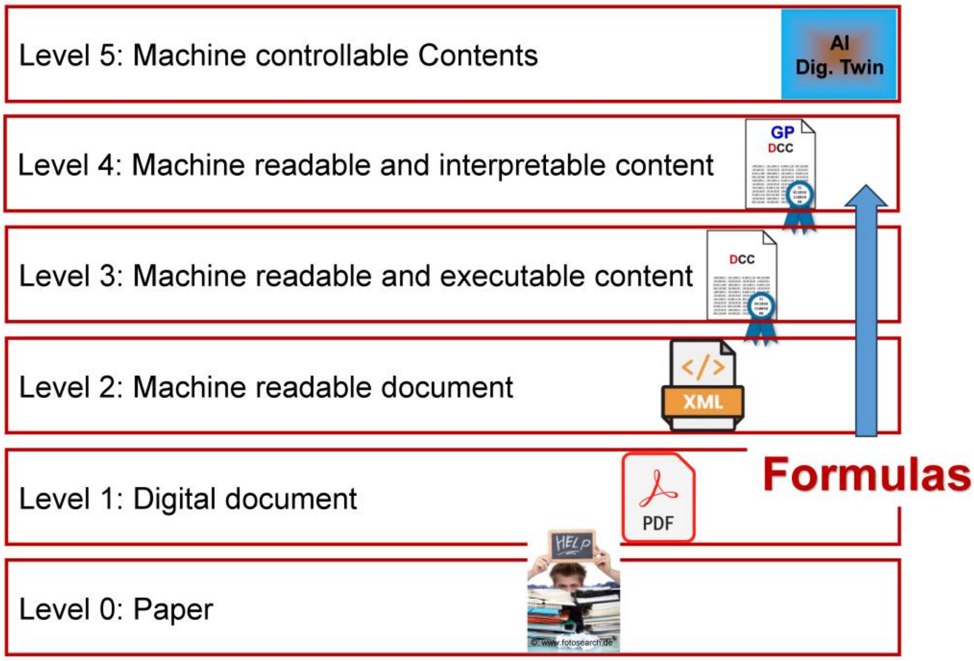
The Utility-Model



From: „IDiS – Initiative Digitale Standards“. [Online].
see: https://www.dke.de/resource/blob/2076816/facc9bde1806e2194a3d26a60c79bf77/idis-whitepaper-1-en---download-data.pdf

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Advantages

- Calculations can be transferred to machines on site!
- No more table interpolation
  - ✓ Example

Weight (kg)	Accleration (m/s^2)
0.01205	10.14324
0.02324	10.14719
0.05542	10.15852
0.06661	10.16246

- What is the value for $m = 0.02$ kg

- Development of trustworthy formula libraries

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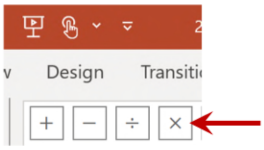
Formulas for humans and machines (1)

Small “·”

Large “·”

- Formulas for humans
  - ✓ $f(x) = mx + b$
  - ✓ $f(x) = m \cdot x + b$
  - ✓ $f(x) = m \cdot x + b$
  - ✓ $f(x) = m * x + b$
  - ✓ $f(x) = m \times x + b$



- MathML
  - ✓ See: https://www.w3.org/TR/MathML3/
  - ✓ Two characteristics exist:
    - Presentation Markup MathML and
    - Content Markup MathML

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Formulas for humans and machines (2)

- Formulas for machines
  - ✓ Content Markup MathML
  - ✓ See: https://www.w3.org/TR/MathML3/chapter4.html
- The principle:
  - ✓ Basic mathematics from school:
    - Brackets first
  - ✓ Polish notation
    - May better known: Reverse Polish Notation

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An Example: $f(x) = m \cdot x + b$

- Calculation sequence
  - ✓ m is multiplied by x
  - ✓ Add b to this result
- Complete Content Markup MathML:

```
<ml:declare type="fn">
    <ml:ci>f</ml:ci>
    <ml:lambda>
        <ml:bvar><ml:ci>x</ml:ci></ml:bvar>
        <ml:apply>
            <ml:plus/>
            <ml:apply>
                <ml:times/>
                <ml:ci>m</ml:ci>
                <ml:ci>x</ml:ci>
            </ml:apply>
            <ml:ci>b</ml:ci>
        </ml:apply>
    </ml:lambda>
</ml:declare>
```

$f(x)$

$=$

$m \cdot x + b$

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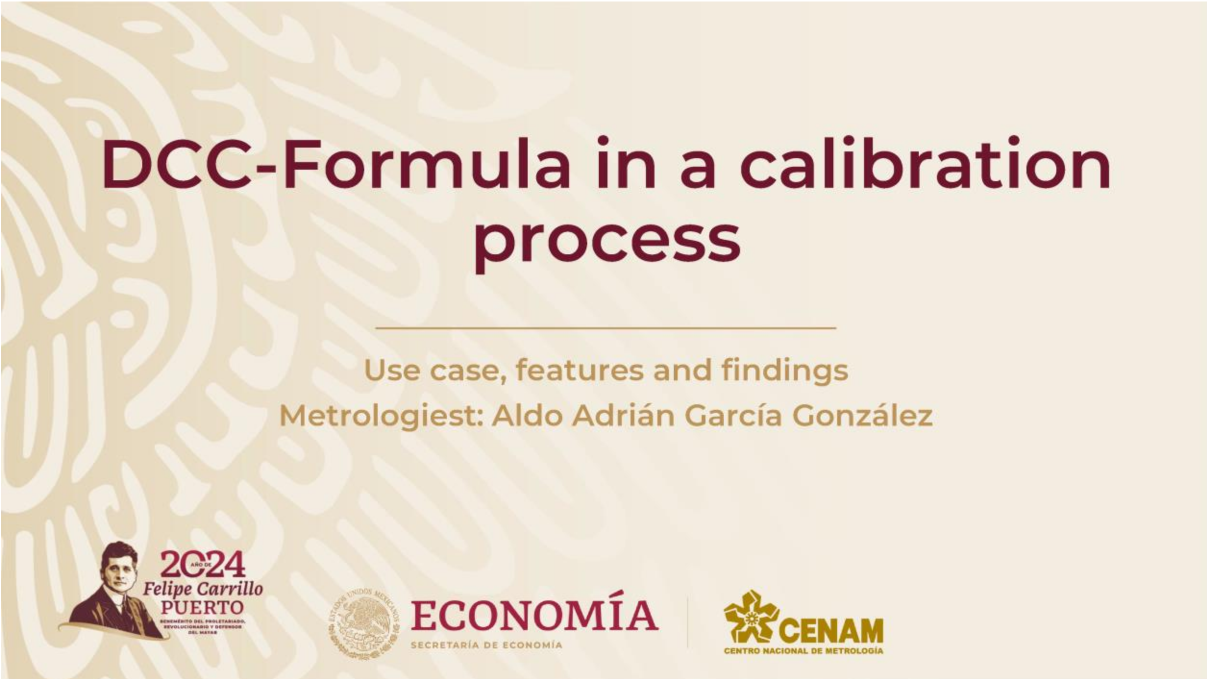
Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Bundesallee 100
38116 Braunschweig
Germany

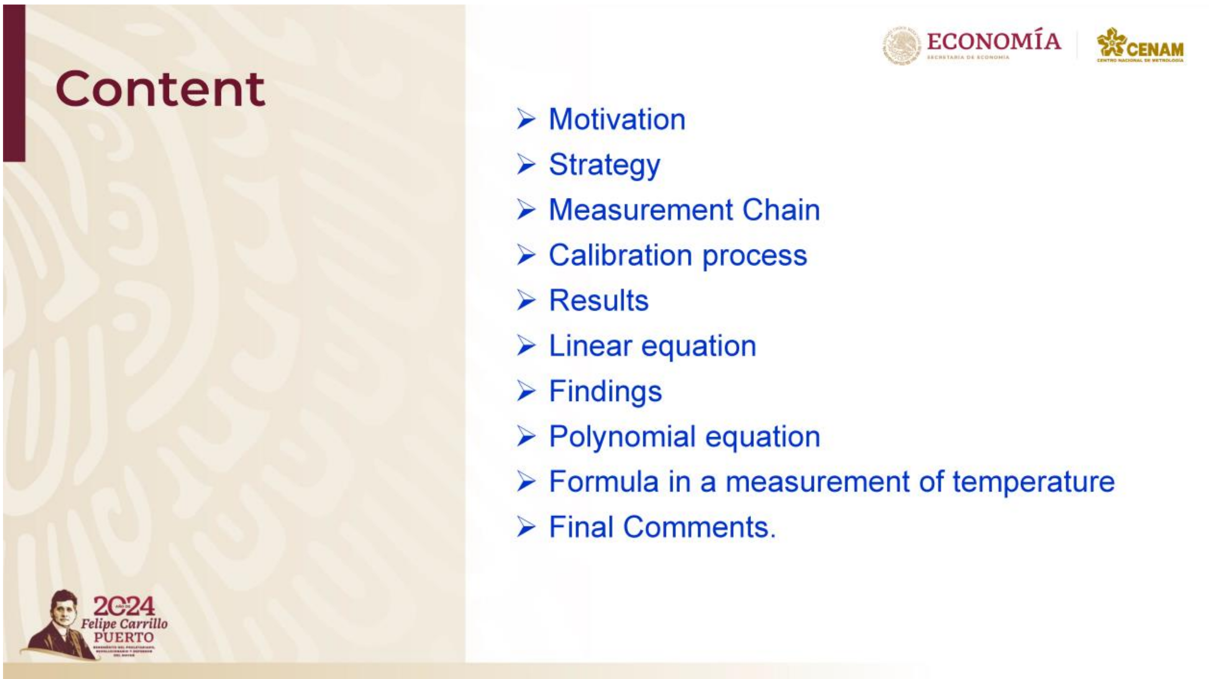
More questions? Please contact:

Dir. u. Prof. Dr. Siegfried Hackel
Phone: +49 531 592-1017
E-Mail: siegfried.hackel@ptb.de

2024-02-28

Presentation Aldo Garcia (CENAM)





ECONOMÍA | CENAM

➢ Motivation

Enable laboratory control of measured results using formulas
at DCC.

Improve the automation of calibration process

➢ Strategy

1. Select a calibration service.
2. Use DCC.
3. Implement Formulas at the DCC
   a. Develop a simple pilot linear equation example.
   b. Findings and proposal of improvement.
   c. Develop a complex polynomial equation example.

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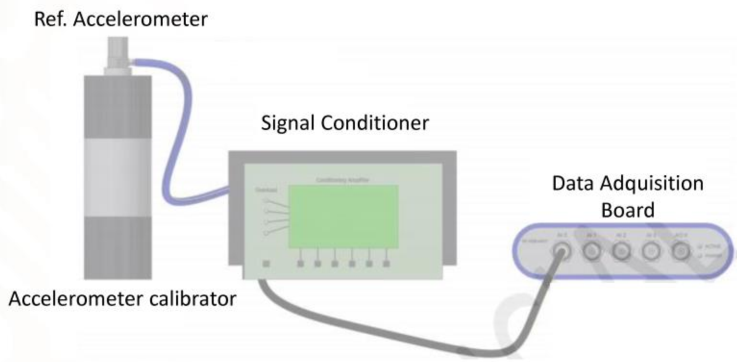
ECONOMÍA | CENAM

➢ Measurement Chain

1. Select a calibration service.
   Calibration of accelerometer calibrators



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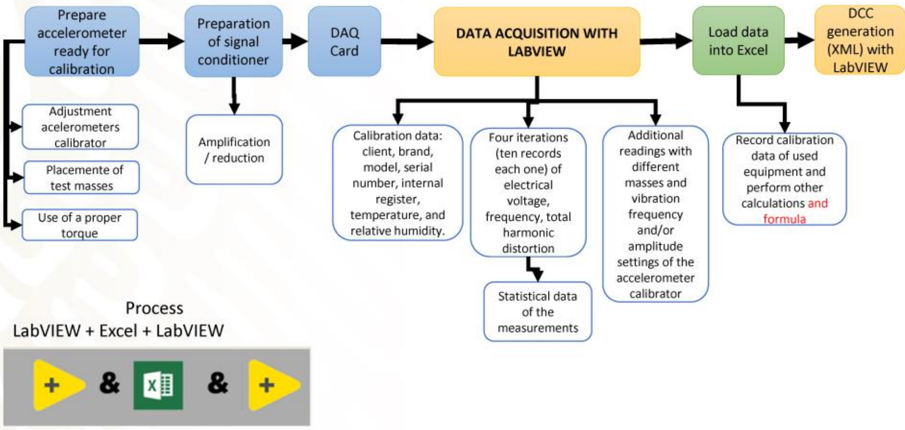
➢ Calibration Process

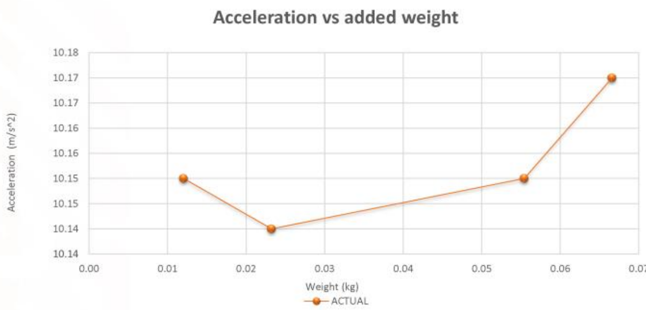


➢Measurement Results

The equation of the line was obtained using the measured mass as x and acceleration as y.

Then using an excel tool we get the lineal equation that describes the measured response of the instrument to be included at the DCC.

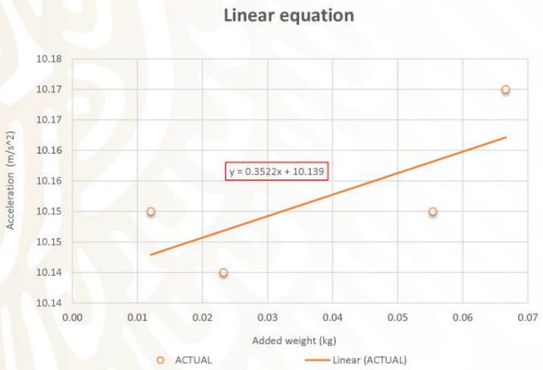
"x" (Measured) (g)	"y" (Measured) $\left(\frac{m}{s^2}\right)$	"y-linear eq" (Calculated) $\left(\frac{m}{s^2}\right)$	"m" $\left(\frac{\frac{m}{s^2}}{g}\right)$	b $\left(\frac{m}{s^2}\right)$
12.05	10.15	??	0.0004	10.139
23.24	10.14	??		
55.42	10.15	??		
66.61	10.17	??		



ECONOMÍA | CENAM

➢ Linear equation

First simple inear equation implementation with MathML




```
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    <ml:ci>f</ml:ci>
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        <ml:apply>
            <ml:plus/>
            <ml:apply>
                <ml:times/>
                <ml:ci>m</ml:ci>
                <ml:ci>x</ml:ci>
            </ml:apply>
            <ml:ci>b</ml:ci>
        </ml:apply>
    </ml:lambda>
</ml:declare>
```

$$f(x) = m \cdot x + b$$

$$f(x) = 0.3522 \cdot x + 10.139$$

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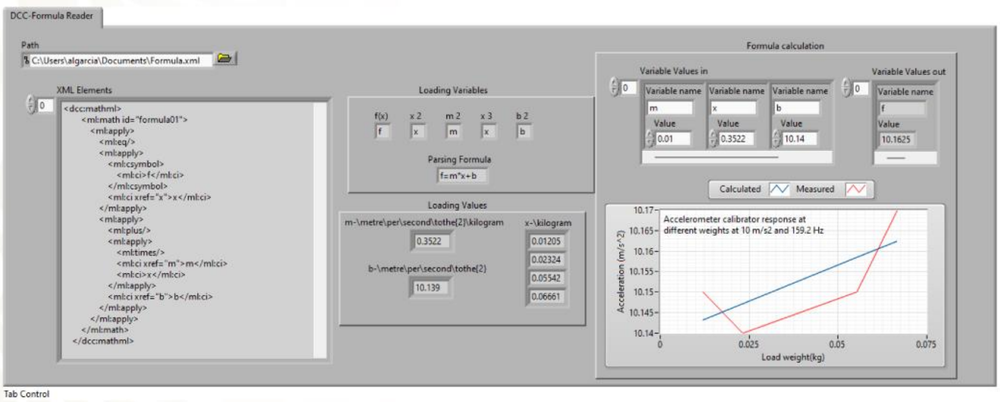
ECONOMÍA | CENAM

➢ How it looks at the DCC using Labview that can be related with VW developments as stakeholder.

First Linear equation implementation



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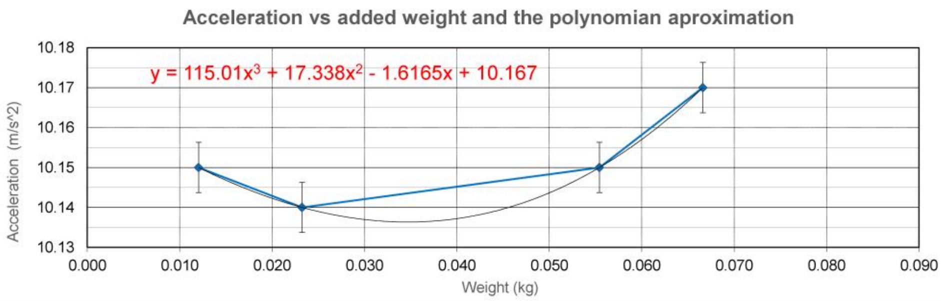
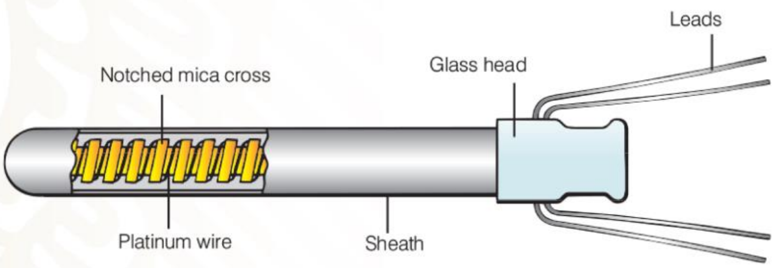
➢ Features and next steps

Oportunity: Develop a control calibration process features.

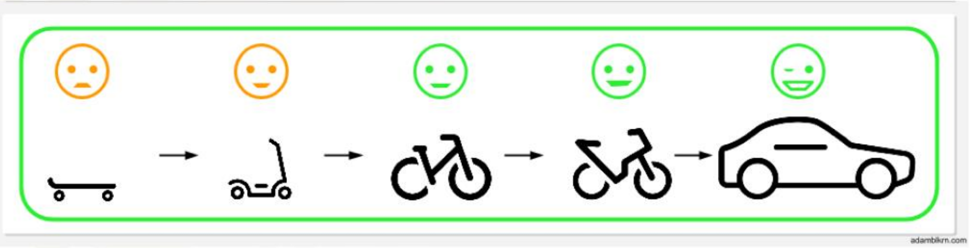
1. Enable control of calibration results
   a. Behaviour results analisys
   b. Automatic creation of traceability charts
2. Looking for Good practices implementation.



➢ Formula in a measurement of temperature with a platinum resistance thermometer
Stakeholder: VW México 2023



Measuring model



$$R_t = R_0(1 + At + Bt^2) \longrightarrow R_t = R_0(1 + At + Bt^2 + Ct^3[1 - t]) \rightarrow T_{90}/K - 273.15 = D_0 + \sum_{i=1}^{9} D_i \left[\frac{W_r(T_{90}) - 2.64}{1.64}\right]^i$$

Callendar Van Dusen

ITS-90

Callendar Van Dusen equation

$$R_t = R_0(1 + At + Bt^2 + Ct^3[1 - t])$$

Coefficients calculated from measured points during calibration

- *A, B y C*

Measured resistance values (unit under calibration)

- R_t, R_0

Temperature measured with a standard thermometers (SPRTs)

- t

ECONOMÍA | CENAM

- Callendar Van Dusen equation at DCC

$$R_t = R_0\left(1 + At + Bt^2\right)$$

Coefficients calculated from measured points during calibration

- A, B

Measured resistance values (unit under calibration)

- R_t, R_0

Temperature measured with a standard thermometers (SPRTs)

- t

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Thanks for you attention
Questions? Please send us a mail

Aldo García: algarcia@cenam.mx

ECONOMÍA SECRETARÍA DE ECONOMÍA | CENAM CENTRO NACIONAL DE METROLOGÍA

Back to "Table of Contents" above

Presentation of Justin Jagieniak (PTB)

Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

GEMIMEG

Formulas in DCCs

Justin Jagieniak PTB working Group 1.24 et al.

PTB Content MathML Snippet

```xml
<ml:math id="formula_01">
   <ml:declare type="fn">
      <ml:ci>f</ml:ci>
      <ml:lambda>
         <ml:bvar><ml:ci>x</ml:ci></ml:bvar>
         <ml:apply>
            <ml:plus/>
            <ml:apply>
               <ml:times/>
               <ml:ci xref="m">m</ml:ci>
               <ml:ci>x</ml:ci>
            </ml:apply>
            <ml:ci xref="b">b</ml:ci>
         </ml:apply>
      </ml:lambda>
   </ml:declare>
</ml:math>
```

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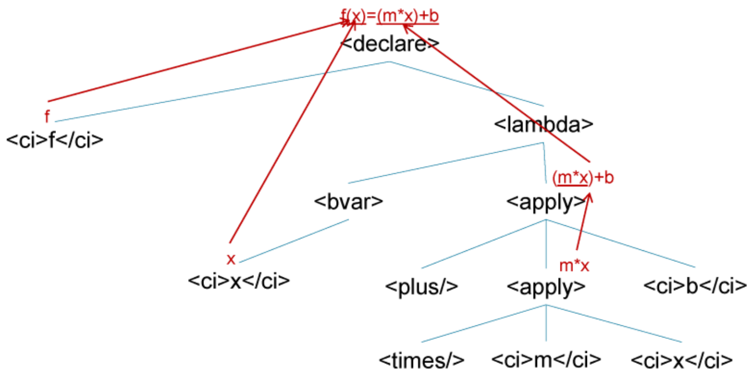
PTB Content MathML Tree



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PTB Content MathML Evaluator

- Standard programming language:
  - Python
- Only standard libraries -> easy to evaluate
  - Decimal (for high accuracion), default ist 28 numbers after zero, but it can be configured with higher accuracion
  - lxml -> for reading XML
  - pySide for a graphical user interface (GUI)

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PTB Content MathML Evaluator

3 modules:

- ContentMathMLEvaluator:
  - It is used to calculate with MathML Formulas and given variables
- DCCFormulaExtractor:
  - Extracts formulas and variables of the DCC
- GUI
  - It is the human-readable design of the program

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PTB Physikalisch-Technische Bundesanstalt Nationales Metrologieinstitut GEMIMEG

Thank you for your attention!

Do you have any questions or comments?

Justin.Jagieniak@ptb.de

Justin Jagieniak PTB working Group 1.24 et al.

16 GEMIMEG-II – From Digital Calibration Certificates to Interoperable Trustchains for the IOT Landscape

Presenting author: Thomas Engel, Siemens AG, Germany
Email: engelthomas@siemens.com

Abstract

Digitalizing the metrology domain with many different stakeholders is a complex and challenging task in order to fulfil all requirements. A trusted quality infrastructure is crucial for modern IOT networks. In particular, calibrating sensors with a stringent chain of traceable calibration information and sensor data in machine readable and machine interpretable way is essential to leverage the potential of qualified and trusted sensor data in modern IOT networks. Furthermore, integrating an increasing number and variety of smart and / or constrained devices, typically with sensors of different modalities, are the main challenges for a thorough digital representation of the topologies, the data and process chains.

The GEMIMEG-II project paved the way to digitalize the metrology domain with many different stakeholders. The digital calibration certificate (DCC) and the corresponding digital calibration request (DCR) as the requirement specification for calibration have been defined, tested and qualified in industrial routine applications. The Quality of Sensing and Quality of Data concept will further support an informed utilisation of sensor data and significantly add value. The digital solution created fits seamlessly to other digitalisation initiatives of broad coverage for Industry 4.0 like Asset Administration Shell (AAS) and Digital Product Passport (DPP) and the related industrial edge ecosystem. This paper will present the results of the German lighthouse project GEMIMEG-II and gives a future perspective.

The GEMIMEG-II project is funded by the German ministry for economic affairs and climate action based on a decision by the German Bundestag under grant number 01 MT20001A.

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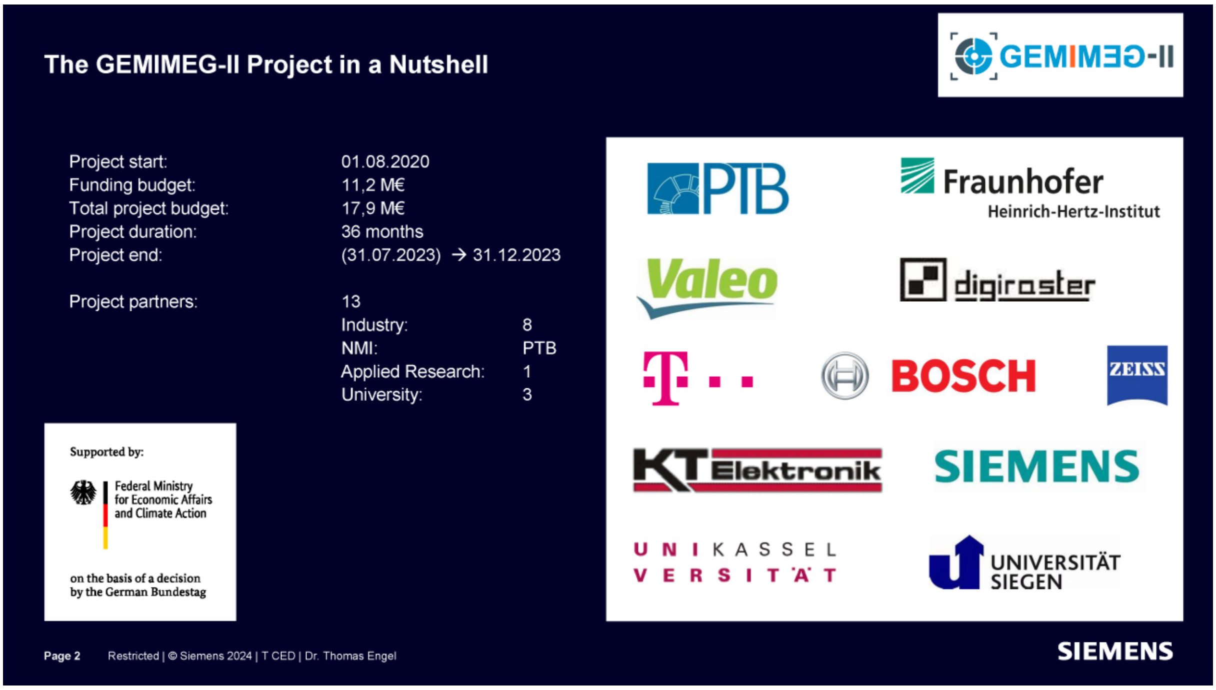
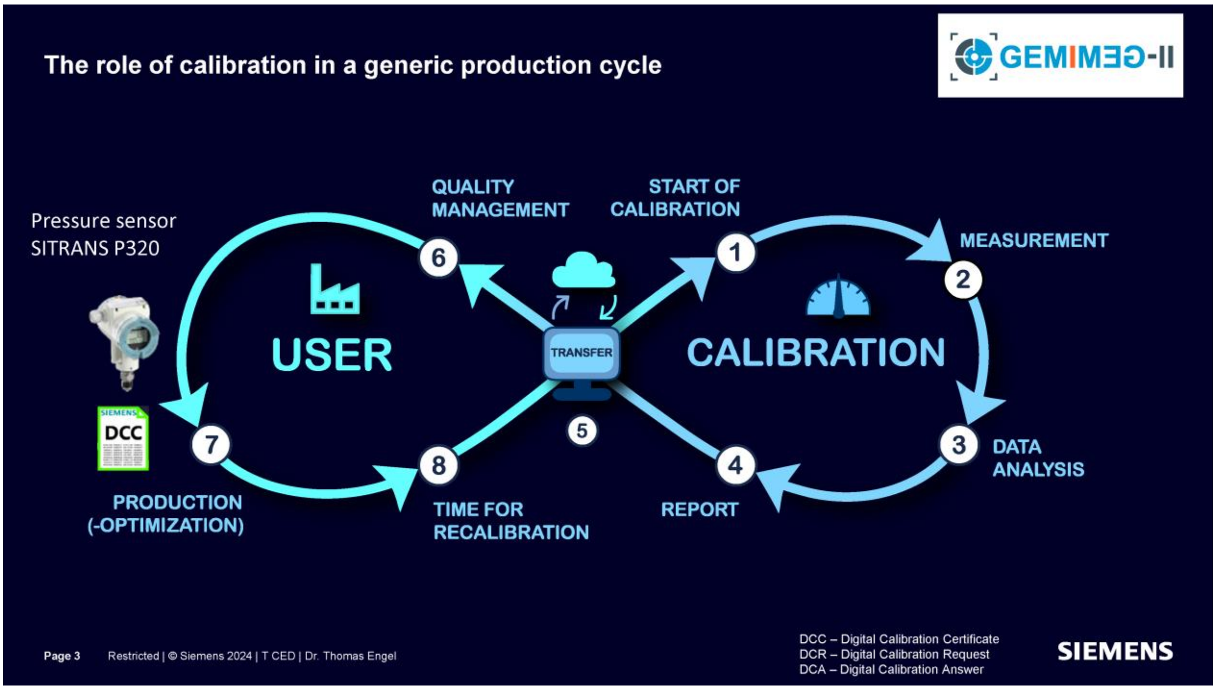
Presentation of Thomas Engel




The role of calibration in a generic production cycle
GEMIMEG-II
Pressure sensor
SITRANS P320
DCC
QUALITY
MANAGEMENT
START OF
CALIBRATION
MEASUREMENT
USER
TRANSFER
CALIBRATION
6
1
2
7
8
5
4
3
DATA
ANALYSIS
PRODUCTION
(-OPTIMIZATION)
TIME FOR
RECALIBRATION
REPORT
Page 3
Restricted | © Siemens 2024 | T CED | Dr. Thomas Engel
DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer
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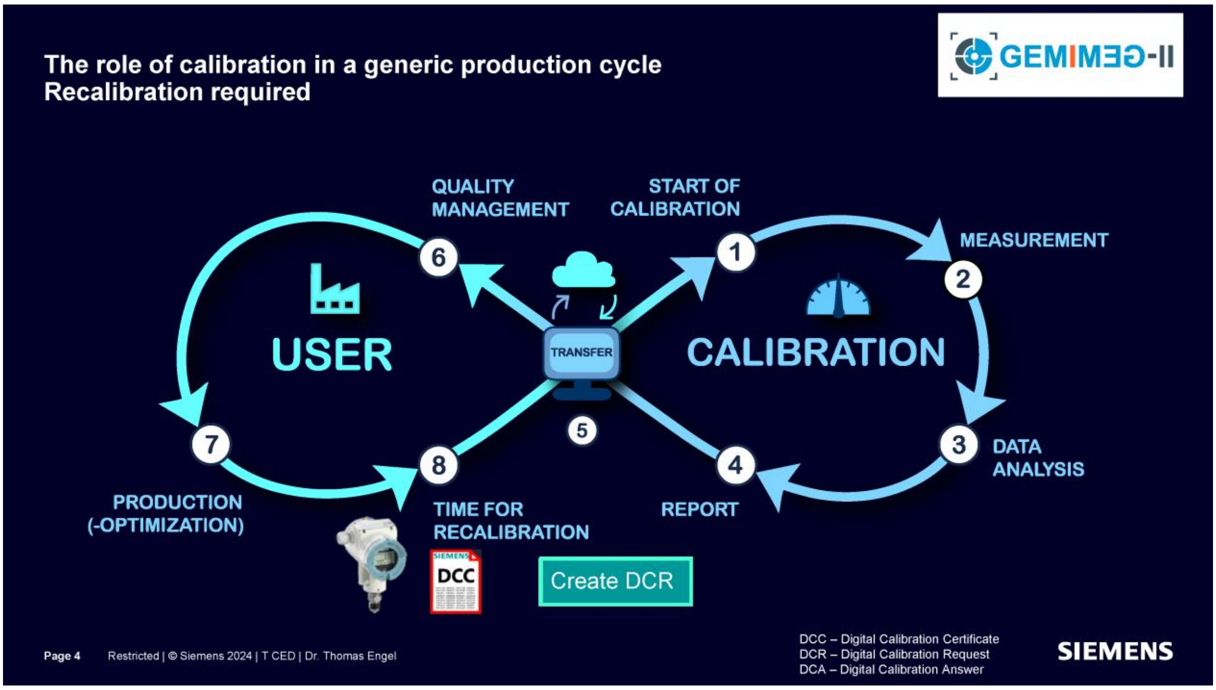
The role of calibration in a generic production cycle
Recalibration required
GEMIMEG-II
QUALITY
MANAGEMENT
START OF
CALIBRATION
MEASUREMENT
USER
TRANSFER
CALIBRATION
6
1
2
7
8
5
4
3
DATA
ANALYSIS
PRODUCTION
(-OPTIMIZATION)
TIME FOR
RECALIBRATION
REPORT
DCC
Create DCR
Page 4
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DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer
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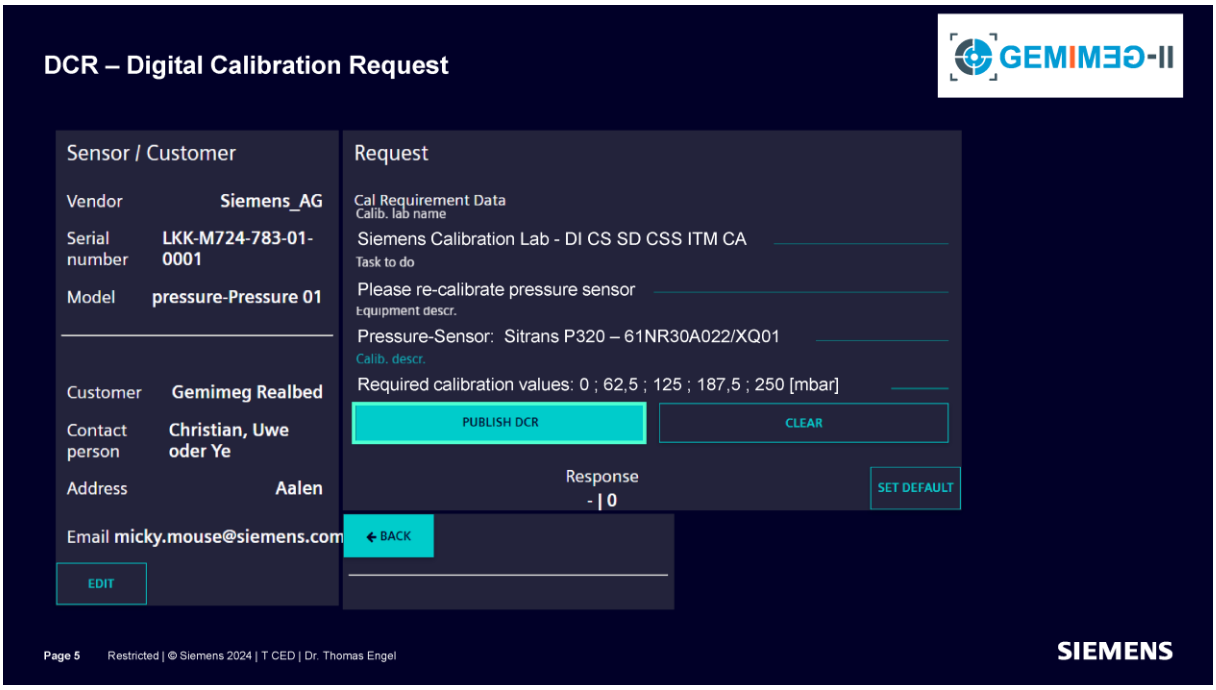
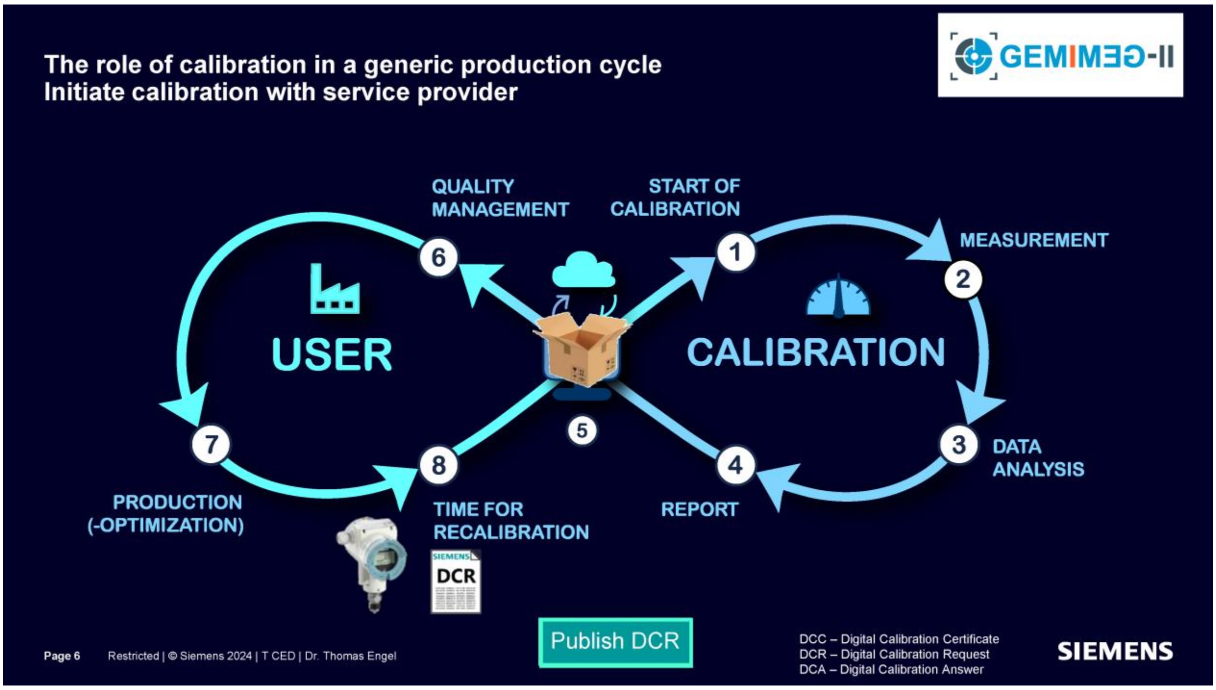

DCR – Digital Calibration Request
GEMIMEG-II
Sensor / Customer
Vendor Siemens_AG
Serial number LKK-M724-783-01-0001
Model pressure-Pressure 01
Customer Gemimeg Realbed
Contact person Christian, Uwe oder Ye
Address Aalen
Email micky.mouse@siemens.com
EDIT
Request
Cal Requirement Data
Calib. lab name
Siemens Calibration Lab - DI CS SD CSS ITM CA
Task to do
Please re-calibrate pressure sensor
Equipment descr.
Pressure-Sensor: Sitrans P320 – 61NR30A022/XQ01
Calib. descr.
Required calibration values: 0 ; 62,5 ; 125 ; 187,5 ; 250 [mbar]
PUBLISH DCR
CLEAR
Response
- | 0
SET DEFAULT
BACK
Page 5 Restricted | © Siemens 2024 | T CED | Dr. Thomas Engel
SIEMENS


The role of calibration in a generic production cycle
Initiate calibration with service provider
GEMIMEG-II
QUALITY MANAGEMENT
START OF CALIBRATION
MEASUREMENT
USER
CALIBRATION
DATA ANALYSIS
PRODUCTION (-OPTIMIZATION)
TIME FOR RECALIBRATION
REPORT
DCR
Publish DCR
DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer
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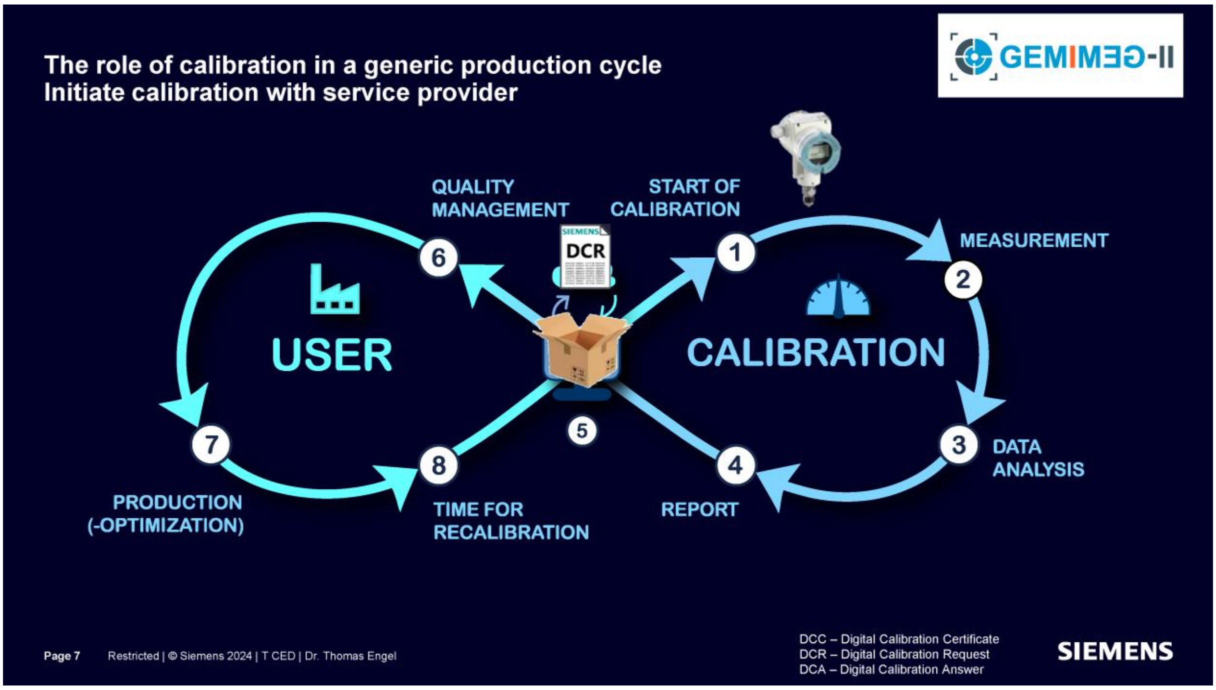
The role of calibration in a generic production cycle
Initiate calibration with service provider
GEMIMEG-II
QUALITY MANAGEMENT
START OF CALIBRATION
MEASUREMENT
DCR
USER
CALIBRATION
1
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8
PRODUCTION (-OPTIMIZATION)
TIME FOR RECALIBRATION
REPORT
DATA ANALYSIS
Page 7
Restricted | © Siemens 2024 | T CED | Dr. Thomas Engel
DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer
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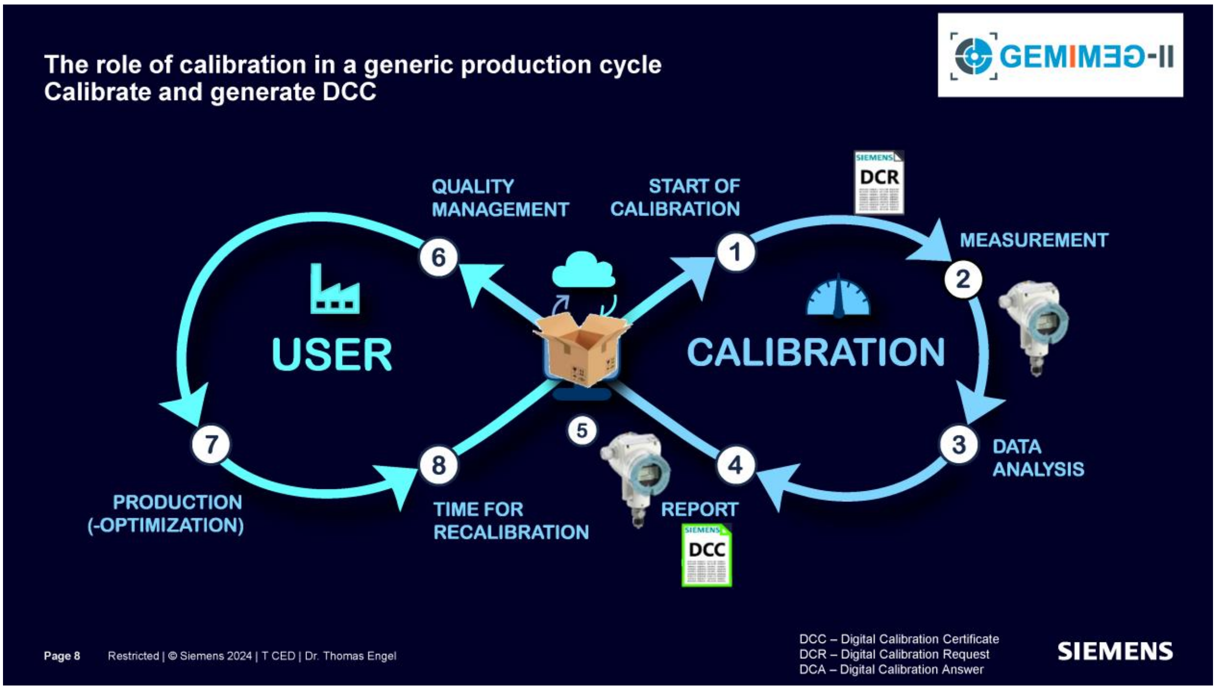
The role of calibration in a generic production cycle
Calibrate and generate DCC
GEMIMEG-II
QUALITY MANAGEMENT
START OF CALIBRATION
DCR
MEASUREMENT
USER
CALIBRATION
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PRODUCTION (-OPTIMIZATION)
TIME FOR RECALIBRATION
REPORT
DCC
DATA ANALYSIS
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DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer
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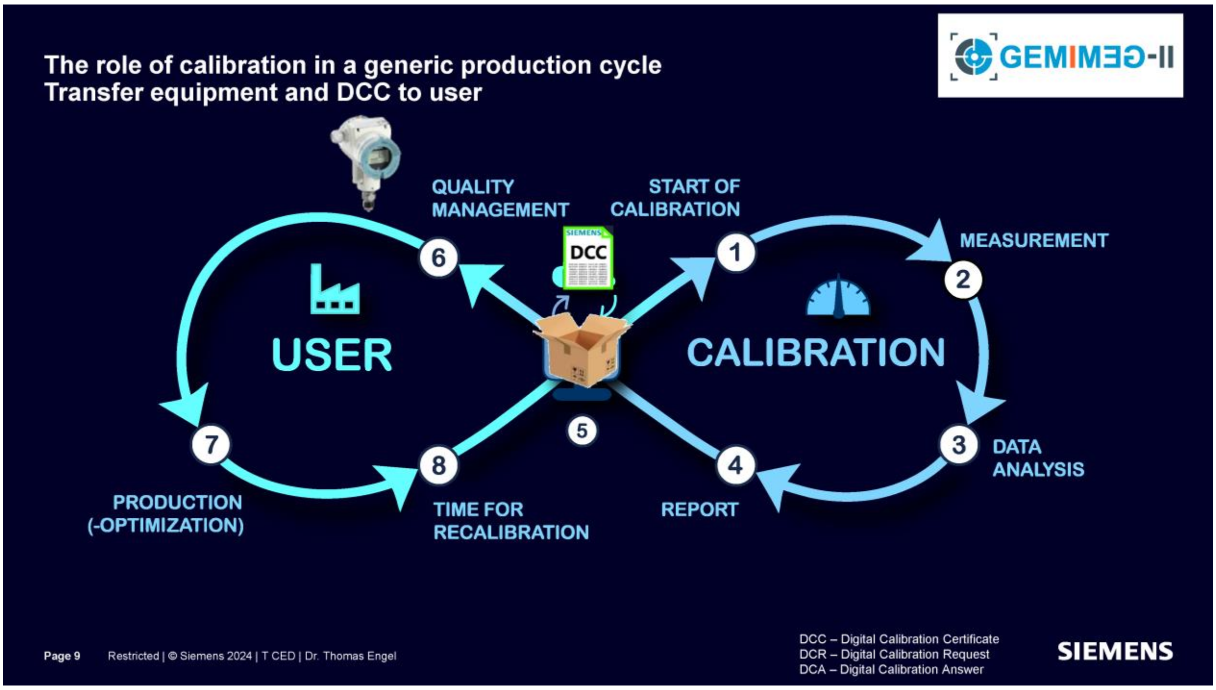
The role of calibration in a generic production cycle
Transfer equipment and DCC to user
GEMIMEG-II
QUALITY MANAGEMENT
START OF CALIBRATION
MEASUREMENT
USER
CALIBRATION
DCC
DATA ANALYSIS
PRODUCTION (-OPTIMIZATION)
TIME FOR RECALIBRATION
REPORT
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Page 9
Restricted | © Siemens 2024 | T CED | Dr. Thomas Engel
DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer
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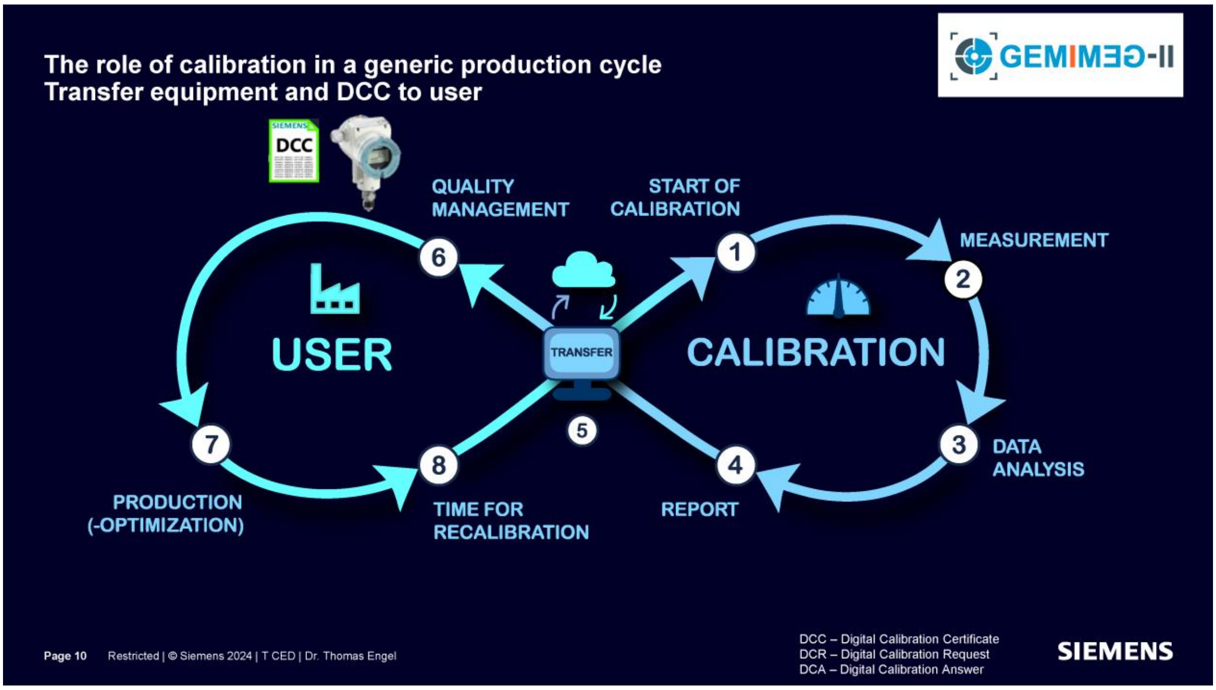
The role of calibration in a generic production cycle
Transfer equipment and DCC to user
GEMIMEG-II
DCC
QUALITY MANAGEMENT
START OF CALIBRATION
MEASUREMENT
USER
TRANSFER
CALIBRATION
DATA ANALYSIS
PRODUCTION (-OPTIMIZATION)
TIME FOR RECALIBRATION
REPORT
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Page 10
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DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer
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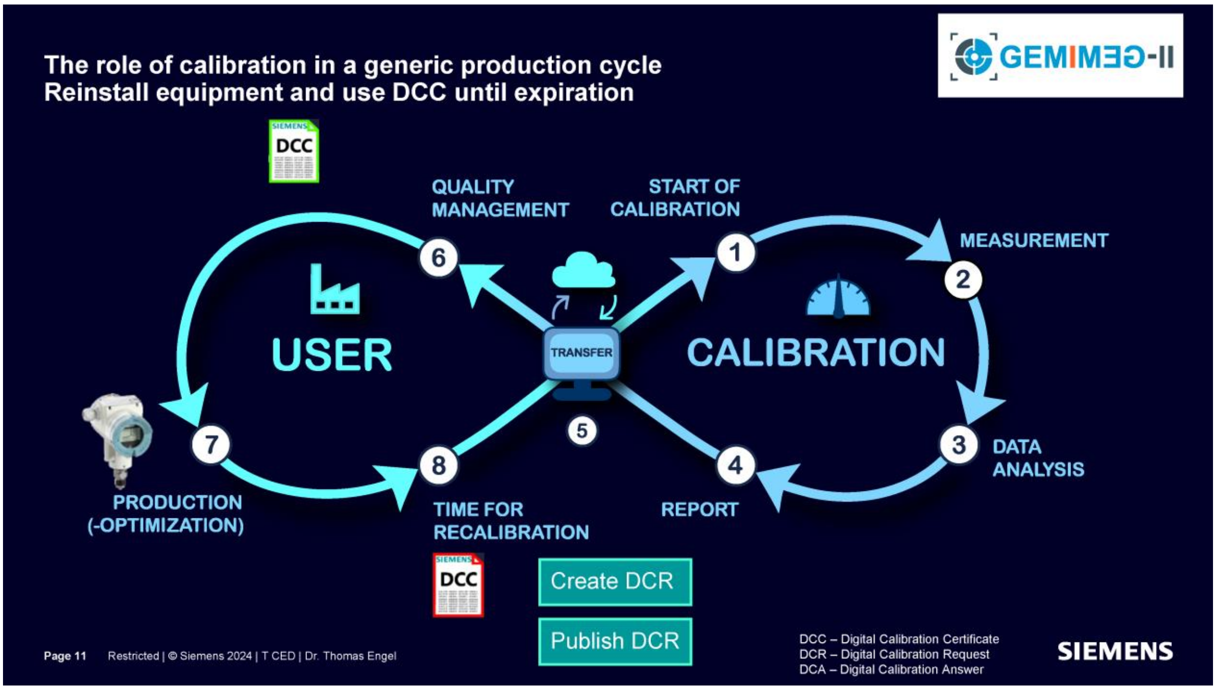

The role of calibration in a generic production cycle
Reinstall equipment and use DCC until expiration
GEMIMEG-II
DCC
QUALITY MANAGEMENT
START OF CALIBRATION
MEASUREMENT
USER
TRANSFER
CALIBRATION
DATA ANALYSIS
REPORT
PRODUCTION (-OPTIMIZATION)
TIME FOR RECALIBRATION
Create DCR
Publish DCR
DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer
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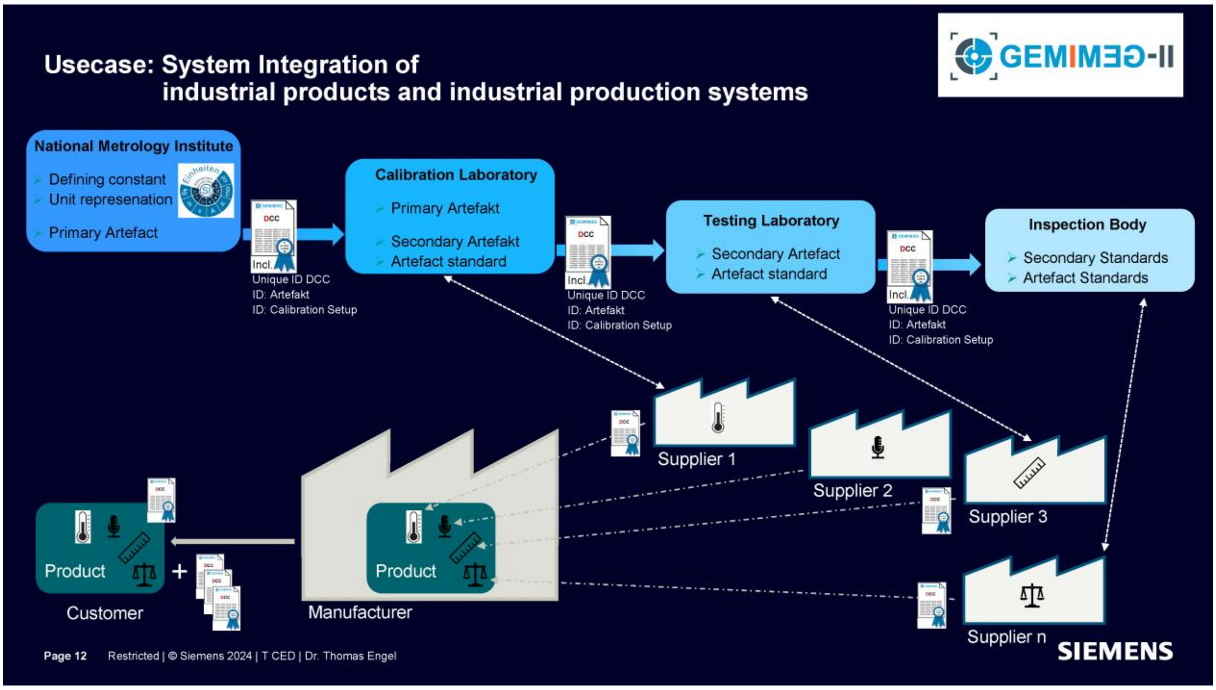

Usecase: System Integration of
industrial products and industrial production systems
GEMIMEG-II
National Metrology Institute
Defining constant
Unit represenation
Primary Artefact
Calibration Laboratory
Primary Artefakt
Secondary Artefakt
Artefact standard
Testing Laboratory
Secondary Artefact
Artefact standard
Inspection Body
Secondary Standards
Artefact Standards
Unique ID DCC
ID: Artefakt
ID: Calibration Setup
Supplier 1
Supplier 2
Supplier 3
Supplier n
Product
Customer
Manufacturer
Page 12
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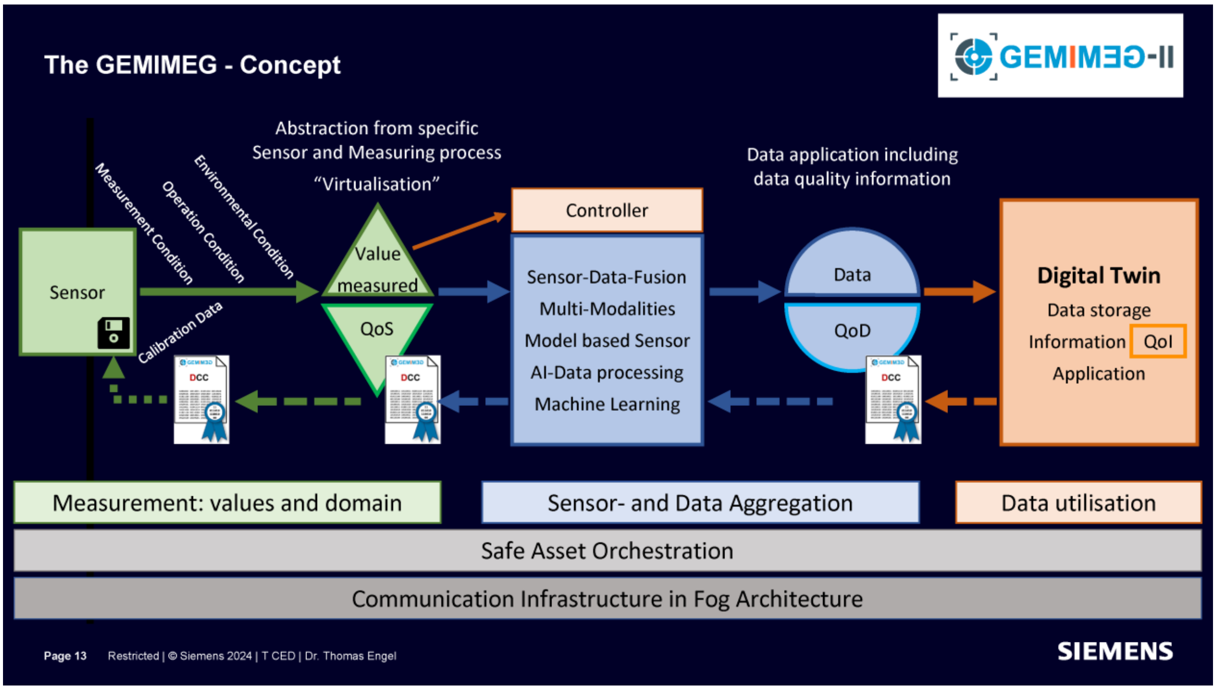
The GEMIMEG - Concept
GEMIMEG-II
Abstraction from specific
Sensor and Measuring process
"Virtualisation"
Measurement Condition
Operation Condition
Environmental Condition
Calibration Data
Sensor
Value
measured
QoS
DCC
Controller
Sensor-Data-Fusion
Multi-Modalities
Model based Sensor
AI-Data processing
Machine Learning
Data application including
data quality information
Data
QoD
Digital Twin
Data storage
Information
QoI
Application
Measurement: values and domain
Sensor- and Data Aggregation
Data utilisation
Safe Asset Orchestration
Communication Infrastructure in Fog Architecture
Page 13
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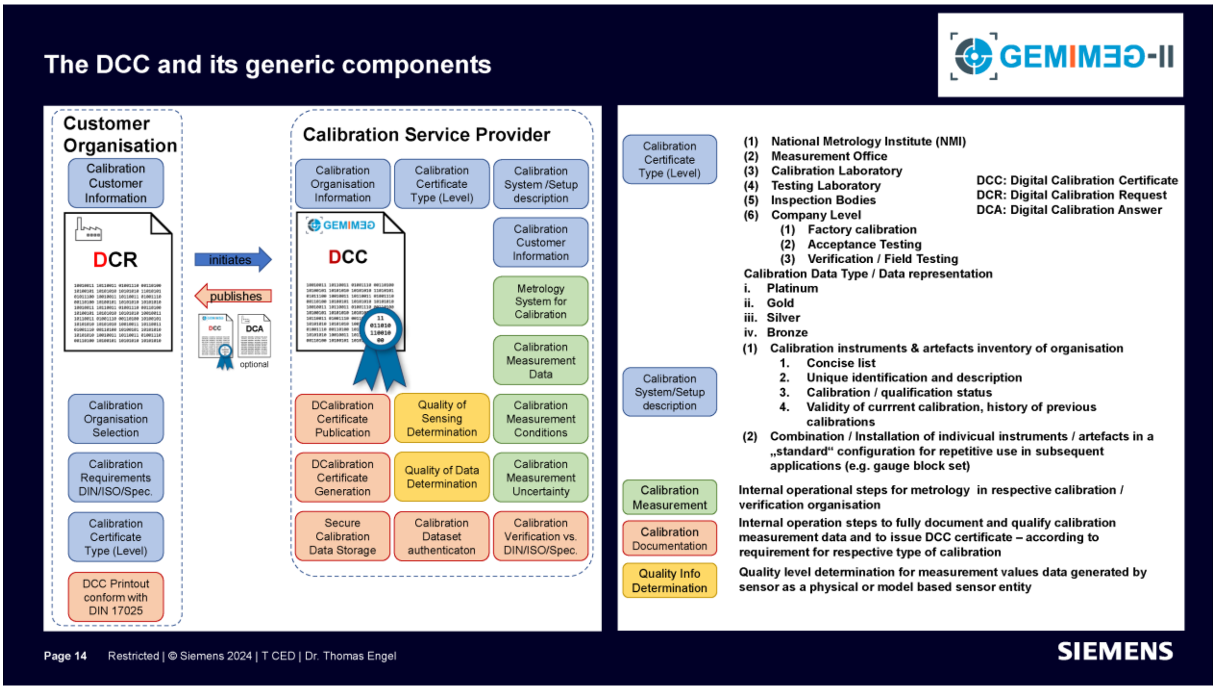
The DCC and its generic components
GEMIMEG-II
Customer Organisation
Calibration Customer Information
DCR
Calibration Organisation Selection
Calibration Requirements DIN/ISO/Spec.
Calibration Certificate Type (Level)
DCC Printout conform with DIN 17025
initiates
publishes
DCC
DCA
optional
Calibration Service Provider
Calibration Organisation Information
Calibration Certificate Type (Level)
Calibration System /Setup description
DCC
Calibration Customer Information
Metrology System for Calibration
Calibration Measurement Data
DCalibration Certificate Publication
Quality of Sensing Determination
Calibration Measurement Conditions
DCalibration Certificate Generation
Quality of Data Determination
Calibration Measurement Uncertainty
Secure Calibration Data Storage
Calibration Dataset authenticaton
Calibration Verification vs. DIN/ISO/Spec.
Calibration Certificate Type (Level)
(1) National Metrology Institute (NMI)
(2) Measurement Office
(3) Calibration Laboratory
(4) Testing Laboratory
(5) Inspection Bodies
(6) Company Level
(1) Factory calibration
(2) Acceptance Testing
(3) Verification / Field Testing
Calibration Data Type / Data representation
i. Platinum
ii. Gold
iii. Silver
iv. Bronze
DCC: Digital Calibration Certificate
DCR: Digital Calibration Request
DCA: Digital Calibration Answer
Calibration System/Setup description
(1) Calibration instruments & artefacts inventory of organisation
1. Concise list
2. Unique identification and description
3. Calibration / qualification status
4. Validity of currrent calibration, history of previous calibrations
(2) Combination / Installation of indivicual instruments / artefacts in a „standard" configuration for repetitive use in subsequent applications (e.g. gauge block set)
Calibration Measurement
Internal operational steps for metrology in respective calibration / verification organisation
Calibration Documentation
Internal operation steps to fully document and qualify calibration measurement data and to issue DCC certificate – according to requirement for respective type of calibration
Quality Info Determination
Quality level determination for measurement values data generated by sensor as a physical or model based sensor entity
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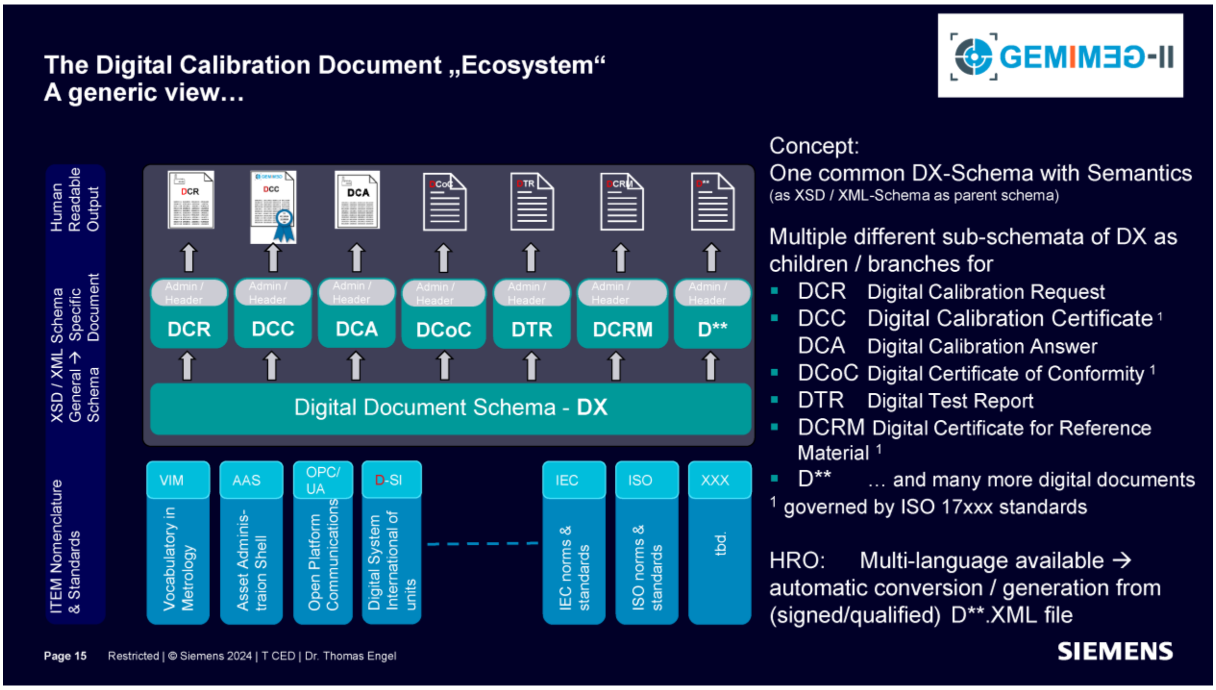
The Digital Calibration Document „Ecosystem“
A generic view…
GEMIMEG-II
Human Readable Output
XSD / XML Schema General → Specific Document Schema
ITEM Nomenclature & Standards
DCR
DCC
DCA
DCoC
DTR
DCRM
D**
Admin / Header
Digital Document Schema - DX
VIM
Vocabulatory in Metrology
AAS
Asset Adminis-traion Shell
OPC/ UA
Open Platform Communications
D-SI
Digital System International of units
IEC
IEC norms & standards
ISO
ISO norms & standards
XXX
tbd.
Concept:
One common DX-Schema with Semantics
(as XSD / XML-Schema as parent schema)
Multiple different sub-schemata of DX as children / branches for
DCR Digital Calibration Request
DCC Digital Calibration Certificate 1
DCA Digital Calibration Answer
DCoC Digital Certificate of Conformity 1
DTR Digital Test Report
DCRM Digital Certificate for Reference Material 1
D** … and many more digital documents
1 governed by ISO 17xxx standards
HRO: Multi-language available → automatic conversion / generation from (signed/qualified) D**.XML file
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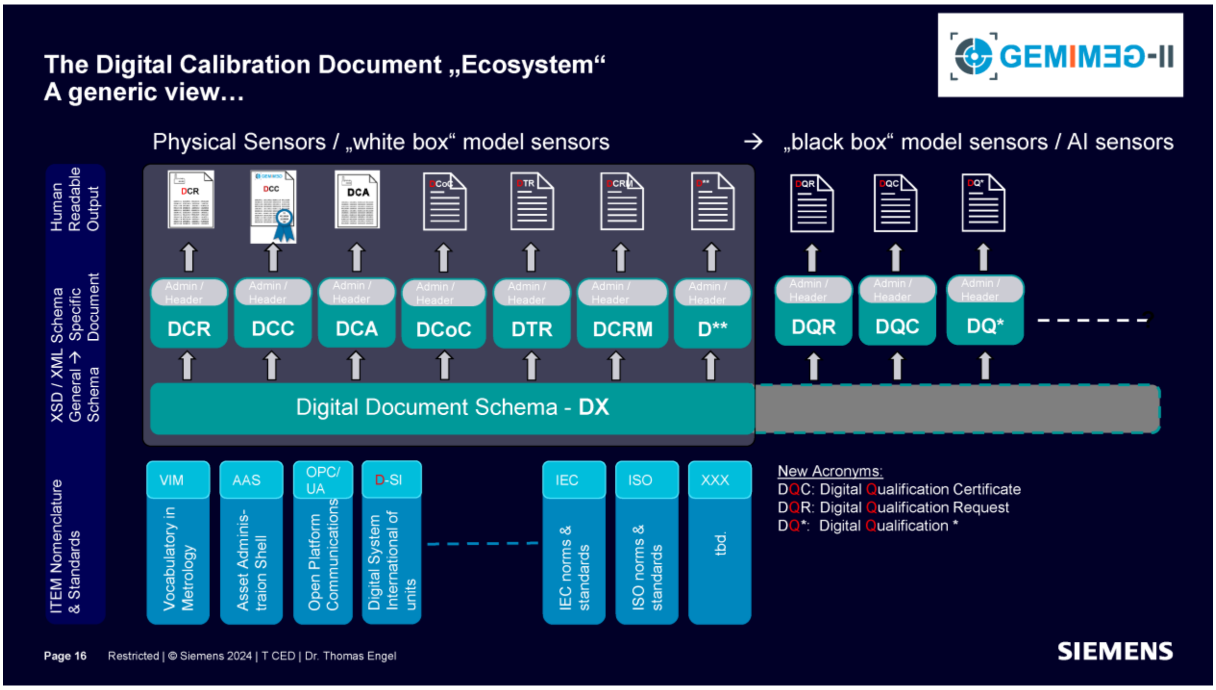
The Digital Calibration Document „Ecosystem“
A generic view…
GEMIMEG-II
Physical Sensors / „white box“ model sensors
→ „black box“ model sensors / AI sensors
Human Readable Output
XSD / XML Schema General → Specific Document Schema
ITEM Nomenclature & Standards
DCR
DCC
DCA
DCoC
DTR
DCRM
D**
DQR
DQC
DQ*
Admin / Header
Digital Document Schema - DX
VIM
Vocabulatory in Metrology
AAS
Asset Adminis-traion Shell
OPC/ UA
Open Platform Communications
D-SI
Digital System International of units
IEC
IEC norms & standards
ISO
ISO norms & standards
XXX
tbd.
New Acronyms:
DQC: Digital Qualification Certificate
DQR: Digital Qualification Request
DQ*: Digital Qualification *
Page 16
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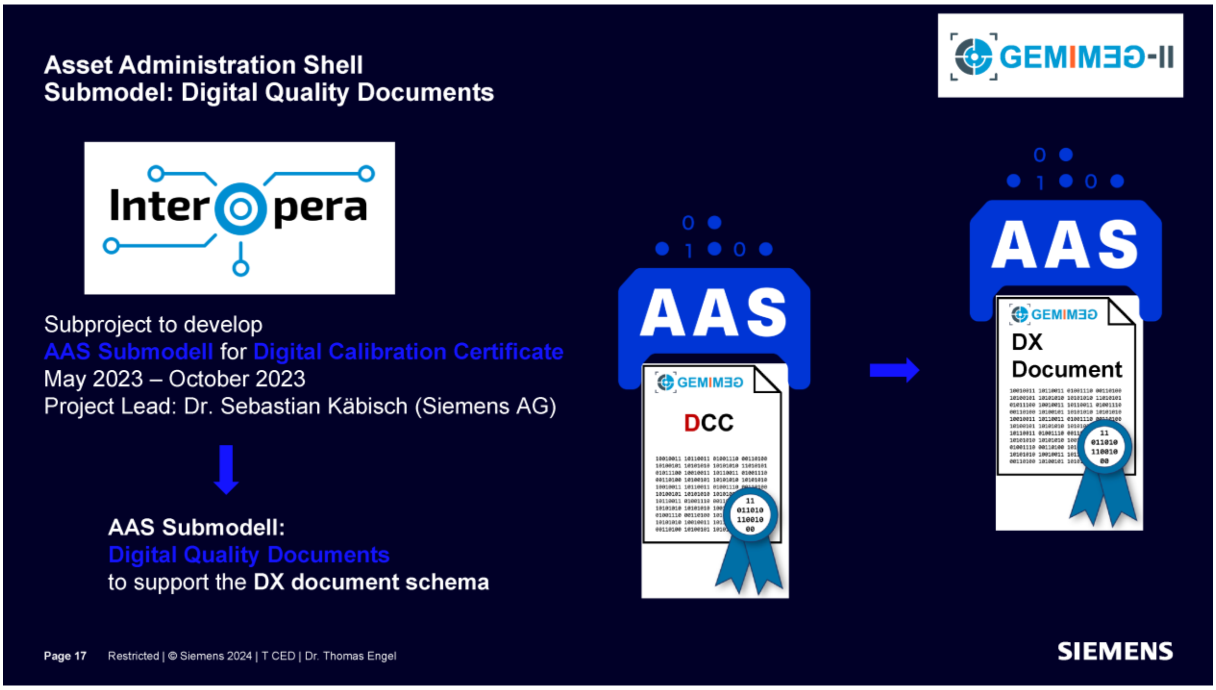
Asset Administration Shell
Submodel: Digital Quality Documents
GEMIMEG-II
InterOpera
Subproject to develop
AAS Submodell for Digital Calibration Certificate
May 2023 – October 2023
Project Lead: Dr. Sebastian Käbisch (Siemens AG)
AAS Submodell:
Digital Quality Documents
to support the DX document schema
AAS
DCC
AAS
DX
Document
Page 17
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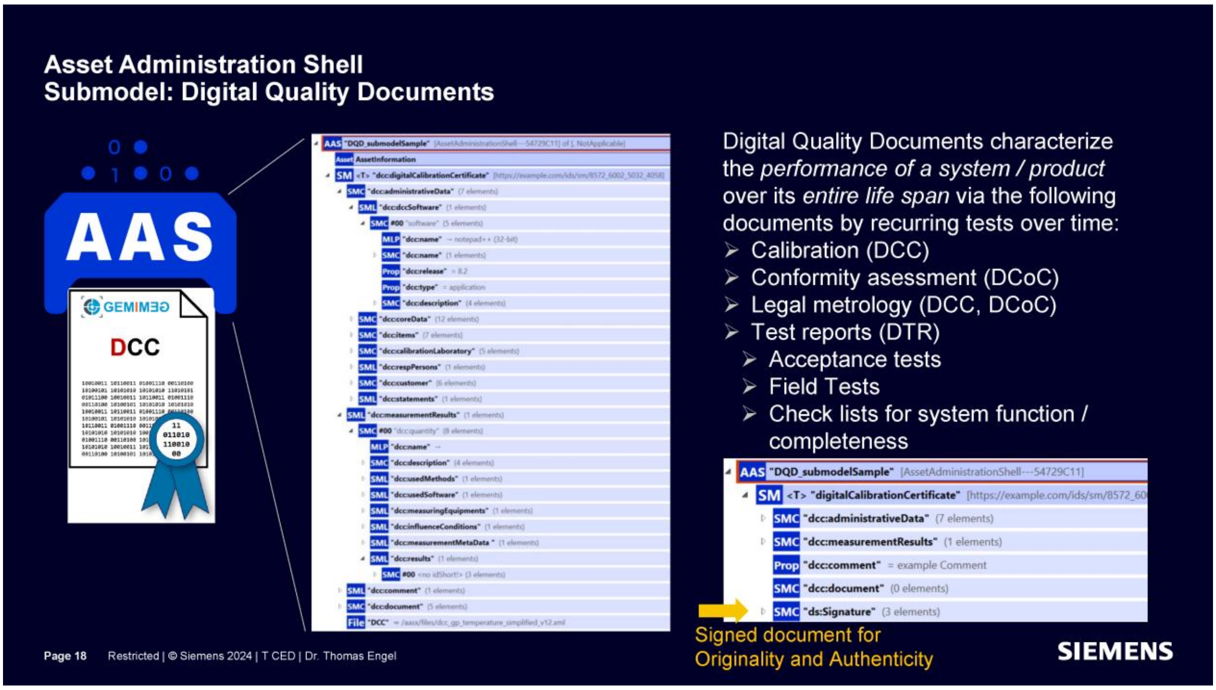
Asset Administration Shell
Submodel: Digital Quality Documents
AAS
DCC
Digital Quality Documents characterize the performance of a system / product over its entire life span via the following documents by recurring tests over time:
➢ Calibration (DCC)
➢ Conformity assessment (DCoC)
➢ Legal metrology (DCC, DCoC)
➢ Test reports (DTR)
➢ Acceptance tests
➢ Field Tests
➢ Check lists for system function / completeness
AAS "DQD_submodelSample" [AssetAdministrationShell---54729C11]
SM <T> "digitalCalibrationCertificate"
SMC "dcc:administrativeData" (7 elements)
SMC "dcc:measurementResults" (1 elements)
Prop "dcc:comment" = example Comment
SMC "dcc:document" (0 elements)
SMC "ds:Signature" (3 elements)
Signed document for
Originality and Authenticity
Page 18
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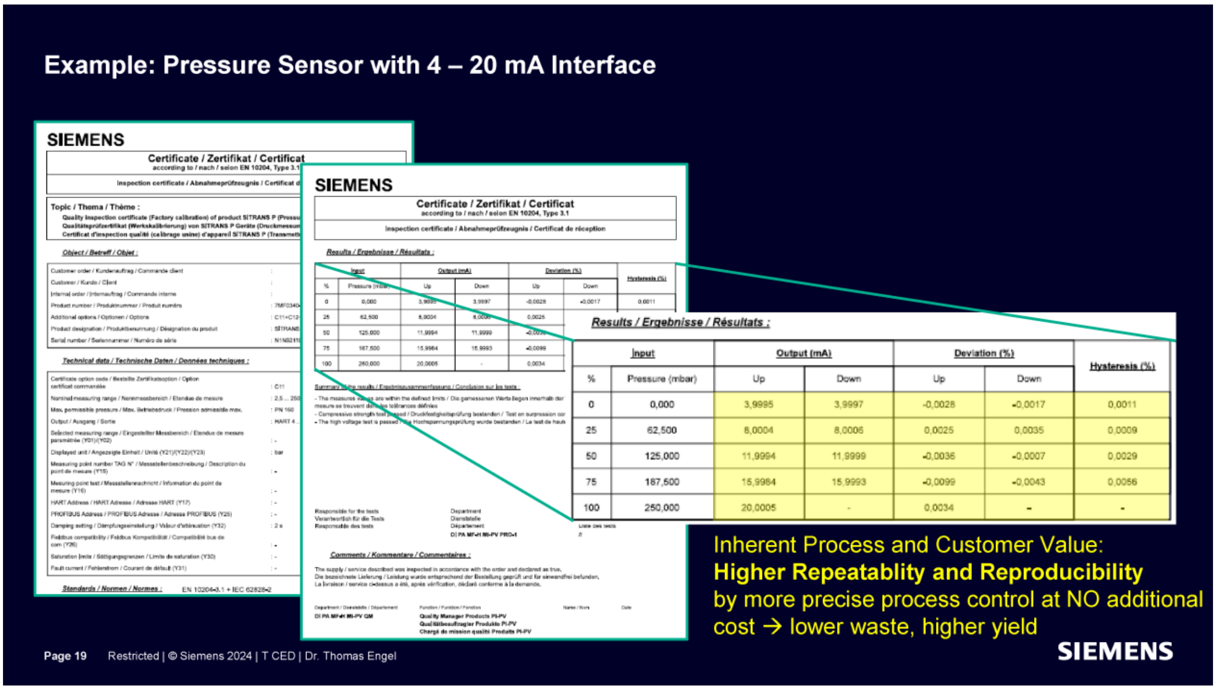
SIEMENS


Example: Pressure Sensor with 4 – 20 mA Interface
SIEMENS
Certificate / Zertifikat / Certificat
Results / Ergebnisse / Résultats :
Input
Output (mA)
Deviation (%)
Hysteresis (%)
% | Pressure (mbar) | Up | Down | Up | Down
0 | 0,000 | 3,9995 | 3,9997 | -0,0028 | -0,0017 | 0,0011
25 | 62,500 | 8,0004 | 8,0006 | 0,0025 | 0,0035 | 0,0009
50 | 125,000 | 11,9994 | 11,9999 | -0,0036 | -0,0007 | 0,0029
75 | 187,500 | 15,9984 | 15,9993 | -0,0099 | -0,0043 | 0,0056
100 | 250,000 | 20,0005 | - | 0,0034 | - | -
Inherent Process and Customer Value:
Higher Repeatablity and Reproducibility
by more precise process control at NO additional cost → lower waste, higher yield
Page 19
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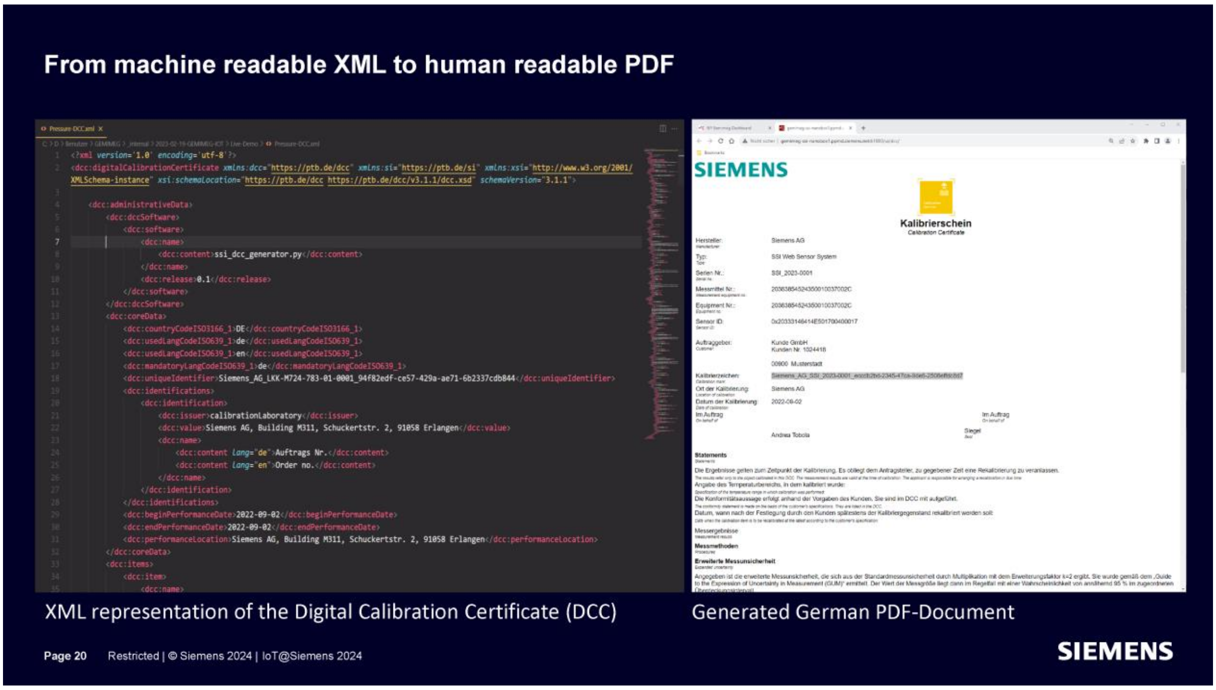
From machine readable XML to human readable PDF
SIEMENS
Kalibrierschein
XML representation of the Digital Calibration Certificate (DCC)
Generated German PDF-Document
Page 20
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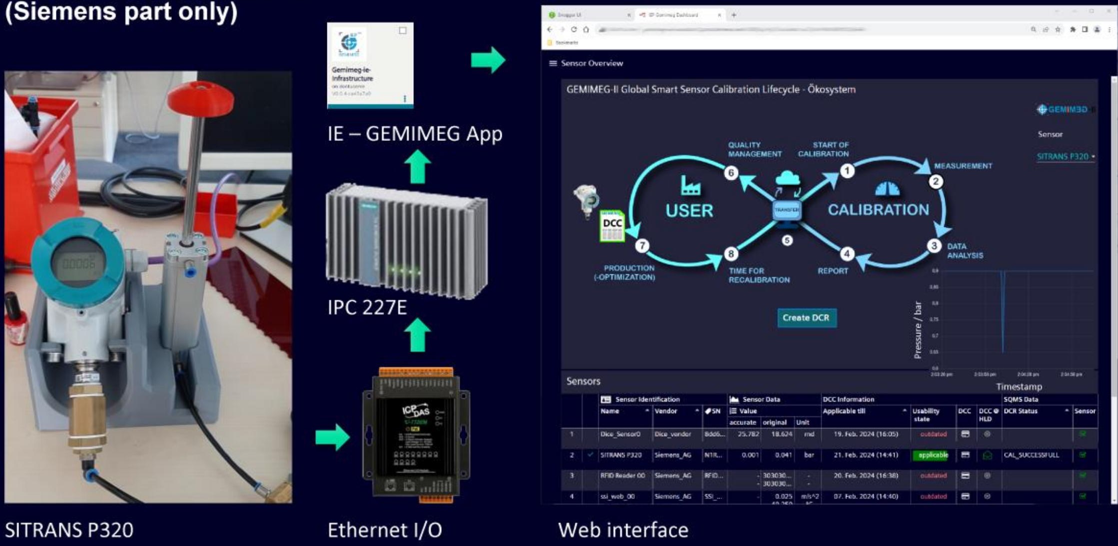
SIEMENS

GEMIMEG-II Demonstrator (Siemens part only)



SIEMENS

Quality Indicators: Quality of X
X: Sensing (S), Data (D), Information (I)

Example Use Case:
„Detection of display reading“

Camera Image Frame: QoS
- Illumination, dynamic range utilized
- Overall contrast

Image Data Analysis: QoD
- Region of interest
- Cropping of display
- Local contrast

Information Generation QoI
- AI: probality of segment reading/number
- AI: classification value

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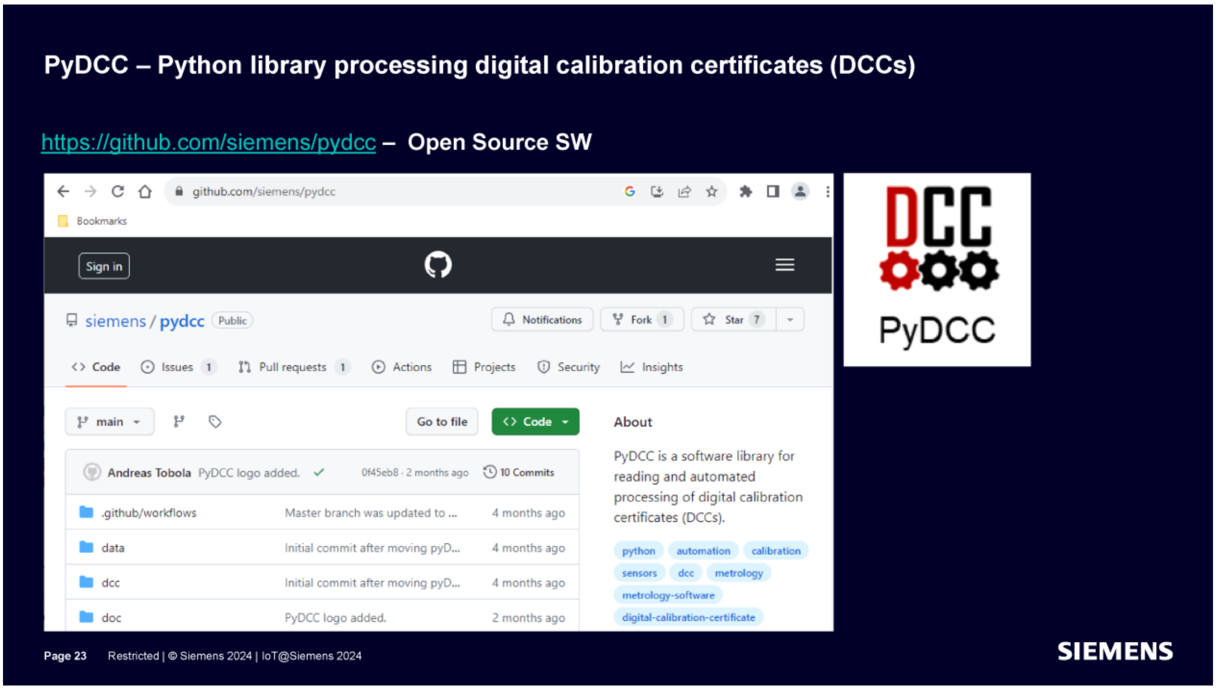
PyDCC – Python library processing digital calibration certificates (DCCs)
https://github.com/siemens/pydcc – Open Source SW
github.com/siemens/pydcc
siemens / pydcc Public
Code Issues 1 Pull requests 1 Actions Projects Security Insights
main
Go to file
Code
Andreas Tobola PyDCC logo added.
10 Commits
.github/workflows Master branch was updated to ... 4 months ago
data Initial commit after moving pyD... 4 months ago
dcc Initial commit after moving pyD... 4 months ago
doc PyDCC logo added. 2 months ago
About
PyDCC is a software library for reading and automated processing of digital calibration certificates (DCCs).
python automation calibration sensors dcc metrology metrology-software digital-calibration-certificate
DCC
PyDCC
Page 23 Restricted | © Siemens 2024 | IoT@Siemens 2024
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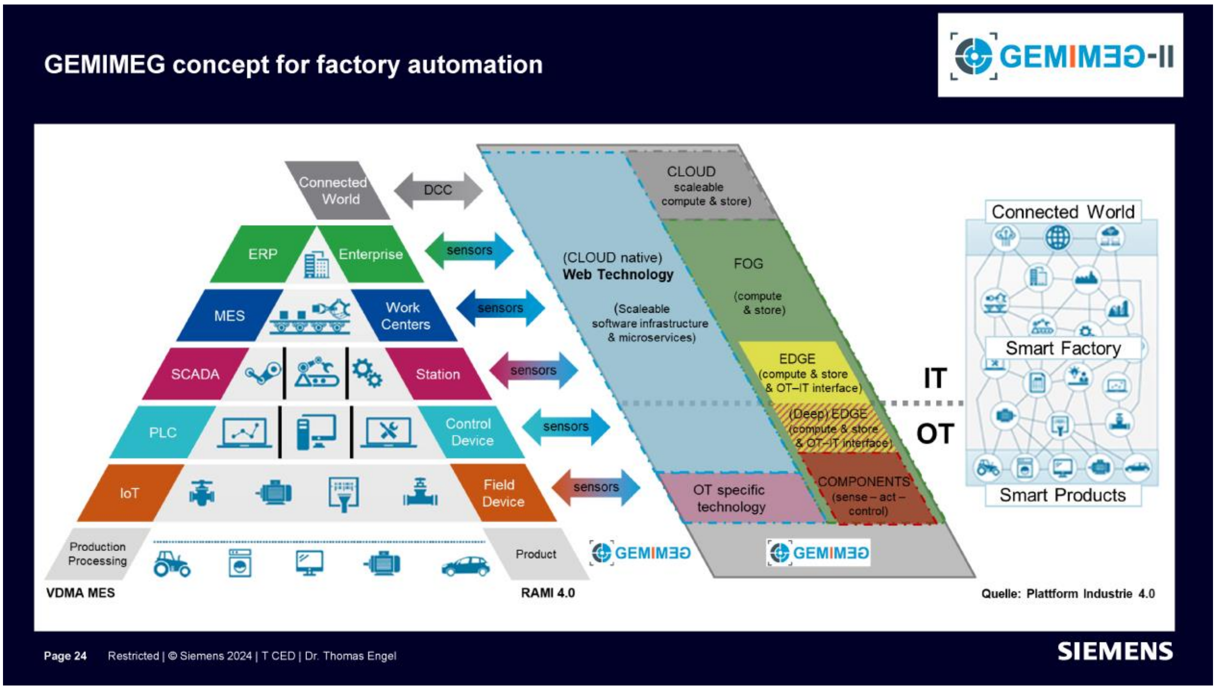
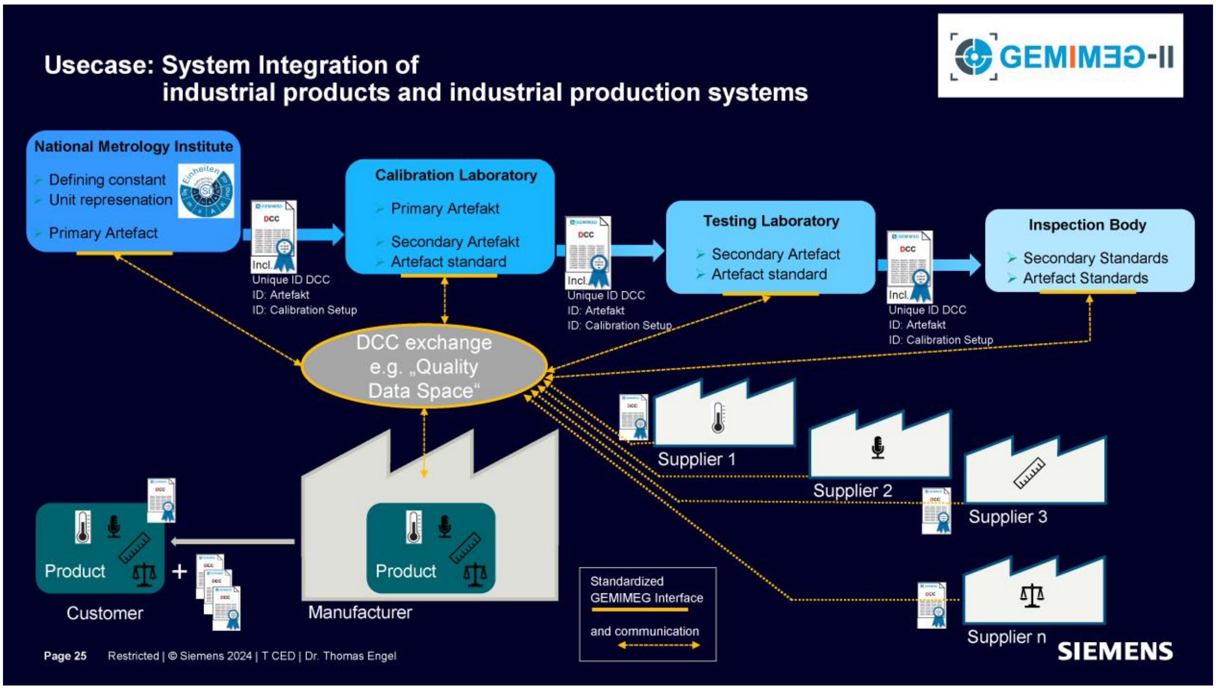

GEMIMEG concept for factory automation
GEMIMEG-II
Connected World
DCC
ERP
Enterprise
MES
Work Centers
SCADA
Station
PLC
Control Device
IoT
Field Device
sensors
Production Processing
Product
VDMA MES
RAMI 4.0
CLOUD scaleable compute & store)
(CLOUD native) Web Technology
(Scaleable software infrastructure & microservices)
FOG
(compute & store)
EDGE (compute & store & OT–IT interface)
(Deep) EDGE (compute & store & OT–IT interface)
OT specific technology
COMPONENTS (sense – act – control)
IT
OT
Connected World
Smart Factory
Smart Products
Quelle: Plattform Industrie 4.0
Page 24 Restricted | © Siemens 2024 | T CED | Dr. Thomas Engel
SIEMENS


GEMIMEG-II
Usecase: System Integration of
industrial products and industrial production systems
National Metrology Institute
Defining constant
Unit representation
Primary Artefact
Calibration Laboratory
Primary Artefakt
Secondary Artefakt
Artefact standard
Testing Laboratory
Secondary Artefact
Artefact standard
Inspection Body
Secondary Standards
Artefact Standards
DCC
Incl.
Unique ID DCC
ID: Artefakt
ID: Calibration Setup
DCC exchange
e.g. „Quality
Data Space“
Supplier 1
Supplier 2
Supplier 3
Supplier n
Product
Customer
Product
Manufacturer
Standardized
GEMIMEG Interface
and communication
Page 25
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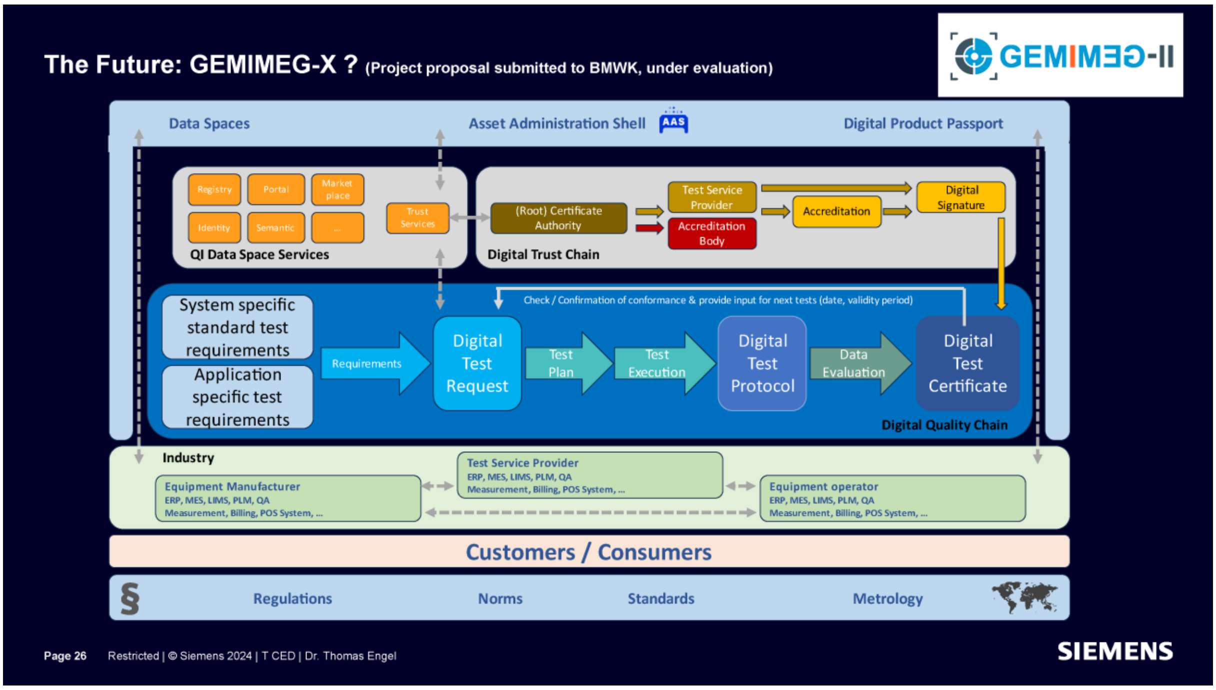
The Future: GEMIMEG-X ? (Project proposal submitted to BMWK, under evaluation)
GEMIMEG-II
Data Spaces
Asset Administration Shell
AAS
Digital Product Passport
Registry
Portal
Market place
Identity
Semantic
...
Trust Services
QI Data Space Services
(Root) Certificate Authority
Test Service Provider
Accreditation Body
Accreditation
Digital Signature
Digital Trust Chain
Check / Confirmation of conformance & provide input for next tests (date, validity period)
System specific standard test requirements
Application specific test requirements
Requirements
Digital Test Request
Test Plan
Test Execution
Digital Test Protocol
Data Evaluation
Digital Test Certificate
Digital Quality Chain
Industry
Test Service Provider
ERP, MES, LIMS, PLM, QA
Measurement, Billing, POS System, ...
Equipment Manufacturer
ERP, MES, LIMS, PLM, QA
Measurement, Billing, POS System, ...
Equipment operator
ERP, MES, LIMS, PLM, QA
Measurement, Billing, POS System, ...
Customers / Consumers
§
Regulations
Norms
Standards
Metrology
Page 26
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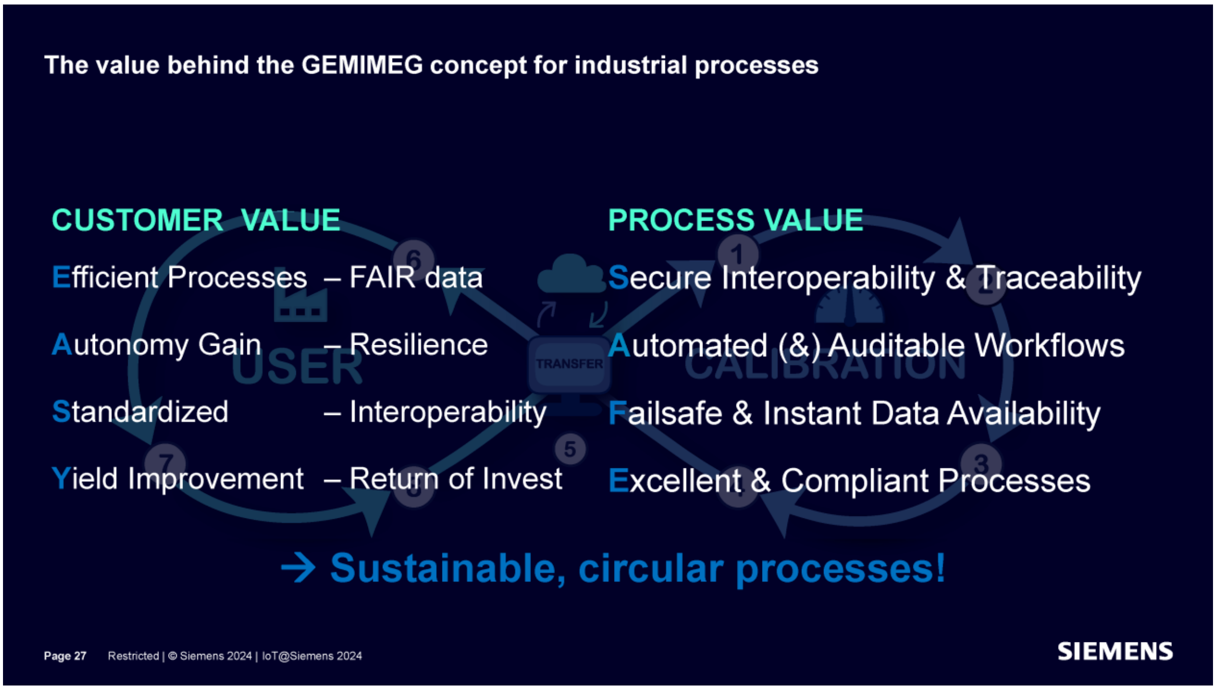
The value behind the GEMIMEG concept for industrial processes
CUSTOMER VALUE
Efficient Processes – FAIR data
Autonomy Gain – Resilience
Standardized – Interoperability
Yield Improvement – Return of Invest
PROCESS VALUE
Secure Interoperability & Traceability
Automated (&) Auditable Workflows
Failsafe & Instant Data Availability
Excellent & Compliant Processes
→ Sustainable, circular processes!
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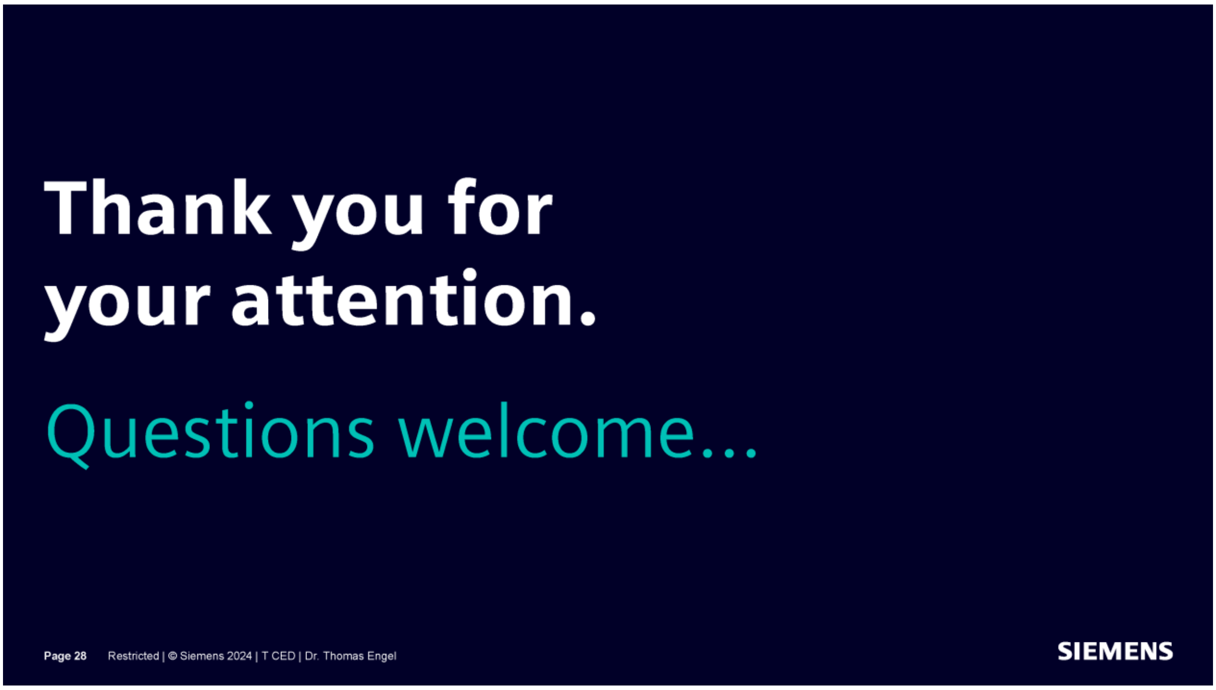
Thank you for your attention.
Questions welcome...
Page 28
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[***Back to “Table of Contents” above***]

Session “Tools & Sofware I” (Chair: David Balslev-Harder)

17 Machine accessible storage of RefTypes with TemaTres

Presenting author: Muhammed-Ali Demir, PTB Germany
Email: muhammed.demir@ptb.de
Additional authors: Daniel Hutzschenreuter Daniel.Hutzschenreuter@ptb.de, Thomas Krah thomas.krah@ptb.de, Shanna Schönhals shanna.schoenhals@ptb.de, Moritz Jordan moritz.jordan@ptb.de, Benjamin Gloger benjamin.gloger@ptb.de

Abstract

RefTypes of DCCs are important for retrieving data out of DCCs and especially making DCCs machine readable, interpretable and executable. RefTypes must be accessible for humans and machines. In this paper we show a solution for making refTypes retrievable for humans and machines by using TemaTres.

As a motivation we will have a look at machine interpretability and machine executability regarding the DCC. We will have a look at requirements for RefTypes e.g., RefTypes must be accessible via PIDs etc (see Findable in FAIR principles). Then we will have a look at TemaTres in general. TemaTres consists of a data base and a web frontend. The web front end offers an api for machines and a sparql endpoint.

When the community agrees on a certain RefType consisting of a definition and rules applying to the RefType, the RefType will be stored via TemaTres and is accessible globally.

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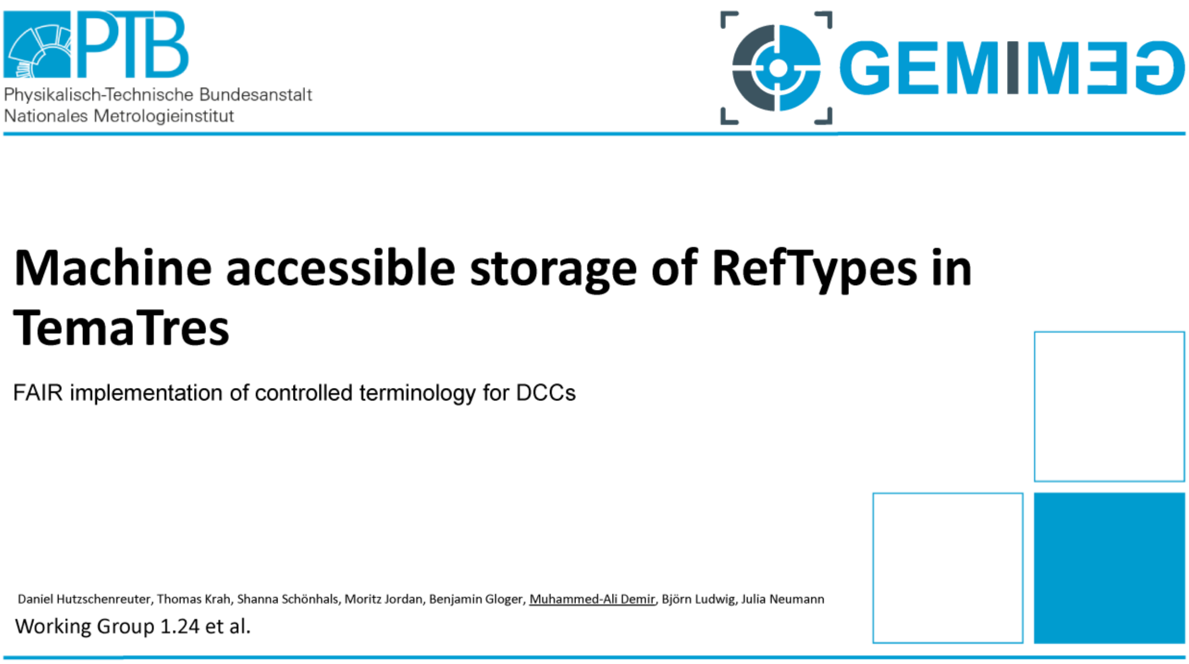
Presentation of Muhammed-Ali Demir



Content

- Motivation
  - Machine interpretable/ controllable content
  - Requirements (incl. FAIR)
- RefTypes in the DCC
- TemaTres for RefTypes
  - Structure (RefTypes & Rules)
  - TemaTres MetaData
  - TemaTres API/ SPARQLE
- Review process for basic RefTypes

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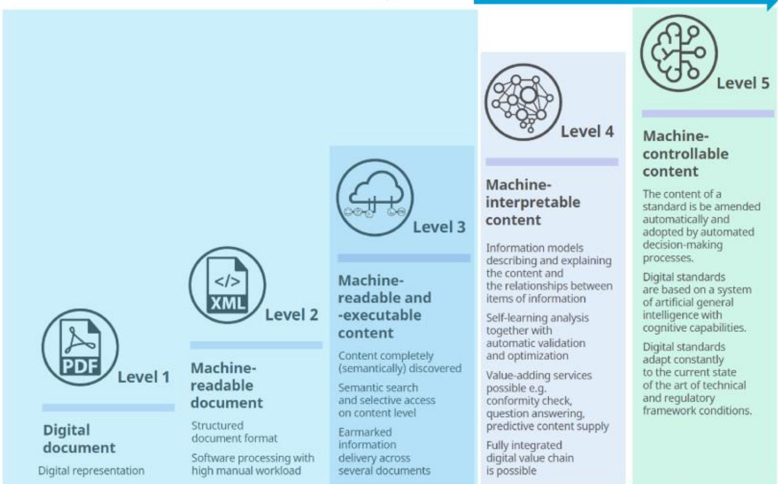
Machine interpretable/ controllable content

- Levels of machine readability



Semantically clean vocabulary for measurands etc. necessary (at latest at Level 4)

IDIS Whitepaper "SCENARIOS FOR DIGITIZING STANDARDIZATION AND STANDARDS" 2021

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Requirements (incl. FAIR)

- Semantically clean vocabularies for measurands etc. ✓ Thesaurus
- FAIR principles
  - Findable: e.g. data accessible via PIDs ✓ URL = PID
  - Accessible: e.g. data accessible by id with standardized comm. protocol ✓ HTTPS/ SPARQL
  - Interoperable: e.g. with other domains/ vocabularies (VIM, Smart norms, …) ✓ Exact Match
  - Reusable: e.g. data well described/ detailed ✓ A lot of options for detailed data/ metadata
- Use of a high level semantic
  - Thesaurus (dictionary for terms/ concepts) with SKOS (compatible to ontologies) ✓ Thes.
  - or Ontology with OWL2
- Tool with GUI vor humans and API for machines (enabling end-to-end automation) ✓ end-to-end has to be tested
- Proposal: TemaTres

RefTypes in the DCC

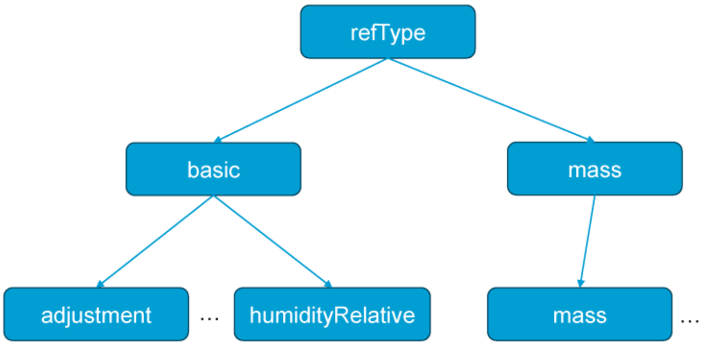
```xml
<dcc:influenceCondition refType="basic_humidityRelative">
    <dcc:name>
        <dcc:content lang="de">Umgebungsbedingung relative Luftfeuchte</dcc:content>
        <dcc:content lang="en">Ambient condition relative humidity</dcc:content>
    </dcc:name>
    <dcc:description>
        <dcc:content lang="de">Diese Werte wurden nicht gemessen, sondern wurden anhand der typischen Wetterbed
        <dcc:content lang="en">These values were not measured, but were given based on typical weather conditio
    </dcc:description>
    <dcc:data>
</dcc:influenceCondition>
```

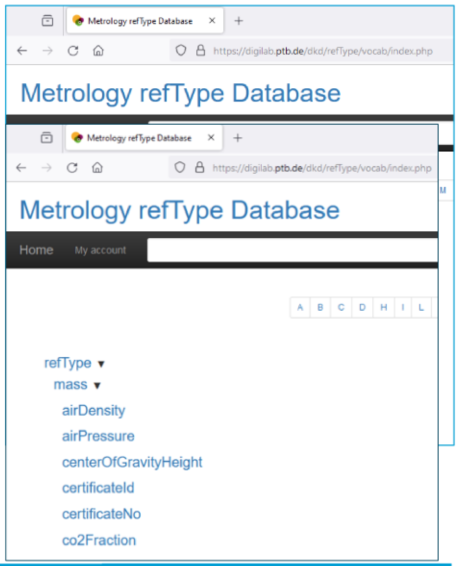
```xml
<dcc:refTypeDefinitions>
    <dcc:refTypeDefinition>
        <dcc:name>
            <dcc:content lang="en">Basic refTypes</dcc:content>
        </dcc:name>
        <dcc:namespace>basic</dcc:namespace>
        <dcc:link>???</dcc:link>
    </dcc:refTypeDefinition>
```

Where can we find the information about refTypes?

Structure of the TemaTres DB - RefTypes

- First aspect: RefTypes





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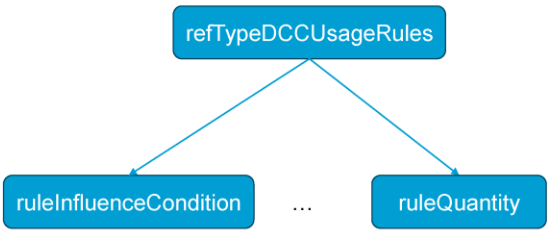
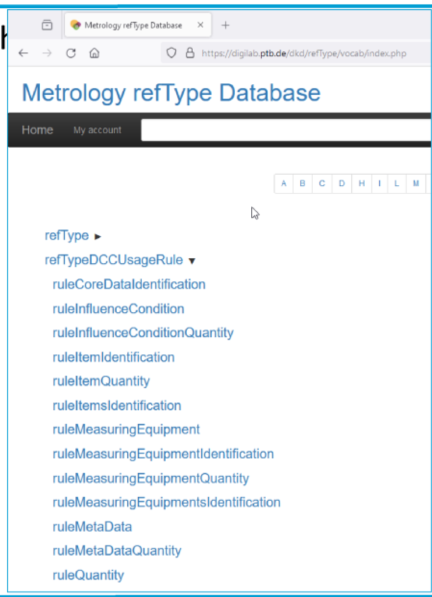
Structure of the TemaTres DB - Rules

- Second aspect: where to apply the RefTypes in th





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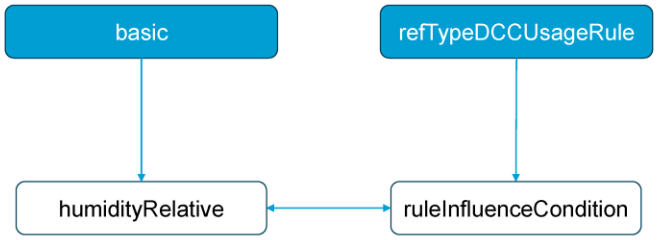
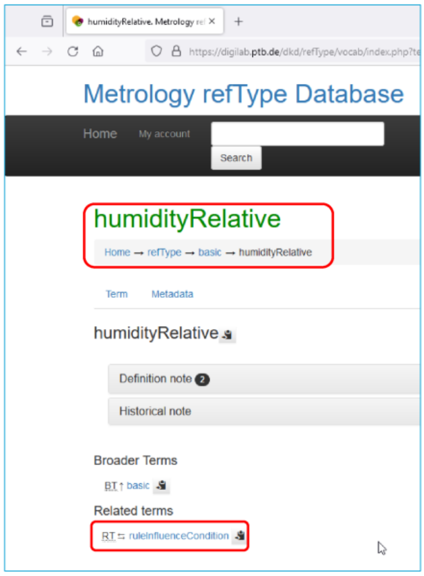
Structure of the TemaTres DB - Combination

- Third aspect: Combination of RefTypes & rules





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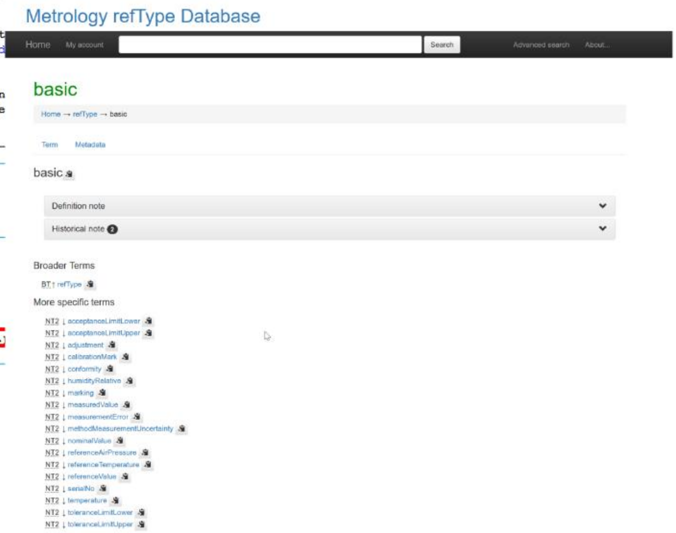
RefTypes in the DCC



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TemaTres Metadata – How to access

humidityRelative

Home → refType → basic → humidityRelative

Term | Metadata

Date of creation	15-Nov-2023
Accepted term	15-Nov-2023
Descendant terms	0
ARK	ark:/99152/t3k957dkx9ew8j
More specific terms	0
Alternative terms	0
Related terms	1
Notes	3
Metadata	BS8723-5 DC MADS SKOS-Core JSON-LD
Search	

show sche

TemaTres Metadata – PIDs

Mit dieser XML-Datei sind anscheinend keine Style-Informationen verknüpft. Nachfolgend wird die Baun


```xml
–<rdf:RDF>
  –<skos:ConceptScheme rdf:about="https://digilab.ptb.de/dkd/refType/vocab/">
     <dc:title>Metrology refType Database</dc:title>
     <dc:creator>German Calibration Service (DKD)</dc:creator>
    –<dc:contributor>
       Thomas Krah, Daniel Hutzschenreuter, Benjamin Gloger, Muhammed-Ali Demir, Moritz Jordan
     </dc:contributor>
    –<dc:publisher>
       Deutscher Kalibrierdienst (German Calibration Service)
     </dc:publisher>
     <dc:rights/>
    –<dc:subject>
       metrology, reference types, digital calibration certificate, certificate of conformity
     </dc:subject>
     <dc:description> </dc:description>
     <dc:date>2023-06-19</dc:date>
     <dct:modified>2024-02-12 10:58:50</dct:modified>
     <dc:language>en-EN</dc:language>
   </skos:ConceptScheme>
  –<skos:Concept rdf:about="https://digilab.ptb.de/dkd/refType/vocab/xml.php?skosTema=101">
     <skos:prefLabel xml:lang="en-EN">humidityRelative</skos:prefLabel>
     <skos:definition xml:lang="en-EN">ambient relative air humidity </skos:definition>
     <skos:definition xml:lang="de-DE">Relative Luftfeuchte der Umgebung. </skos:definition>
     <skos:historyNote xml:lang="en-EN"> 2023-11-15 Created </skos:historyNote>
     <skos:inScheme rdf:resource="https://digilab.ptb.de/dkd/refType/vocab/"/>
     <skos:related rdf:resource="https://digilab.ptb.de/dkd/refType/vocab/xml.php?skosTema=12"/>
     <skos:broader rdf:resource="https://digilab.ptb.de/dkd/refType/vocab/xml.php?skosTema=2"/>
     <dct:created>2023-11-15 14:13:31</dct:created>
   </skos:Concept>
 </rdf:RDF>
```


PID of the RefType e.g. basic_humidityRelative

TemaTres Metadata – PIDs

Mit dieser XML-Datei sind anscheinend keine Style-Informationen verknüpft. Nachfolgend wird die Baun


```xml
-<rdf:RDF>
  -<skos:ConceptScheme rdf:about="https://digilab.ptb.de/dkd/refType/vocab/">
    <dc:title>Metrology refType Database</dc:title>
    <dc:creator>German Calibration Service (DKD)</dc:creator>
    -<dc:contributor>
      Thomas Krah, Daniel Hutzschenreuter, Benjamin Gloger, Muhammed-Ali Demir, Moritz Jordan
    </dc:contributor>
    -<dc:publisher>
      Deutscher Kalibrierdienst (German Calibration Service)
    </dc:publisher>
    <dc:rights/>
    -<dc:subject>
      metrology, reference types, digital calibration certificate, certificate of conformity
    </dc:subject>
    <dc:description> </dc:description>
    <dc:date>2023-06-19</dc:date>
    <dct:modified>2024-02-12 10:58:50</dct:modified>
    <dc:language>en-EN</dc:language>
  </skos:ConceptScheme>
  -<skos:Concept rdf:about="https://digilab.ptb.de/dkd/refType/vocab/xml.php?skosTema=101">
    <skos:prefLabel xml:lang="en-EN">humidityRelative</skos:prefLabel>
    <skos:definition xml:lang="en-EN">ambient relative air humidity </skos:definition>
    <skos:definition xml:lang="de-DE">Relative Luftfeuchte der Umgebung. </skos:definition>
    <skos:historyNote xml:lang="en-EN"> 2023-11-15 Created </skos:historyNote>
    <skos:inScheme rdf:resource="https://digilab.ptb.de/dkd/refType/vocab/"/>
    <skos:related rdf:resource="https://digilab.ptb.de/dkd/refType/vocab/xml.php?skosTema=12"/>
    <skos:broader rdf:resource="https://digilab.ptb.de/dkd/refType/vocab/xml.php?skosTema=2"/>
    <dct:created>2023-11-15 14:13:31</dct:created>
  </skos:Concept>
</rdf:RDF>
```


PID of the rule, where this refType can/has to be used e.g. in influence conditions

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TemaTres Metadata – PIDs

Mit dieser XML-Datei sind anscheinend keine Style-Informationen verknüpft. Nachfolgend wird die Baun


```xml
-<rdf:RDF>
  -<skos:ConceptScheme rdf:about="https://digilab.ptb.de/dkd/refType/vocab/">
    <dc:title>Metrology refType Database</dc:title>
    <dc:creator>German Calibration Service (DKD)</dc:creator>
    -<dc:contributor>
      Thomas Krah, Daniel Hutzschenreuter, Benjamin Gloger, Muhammed-Ali Demir, Moritz Jordan
    </dc:contributor>
    -<dc:publisher>
      Deutscher Kalibrierdienst (German Calibration Service)
    </dc:publisher>
    <dc:rights/>
    -<dc:subject>
      metrology, reference types, digital calibration certificate, certificate of conformity
    </dc:subject>
    <dc:description> </dc:description>
    <dc:date>2023-06-19</dc:date>
    <dct:modified>2024-02-12 10:58:50</dct:modified>
    <dc:language>en-EN</dc:language>
  </skos:ConceptScheme>
  -<skos:Concept rdf:about="https://digilab.ptb.de/dkd/refType/vocab/xml.php?skosTema=101">
    <skos:prefLabel xml:lang="en-EN">humidityRelative</skos:prefLabel>
    <skos:definition xml:lang="en-EN">ambient relative air humidity </skos:definition>
    <skos:definition xml:lang="de-DE">Relative Luftfeuchte der Umgebung. </skos:definition>
    <skos:historyNote xml:lang="en-EN"> 2023-11-15 Created </skos:historyNote>
    <skos:inScheme rdf:resource="https://digilab.ptb.de/dkd/refType/vocab/"/>
    <skos:related rdf:resource="https://digilab.ptb.de/dkd/refType/vocab/xml.php?skosTema=12"/>
    <skos:broader rdf:resource="https://digilab.ptb.de/dkd/refType/vocab/xml.php?skosTema=2"/>
    <dct:created>2023-11-15 14:13:31</dct:created>
  </skos:Concept>
</rdf:RDF>
```


PID of the RefType namespace e.g. basic

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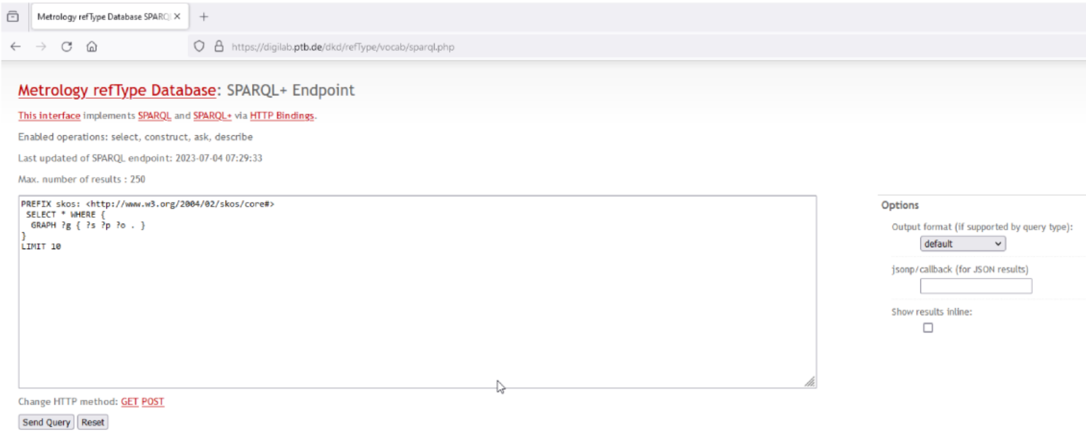
TemaTres API/ SPARQLE



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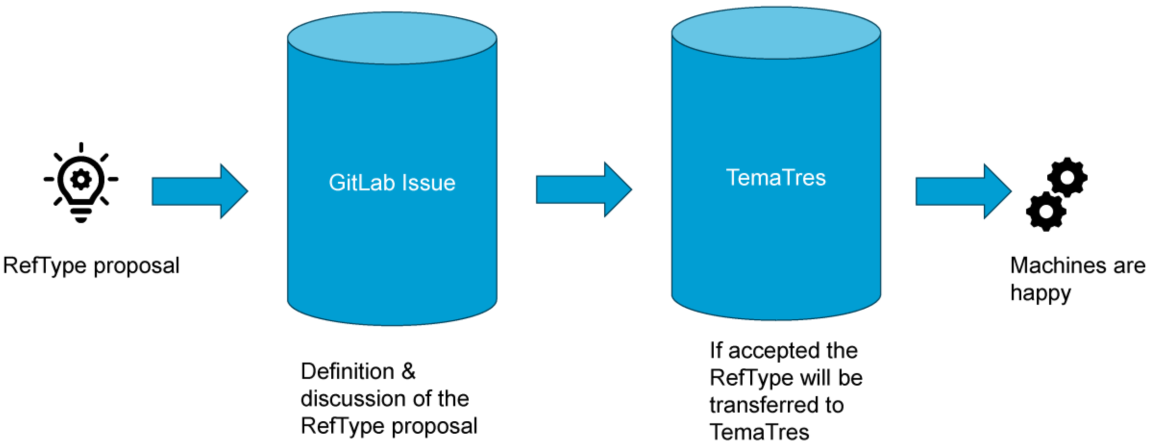
Review process for basic RefTypes

- Review of RefType proposals in cross-sectional group of DKD



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Try it Yourself!

TemaTres for RefTypes:
https://digilab.ptb.de/dkd/refType/vocab/index.php

Information about TemaTres:
https://vocabularyserver.com/web/

Skos:
https://www.w3.org/2009/08/skos-reference/skos.html

PTB
Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

GEMIMEG

Daniel Hutzschenreuter
Phone: +49 531 592-9420
Email: daniel.hutzschenreuter@ptb.de

Shanna Schönhals
Phone: +49 531 592-1240
Email: shanna.schoenhals@ptb.de

Moritz Jordan
Phone: +49 531 592-1245
Email: moritz.jordan@ptb.de

Thomas Krah
+49 531 592-9451
thomas.krah@ptb.de

Benjamin Gloger
+49 531 592-1019
benjamin.gloger@ptb.de

Muhammed-Ali Demir
Phone: +49 531 592-1241
muhammed.demir@ptb.de

Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

Thank you for your attention!

Do you have any questions or comments?

Daniel Hutzschenreuter, Thomas Krah, Shanna Schönhals, Moritz Jordan, Benjamin Gloger, Muhammed-Ali Demir, Björn Ludwig, Julia Neumann
Working Group 1.24 et al.

Back to "Table of Contents" above

18 The practicality of extracting data from a DCC – development of an interpretation and demonstration tool.

Presenting author: Jonas Vind, DTI Danish Technological Institute, Denmark
Email: jvin@teknologisk.dk

Abstract

As the calibration laboratories across the globe unlock how to generate digital calibration certificates (DCC) another problem must be solved from the customer's point of view: His or her main problem lies within reading, mapping and understanding the data that the calibration laboratories have filled in their own DCC template according to the common schema. Even though it is well structured, it can be difficult to know where to start and how do you do it efficiently.

We, at Danish Technological Institute (DTI), have created our own interpretation tool as a parallel version of the Gemimeg tool but with the focus on presentation of data that are relevant to the customer. In our tool we minimize the administrative data to only relevant for the customer while showcasing what is important for them: the calibration results. The emphasis of this study is to showcase our process when extracting data from DCC's and mapping it onto our interpretation tool. Through this study, we will also describe which problems we encountered and still have when expanding the reading algorithm to DCC's from multiple different companies. This will exemplify how DCC's can vary and how one may remedy this.

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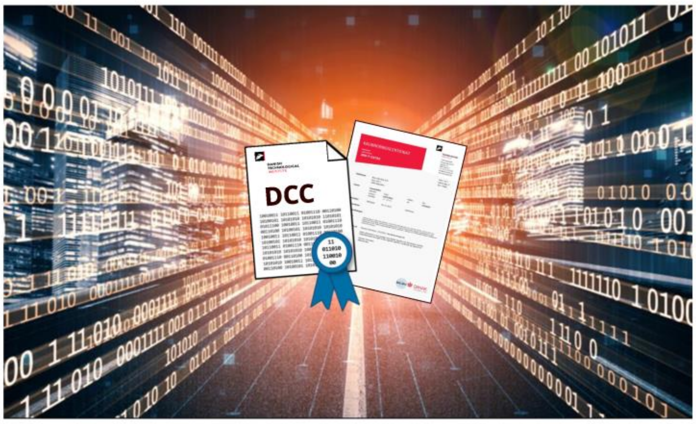
Presentation of Jonas Vind

Outline

- Who are we?
- Motivation
- The tools we build
- Learnings and ideas
- Improvements to the DCC format



Last years presentation: Link

Teknologisk Institut

Who are we?

- Self-owned non-profit institute with +1000 employees in Denmark
- Designated Institute (DI) for contact thermometry, water content, flow, anemometry and geometry
- Calibration and Metrology services also include pressure, force, humidity, mass, hardness and DC electricity
- > 75.000 pieces of equipment calibrated for more than 3000 customers per year
- Accredited by The Danish Accreditation Service, DANAK, member of EA (European Co-operation for Accreditation) and ILAC (International Laboratory Accreditation)

Teknologisk Institut

Who are we?

Jonas Emil Vind
- Background in Engineering
- Works with calibrations

Jakob Fester
- Background in Physics
- Works with metrology

Hans Christian
- Background in software
- Works with IT development

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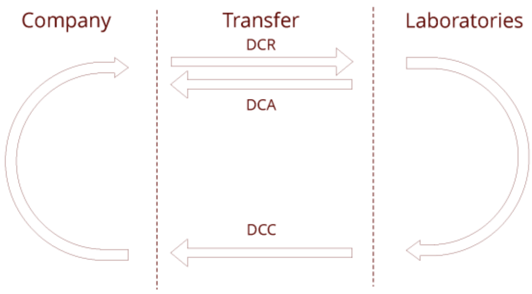
Motivation

- Automation of **internal** calibrations and calibration orders
- Implementation of DCC and DCR services for calibration **customers**
- Facilitate uptake in Danish Industry in coordination and collaboration with partners in the Danish system of Research and Technology Organizations ("GTS institutes") as well as by participating in EURAMET working groups and projects
- Collaborate with Danish companies to provide input to the **international** harmonization of DCC and DCR
- Create a discussion between **users**, **developers** and **calibrations laboratories**



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The tools we build

- External page that allows for external use
  - Made for Danish partners
    - All text is Danish but can be translated through a browser plugin
  - Focus was to build a showcasing tool
    - A simpler version of GEMIMEG
- Requires a login but is free to be used
  - https://apps.teknologisk.dk/digital-kalibrering/

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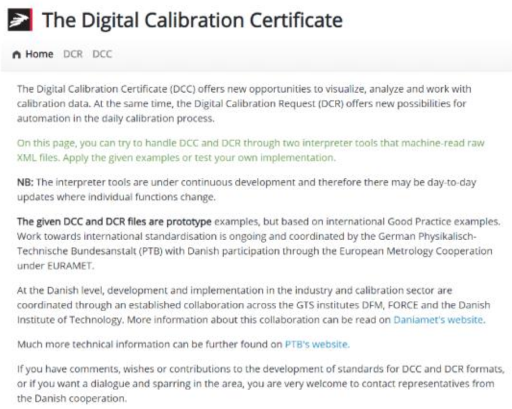
The tools we build - frontpage

- A homepage that explains the project
  - A visualization tool
    - Makes demonstration possible and simple
    - Made to communicate DCC to Danish partners
  - Link to Danish website about DCC
  - Link to PTB's website about DCC



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The tools we build – DCC page

- Functions
  - Upload DCC file (only for version 3.1.2)
  - Download an example to try out
- When uploaded
  - Extraction of only relevant data to showcase to the user
  - Creates a simple interface

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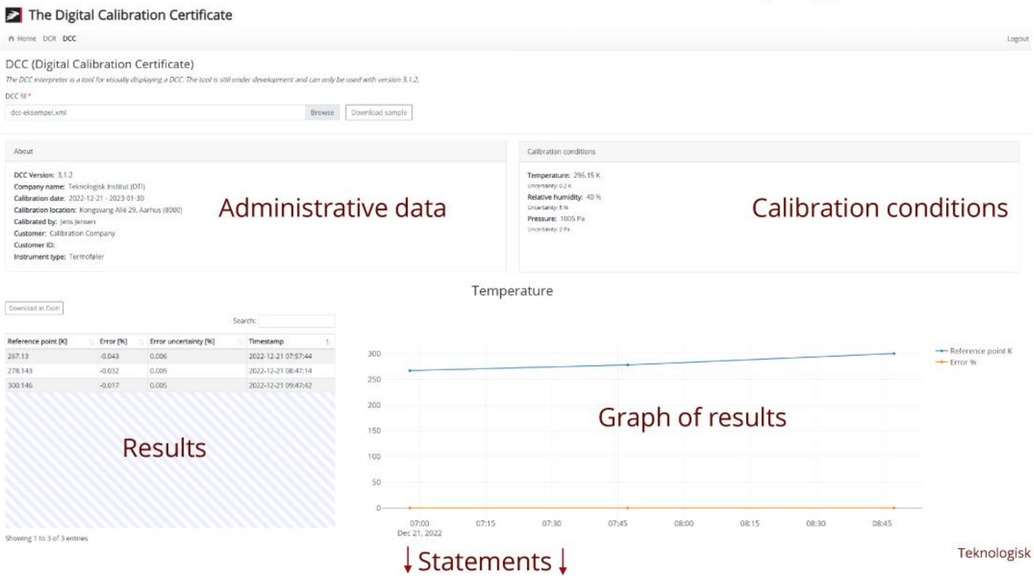
The tools we build – DCC page



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The tools we build – DCR page

- Functions
  - Upload DCR prototype (made by DTI)
  - Download an example to try out
- When uploaded
  - Extraction of all data
- Used last year as a demo for DCR

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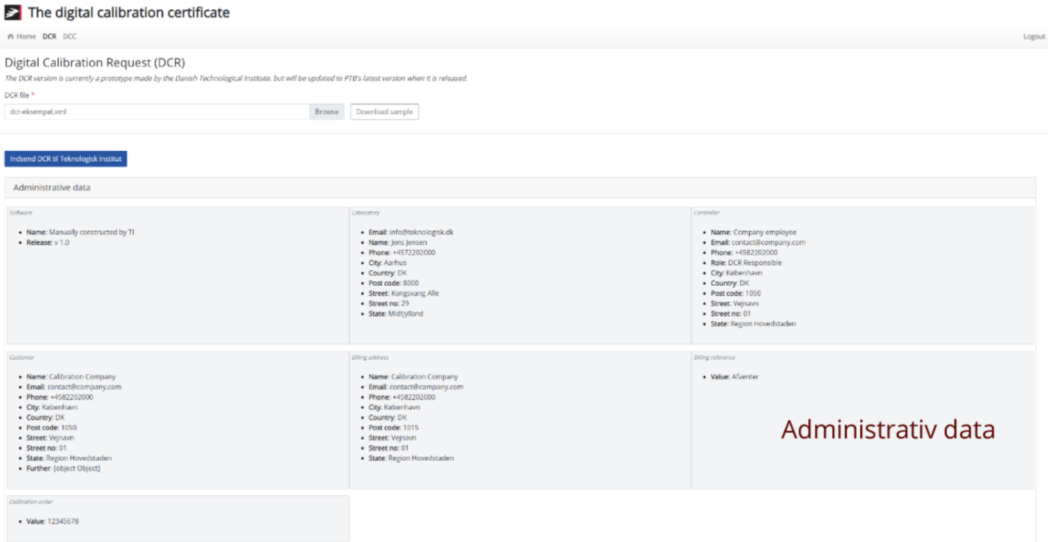
The tools we build – DCR page



↓Request info↓

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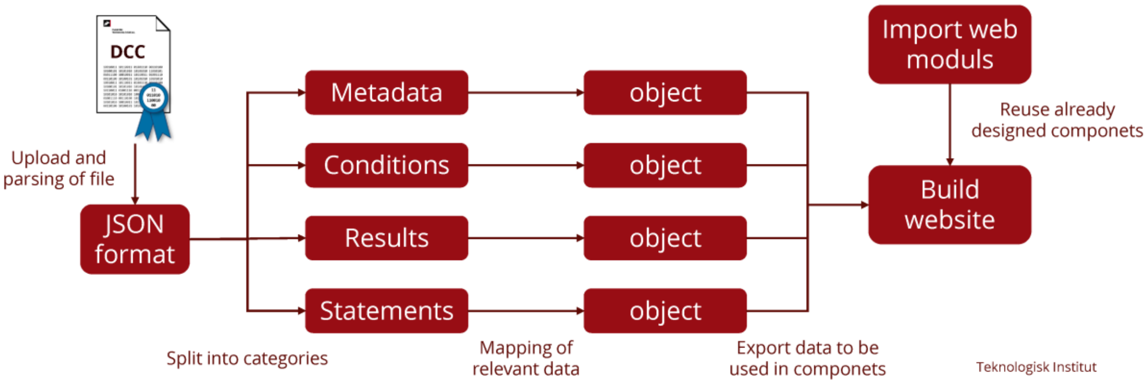
The tools we build – our process

- Extraction through a converter module
  - Conversion between XML to JSON using xml2js



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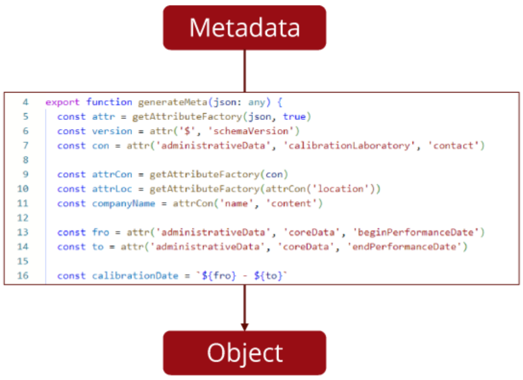
The tools we build – our process

- Mapping out the data we need is necessary
  - Point where the data needs to be extracted from
- The tree structure is changed to attributes
  - Because of the JSON format
- Output is a collected object ready to be used



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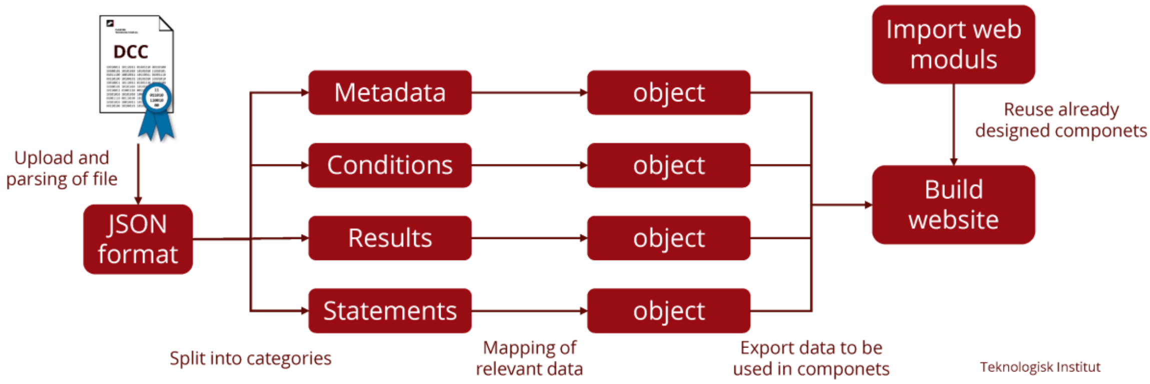
The tools we build – our process

- Extraction through a converter module
  - Conversion between XML to JSON using [xml2js]
- Important for us to reuse developed modules
  - Simplifies the process



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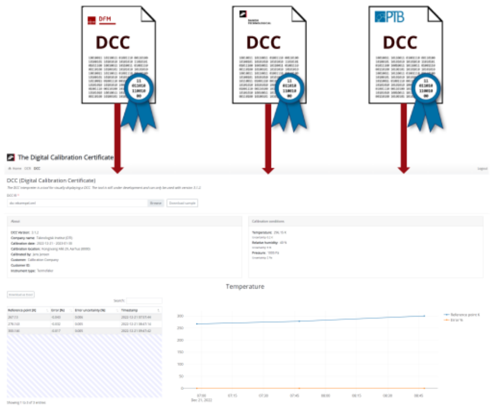
The tools we build – the future

- A playground
  - Try other DCC template formats
  - Testing of first DCC's from DK companies
  - Try out DCR when it is ready
- Improve user experience
  - Better showcase of data
- Keep using it to showcase DCC



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Learnings and ideas

- Positive findings:
  - A lot of freedom to use whatever data the users find relevant
  - Easy to visualize and implement in categories
    - Made possible by the tree structure
  - It would be very easy to translate and jump between language because of the structure


```xml
<dcc:digitalCalibrationCertificate xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns:dcc="https://ptb.de/dcc" xmlns:si="https://ptb.de/si" xsi:schemaLocation="https://ptb.de/dcc
 https://ptb.de/dcc/v3.1.1/dcc.xsd" schemaVersion="3.1.2">
  <dcc:administrativeData>
    <dcc:dccSoftware>
    ...
    </dcc:dccSoftware>
    <dcc:coreData>
    ...
    </dcc:coreData>
    <dcc:items>
    ...
    </dcc:items>
    <dcc:calibrationLaboratory>
    ...
    </dcc:calibrationLaboratory>
    <dcc:respPersons>
    ...
    </dcc:respPersons>
    <dcc:customer>
    ...
    </dcc:customer>
    <dcc:statements>
    ...
    </dcc:statements>
  </dcc:administrativeData>
  <dcc:measurementResults>
    <dcc:measurementResult>
      <dcc:name>
      ...
      </dcc:name>
      <dcc:usedMethods>
      ...
      </dcc:usedMethods>
      <dcc:usedSoftware>
      ...
      </dcc:usedSoftware>
      <dcc:measuringEquipments>
      ...
      </dcc:measuringEquipments>
      <dcc:influenceConditions>
      ...
      </dcc:influenceConditions>
      <dcc:results>
      ...
      </dcc:results>
    </dcc:measurementResult>
  </dcc:measurementResults>
</dcc:digitalCalibrationCertificate>
```


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Learnings and ideas

- Challenges:
  - XML is not necessary build with web development in mind
    - The tree structure does not necessary define amounts of data (is it a list or a single value)
  - With the current state mapping is necessary
    - Meaning it may break in case of change
    - With each version it is necessary to check mappings
  - Manuel conversions of units
    - Hard to find a library that takes the DCC unit as an input and converts it to the desired unit


```xml
<dcc:measurementResults>
  <dcc:measurementResult>
    <dcc:name>
    ...
    </dcc:name>
    <dcc:usedMethods>
    ...
    </dcc:usedMethods>
    <dcc:usedSoftware>
    ...
    </dcc:usedSoftware>
    <dcc:measuringEquipments>
    ...
    </dcc:measuringEquipments>
    <dcc:influenceConditions>
      <dcc:influenceCondition refType="temperature">
        <dcc:name>
        ...
        </dcc:name>
        <dcc:data>
          <dcc:quantity refType="temperature">
            <dcc:name>
            ...
            </dcc:name>
            <si:real>
              <si:value>293.54999999999995</si:value>
              <si:unit>\kelvin</si:unit>
            </si:real>
            <dcc:relativeUncertainty>
            ...
            </dcc:relativeUncertainty>
          </dcc:quantity>
        </dcc:data>
      </dcc:influenceCondition>
      <dcc:influenceCondition refType="humidity">
      ...
      </dcc:influenceCondition>
      <dcc:influenceCondition refType="pressure">
      ...
      </dcc:influenceCondition>
    </dcc:influenceConditions>
    <dcc:results>
    ...
    </dcc:results>
  </dcc:measurementResult>
</dcc:measurementResults>
</dcc:digitalCalibrationCertificate>
```


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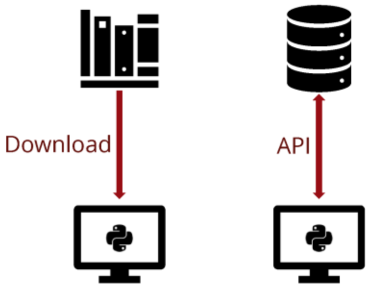
Learnings and ideas

- How can this mapping problem be fixed?
  - Include the schema in the development of tools
    - This can be complicated to do and needs a lot of resources
  - Make the DCC more locked
    - Meaning the XML schema will not be as flexible
  - A universal library that can be imported
    - Converts the XML to standard objects that can be used in Excel functions or web development
    - Easier control over units
  - An API function
    - Converts XML to the wished output
    - Independent of platform



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Learnings and ideas

- Would it be fixed if switched to another format, like JSON?
  - JSON has a great structure for data
  - Creates key-value pairs instead of a complex three pattern
    - Minimal syntax
  - Lots of support especially for parsing data with newer systems
    - Modern frameworks works great with JSON

- JSON is not necessary the solution but an interesting option to research further


```xml
<dcc:influenceConditions>
    <dcc:influenceCondition refType="temperature">
        <dcc:name>
            <dcc:content lang="dk">Temperatur</dcc:content>
            <dcc:content lang="en">Temperature</dcc:content>
        </dcc:name>
        <dcc:data>
            <dcc:quantity refType="temperature">
                <dcc:name>
                    <dcc:content lang="dk">Temperatur</dcc:content>
                    <dcc:content lang="en">Temperature</dcc:content>
                </dcc:name>
                <si:real>
                    <si:value>293.54999999999995</si:value>
                    <si:unit>\kelvin</si:unit>
                </si:real>
                <dcc:relativeUncertainty>
                    <dcc:relativeUncertaintySingle>
                        <si:value>0.7</si:value>
                        <si:unit>\kelvin</si:unit>
                    </dcc:relativeUncertaintySingle>
                </dcc:relativeUncertainty>
            </dcc:quantity>
        </dcc:data>
    </dcc:influenceCondition>
    <dcc:influenceCondition refType="humidity">
        <dcc:name>
            <dcc:content lang="dk">Relativ luftfugtighed</dcc:content>
```

```json
{
  "influenceCondition": [
    {"temperature":{
      "name":{"dk":"Temperatur","en":"Temperature"},
      "dataSI":{"value": 293.54999999999995,"relativeUncertainty":0.7,"unit": "\\kelvin"},
      "dataOther":[
        {"value": 20.4,"relativeUncertainty":0.7,"unit": "\\Celcius"},
        {"value": 68.72,"relativeUncertainty":1.26,"unit": "\\Fahrenheit"}]}},
    {"humidity":{
      "name":{"dk":"Relativ luftfugtighed","en":"Relative humidity"},
      "dataSI":{"value": 38,"relativeUncertainty":5,"unit": "\\one"}}},
    {"pressure":{
      "name":{"dk":"Tryk","en":"Pressure"},
      "dataSI":{"value": 101710,"relativeUncertainty":18,"unit": "\\kilogram\\metre\\tothe{-1}\\second\\tothe{-2}"},
      "dataOther":[
        {"value": 1017.1,"relativeUncertainty":0.18,"unit": "\\hPa"},
        {"value": 1017.1,"relativeUncertainty":0.18,"unit": "\\mbar"}]}}
  ]
}
```


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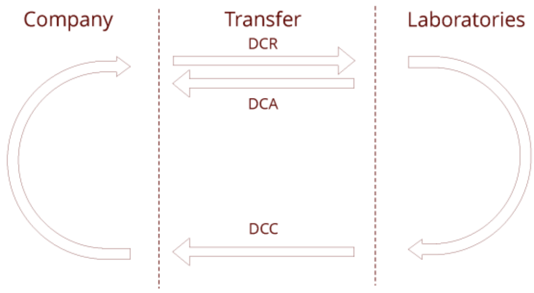
Improvements to the DCC format

- The main problem with DCC is mapping the data to be used
  - A solution must be found before it can create impact
- DCC as an idea have some good features
  - Great and well-defined structures
  - Possibility for a lot of data which gives flexibility
  - Makes data machine readable



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Conclusion

- The use of XML with DCC creates a difficulties for software and web development
  - Can maybe be solved by:
    - Working more with the schema
    - A library solution that can be imported
    - An API solution across platforms
    - Switching to another format, like JSON
- Should you start developing your own tool?
  - Yes! It the best way to really learn the strength of calibration certificates for the future

Danish Agency for Higher Education and Science

Acknowledgement: This study was supported by a grant from Danish Technological Institutes performance contract 2021-2024, entered with the Danish Agency for Higher Education and Science, under The Ministry of Higher Education and Science Denmark. Collaborators are greatly acknowledged.

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19 How to handle DCC data: the DCCSearch Tool

Presenting author: Gamze Söylev-Öktem, PTB Germany
Email: gamze.soeylev-oektem@ptb.de
Additional authors: Benjamin Gloger benjamin.gloger@ptb.de

Abstract

Retrieving the correct data from a DCC is a very important topic for everyone interested in DCC. Various approaches can be used for this task. One opfton is to rely on attributes of the DCC. The DCC Schema offers different attributes to help with this task. Namely reftype and refId. The DCCSearch tool is written by the DCC core team by using open-source libraries to demonstrate how these attributes can be used to extract data from any DCC.

The tool is written in Python and the main library that is used is 'saxonche'. It works with any DCC. The user fi’rst needs to choose a DCC. After that, all 'reftype' and 'id' attributes of the selected DCC are found and offered to the user in tables to choose from. The user can choose any number of attributes.

The elements that the 'id' attributes belong to are also shown and it is possible to display them by clicking on the element name. The 'id' attributes are used as 'refId' for the search.

The given attributes can either be attached to one single element or they may be attached to two separate elements that are in a parent-child relaftonship. For instance, in cases where there are multiple objects or multiple parts of an object, we may need to use same 'reftype' attribute for mulitple elements and need addiftonal attributes to be able to idenftfy them correctly. So, only giving one attribute might not be enough to get the specifi’c data. In such cases, one of the ancestor elements of the wanted element will have another 'reftype' or 'refId' attribute. By choosing the necessary 'reftype' attributes, it is possible for the user to get the specifi’c informafton that they need.

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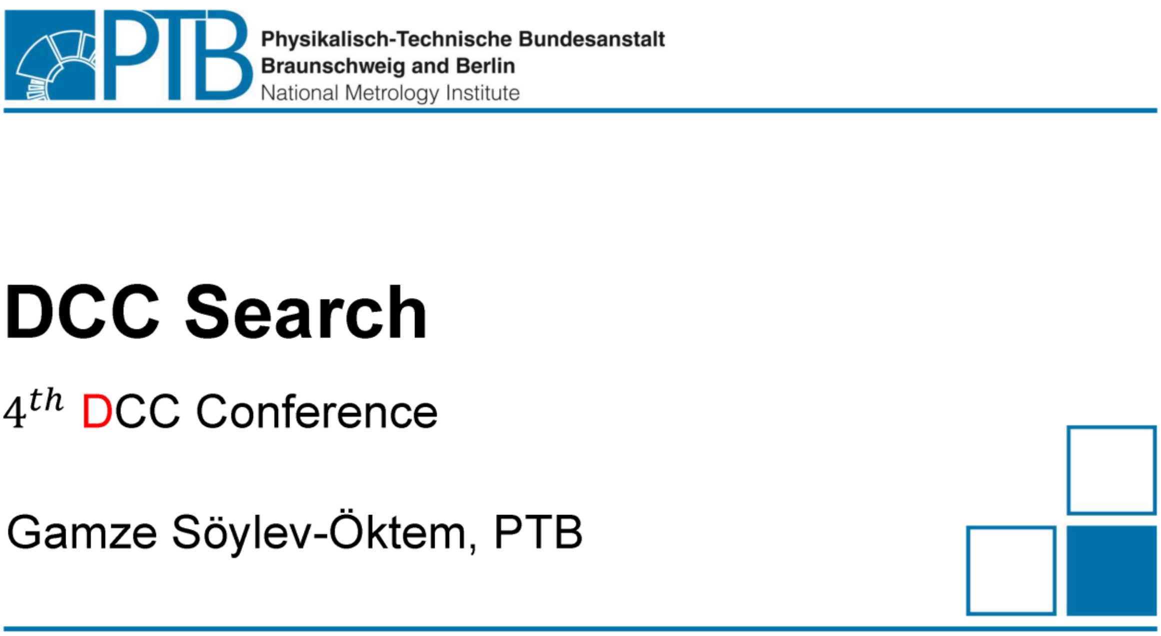
Presentation of Gamze Söylev-Öktem



How to Get Data from a DCC?

- XML is human readable


```xml
<?xml version="1.0" encoding="UTF-8"?>
<dcc:digitalCalibrationCertificate xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
                                   xmlns:dcc="https://ptb.de/dcc"
                                   xmlns:si="https://ptb.de/si" xsi:schemaLocation="https://ptb.de/dcc https://ptb.de/dcc/v3.2.1/dcc.xsd" schemaVersion="3.2.1">
 <dcc:administrativeData>
  <dcc:dccSoftware>
   <dcc:software>
    <dcc:name>
     <dcc:content>Notepad++ (32-bit)</dcc:content>
    </dcc:name>
    <dcc:release>v8.2</dcc:release>
   </dcc:software>
  </dcc:dccSoftware>
  <dcc:coreData>
   <dcc:countryCodeISO3166_1>DE</dcc:countryCodeISO3166_1>
   <dcc:usedLangCodeISO639_1>en</dcc:usedLangCodeISO639_1>
   <dcc:usedLangCodeISO639_1>de</dcc:usedLangCodeISO639_1>
   <dcc:mandatoryLangCodeISO639_1>en</dcc:mandatoryLangCodeISO639_1>
   <dcc:uniqueIdentifier>GP_DCC_temperature_simplified_1.1.1</dcc:uniqueIdentifier>
   <dcc:identifications>
    <dcc:identification>
     <dcc:issuer>calibrationLaboratory</dcc:issuer>
     <dcc:value>string-calibrationLaboratory-coreData</dcc:value>
```

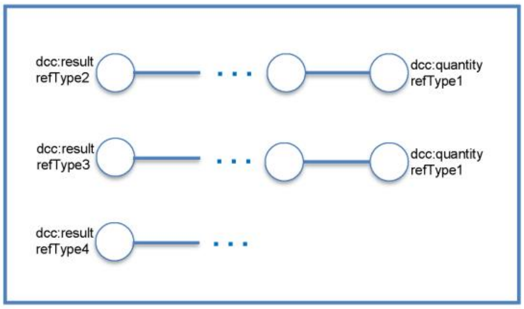

Machine Readability and Interpretability of DCC

- Element names
- Attributes
  - refType
  - refId

What am I looking for in my DCC

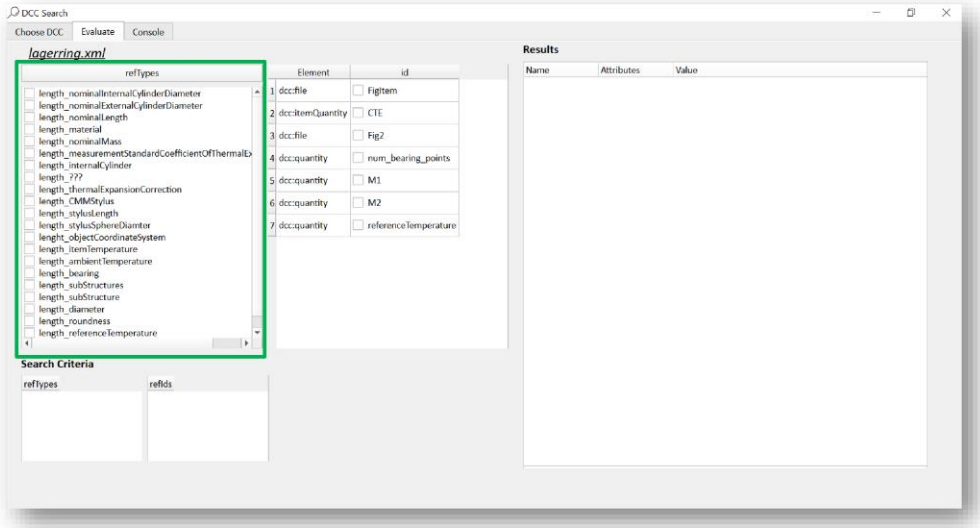
```xml
<dcc:quantity refType="basic_measuredValue">
  <dcc:name>
    <dcc:content lang="de">Angezeigter Messwert Kalibriergegenstand</dcc:content>
    <dcc:content lang="en">Indicated measured value probe</dcc:content>
  </dcc:name>
  <si:hybrid>
    <si:realListXMLList>
      <si:valueXMLList>306.35 373.45 448.05 523.05 593.35</si:valueXMLList>
      <si:unitXMLList>\kelvin</si:unitXMLList>
      <si:dateTimeXMLList>1957-08-13T08:25:00Z 1957-08-13T09:25:00Z 1957-08-13T10:25:00Z 1957-08-13T11:25:00Z 1957-08-13T12:25:00Z</si:dateTimeXMLList>
    </si:realListXMLList>
    <si:realListXMLList>
      <si:valueXMLList>33.2 100.3 174.9 249.9 320.2</si:valueXMLList>
      <si:unitXMLList>\degreecelsius</si:unitXMLList>
    </si:realListXMLList>
  </si:hybrid>
</dcc:quantity>
```

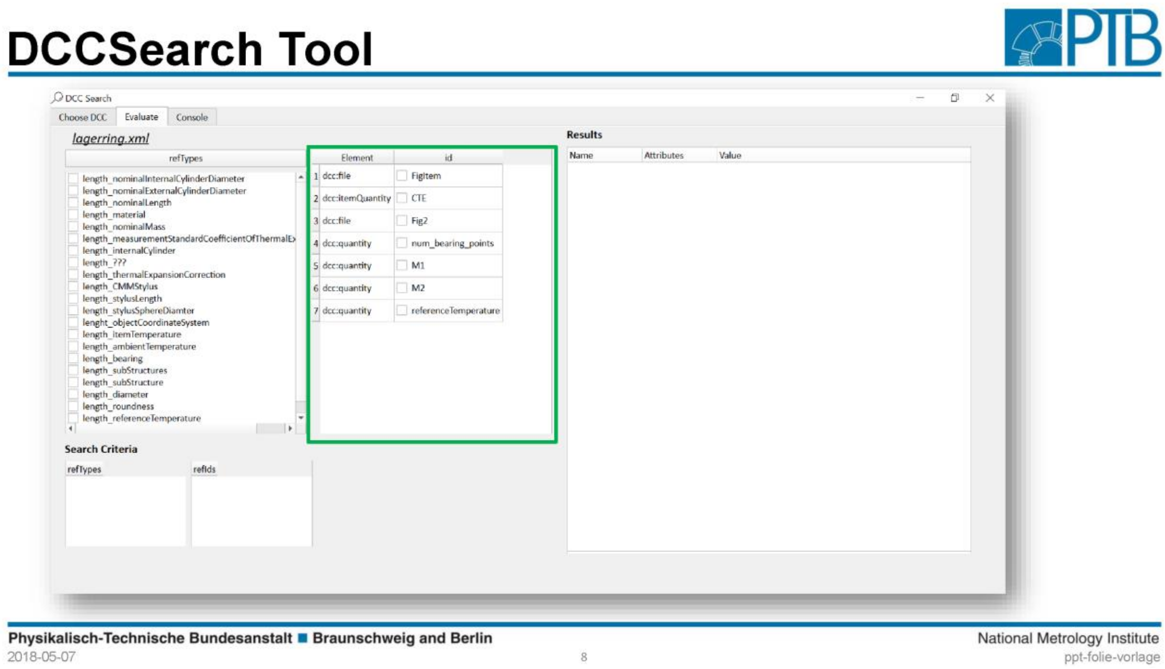

DCCSearch Tool



DCCSearch Tool

DCCSearch Tool




DCCSearch Tool
DCC Search
Choose DCC
Evaluate
Console
lagerring.xml
refTypes
length_nominalInternalCylinderDiameter
length_nominalExternalCylinderDiameter
length_nominalLength
length_material
length_nominalMass
length_measurementStandardCoefficientOfThermalE
length_internalCylinder
length_???
length_thermalExpansionCorrection
length_CMMStylus
length_stylusLength
length_stylusSphereDiamter
lenght_objectCoordinateSystem
length_itemTemperature
length_ambientTemperature
length_bearing
length_subStructures
length_subStructure
length_diameter
length_roundness
length_referenceTemperature
Element
id
1 dcc:file FigItem
2 dcc:itemQuantity CTE
3 dcc:file Fig2
4 dcc:quantity num_bearing_points
5 dcc:quantity M1
6 dcc:quantity M2
7 dcc:quantity referenceTemperature
Results
Name
Attributes
Value
Search Criteria
refTypes
refIds
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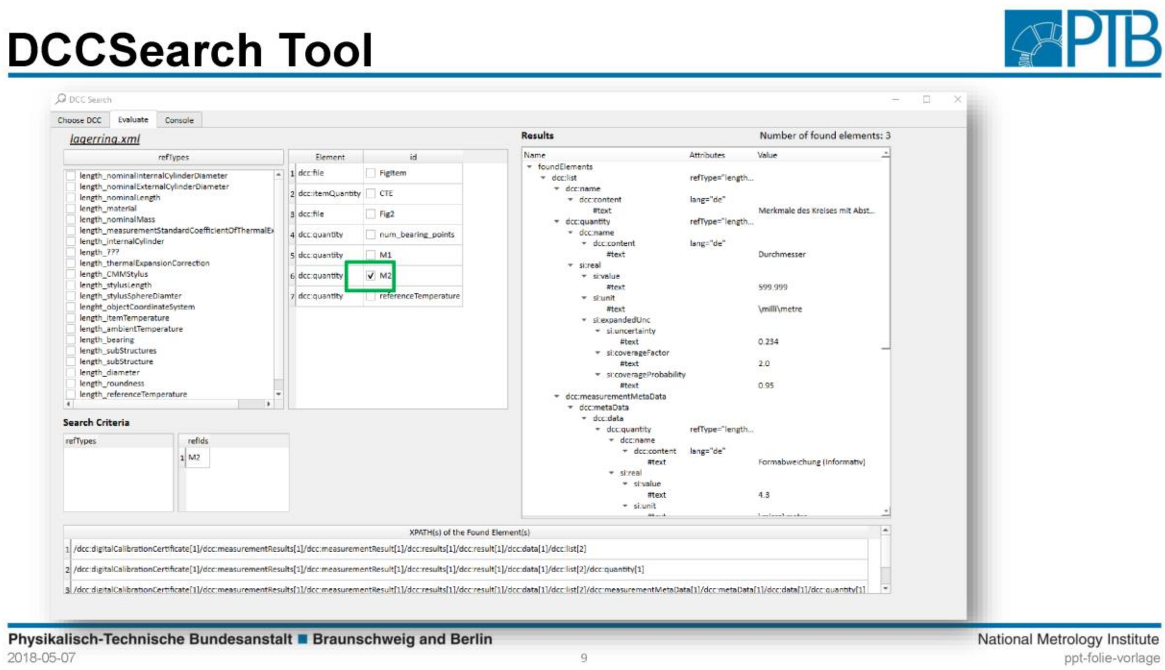
DCCSearch Tool
DCC Search
Choose DCC
Evaluate
Console
lagerring.xml
refTypes
Element
id
1 dcc:file FigItem
2 dcc:itemQuantity CTE
3 dcc:file Fig2
4 dcc:quantity num_bearing_points
5 dcc:quantity M1
6 dcc:quantity M2
7 dcc:quantity referenceTemperature
Results
Number of found elements: 3
Name
Attributes
Value
foundElements
dcc:list
dcc:name
dcc:content
#text
dcc:quantity
si:real
si:value
si:unit
si:expandedUnc
si:uncertainty
si:coverageFactor
si:coverageProbability
dcc:measurementMetaData
dcc:metaData
dcc:data
refType="length...
lang="de"
Merkmale des Kreises mit Abst...
Durchmesser
599.999
\milli\metre
0.234
2.0
0.95
Formabweichung (informativ)
4.3
Search Criteria
refTypes
refIds
1 M2
XPATH(s) of the Found Element(s)
1 /dcc:digitalCalibrationCertificate[1]/dcc:measurementResults[1]/dcc:measurementResult[1]/dcc:results[1]/dcc:result[1]/dcc:data[1]/dcc:list[2]
2 /dcc:digitalCalibrationCertificate[1]/dcc:measurementResults[1]/dcc:measurementResult[1]/dcc:results[1]/dcc:result[1]/dcc:data[1]/dcc:list[2]/dcc:quantity[1]
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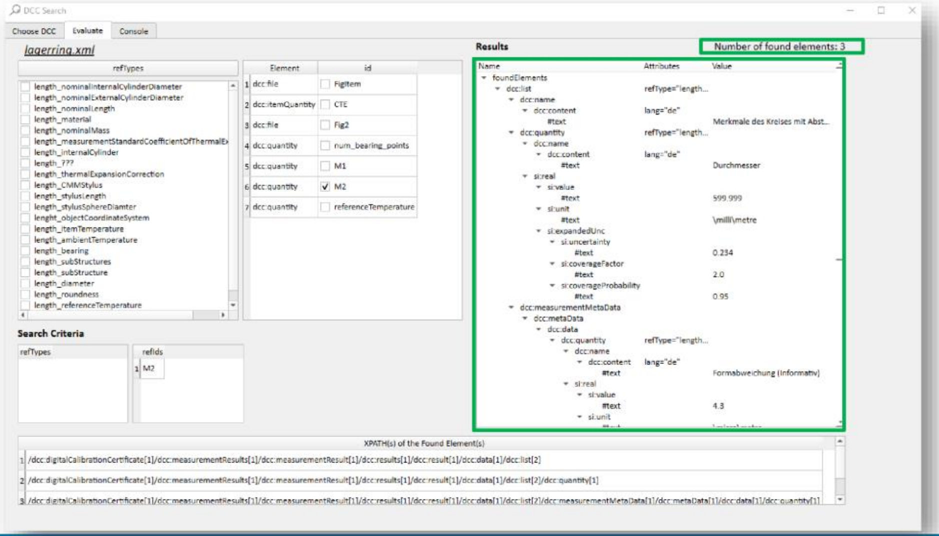
DCCSearch Tool



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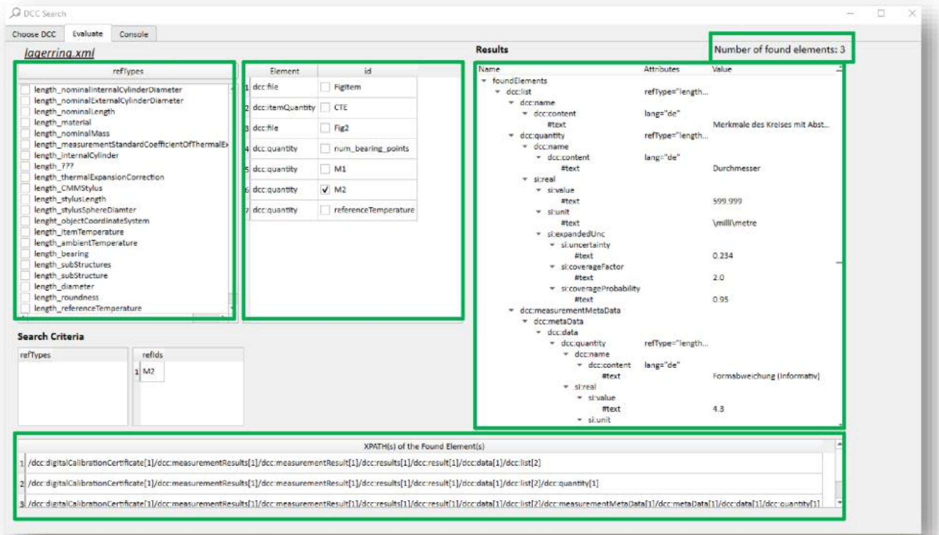
DCCSearch Tool



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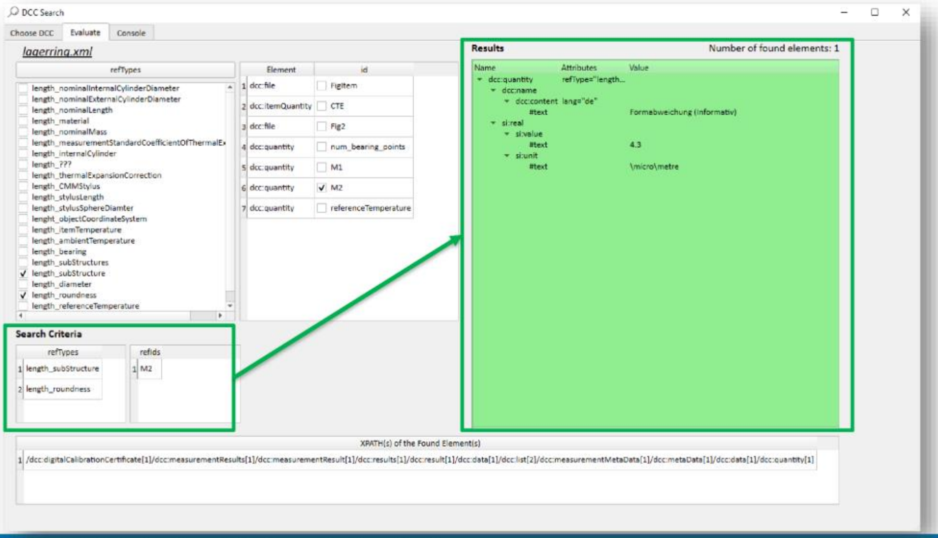
DCCSearch Tool



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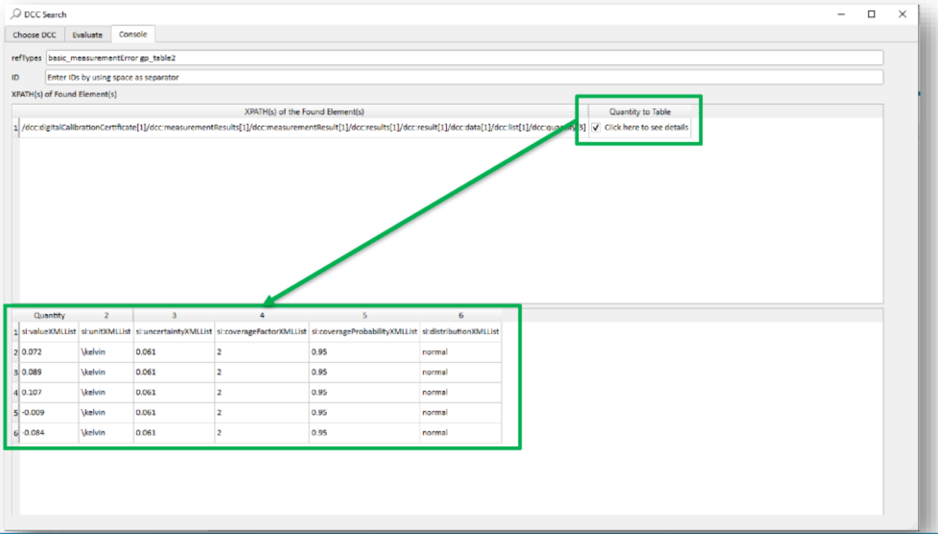
DCCSearch Tool



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Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
Bundesallee 100
38116 Braunschweig
Gamze Söylev-Öktem
E-Mail: gamze.soeylev-oektem@ptb.de
www.ptb.de

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20 Implementation of Management and Calibration Software: Data Digitization and Reflections on FAIR Principles in Laboratory Routine

Presenting author: Igor Fernando Modesto Garcia, Health Products Laboratory - LABPROSAUD, Brazil
Email: lem.labprosaud@ifba.edu.br
Additional authors: Jeovana Santos Ferreira, Eric Matos Macedo, Marcus Vinicius Teixeira Navarro and José Guilherme Pereira Peixoto

Abstract

What technologies derived from the Fourth Industrial Revolution can we implement to optimize laboratory activities? What concepts and frameworks can be used for the interoperability of administrative and technical data related to DCCs and reports? How can we consider software solutions to improve quality management and calibration processes? And to what extent can we apply FAIR principles when user data is linked?

This work shows a use case of management and calibration software that was applied in the routine activities of a laboratory (ISO 17025 accredited), the main data that was digitized and a brief reflection on the application of FAIR principles.

The *Pandora IRTech* software was built based on a conceptual model derived from a doctoral thesis which mapped the processes, risks, and steps necessary to digitize the quality infrastructure of a laboratory that calibrates quantities of ionizing radiation.

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Presentation of Igor Fernando Modesto Garcia

4th International DCC Conference: DCC for FAIR principles in the quality infrastructure

- What technologies derived from the Fourth Industrial Revolution can we implement to optimize laboratory activities?
- How can we consider software solutions to improve quality management and calibration processes?

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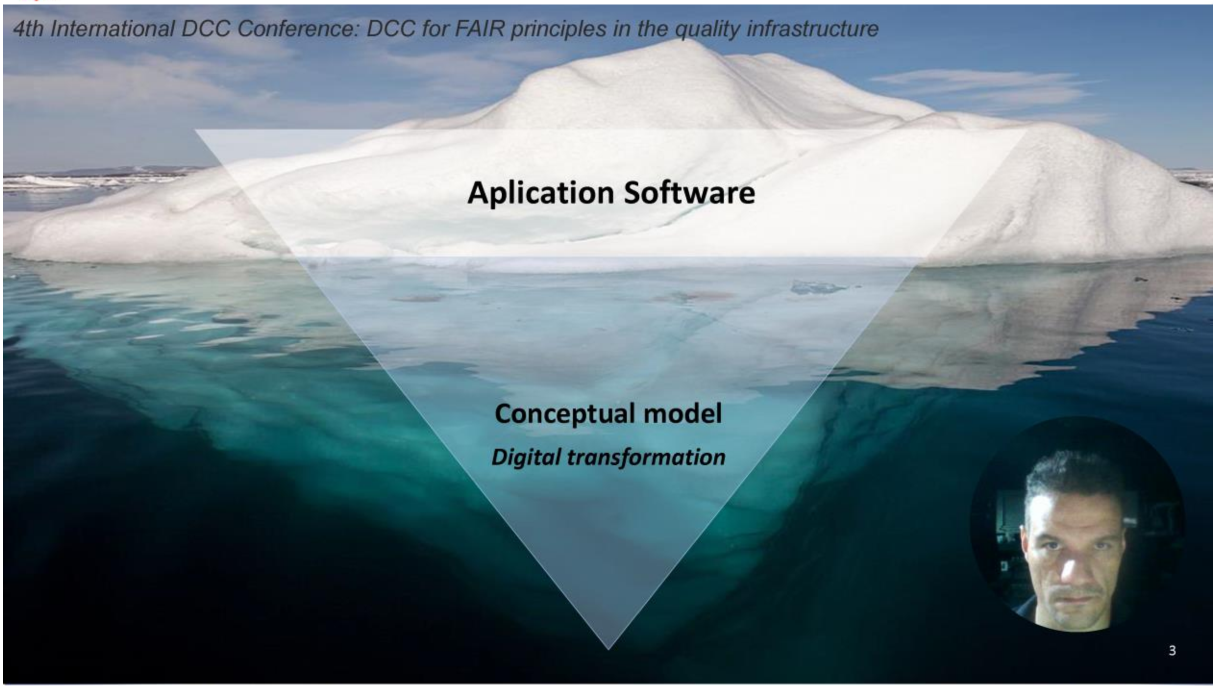

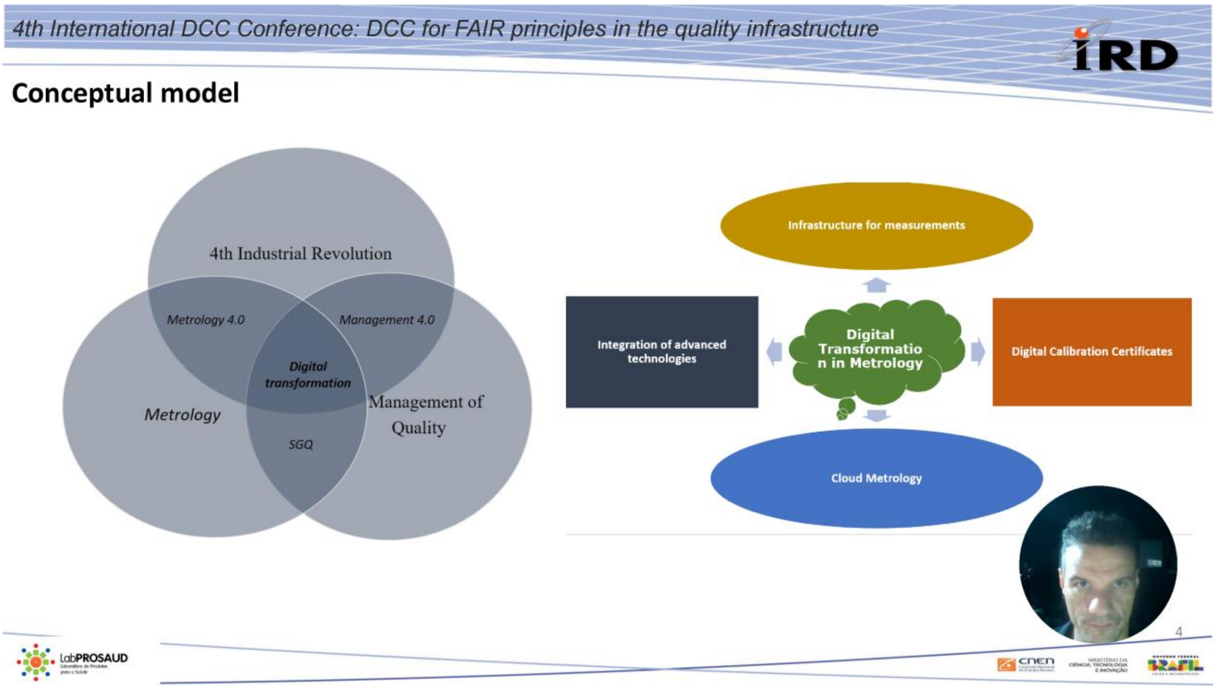
4th International DCC Conference: DCC for FAIR principles in the quality infrastructure
IRD
Conceptual model
4th Industrial Revolution
Metrology 4.0
Management 4.0
Digital transformation
Metrology
Management of Quality
SGQ
Infrastructure for measurements
Integration of advanced technologies
Digital Transformation in Metrology
Digital Calibration Certificates
Cloud Metrology
4
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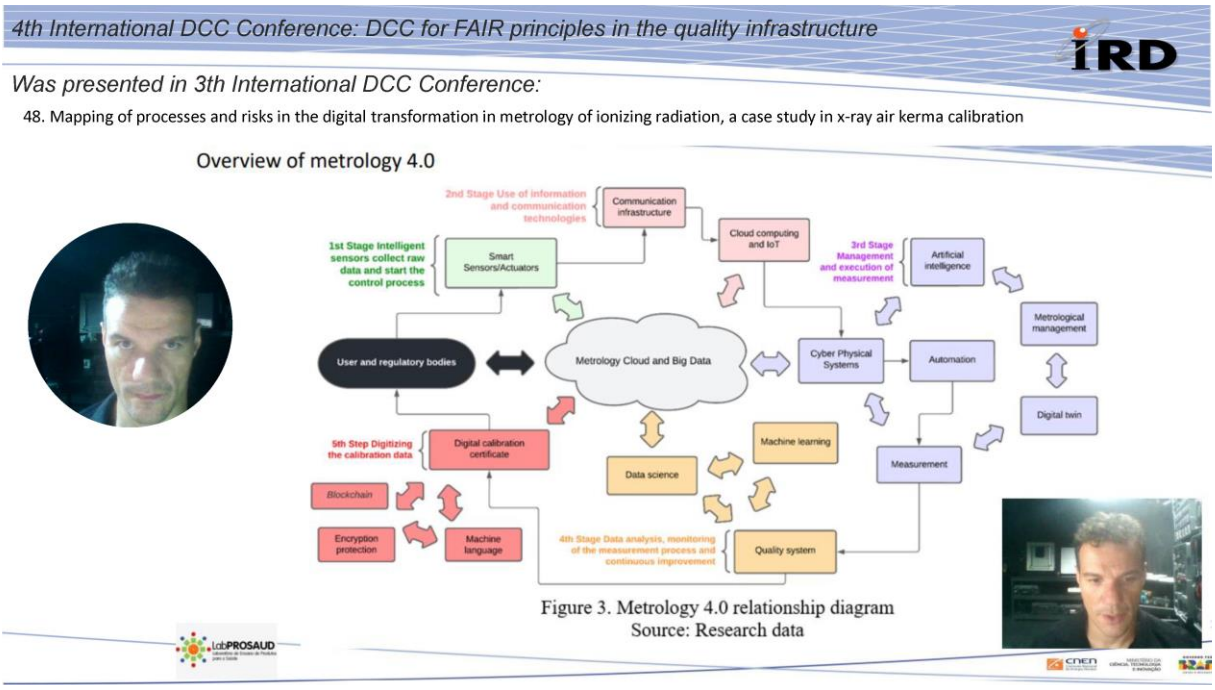
4th International DCC Conference: DCC for FAIR principles in the quality infrastructure
IRD
Was presented in 3th International DCC Conference:
48. Mapping of processes and risks in the digital transformation in metrology of ionizing radiation, a case study in x-ray air kerma calibration
Overview of metrology 4.0
2nd Stage Use of information and communication technologies
Communication infrastructure
Cloud computing and IoT
1st Stage Intelligent sensors collect raw data and start the control process
Smart Sensors/Actuators
3rd Stage Management and execution of measurement
Artificial intelligence
Metrological management
User and regulatory bodies
Metrology Cloud and Big Data
Cyber Physical Systems
Automation
Digital twin
5th Step Digitizing the calibration data
Digital calibration certificate
Machine learning
Data science
Measurement
Blockchain
Encryption protection
Machine language
4th Stage Data analysis, monitoring of the measurement process and continuous improvement
Quality system
Figure 3. Metrology 4.0 relationship diagram
Source: Research data
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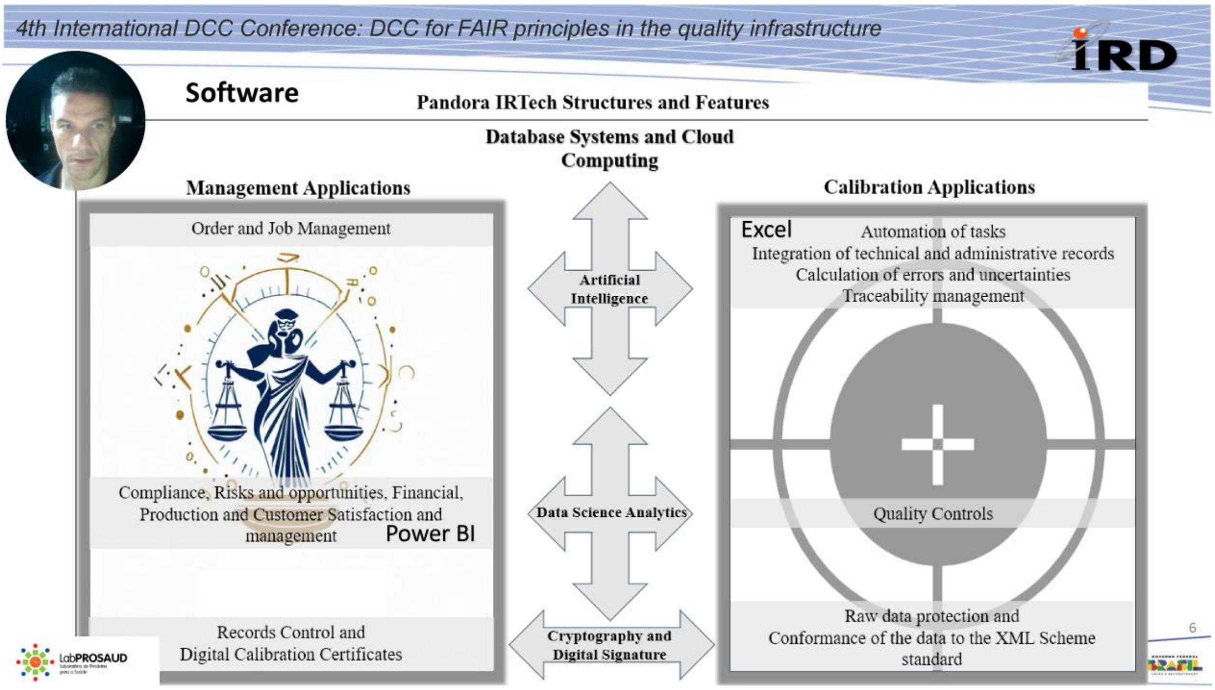

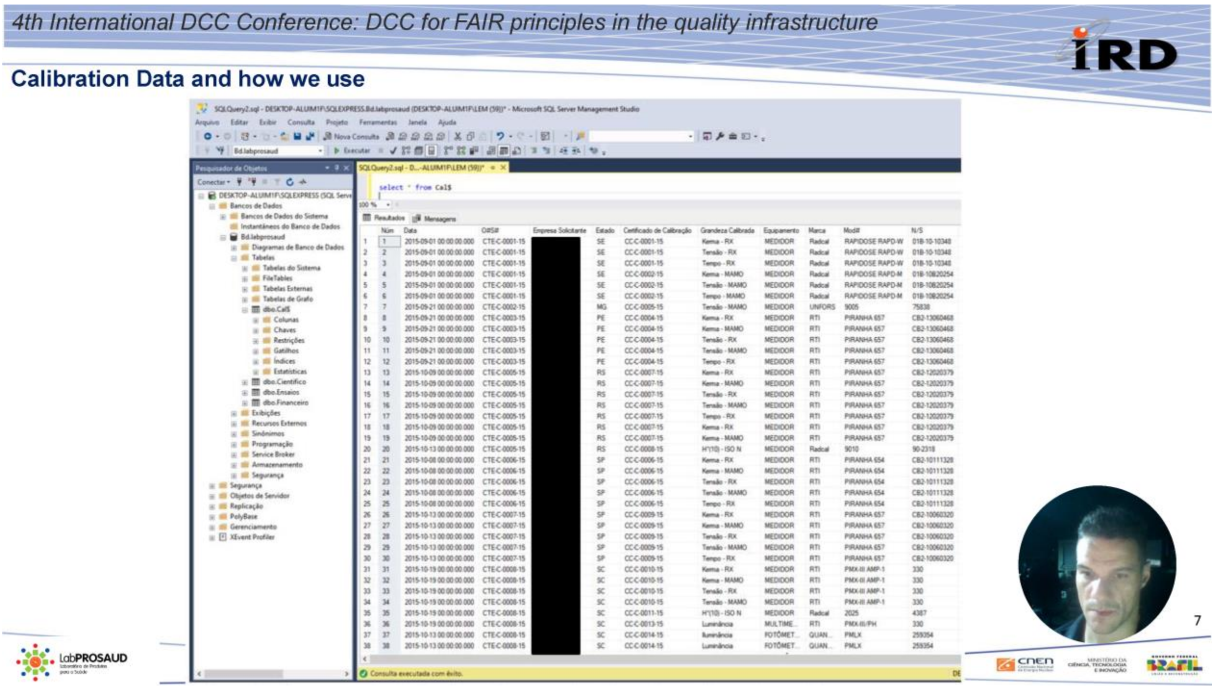

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2	2	2015-09-01 00:00:00.000	CTE-C-0001-15		SE	CC-C-0001-15	Tensão - RX	MEDIDOR	Radcal	RAPIDOSE RAPD-W	01B-10-10348
3	3	2015-09-01 00:00:00.000	CTE-C-0001-15		SE	CC-C-0001-15	Tempo - RX	MEDIDOR	Radcal	RAPIDOSE RAPD-W	01B-10-10348
4	4	2015-09-01 00:00:00.000	CTE-C-0001-15		SE	CC-C-0002-15	Kerma - MAMO	MEDIDOR	Radcal	RAPIDOSE RAPD-M	01B-10820254
5	5	2015-09-01 00:00:00.000	CTE-C-0001-15		SE	CC-C-0002-15	Tensão - MAMO	MEDIDOR	Radcal	RAPIDOSE RAPD-M	01B-10820254
6	6	2015-09-01 00:00:00.000	CTE-C-0001-15		SE	CC-C-0002-15	Tempo - MAMO	MEDIDOR	Radcal	RAPIDOSE RAPD-M	01B-10820254
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8	8	2015-09-21 00:00:00.000	CTE-C-0003-15		PE	CC-C-0004-15	Kerma - RX	MEDIDOR	RTI	PIRANHA 657	CB2-13060468
9	9	2015-09-21 00:00:00.000	CTE-C-0003-15		PE	CC-C-0004-15	Kerma - MAMO	MEDIDOR	RTI	PIRANHA 657	CB2-13060468
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12	12	2015-09-21 00:00:00.000	CTE-C-0003-15		PE	CC-C-0004-15	Tempo - RX	MEDIDOR	RTI	PIRANHA 657	CB2-13060468
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15	15	2015-10-09 00:00:00.000	CTE-C-0005-15		RS	CC-C-0007-15	Tensão - RX	MEDIDOR	RTI	PIRANHA 657	CB2-12020379
16	16	2015-10-09 00:00:00.000	CTE-C-0005-15		RS	CC-C-0007-15	Tensão - MAMO	MEDIDOR	RTI	PIRANHA 657	CB2-12020379
17	17	2015-10-09 00:00:00.000	CTE-C-0005-15		RS	CC-C-0007-15	Tempo - RX	MEDIDOR	RTI	PIRANHA 657	CB2-12020379
18	18	2015-10-09 00:00:00.000	CTE-C-0005-15		RS	CC-C-0007-15	Kerma - RX	MEDIDOR	RTI	PIRANHA 657	CB2-12020379
19	19	2015-10-09 00:00:00.000	CTE-C-0005-15		RS	CC-C-0007-15	Kerma - MAMO	MEDIDOR	RTI	PIRANHA 657	CB2-12020379
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24	24	2015-10-08 00:00:00.000	CTE-C-0006-15		SP	CC-C-0006-15	Tensão - MAMO	MEDIDOR	RTI	PIRANHA 654	CB2-10111328
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26	26	2015-10-13 00:00:00.000	CTE-C-0007-15		SP	CC-C-0009-15	Kerma - RX	MEDIDOR	RTI	PIRANHA 657	CB2-10060320
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32	32	2015-10-19 00:00:00.000	CTE-C-0008-15		SC	CC-C-0010-15	Kerma - MAMO	MEDIDOR	RTI	PMX-III AMP-1	330
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36	36	2015-10-19 00:00:00.000	CTE-C-0008-15		SC	CC-C-0013-15	Luminância	MULTIME...	RTI	PMX-III/PH	330
37	37	2015-10-13 00:00:00.000	CTE-C-0008-15		SC	CC-C-0014-15	Iluminância	FOTÔMET...	QUAN...	PMLX	259354
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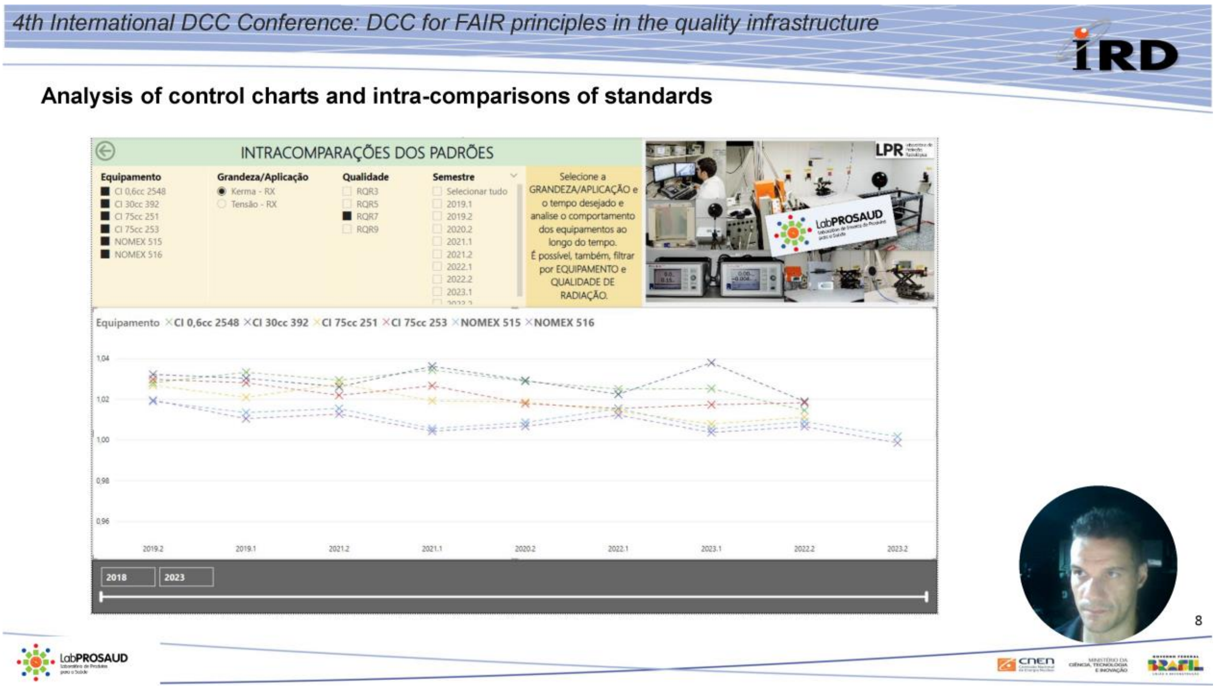
4th International DCC Conference: DCC for FAIR principles in the quality infrastructure
IRD
Analysis of control charts and intra-comparisons of standards
INTRACOMPARAÇÕES DOS PADRÕES
Equipamento
CI 0,6cc 2548
CI 30cc 392
CI 75cc 251
CI 75cc 253
NOMEX 515
NOMEX 516
Grandeza/Aplicação
Kerma - RX
Tensão - RX
Qualidade
RQR3
RQR5
RQR7
RQR9
Semestre
Selecionar tudo
2019.1
2019.2
2020.2
2021.1
2021.2
2022.1
2022.2
2023.1
Selecione a GRANDEZA/APLICAÇÃO e o tempo desejado e analise o comportamento dos equipamentos ao longo do tempo. É possível, também, filtrar por EQUIPAMENTO e QUALIDADE DE RADIAÇÃO.
LPR
LabPROSAUD
Equipamento CI 0,6cc 2548 CI 30cc 392 CI 75cc 251 CI 75cc 253 NOMEX 515 NOMEX 516
1,04
1,02
1,00
0,98
0,96
2019.2
2019.1
2021.2
2021.1
2020.2
2022.1
2023.1
2022.2
2023.2
2018
2023
8
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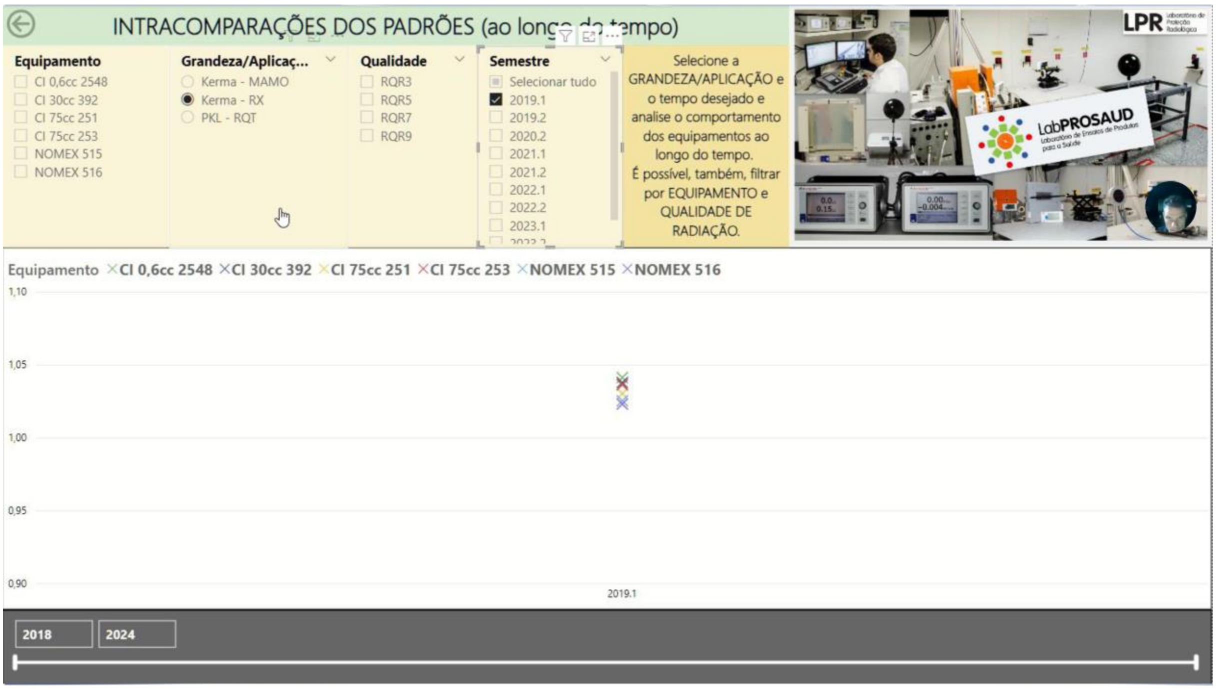
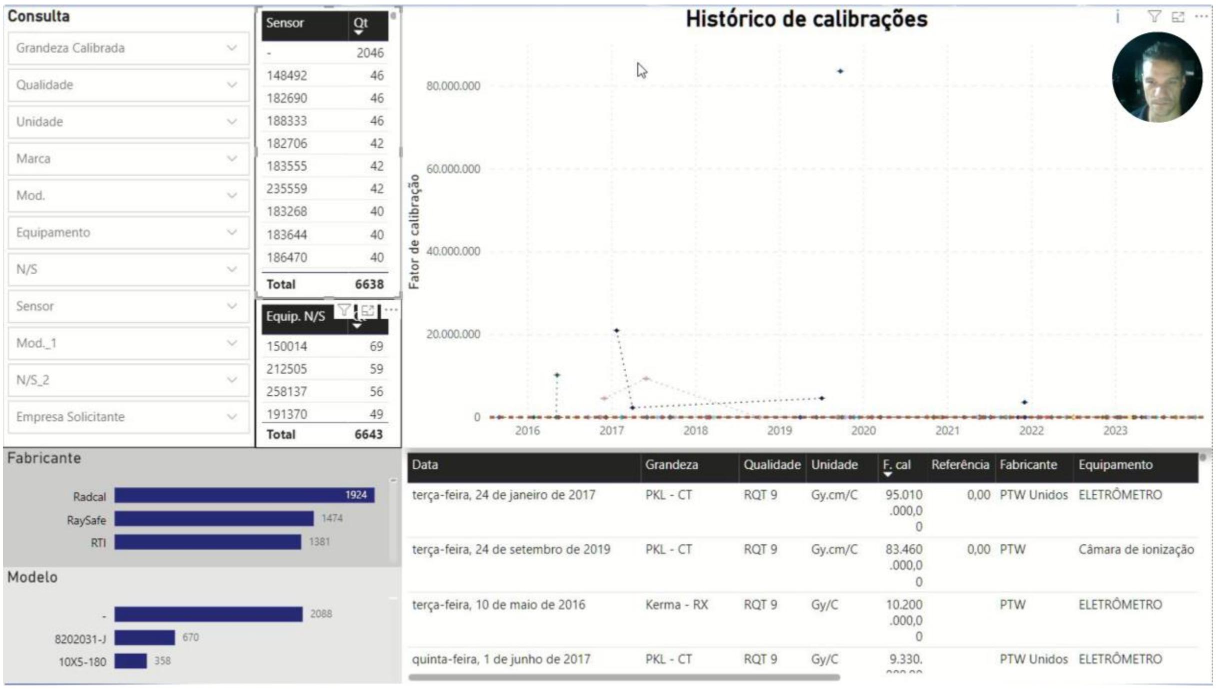
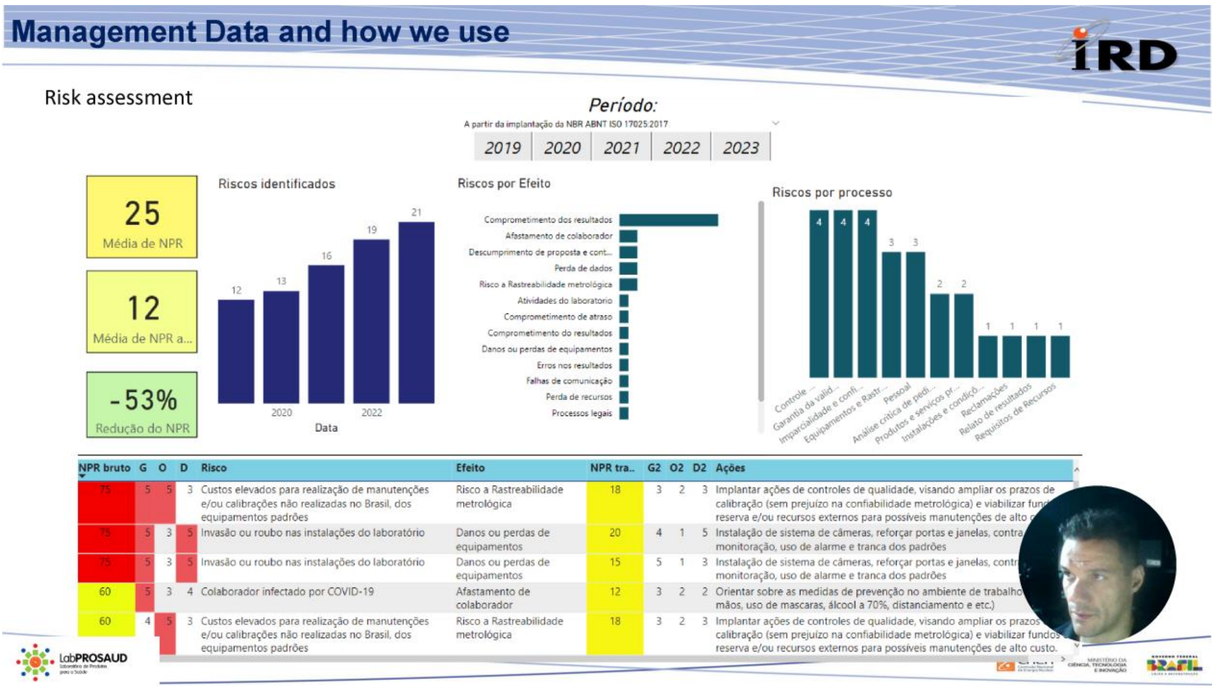

INTRACOMPARAÇÕES DOS PADRÕES (ao longo do tempo)
Equipamento
CI 0,6cc 2548
CI 30cc 392
CI 75cc 251
CI 75cc 253
NOMEX 515
NOMEX 516
Grandeza/Aplicaç...
Kerma - MAMO
Kerma - RX
PKL - RQT
Qualidade
RQR3
RQR5
RQR7
RQR9
Semestre
Selecionar tudo
2019.1
2019.2
2020.2
2021.1
2021.2
2022.1
2022.2
2023.1
Selecione a GRANDEZA/APLICAÇÃO e o tempo desejado e analise o comportamento dos equipamentos ao longo do tempo. É possível, também, filtrar por EQUIPAMENTO e QUALIDADE DE RADIAÇÃO.
LPR
LabPROSAUD
Equipamento CI 0,6cc 2548 CI 30cc 392 CI 75cc 251 CI 75cc 253 NOMEX 515 NOMEX 516
1,10
1,05
1,00
0,95
0,90
2019.1
2018
2024


Consulta
Grandeza Calibrada
Qualidade
Unidade
Marca
Mod.
Equipamento
N/S
Sensor
Mod._1
N/S_2
Empresa Solicitante
Sensor Qt
- 2046
148492 46
182690 46
188333 46
182706 42
183555 42
235559 42
183268 40
183644 40
186470 40
Total 6638
Equip. N/S
150014 69
212505 59
258137 56
191370 49
Total 6643
Histórico de calibrações
Fator de calibração
80.000.000
60.000.000
40.000.000
20.000.000
0
2016 2017 2018 2019 2020 2021 2022 2023
Fabricante
Radcal 1924
RaySafe 1474
RTI 1381
Modelo
- 2088
8202031-J 670
10X5-180 358
Data Grandeza Qualidade Unidade F. cal Referência Fabricante Equipamento
terça-feira, 24 de janeiro de 2017 PKL - CT RQT 9 Gy.cm/C 95.010.000,0 0,00 PTW Unidos ELETRÔMETRO
terça-feira, 24 de setembro de 2019 PKL - CT RQT 9 Gy.cm/C 83.460.000,0 0,00 PTW Câmara de ionização
terça-feira, 10 de maio de 2016 Kerma - RX RQT 9 Gy/C 10.200.000,0 PTW ELETRÔMETRO
quinta-feira, 1 de junho de 2017 PKL - CT RQT 9 Gy/C 9.330. PTW Unidos ELETRÔMETRO


Management Data and how we use
IRD
Risk assessment
Período:
A partir da implantação da NBR ABNT ISO 17025:2017
2019 2020 2021 2022 2023
25
Média de NPR
12
Média de NPR a...
-53%
Redução do NPR
Riscos identificados
12 13 16 19 21
2020 2022
Data
Riscos por Efeito
Comprometimento dos resultados
Afastamento de colaborador
Descumprimento de proposta e cont...
Perda de dados
Risco a Rastreabilidade metrológica
Atividades do laboratório
Comprometimento de atraso
Comprometimento do resultados
Danos ou perdas de equipamentos
Erros nos resultados
Falhas de comunicação
Perda de recursos
Processos legais
Riscos por processo
4 4 4 3 3 2 2 1 1 1 1
Controle ...
Garantia da valid...
Imparcialidade e confi...
Equipamentos e Rastr...
Pessoal
Análise crítica de pedi...
Produtos e serviços pr...
Instalações e condiçõ...
Reclamações
Relato de resultados
Requisitos de Recursos
NPR bruto G O D Risco Efeito NPR tra... G2 O2 D2 Ações
75 5 5 3 Custos elevados para realização de manutenções e/ou calibrações não realizadas no Brasil, dos equipamentos padrões | Risco a Rastreabilidade metrológica | 18 3 2 3 Implantar ações de controles de qualidade, visando ampliar os prazos de calibração (sem prejuízo na confiabilidade metrológica) e viabilizar fun... reserva e/ou recursos externos para possíveis manutenções de alto c...
75 5 3 5 Invasão ou roubo nas instalações do laboratório | Danos ou perdas de equipamentos | 20 4 1 5 Instalação de sistema de câmeras, reforçar portas e janelas, contra... monitoração, uso de alarme e tranca dos padrões
75 5 3 5 Invasão ou roubo nas instalações do laboratório | Danos ou perdas de equipamentos | 15 5 1 3 Instalação de sistema de câmeras, reforçar portas e janelas, contr... monitoração, uso de alarme e tranca dos padrões
60 5 3 4 Colaborador infectado por COVID-19 | Afastamento de colaborador | 12 3 2 2 Orientar sobre as medidas de prevenção no ambiente de trabalho... mãos, uso de mascaras, álcool a 70%, distanciamento e etc.)
60 4 5 3 Custos elevados para realização de manutenções e/ou calibrações não realizadas no Brasil, dos equipamentos padrões | Risco a Rastreabilidade metrológica | 18 3 2 3 Implantar ações de controles de qualidade, visando ampliar os prazos... calibração (sem prejuízo na confiabilidade metrológica) e viabilizar fundos... reserva e/ou recursos externos para possíveis manutenções de alto custo.
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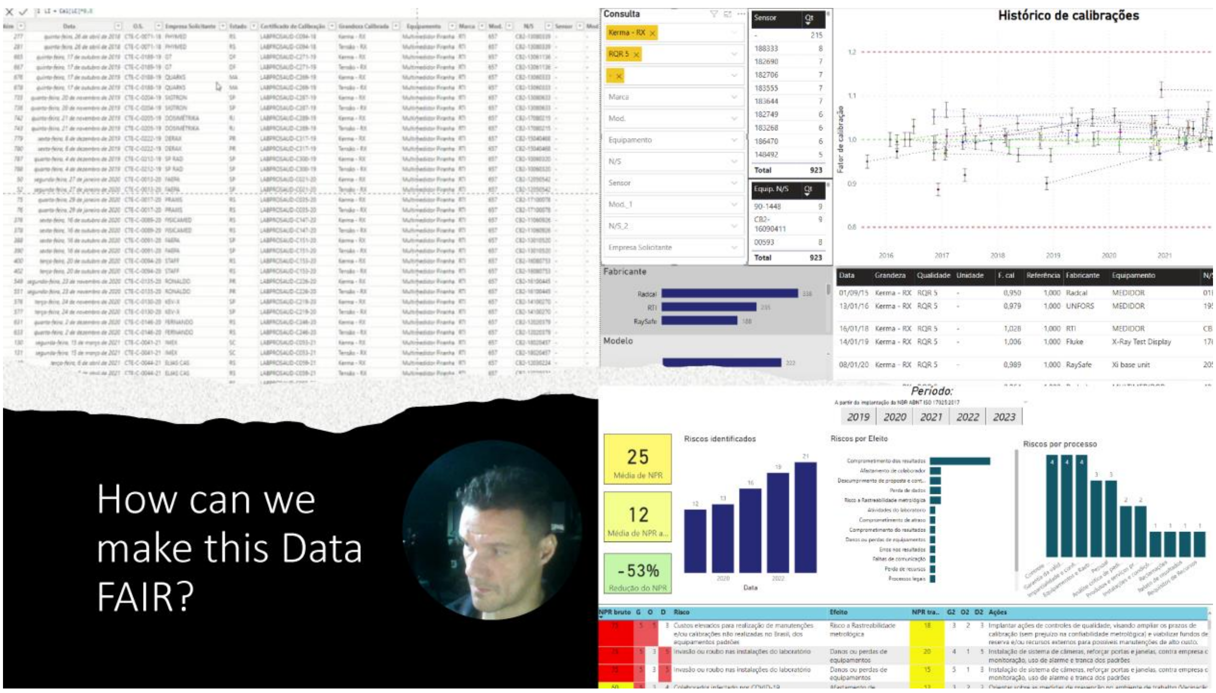
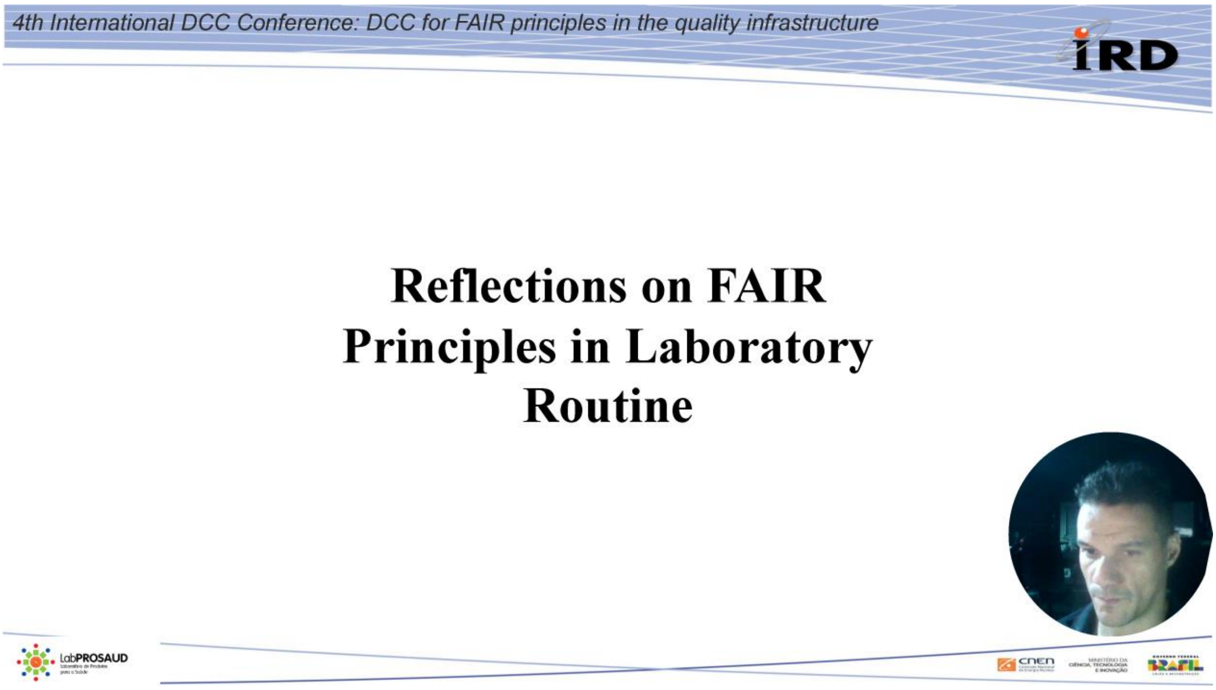
Gestão de riscos e oportunidades
A partir da implantação da NBR ABNT ISO 17025:2017
Período:
2019
2020
2021
2022
2023
27
Média de NPR
13
Média de NPR a...
-53%
Redução do NPR
Riscos identificados
Data
Riscos por Efeito
Comprometimento dos resultados
Danos ou perdas de equipamentos
Descumprimento de proposta e cont...
Falhas de comunicação
Perda de dados
Risco a Rastreabilidade metrológica
Afastamento de colaborador
Atividades do laboratório
Comprometimento de atraso
Comprometimento do resultados
Diminuição da receita
Dose acima do limite normativo
Riscos por processo
NPR bruto
G
O
D
Risco
Efeito
NPR tra..
G2
O2
D2
Ações
Instalações e condições ambientais
Danos ou perdas de equipamentos
Instalação de sistema de câmeras, reforçar portas e janelas, contratar empres monitoração, uso de alarme e tranca dos padrões em local mais seguro.
Custos elevados para realização de manutenções e/ou calibrações não realizadas no Brasil, dos equipamentos padrões
Risco a Rastreabilidade metrológica
Implantar ações de controles de qualidade, visando ampliar os prazos de calibração (sem prejuízo na confiabilidade metrológica) e viabilizar fundos de reserva e/ou recursos externos para possíveis manutenções de alto custo.
Invasão ou roubo nas instalações do laboratório
Colaborador infectado por COVID-19
Afastamento de colaborador
Orientar sobre as medidas de prevenção no ambiente de trabalho (Vacinação mãos, uso de mascaras, álcool a 70%, distanciamento e etc.)


Histórico de calibrações
Consulta
Fabricante
Modelo
How can we make this Data FAIR?
Período:
25
Média de NPR
12
Média de NPR a...
-53%
Redução do NPR
Riscos identificados
Riscos por Efeito
Riscos por processo


4th International DCC Conference: DCC for FAIR principles in the quality infrastructure
IRD
Reflections on FAIR Principles in Laboratory Routine
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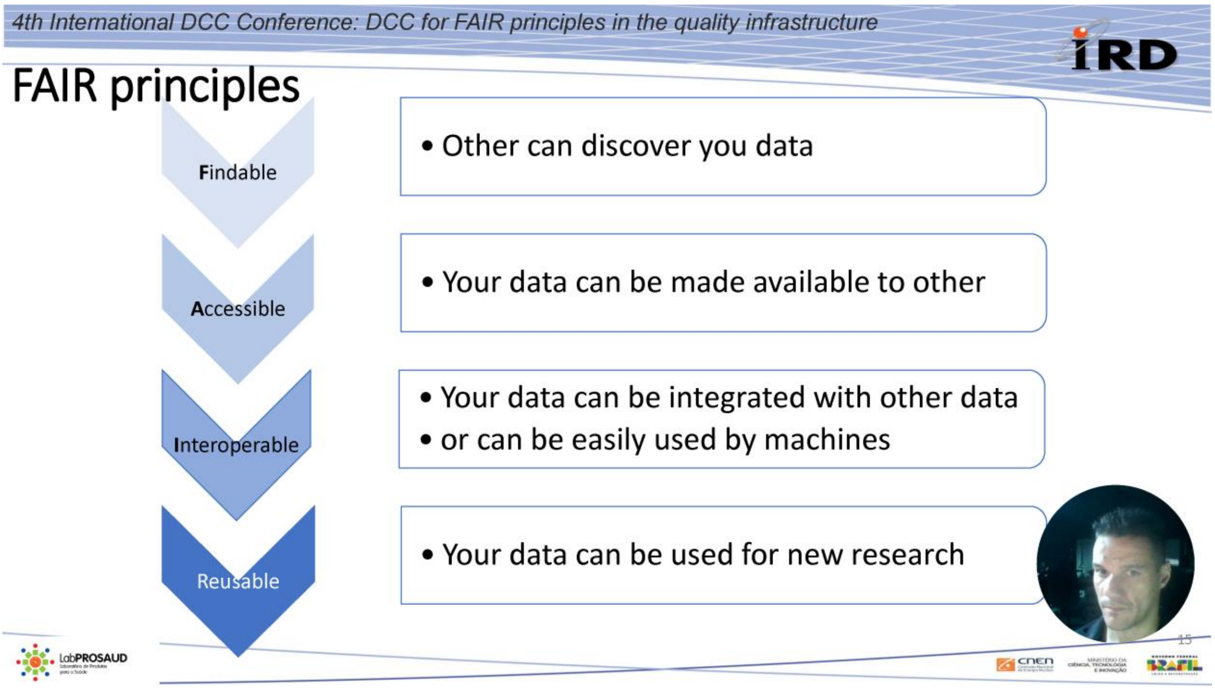
4th International DCC Conference: DCC for FAIR principles in the quality infrastructure
IRD
FAIR principles
Findable
• Other can discover you data
Accessible
• Your data can be made available to other
Interoperable
• Your data can be integrated with other data
• or can be easily used by machines
Reusable
• Your data can be used for new research
15
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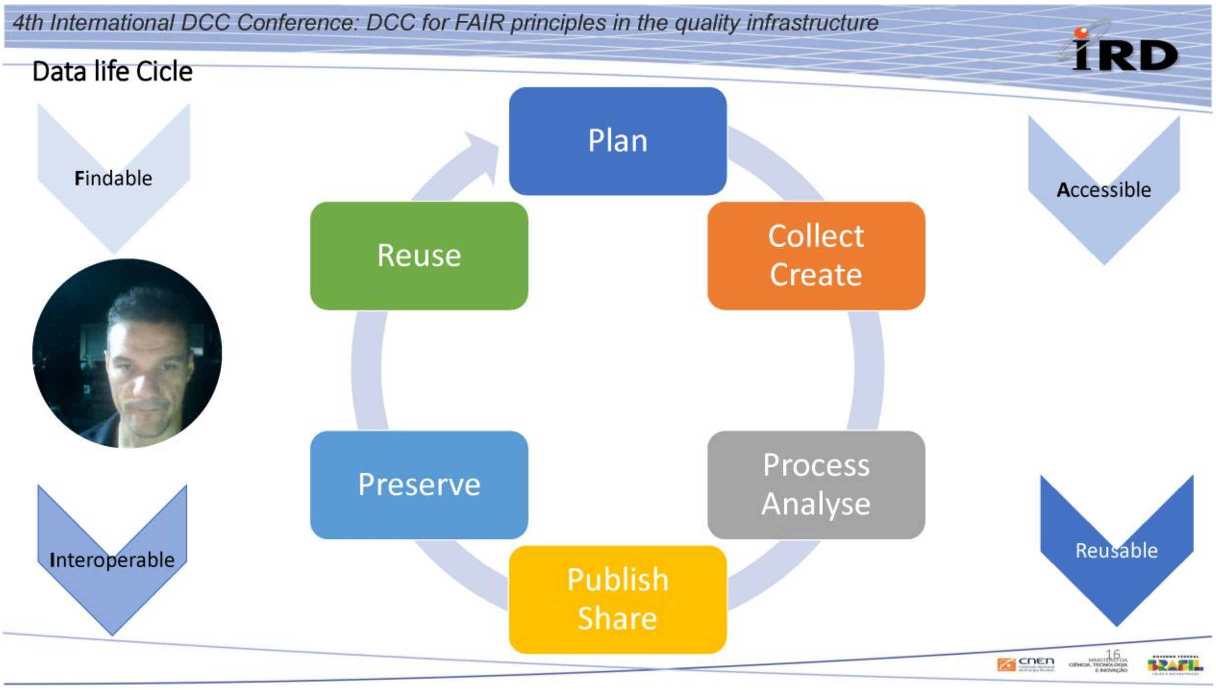
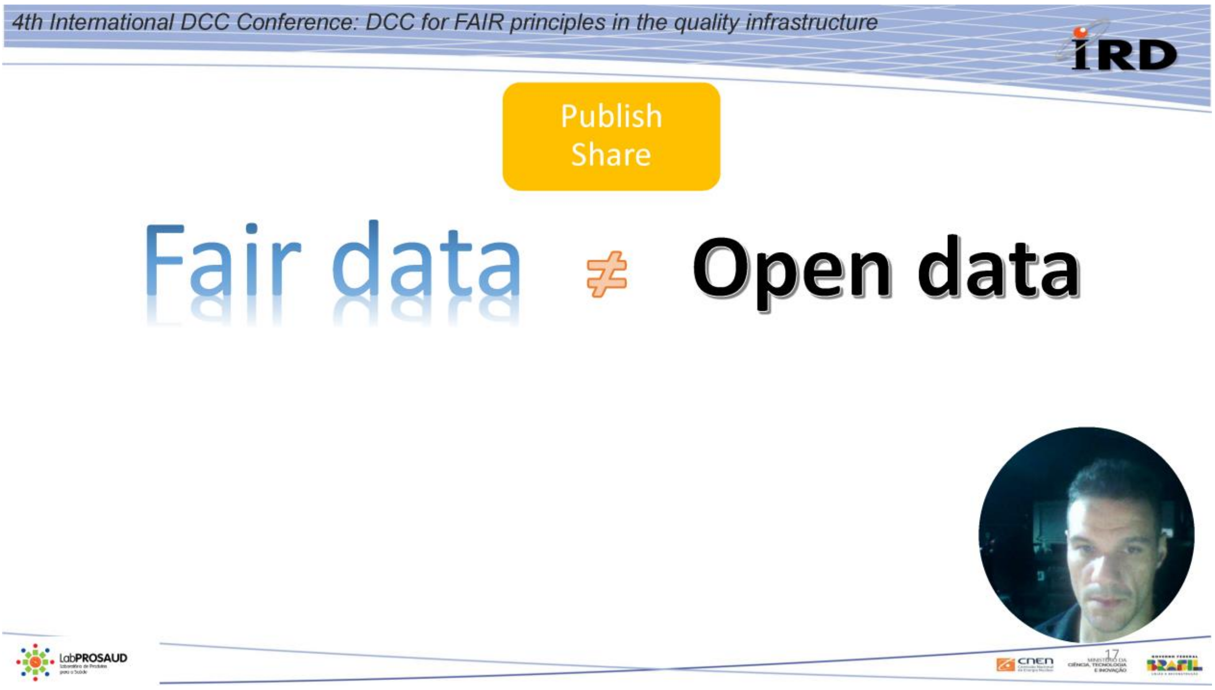
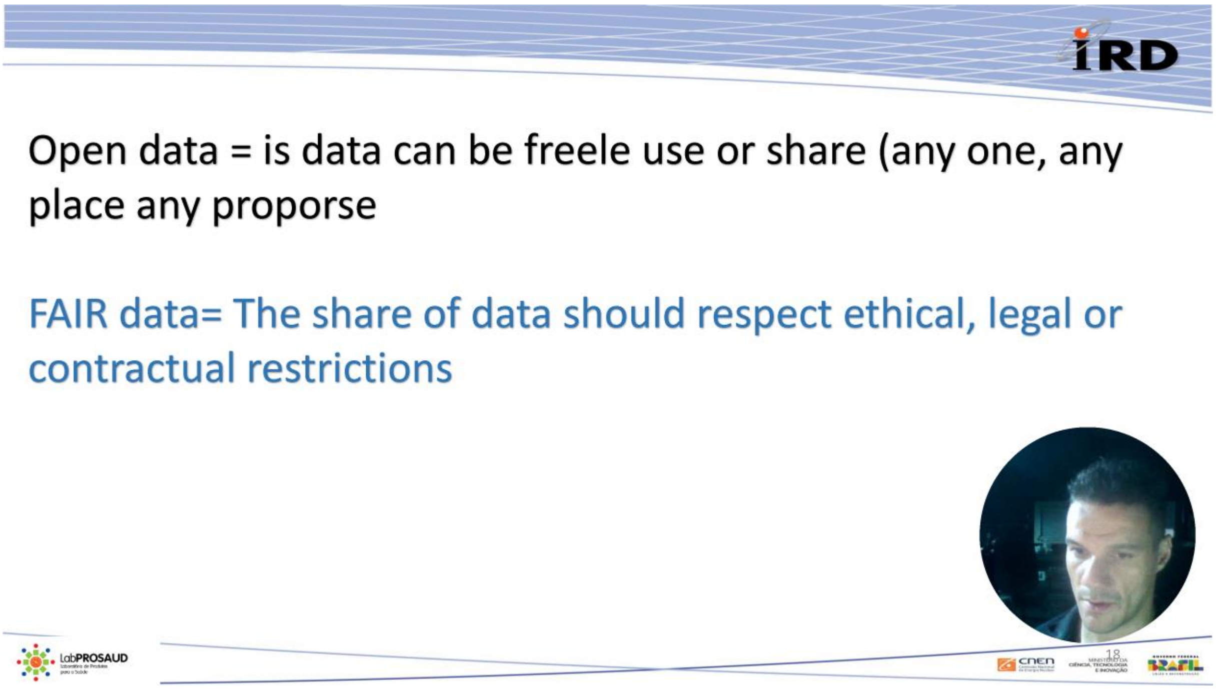

4th International DCC Conference: DCC for FAIR principles in the quality infrastructure
IRD
Data life Cicle
Findable
Accessible
Interoperable
Reusable
Plan
Collect
Create
Process
Analyse
Publish
Share
Preserve
Reuse
16


4th International DCC Conference: DCC for FAIR principles in the quality infrastructure
IRD
Publish
Share
Fair data ≠ Open data
LabPROSAUD
17


IRD
Open data = is data can be freele use or share (any one, any place any proporse
FAIR data= The share of data should respect ethical, legal or contractual restrictions
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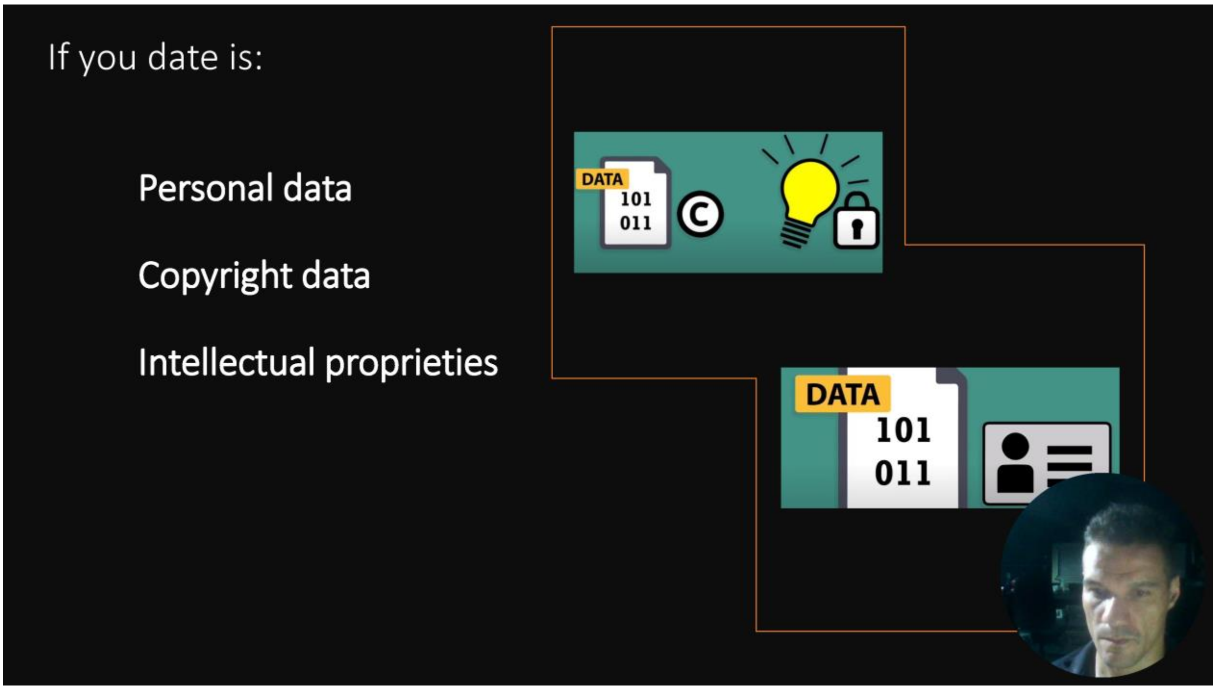
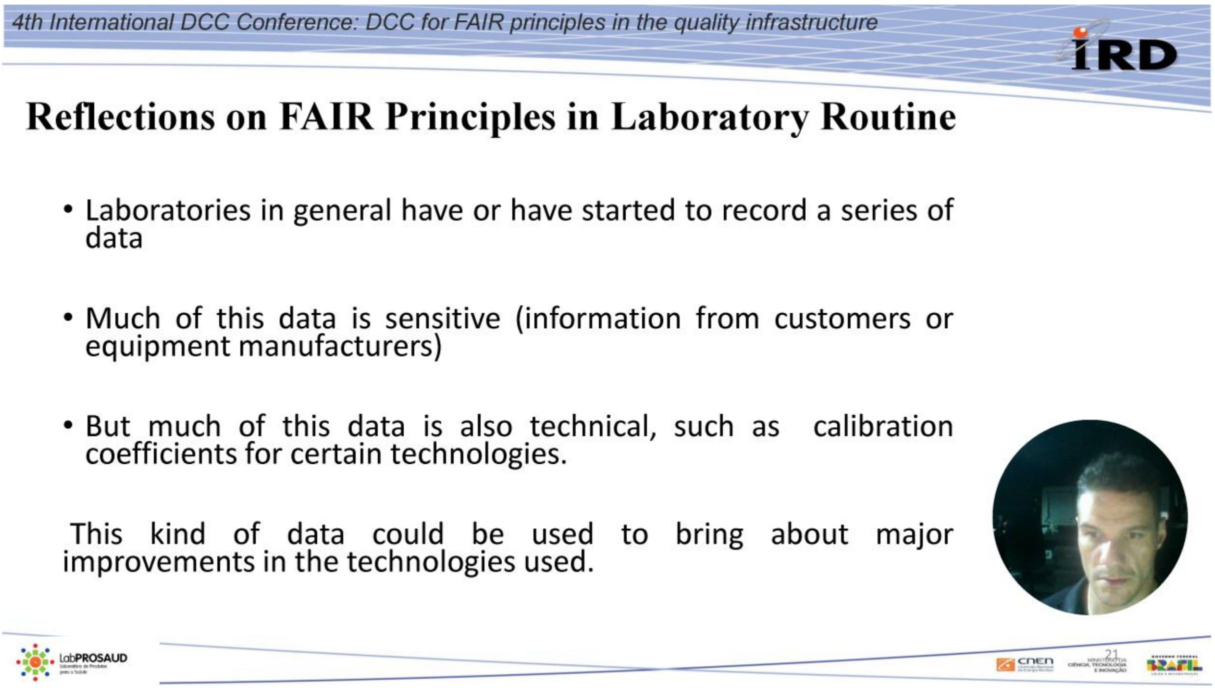
18


If you date is:
Personal data
Copyright data
Intellectual proprieties
DATA
101
011
DATA
101
011


You should PROTECT your data for unauthorize access
DATA
101
011
• But you should create and distribute a description of your data
Code
Location
20


4th International DCC Conference: DCC for FAIR principles in the quality infrastructure
IRD
Reflections on FAIR Principles in Laboratory Routine
• Laboratories in general have or have started to record a series of data
• Much of this data is sensitive (information from customers or equipment manufacturers)
• But much of this data is also technical, such as calibration coefficients for certain technologies.
This kind of data could be used to bring about major improvements in the technologies used.
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Reflections on FAIR Principles in Laboratory Routine

- Currently the main way to share this data is through the publication of scientific articles.
- But the use of just a DOI does not make this data FAIR

Table 3. Quantification of the risks of the traditional calibration process (FMEA).

Agent	Effect	Risk	S	O	D	RPN[1]	Actions	S	O	D	RPN[2]
User	Inaccurate calibration	Error in defining calibration criteria	4	2	2	16	User training and laboratory advice	3	2	2	12
		Error in the analysis and use of the CC	4	4	4	64		3	3	2	18
Logistics	Calibration not performed	Damage, loss, or theft of user equipment	5	3	3	45	Insurance and internal controls	4	2	3	36
		Excessive delay and calibration not performed	5	2	2	20		4	2	1	8
Laboratory management	Inaccurate calibration	Failure to comply with calibration requirements	4	3	3	36	Procedures for quality controls, internal and external audits	3	2	2	12
		Conflict of interest and confidentiality	3	2	3	18		3	1	2	6
		Receiving, handling, transport, and storage	4	2	3	24		4	2	2	16
	Calibration not performed	Break-in or theft of laboratory facilities	5	1	5	25	Security system	3	1	5	15
Laboratory calibration technique	Inaccurate calibration	Errors in calibration measurements	4	3	3	36	Procedures for quality controls, internal and external audits	4	2	2	16
		Errors in uncertainty calculations	4	3	4	48		4	2	4	32
		Errors in the calibration certificate information	4	3	2	24		4	2	1	8
		Equipment identification errors	1	3	3	9		1	2	2	4
		Unstable environmental conditions	3	3	3	27		2	1	2	4
	Calibration not performed	Patterns stop working	5	2	2	20	Reservation system	2	1	2	4
		User equipment does not work	5	3	2	30	No actions, calibration should be canceled	5	3	2	30
Regulatory bodies	Inaccurate calibration	Definition of calibration criteria	4	2	1	8	Team training	3	1	1	3
		Market surveillance error	4	2	4	32		3	2	2	12
					Total	*490*				*Total*	*242*

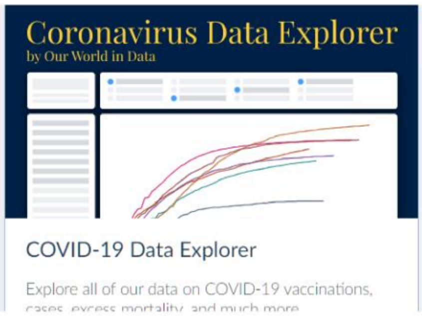
LabPROSAUD

4th International DCC Conference: DCC for FAIR principles in the quality infrastructure

IRD

Reflections on FAIR Principles in Laboratory Routine

- Maybe it's time to start organizing ourselves and setting up a data sharing system for metrology



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21 Case study of digital certificate using various formats suitable for the transitionperiod from paper to digital form

Presenting author: David Mahovský, Cesky Metrologicky Institut
Email: dmahovsky@cmi.cz
Additional authors: Martin Koval mkoval@cmi.cz

Abstract

The Digital Certificate is expected to be in a machine-readable, platform-independent format. Such formats that are widely known include XML, JSON, and YAML, but also others such as NEON. The common characteristic of these formats is their relatively easy creation and modification using simple text editors. However, this poses a significant secu¬rity challenge regarding the forgery of such certificates. This work explores the possibility of locking the aforementioned digital formats within a PDF/A-3A container, which com¬plies with the ISO 19005-3 standard for document archiving. After sealing this PDF/A-3A with an electronic signature, the attached files are protected against editing. For the veri¬fication of downloaded attachments, each file can be equipped with a cryptographic hash function.

The technical part of the work focuses on unifying the electronic version of a paper calibration sheet with selected attachments in the MS Excel environment. The SHA-256 cryptographic hash function is used, and Python language libraries are employed for its calculation. The creation of the resulting PDF/A-3A makes use of the LATEX program. The combination of the electronic version of paper certificates with machine-readable attachments results in a hybrid form of DCC, facilitating users in transitioning from paper to digital calibration certificates. This hybrid form is suitable, especially in calibration laboratories where is difficult to change old habits or to unify dozens of laboratories in a short period.

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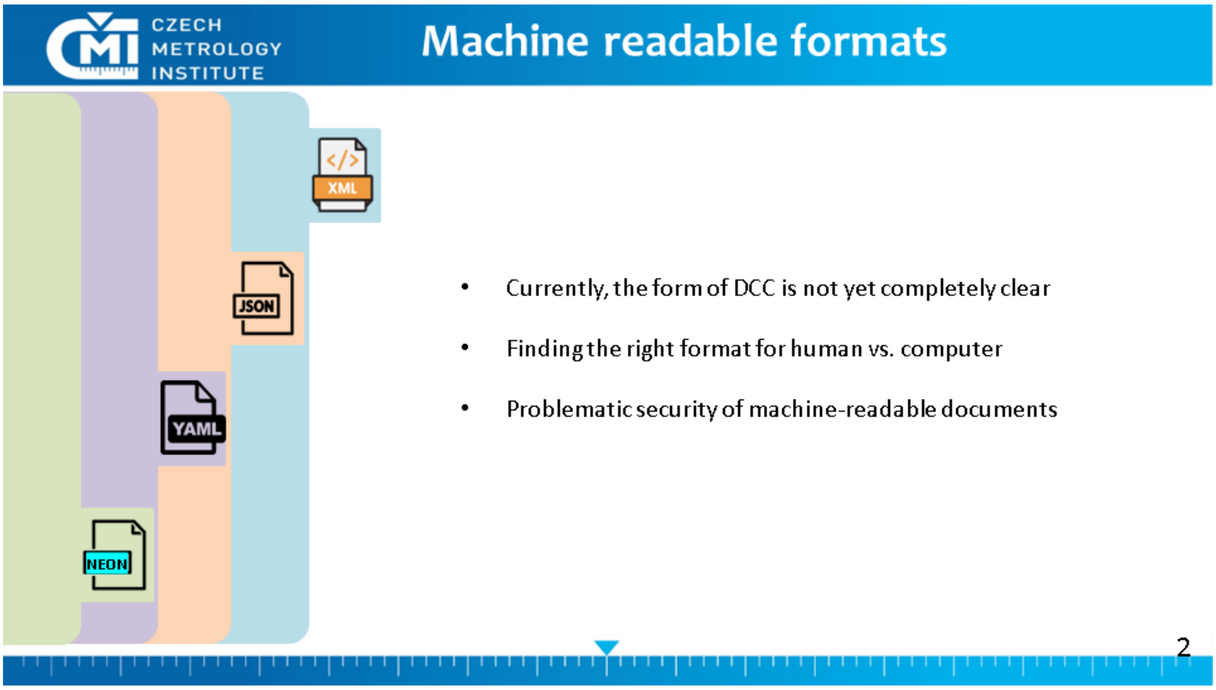
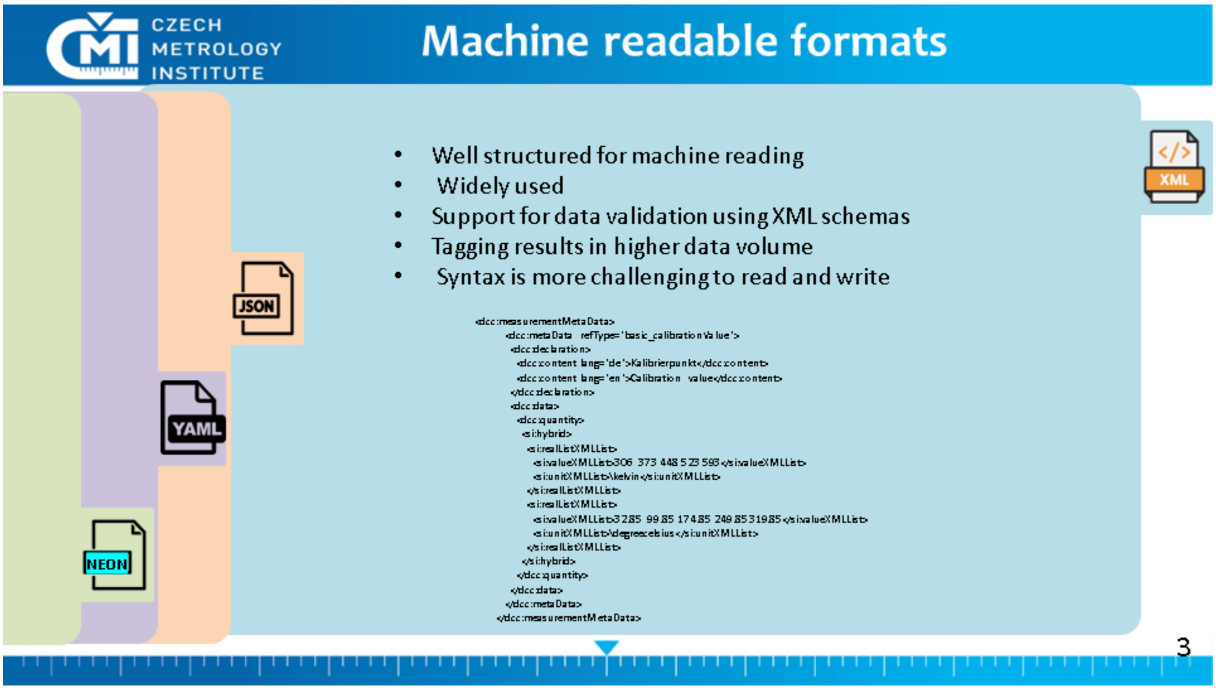
Presentation of David Mahovský


CZECH METROLOGY INSTITUTE
Machine readable formats
Currently, the form of DCC is not yet completely clear
Finding the right format for human vs. computer
Problematic security of machine-readable documents
2


CZECH METROLOGY INSTITUTE
Machine readable formats
Well structured for machine reading
Widely used
Support for data validation using XML schemas
Tagging results in higher data volume
Syntax is more challenging to read and write
<dcc:measurementMetaData>
<dcc:metaData refType='basic_calibrationValue'>
<dcc:declaration>
<dcc:content lang='de'>Kalibrierpunkt</dcc:content>
<dcc:content lang='en'>Calibration value</dcc:content>
</dcc:declaration>
<dcc:data>
<dcc:quantity>
<si:hybrid>
<si:realListXMLList>
<si:valueXMLList>306 373 448 523 593</si:valueXMLList>
<si:unitXMLList>\kelvin</si:unitXMLList>
</si:realListXMLList>
<si:realListXMLList>
<si:valueXMLList>32.85 99.85 174.85 249.85 319.85</si:valueXMLList>
<si:unitXMLList>\degreecelsius</si:unitXMLList>
</si:realListXMLList>
</si:hybrid>
</dcc:quantity>
</dcc:data>
</dcc:metaData>
</dcc:measurementMetaData>
3

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Machine readable formats

- Simple and lightweight,
- support for data serialization and deserialization
- Lacks support for comments,
- Limited structure for unstructured data.


```
{
  'measurementMetaData': {
    'metaData': {
      'refType': 'basic_calibrationValue',
      'declaration': {
        'content': [
          {'lang': 'de', 'value': 'Kalibrierpunkt'},
          {'lang': 'en', 'value': 'Calibration value'}
        ]
      },
      'data': {
        'quantity': {
          'hybrid': {
            'realListXMLList': [
              {
                'valueXMLList': '306 373 448 523 593',
                'unitXMLList': '\\kelvin'
              },
              {
                'valueXMLList': '32.85 99.85 174.85 249.85 319.85',
                'unitXMLList': '\\degreecelsius'
              }
            ]
          }
        }
      }
    }
  }
}
```


XML JSON YAML NEON

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Machine readable formats

- Human-readable
- minimizes the need for tagging,
- support for comments
- hierarchical data structure
- structure using offset - poor error detection
- less efficient for large volume data

YAML


```
measurementMetaData:
  metaData:
    refType: basic_calibrationValue
    declaration:
      content:
        - lang: de
          value: Kalibrierpunkt
        - lang: en
          value: Calibration value
    data:
      quantity:
        hybrid:
          realListXMLList:
            - valueXMLList: '306 373 448 523 593'
              unitXMLList: '\kelvin'
            - valueXMLList: '32.85 99.85 174.85 249.85 319.85'
              unitXMLList: '\degreecelsius'
```


XML JSON YAML NEON

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Machine readable formats

- Simple and readable syntax
- support for comments
- hierarchical structure
- Less widespread than other formats
- limited support from tools and libraries

NEON


```
measurementMetaData:
 metaData:
  refType: basic_calibrationValue
  declaration:
   dcc:content:
    - {lang: de, value: Kalibrierpunkt}
    - {lang: en, value: Calibration value}
  data:
   dcc:quantity:
    si:hybrid:
     si:realListXMLList:
      - {si:valueXMLList: '306 373 448 523 593', si:unitXMLList: '\kelvin'}
      - {si:valueXMLList: '32.85 99.85 174.85 249.85 319.85', si:unitXMLList: '\degreecelsius'}
```


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Visual comparison of formats

XML


```
<dcc:measurementMetaData>
    <dcc:metaData refType='basic_calibrationValue'>
     <dcc:declaration>
      <dcc:content lang='de'>Kalibrierpunkt</dcc:content>
      <dcc:content lang='en'>Calibration value</dcc:content>
     </dcc:declaration>
     <dcc:data>
      <dcc:quantity>
       <si:hybrid>
        <si:realListXMLList>
         <si:valueXMLList>306 373 448 523 593</si:valueXMLList>
         <si:unitXMLList>\kelvin</si:unitXMLList>
        </si:realListXMLList>
        <si:realListXMLList>
         <si:valueXMLList>32.85 99.85 174.85 249.85 319.85</si:valueXMLList>
         <si:unitXMLList>\degreecelsius</si:unitXMLList>
        </si:realListXMLList>
       </si:hybrid>
      </dcc:quantity>
     </dcc:data>
    </dcc:metaData>
   </dcc:measurementMetaData>
```


JSON


```
{
 'measurementMetaData': {
  'metaData': {
   'refType': 'basic_calibrationValue',
   'declaration': {
    'content': [
     {'lang': 'de', 'value': 'Kalibrierpunkt'},
     {'lang': 'en', 'value': 'Calibration value'}
    ]
   },
   'data': {
    'quantity': {
     'hybrid': {
      'realListXMLList': [
       {
        'valueXMLList': '306 373 448 523 593',
        'unitXMLList': '\\kelvin'
       },
       {
        'valueXMLList': '32.85 99.85 174.85 249.85 319.85',
        'unitXMLList': '\\degreecelsius'
       }
      ]
     }
    }
   }
  }
 }
}
```


YAML


```
measurementMetaData:
 metaData:
  refType: basic_calibrationValue
  declaration:
   content:
    - lang: de
      value: Kalibrierpunkt
    - lang: en
      value: Calibration value
  data:
   quantity:
    hybrid:
     realListXMLList:
      - valueXMLList: '306 373 448 523 593'
        unitXMLList: '\kelvin'
      - valueXMLList: '32.85 99.85 174.85 249.85 319.85'
        unitXMLList: '\degreecelsius'
```


NEON


```
measurementMetaData:
 metaData:
  refType: basic_calibrationValue
  declaration:
   dcc:content:
    - {lang: de, value: Kalibrierpunkt}
    - {lang: en, value: Calibration value}
  data:
   dcc:quantity:
    si:hybrid:
     si:realListXMLList:
      - {si:valueXMLList: '306 373 448 523 593', si:unitXMLList: '\kelvin'}
      - {si:valueXMLList: '32.85 99.85 174.85 249.85 319.85', si:unitXMLList: '\degreecelsius'}
```


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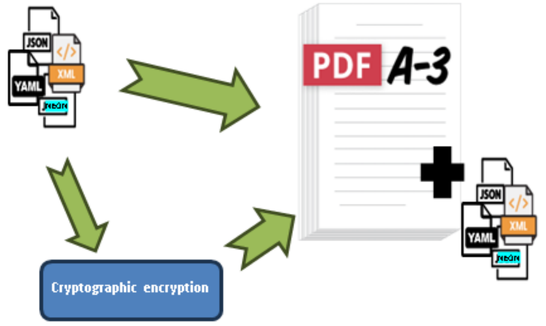
Hybrid form of DCC



- Preserving the visual appearance of CC
- Archiving large volumes of data
- Archiving files of various formats
- Easy digital signature option
- Long-term archiving (ISO 19005-3)

8

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Cryptographic hash functions

Determinism: For the **same input**, the hash function will always produce the **same output**.

Fast Computation: Hash functions are designed to be computationally efficient, capable of **quickly processing** input data to generate the hash value.

Irreversibility: It should be computationally **infeasible to reverse** the process and derive the original input data from its hash value.

Uniformity: A good hash function aims to evenly distribute hash values across its output space to **minimize collisions**

Fixed Output Size: Regardless of the size of the input data, the hash function produces a hash value with a **fixed length**.

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SHA-256

- Virtually unbreakable with today's computing technology
- Quick calculation
- Negligible probability of collision
- Many tools and libraries

```python
import hashlib

def generate_sha256(file_path):
    sha256_hash = hashlib.sha256()

    with open(file_path, "rb") as f:

        for byte_block in iter(lambda: f.read(4096), b""):
            sha256_hash.update (byte_block)

    return sha256_hash.hexdigest()

sha256 = generate_sha256(file_path)
print (sha256)
```

computational algorithm of SHA-256 in Python

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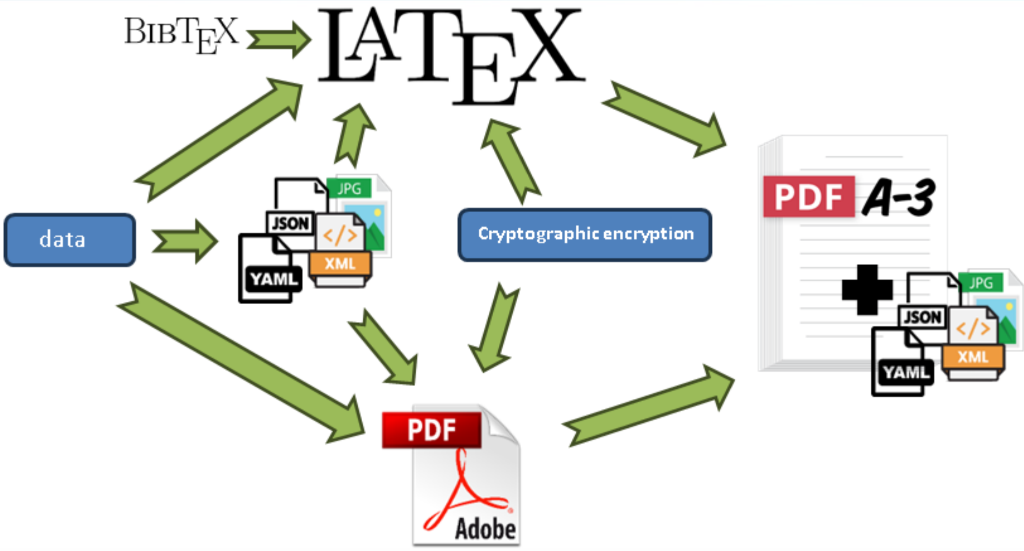
Way to the hybrid DCC



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22 Python-based development libraries and Web Applications to process array-like DCC data using a internal JSON representation.

Presenting author: Benedikt Seeger, PTB Germany
Email: benedikt.seeger@ptb.de
Additional authors: Vanessa Stehr, Dr. Thomas Bruns

Abstract

In certain scenarios, opting for JSON over XML offers significant benefits, as JSON has a lightweight structure and is intuitive to use with popular programming languages such as Python, Java, and JavaScript. In addition, JSON's native ability to handle array formats increases its usefulness. To facilitate the integration of JSON into DCC utilising software, we have designed a lightweight Python library. This library converts XML to JSON and vice versa, while preserving the content of tags, attributes, and comments. We have also developed a user-friendly Web-API and GUI that are conveniently packaged in a Docker container. This eliminates the need for external XML libraries in software development processes.

Our endeavours further extend to the creation of a library that is specialized in managing vectorized data and arrays of such data in the JSON DCC format. This library simplifies the process of automatic visualization of DCC formated data and supports the export into formats like CSV, ODF and XLSX. It is also equipped to handle the conversion and serialization of relative and absolute uncertainties to ensure that data is accurately represented in XML format. Based on these fundamental libraries, we have introduced a web application that efficiently retrieves and presents tabulated data within the DCC. Users can conveniently download this data in CSV, ODF or XLSX format. Within the application D-SI units are converted into their LaTeX representation for increased clarity. It also supports multilingual functionality allowing users to switch between different language options as required, if the DCC is multilingual.

To integrate tabulated data generated by various calibration systems and software into a DCC or a DCC template, we have developed the DCCTableTool. This web-based tool is built upon our aforementioned libraries and features a REST API backend. This backend enables the conversion of data from formats like XLSX, CSV, or ODF into JSON/XML, guided by a user-defined control file. The backend is complemented by a web GUI that displays tabulated data and allows users to select columns representing values and uncertainties. The selected data is then integrated into the DCC. Once integrated, the tool generates a control file to facilitate the automation of these tasks via the REST API, thus, streamlining the process of reading and writing tabulated data from the DCC using existing systems and software. The DCCTableTool was developed in Python and will be available both as a Docker container and as a Python library.

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Presentation of Benedikt Seeger

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Nationales Metrologieinstitut

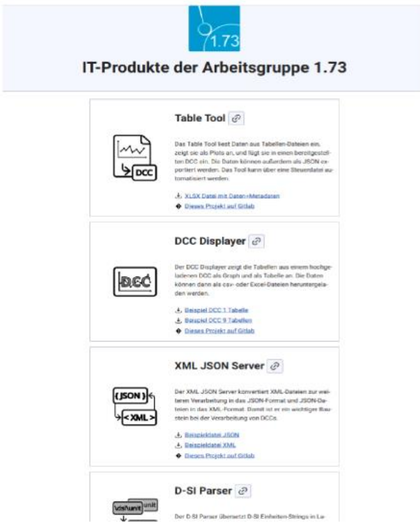
Python-based development libraries and Web Applications to process array-like DCC data using a internal JSON representation

4th International DCC Conference Tools & Software I

Benedikt Seeger, Vanessa Stehr,
Dr. Thomas Bruns AG 1.73 PTB

Content

1. XML JSON Converter
2. DCC-Viewer
3. D-SI Parser & Comeparator
4. Ring-Comparison-Tool



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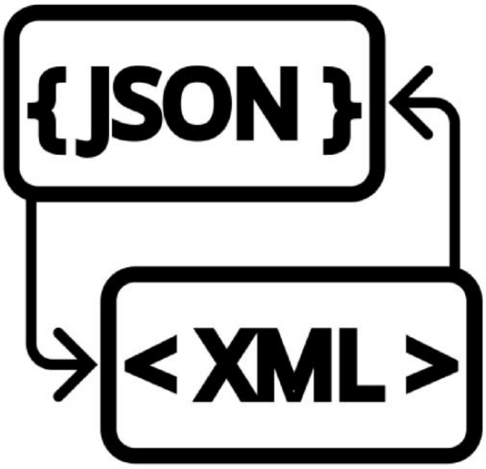
XML - JSON Converter



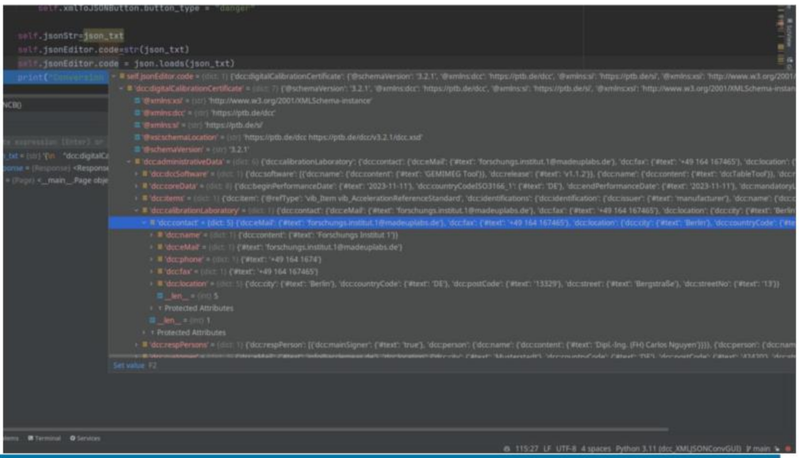
Introduction: XML and JSON

- XML and JSON are two different text-based data formats for hierarchical data
  - For interoperation the structure of the data is important not the file format
- DCC uses XML
- JSON is natively supported by many programming languages and databases (Python, Java, JavaScript)
  - therefore faster and easier to access in code

Introduction: XML and JSON

Introspection in Python

- Change and view variables at runtime
- Hierarchy is taken into account



Mapping rules

- JSON does not support attributes
- Instead, attributes are represented as keys with @
- The values get the key #text


```
▼ dcc:list {2}
    @refType : vib_voltageTransferFunction basic_1IndexTable
  ▼ dcc:quantity [4]
    ▼ 0 {3}
        @refType : vib_frequency vib_nominalFrequency basic_TableIndex0
      ▼ dcc:name {1}
        ▼ dcc:content [2]
          ▼ 0 {2}
              @lang : de
              #text : Anregungsfrequenz
```

Dealing with repeatable fields

- Every XML-Element is mapped to an JSON Dict
- Attributes of the Element are with in the Dict
- Repeatable fields like the listed ones are always converted in an list. Even when containing only one element

software	refTypeDefinition	equipmentClass	mandatoryLangCodeISO639_1	measuringEquipmentQuantity
usedLangCodeISO639_1	measuringEquipment	item	itemQuantity	identification
respPerson	statement	measurementResult	usedMethod	norm
reference	influenceCondition	result	metaData	countryCodeISO3166_1
content	file	formula		

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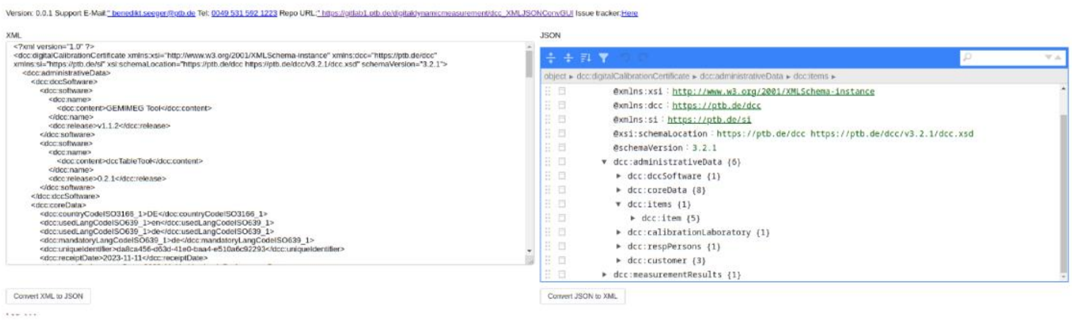
XML – Json Converter-Tool

- Our tool converts XML to JSON and vice versa without loss
- Access to the functions as a Python library, via a web GUI or a REST API



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Python-Library

- We have developed a library for working with tabulated data from the DCC in Python
- Serializing and deserializing XML and JSON
- Consideration and handling of absolute and relative uncertainties
- Indexing of tabulated data
- Visualization with Bokeh
- Export to other formats (CSV, XLSX, ODT, ...)

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Table-Tool

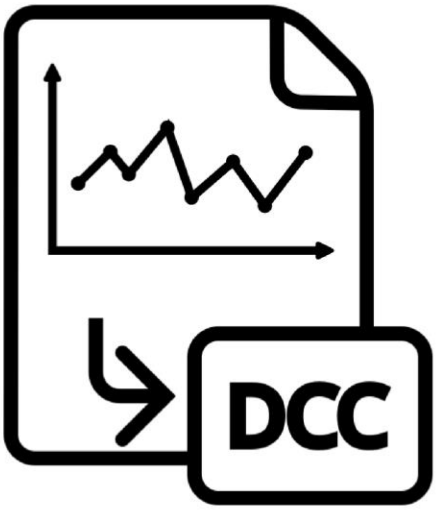

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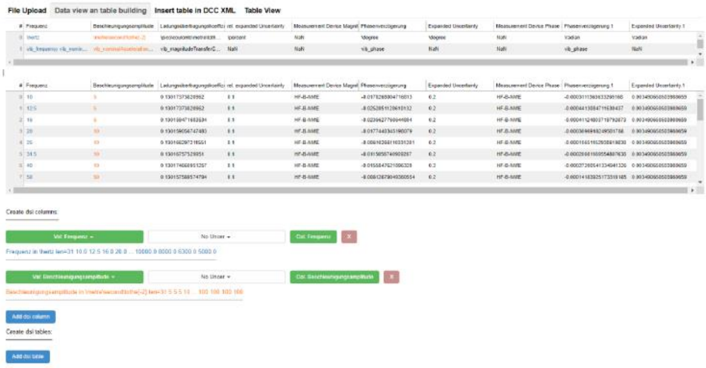
Table-Tool

Automated web tool for creating DCC-XML tables from spreadsheet data (XLSX, CSV,...)

REST-API with control file for repeated usage.



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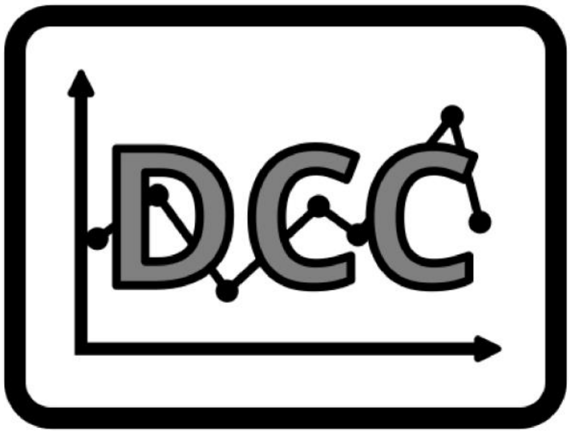
DCC-Viewer



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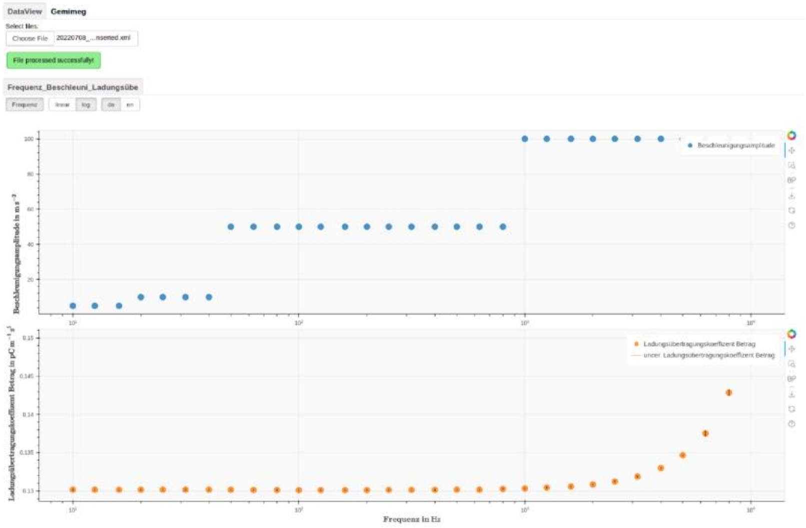
DCC-Viewer



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DCC-Viewer

#	Frequenz	Beschleunigungsamplitude	Ladungsübertragungskoeffizent Betrag	Ladungsübertragungskoeffizent Betrag rel
0	Frequenz	Beschleunigungsamplitude	Ladungsübertragungskoeffizent Betrag	Ladungsübertragungskoeffizent Betrag rel
1	\hertz	\metre\second\tothe{-2}	\pico\coulomb\metre\tothe{-1}\second\tothe{2}	\one
2	'vib_frequency', 'vib_nominalFrequency', 'basic_TableIndex0'	'vib_nominalAccelerationAmplitude', 'vib_accelerationAmplitude'	'vib_magnitudeTransferCoefCharge'	
3	{'de': 'Frequenz', 'en': 'Frequency'}	{'de': 'Beschleunigungsamplitude', 'en': 'Acceleration Amplitude'}	{'de': 'Ladungsübertragungskoeffizent Betrag', 'en': 'Charge transfer coefficient	
4	10	5	0.13017	0.001
5	12.5	5	0.13017	0.001
6	16	5	0.13016	0.001
7	20	10	0.13016	0.001
8	25	10	0.13017	0.001
9	31.5	10	0.13017	0.001
10	40	10	0.13017	0.001
11	50	50	0.13016	0.001
12	63	50	0.13013	0.001
13	80	50	0.13013	0.001
14	100	50	0.13012	0.001

Choose file format...

Download

No file download requested.

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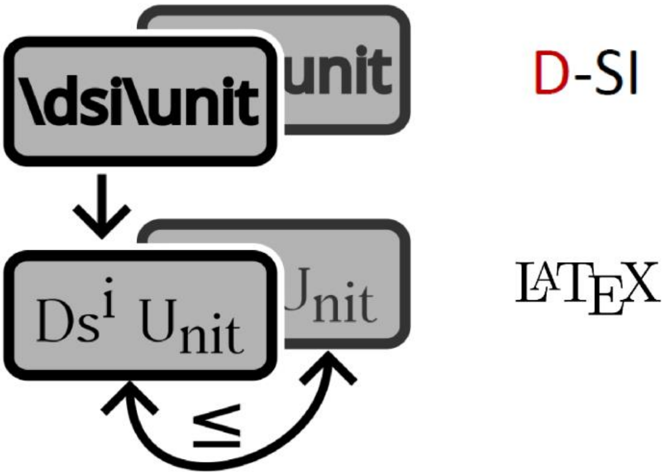
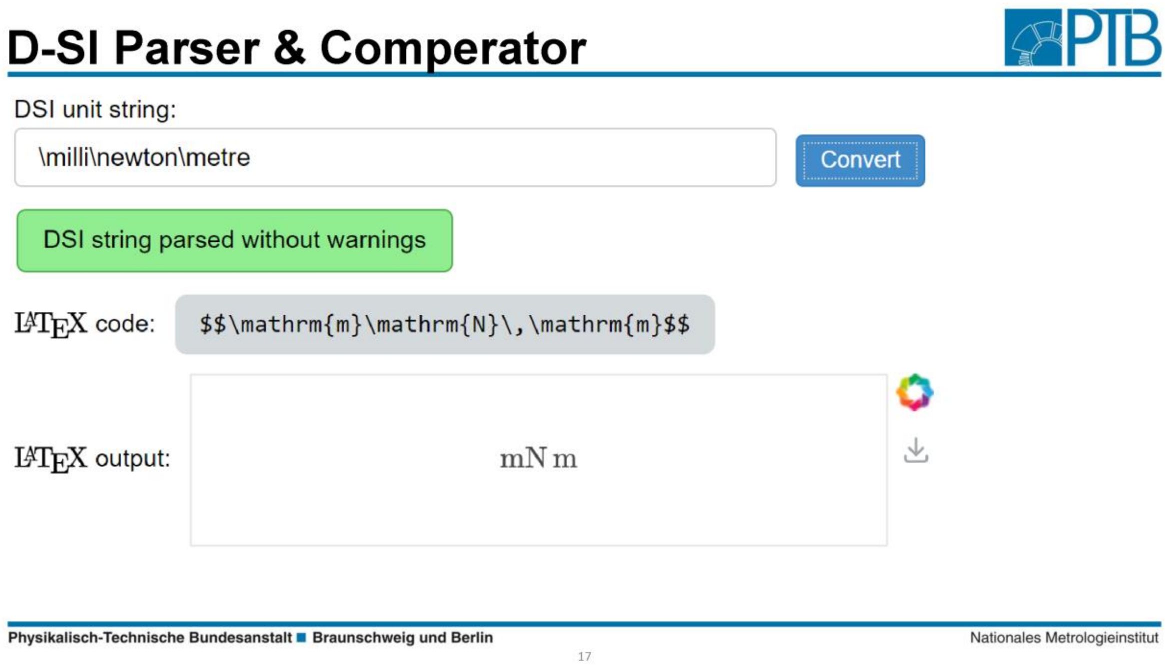
D-SI Parser & Comperator



D-SI Parser & Comperator

- To simplify working with D-SI unit strings, we have developed a Python library and associated web GUI for parsing and comparison
- When comparing, the units are converted to SI base units and, if possible, the conversion scalar is determined
- Math operators +, -, *,/ and ^ are supported to do calculations with the units


D-SI Parser & Comperator
PTB
DSI unit string:
\milli\newton\metre
Convert
DSI string parsed without warnings
LaTeX code:
$$\mathrm{m}\mathrm{N}\,\mathrm{m}$$
LaTeX output:
mN m
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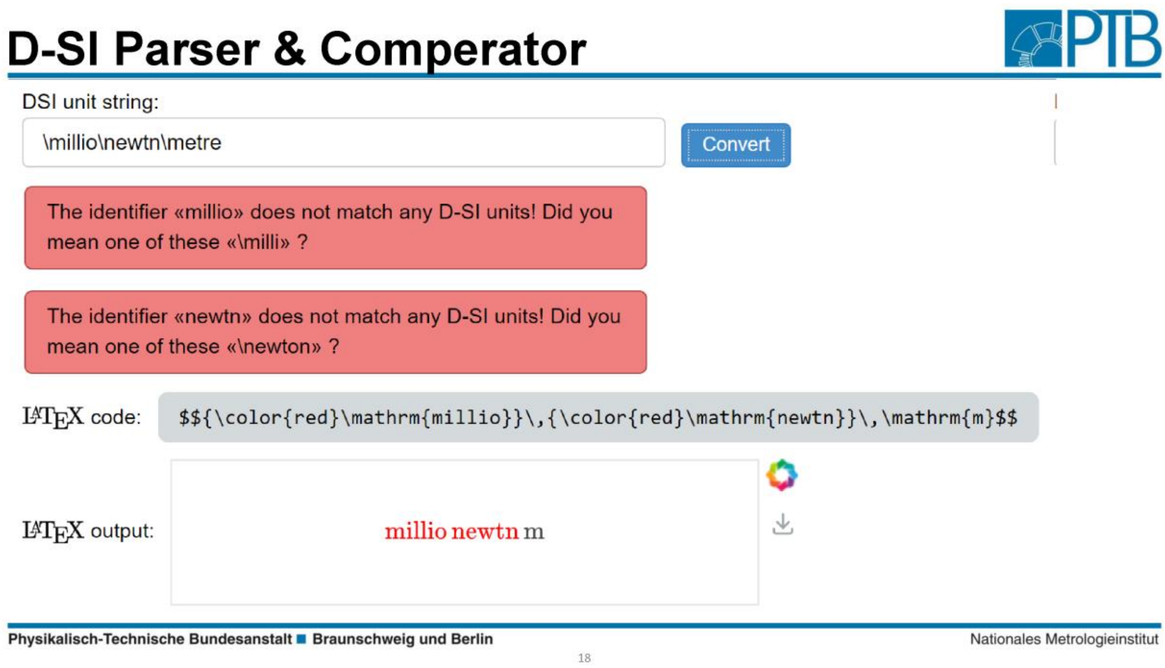
D-SI Parser & Comperator
PTB
DSI unit string:
\millio\newtn\metre
Convert
The identifier «millio» does not match any D-SI units! Did you mean one of these «\milli» ?
The identifier «newtn» does not match any D-SI units! Did you mean one of these «\newton» ?
LaTeX code:
$${\color{red}\mathrm{millio}}\,{\color{red}\mathrm{newtn}}\,\mathrm{m}$$
LaTeX output:
millio newtn m
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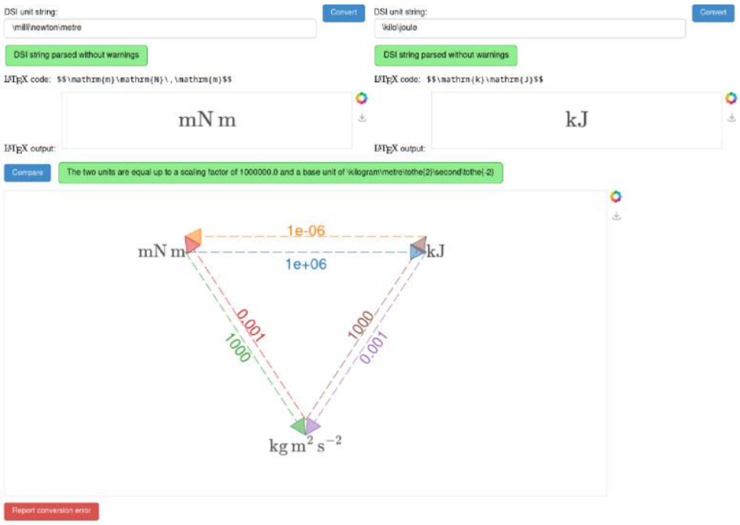
D-SI Parser & Comperator



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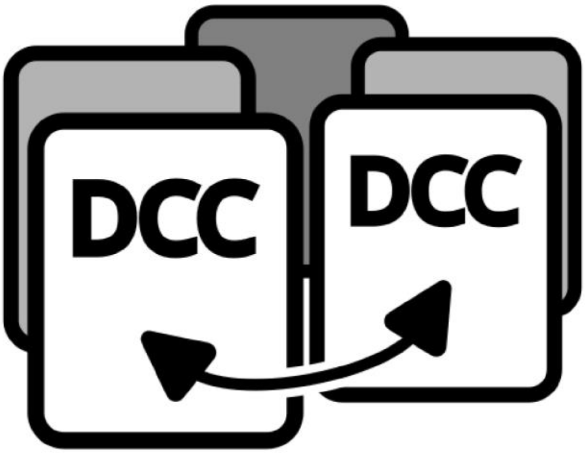
Ring-Comparison-Tool



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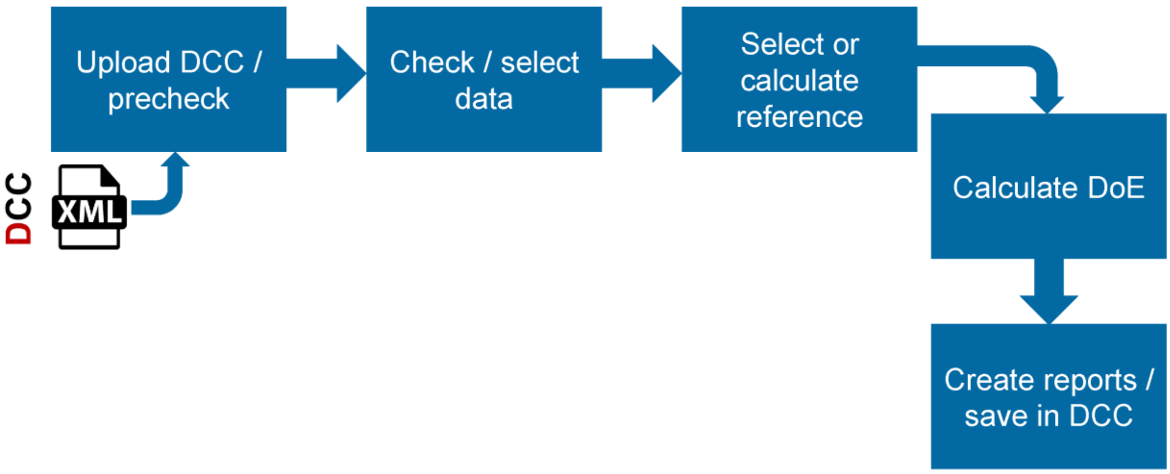
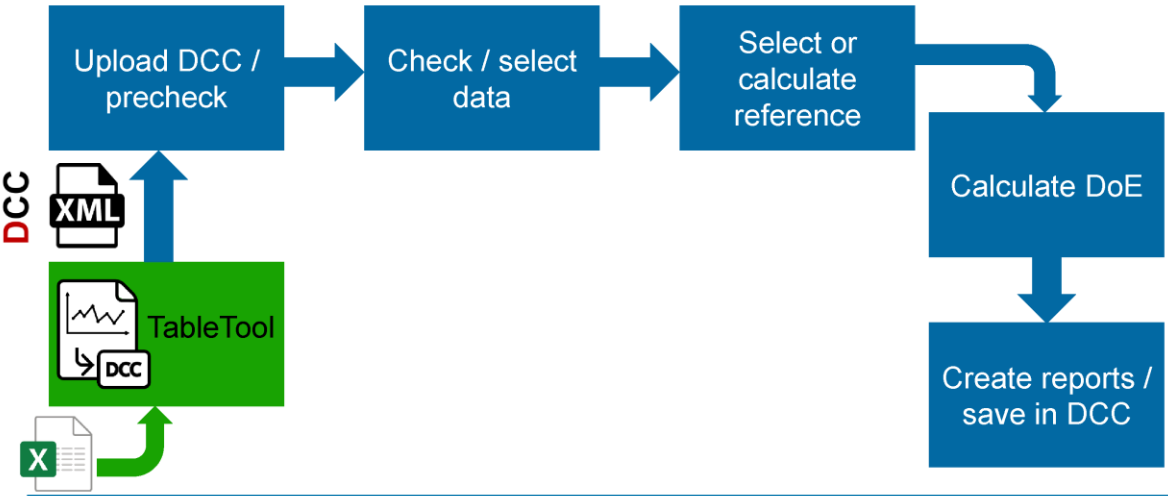
Motivation

- Manual evaluation of interlaboratory comparisons using Excel tables is time-consuming and error-prone
- Automated evaluation is possible with DCC, as the structured data can be easily interpreted by machines
- Due to the reduced manual effort, errors are less likely and logical checks can be easily integrated into the automated process

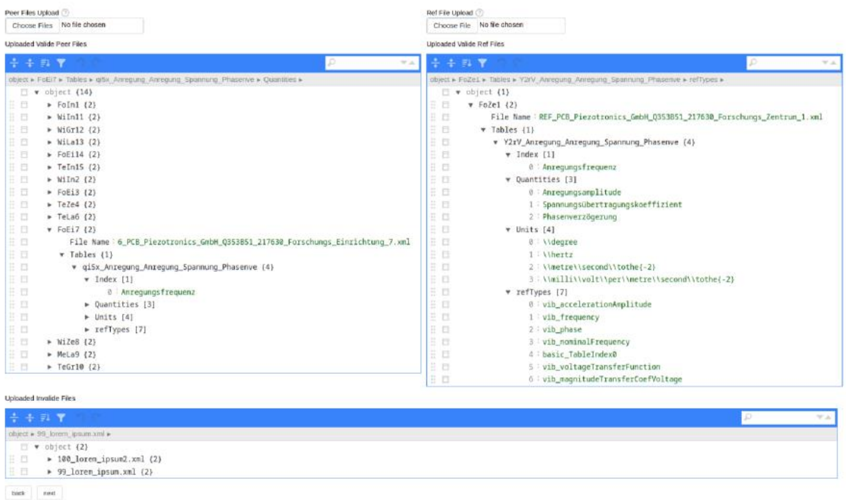
Procedure of the automated evaluation



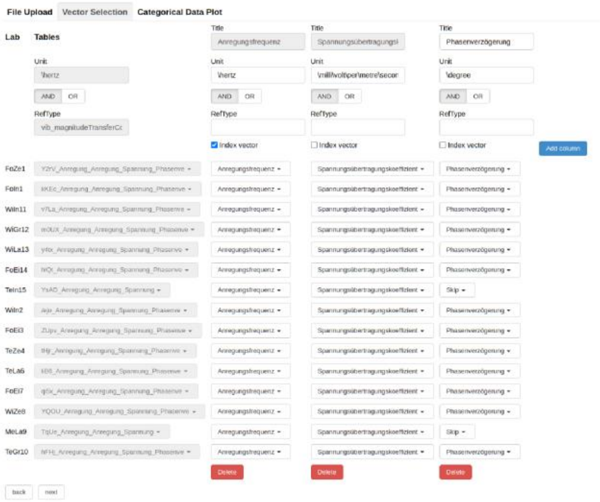
Procedure of the automated evaluation



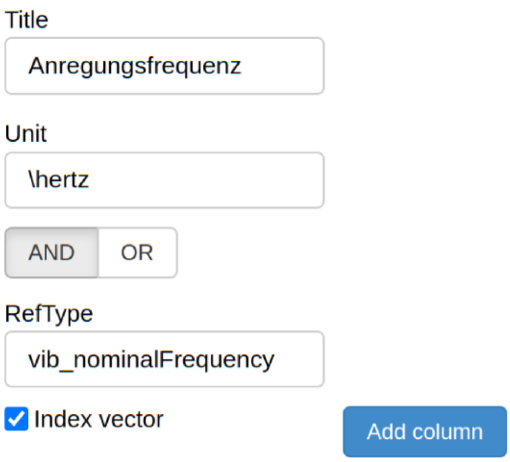
File Upload



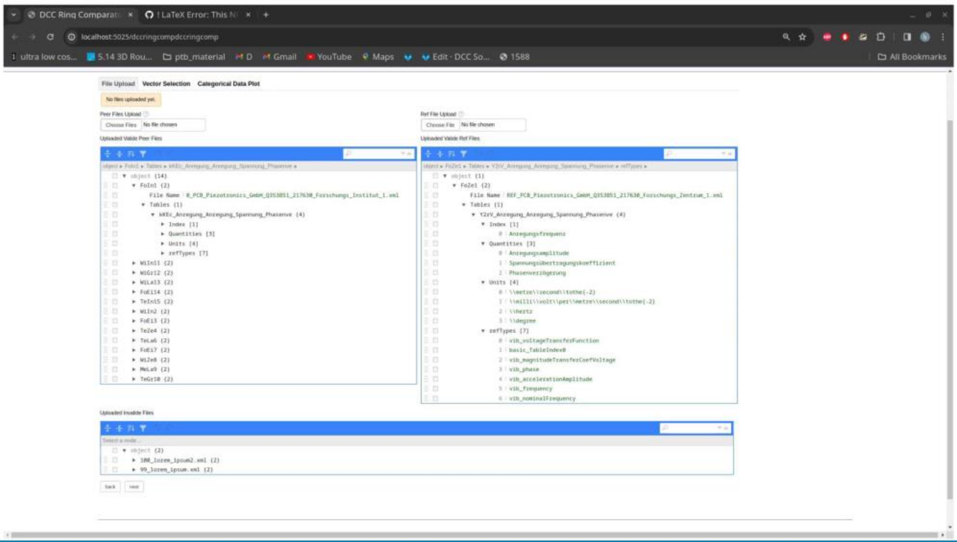
Procedure of the automated evaluation



Filtering with refType and Units



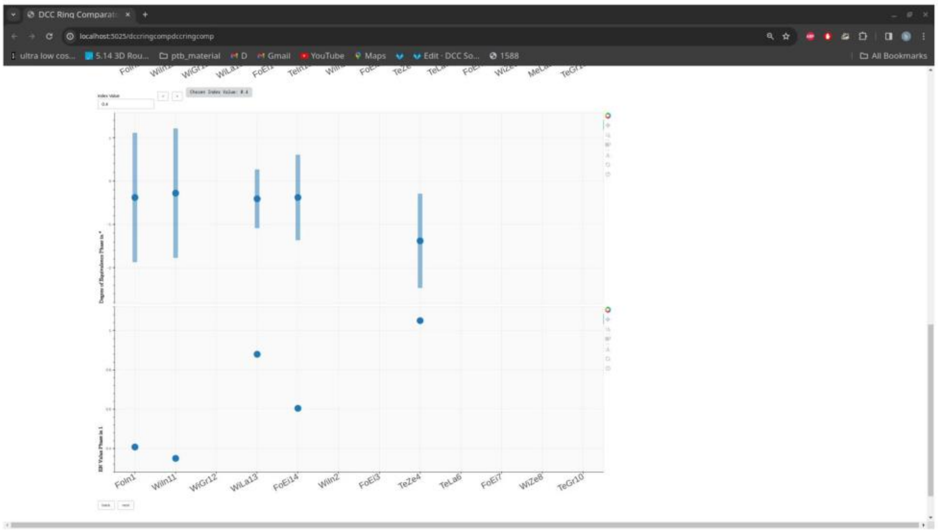
Procedure of the automated evaluation



Evaluation results

- Results of the evaluation are inserted in the participant DCC
  - As `dcc:measurementResult` element
- Visual representation of the results as plots:
  - Categorized by indices with pre-filtering
  - per individual participant

Visualization of the results



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Nationales Metrologieinstitut

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Questions and discussion

Contact

Benedikt Seeger

Benedikt.seeger@ptb.de

https://gitlab1.ptb.de/Seeger

https://gitlab1.ptb.de/digitaldynamicmeasurement

Physikalisch-Technische Bundesanstalt ■ Braunschweig und Berlin

Nationales Metrologieinstitut

1.73 Digitalisierung dynamischer Messprozesse

Dr. Thomas
Bruns

Benedikt
Seeger

Vanessa
Stehr

Physikalisch-Technische Bundesanstalt ■ Braunschweig und Berlin Nationales Metrologieinstitut

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Session “Industry Applications” (Chair: Aldo Adrian Garcia Gonzalez, CENAM)

23 Serializing uncertainty to enhance traceable measurements

Presenting author: Blair Hall, Measurement Standards Laboratory of New Zealand (MSL)
Email: blair.hall@measurement.govt.nz
Additional authors: Joseph Borbely joseph.borbely@measurement.govt.nz

Abstract

Digitalisation of information passed along traceability chains offers enhanced value to end users of measurement data. Digital records can deliver detailed information about contributions to the uncertainty of measured values, leading to better-informed decision making at the end of chains.

This presentation shows how data modelling with adequate representations for measured data can produce serializable digital records for measured values with full uncertainty budgets. When these records are passed along a traceability chain, downstream agents can take advantage of a more nuanced representation.

The approach draws on guidance in the Guide to the Expression of Uncertainty in Measurement (GUM) [1]. GUM-compliant data processing is facilitated by adopting the abstract notion of an *uncertain number*, which is straightforward to implement in software [2, 3]. Digital records, produced by serialising the results of uncertain-number data processing, can be passed from one stage of a traceable measurement to the next, typically inside calibration or measurement reports. At the end of a traceability chain, where data is used to inform a decision process, accurate inferences about a measurand are produced by rigorous handling of the various contributions to measurement uncertainty.

References

[1] BIPM; IEC; IFCC; ILAC; ISO; IUPAC; IUPAP; OIML. *Evaluation of Measurement Data—Guide to the Expression of Uncertainty in Measurement* JCGM 100:2008 (GUM 1995 with Minor Corrections), 1st ed.; BIPM Joint Committee for Guides in Metrology: Paris, France, 2008.

[2] B. D. Hall, *Computing uncertainty with uncertain numbers*, Metrologia 43(6):L56, 2006, DOI: 10.1088/0026-1394/43/6/N07 [3] B. D. Hall, *The GUM Tree Calculator: A Python Package for Measurement Modelling and Data*

Processing with Automatic Evaluation of Uncertainty, Metrology 2(1):128, 2022,

DOI: 10.3390/metrology2010009

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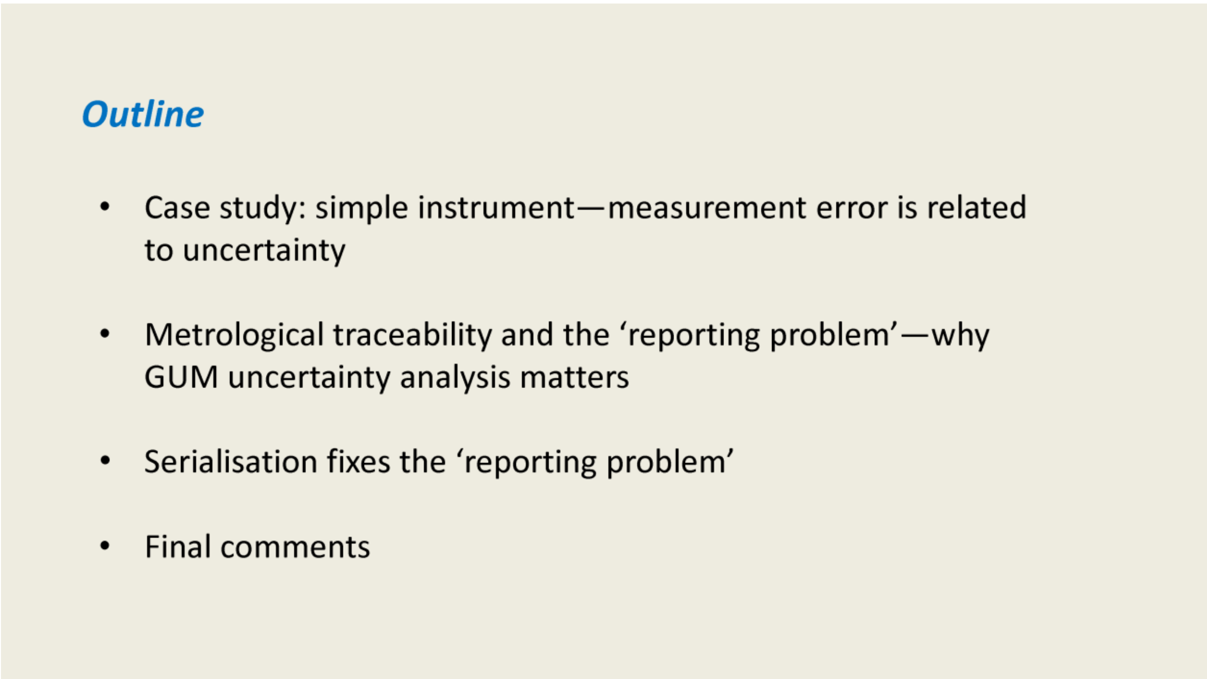
Presentation of Blair Hall



A scenario: measuring laboratory lighting levels

hhvactools.co.nz

Indication [*i*]

Calibrated

$$y_i \approx Y_i(1 + E_{\mathrm{sys}} + E_{\mathrm{rnd}\cdot i})$$

Measurand

Typical relative errors are in a ratio of about 10 : 1 (fixed : random).

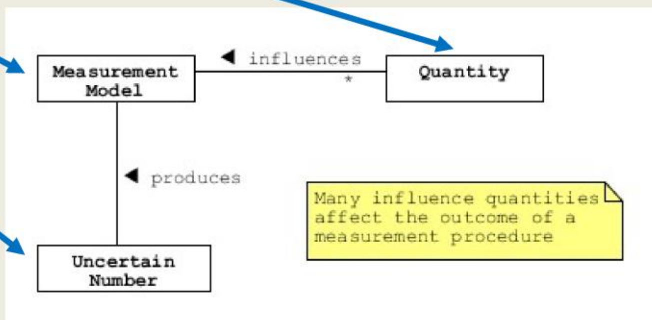
www.eaglesafetyandenvironment.co.uk/lighting-surveys

GUM analysis needs a measurement model—so does software

$$Y_i \approx y_i\underbrace{(1 - E_{\mathrm{sys}} - E_{\mathrm{rnd}\cdot i})}$$

A result is always subject to unknown error, which is accounted for by uncertainty.

Components of uncertainty account for different influences



The GUM Tree Calculator (GTC)

GTC

docs passing | Tests passing | pypi package 1.3.8 | DOI 10.5281/zenodo.6404096

The GUM Tree Calculator is a Python package for processing data with measurement uncertainty.

Python objects, called uncertain numbers, are used to encapsulate information about measured quantities. Calculations of derived quantities that involve uncertain numbers will propagate this information automatically. So, data processing results are always accompanied by uncertainties.

GTC follows international guidelines on the evaluation of measurement data and measurement uncertainty (the so-called GUM). It has been developed for use in the context of metrology, test and calibration work.

https://github.com/MSLNZ/GTC

```
meter = Meter(u_sys=0.009,u_rnd=0.001)

Y_1 = meter.result(1012)
Y_2 = meter.result(978)

display( "Y_1",Y_1 )
display( "Y_2",Y_2 )
```

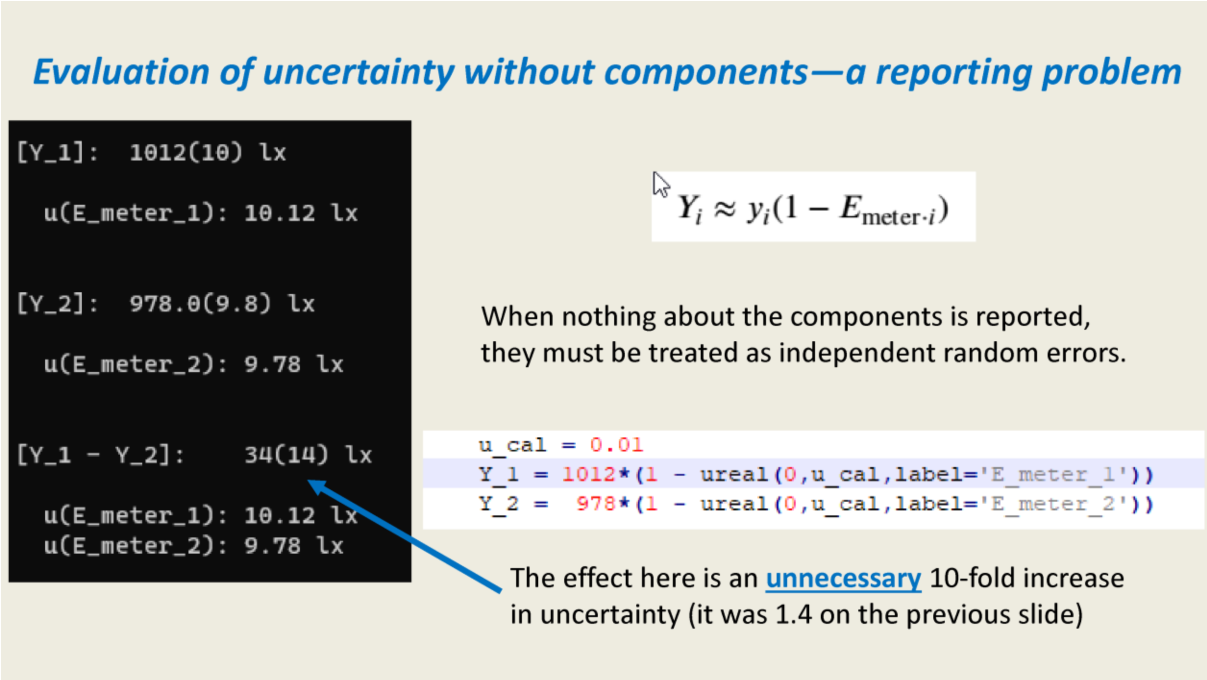
```
[Y_1]:  1012.0(9.2) lx

  u(E_sys):      9.11 lx
  u(E_rnd_1):    1.01 lx


[Y_2]:  978.0(8.9) lx

  u(E_sys):      8.80 lx
  u(E_rnd_2):    0.98 lx
```

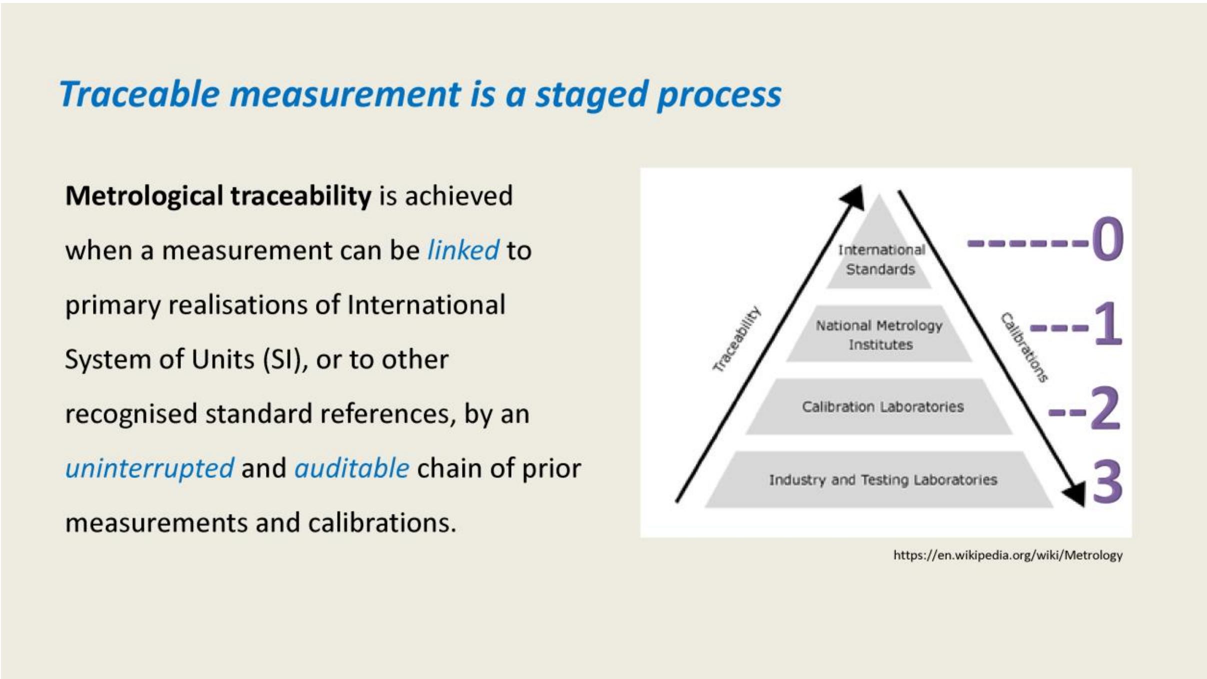
Data processing

```
display( "Y_1 - Y_2",Y_1 - Y_2 )
```

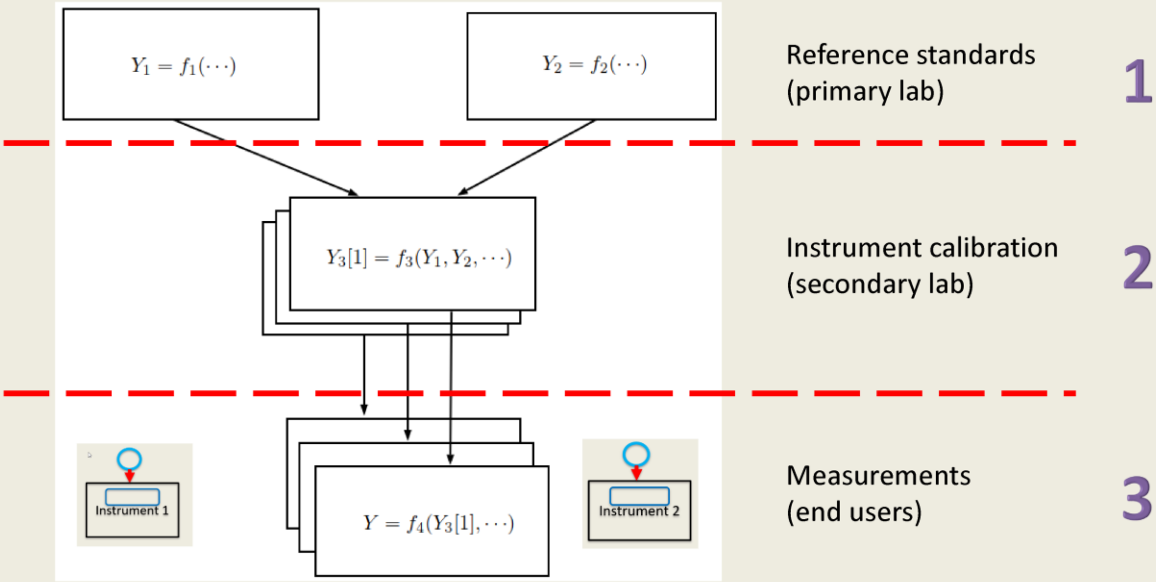
```
[Y_1 - Y_2]:     34.0(1.4) lx

  u(E_rnd_1):    1.01 lx
  u(E_rnd_2):    0.98 lx
  u(E_sys):      0.31 lx
```

The influence of the systematic term is much less when we take the difference


Evaluation of uncertainty without components—a reporting problem
[Y_1]: 1012(10) lx
u(E_meter_1): 10.12 lx
[Y_2]: 978.0(9.8) lx
u(E_meter_2): 9.78 lx
[Y_1 - Y_2]: 34(14) lx
u(E_meter_1): 10.12 lx
u(E_meter_2): 9.78 lx
$Y_i \approx y_i(1 - E_{\text{meter-}i})$
When nothing about the components is reported, they must be treated as independent random errors.
u_cal = 0.01
Y_1 = 1012*(1 - ureal(0,u_cal,label='E_meter_1'))
Y_2 = 978*(1 - ureal(0,u_cal,label='E_meter_2'))
The effect here is an unnecessary 10-fold increase in uncertainty (it was 1.4 on the previous slide)


Traceable measurement is a staged process
Metrological traceability is achieved when a measurement can be linked to primary realisations of International System of Units (SI), or to other recognised standard references, by an uninterrupted and auditable chain of prior measurements and calibrations.
International Standards
National Metrology Institutes
Calibration Laboratories
Industry and Testing Laboratories
Traceability
Calibrations
0
1
2
3
https://en.wikipedia.org/wiki/Metrology

The 'reporting problem' is due to summarised stage results

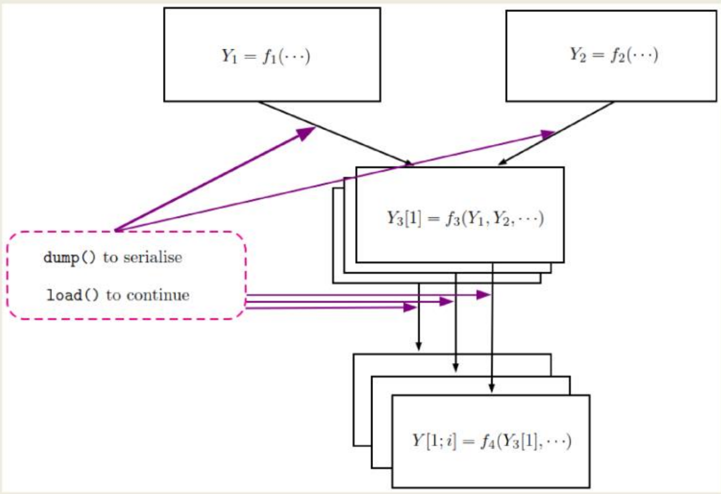


Serialisation fixes the 'reporting problem'

GTC (v1.5.0) provides simple serialising commands for both JSON and XML formats

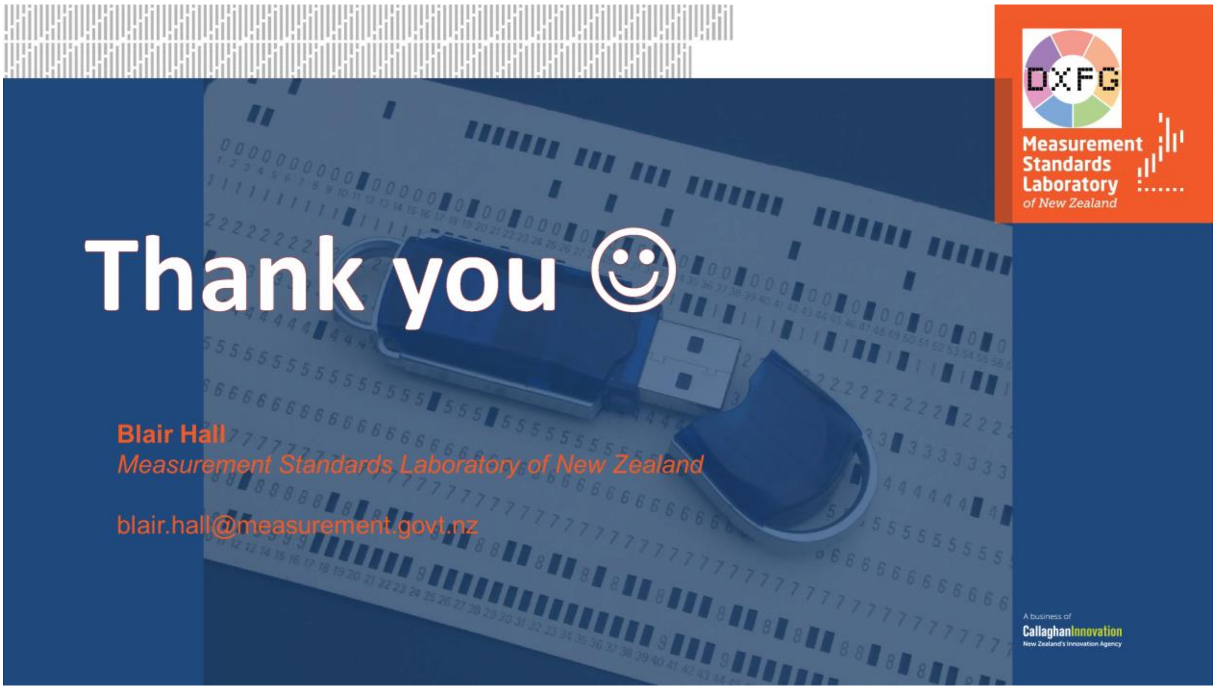
Uncertain numbers are first selected for serialisation, then 'dumped' to a string or file.

Data can be 'loaded' without loss of uncertainty information.



Final comments

- Metrological traceability underpins critical decision-making
  (the accuracy of uncertainty statements really do matter => $$$)
- Traceability is really about measurement error and hence uncertainty analysis
- Digital systems can handle traceability data better than people
  (so don't just copy the people-based process)
- When this is done the benefits of traceability will become more widely available:
  - better information for end-users
  - better decisions
  - enhanced value
- Traceability information needs to be serialised (DCC planning should acknowledge this)
- GTC implements a solution to the 'reporting problem'



Additional information

1. B. D. Hall and D. R. White, *Digital representation of measurement uncertainty*, Measurement: Sensors, vol 18, Dec. 2021, 10074. DOI: 10.1016/j.measen.2021.100074 , XXIII IMEKO World Congress (Aug. 30 – Sept. 3, 2021, Yokohama, Japan)

2. Blair D. Hall and Ryan M. White, *Representing metrological traceability in digital systems*, DOI: 10.21014/tc6-2022.014, IMEKO M4DConf (Sept. 19—21, 2022, Berlin, Germany)

3. B. D. Hall, *The GUM Tree Calculator: A Python Package for Measurement Modelling and Data Processing with Automatic Evaluation of Uncertainty*, Metrology, 2022, 2, 128—149. DOI: 10.3390/metrology2010009

4. Blair D. Hall, *Automating metrological data processing*, Digital Transformation in Metrology Workshop: DCC for developer and its implementation in NQI (21-23 August 2023, Bangkok, Thailand), DOI: 10.5281/zenodo.8275150

5. B. D. Hall and J. S. Borbely, *The GUM Tree Calculator*, https://github.com/MSLNZ/GTC

6. B. D. Hall and J. S. Borbely, *GTC Documentation*, https://gtc.readthedocs.io/en/stable/

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24 DCC for FAIR principles in the quality infrastructure

Presenting author: Christian Müller-Schöll, Mettler-Toledo Int. Inc., Greifensee, Switzerland

Email: christian.mueller-schoell@mt.com
Additional authors:

Abstract

A number of documents (GUM, ISO 17025, ILAC, EA and accreditation bodies' documents) require the rounding of reported calibration results and their uncertainties to a certain level of accuracy. Yet, none of these documents states the purpose of this requirement. There are some terms for characterizing an excessive number of digits like "overprecision", "false precision" or in German "Scheingenauigkeit" ("apparent accuracy").
The author is convinced that all these terms are justified only by the property of the human being to be susceptible to be misled by overprecision. The German word "Scheingenauigkeit" underpins this since "Schein" means "apparent", but only the human perception is susceptible to this while a machine is not. The purpose of the above requirement is therefore obviously, to protect the human reader of a calibration report from being misled or fooled.

A machine would not be fooled by a large number of digits: When the DCC is used for communicating numbers to machines (e.g. to LIMS or to manufacturing systems), no rounding is necessary. If the very final measuring result using the calibrated instrument is meant to be communicated to a human, this final result may be rounded. The effect is less rounding error of the final result. Therefore, calibration results communicated in DCC's should not be rounded. Documents requiring rounding should be amended to state the purpose of the requirement.

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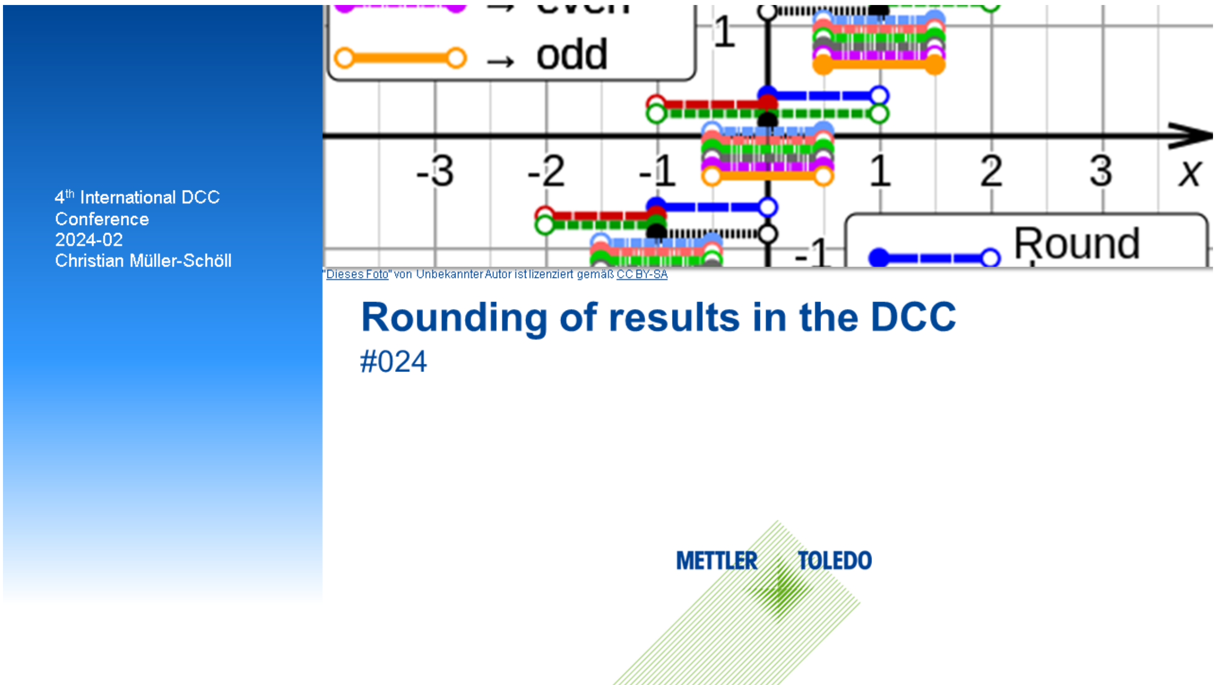
Presentation of Christian Müller-Schöll

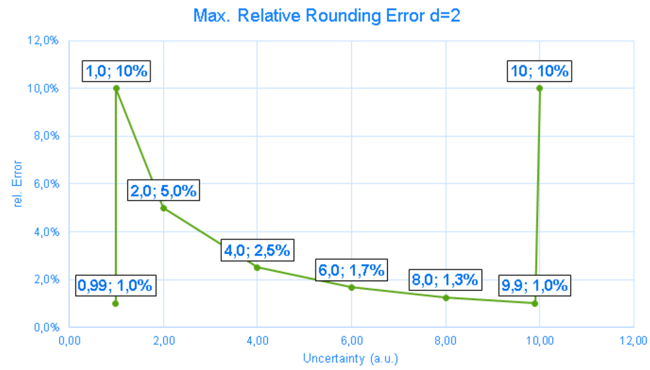


Topics Covered

METTLER TOLEDO | 2

What do we do when rounding?

METTLER TOLEDO | 3



- Rounding the uncertainty introduces another contribution of uncertainty into the uncertainty
- By using two significant digits, the "relative error by rounding" is limited to 10 percent maximum
- The relative error is not constant, it varies between 1 % and 10 %

Why should we round results in the DCC?

- Several standard require rounding of calibration results:
- ILAC P14
- GUM
- Etc.
- But what do they really require?

GUM statement

GUM:

- 7.2.6 The numerical values of the estimate y and its standard uncertainty uc(y) or expanded uncertainty U **should** not be given with an excessive number of digits. **It usually suffices** to quote uc(y) and U [as well as the standard uncertainties u(xi) of the input estimates xi] to **at most two significant digits**, **although** in **some cases** it may be necessary to retain additional digits to avoid round-off errors in **subsequent calculations**.

- GUM is quite vague
- Not clear what "usually suffices" is
- Not clear what "at most" means
- Relativized by "in some cases"
- "Subsequent calculations" seem to be an issue

- Question: Isn't the purpose of a calibration result always a "subsequent calculation"??

Note:

- It is a "should" statement
- The reason/motivation for rounding is not explained (= "why round?")
- "At most" is dangerous! – See rounding error!

ILAC statement

METTLER TOLEDO | 6

- ILAC P14
- 5.3 The value of the expanded uncertainty **shall** be given to, at most, two significant digits. Where the measurement result has been rounded, that rounding shall be applied when all calculations have been **completed**;

- It became a SHALL-statement!
- Same as before: A calibration result is by its nature the input to subsequent calculations. So, should we round?
- The reason/motivation for rounding is not explained (= "why round?")
- "At most" is dangerous! – See rounding error!

Some Arguments for Rounding

METTLER TOLEDO | 7

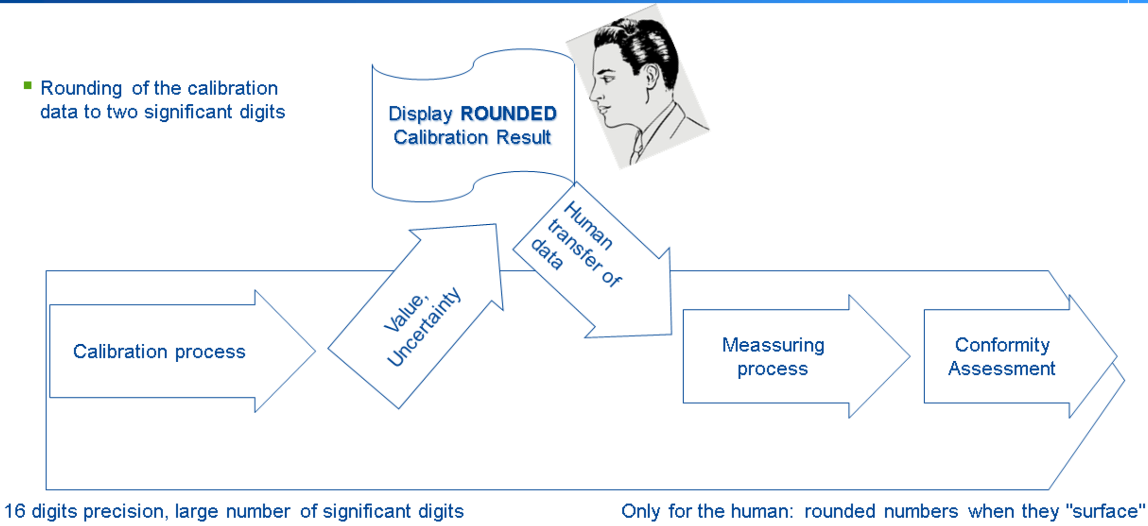
- Probably the purpose of rounding is to avoid an effect which is called
- Overprecision
- False precision
- (German: Schein-Genauigkeit, apparent accuracy)
- ... But who would be susceptible to this?

- Only the human perception is susceptible to false precision while a machine is not.
- The purpose of rounding is therefore obviously, to protect the *human reader* of a number from being misled or fooled.
- A machine in the position of a reader/recipient cannot be fooled.
- Rounding for a machine recipient is superfluous

Processing of numbers with a traditional calibration certificate

METTLER TOLEDO | 8

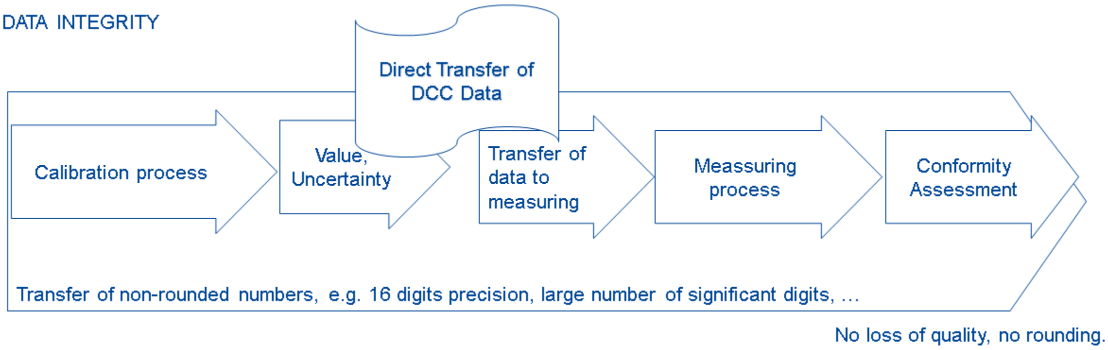
- Rounding of the calibration data to two significant digits



Pure digital processing of numbers from calibration to measuring

METTLER TOLEDO | 9

- No rounding
- No human readable calibration certificate
- No need to round a calibration value in an integrated process
- DATA INTEGRITY



Conclusions

METTLER TOLEDO | 10

- The purpose of rounding is never mentioned
- I assume, rounding of results was introduced to prevent fooling a human reader
- Competent humans cannot be fooled
- Machine transfer is "fool-proof"

- The purpose of every calibration results is a "subsequent calculation"!

- GUM and ILAC texts must be re-written in the light of digitalization:
  - Purpose of rounding must be stated for clarity

- Rounding of calibration results degrades the quality of the numbers given
- Rounding is a source of error for subsequent activities (= an additional contribution to the uncertainty!)

- If there is no "foolable human" involved, rounding is unnecessary and should be avoided.

Questions, Discussion

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Do you now have a question?

Sources

- 5 ILAC Policy on Statement of Measurement Uncertainty on Calibration Certificates
- …
- 5.3 The numerical value of the expanded uncertainty shall be given to, at most, two significant digits.

(ILAC-P14:09/2020)

- 7 Reporting uncertainty
- …
- 7.2.6 The numerical values of the estimate *y* and its standard uncertainty *u*c(*y*) or expanded uncertainty *U* should not be given with an excessive number of digits. It usually suffices to quote *u*c(*y*) and *U* [as well as the standard uncertainties *u*(*xi*) of the input estimates *xi*] to at most two significant digits, although in some cases it may be necessary to retain additional digits to avoid round-off errors in subsequent calculations.

(GUM JCGM 100:2008)

- Question: why should "retain additional digits" not apply generally for any "subsequent calculations" (assuming there are always subsequent calculations to calibrations!)

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25 Automated Generation and Utilization of accredited temperature DCCs

Presenting author: Michael Melzer, Bundesanstalt für Materialforschung und -prüfung (BAM), Germany
Email: michael.melzer@bam.de
Additional authors: Nanine Brunner nanine.brunner@bam.de, Keerthana Nattuveettil keerthana.nattuveettil@bam.de, Marcus Thomas, Carlo Tiebe

Abstract:

The accredited calibration laboratory of the German Federal Institute for Materials Research and Testing (BAM) has established verified XML digital calibration certificates for calibrations of resistance thermometers within the scope of its accreditation. Hence, all necessary information according to ISO/IEC 17025 and the DKD-R 5-1 calibration rule is provided in a machine-readable and machine-interpretable form.

For the automated DCC generation, a self-implemented middleware is compiling the meta-data (i.e. customer-, order-, item- and method data) and combines it with the measured calibration data and influence conditions into a process- and lab-specific DCC template. This DCC software is able to handle both, single probe calibrations (e.g. Pt 100) as well as measurement chains (e.g. thermometers and temperature loggers) and also supports multiple item calibrations with the automated creation of individual DCC files. All generated DCCs can be readily validated against the DCC scheme (v.3.2.1).

The validated and authorized DCCs are equipped with the novel digital accreditation symbol, that was recently piloted with the German national accreditation body (DAkkS), to form `eAttestations´. This advanced electronic seal with a qualified certificate, after successful validation by the receiver, provides three basic functionalities in a DCC:

1. Authenticity: It confirms that the issued certificate actually originates from the BAM calibration laboratory (D-K-11075-08)
2. Integrity: It protects all the data and information in the DCC from change and manipulation
3. Accreditation: It verifies the active accreditation status of the issuing body at the time of sealing (authorization)

Thus, this accreditation seal can fully replace an electronic signature on an accredited DCC.

In order to demonstrate the added value of DCCs also on the receiver side, the BAM DCC- team started to develop a simple but capable DCC demonstrator. For the use case of thermal process monitoring, the software reads out the metrological data of an incoming DCC, performs a linear regression of the temperature calibration values, uses the obtained calibration function to correct the raw sensor readings, extends the DCC measurement uncertainty values with further contributions (e.g. from the correction and the hysteresis) and adjusts the process-defined acceptance limits to account for the measurement uncertainty, all in real-time. Hence, it automatically utilizes a DCC to obtain metrological traceability and a quality-assured process conformity assessment, practically at the push of a button.

In the talk, the automated DCC generation in the scope of our accreditation, including the electronic sealing with the digital accreditation symbol, as well as the one-click DCC utilization with our demonstrator will be presented.

The work was performed within the national QI-Digital initiative.

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Presentation of Michael Melzer

BAM

28.02.2024

AUTOMATED GENERATION AND UTILIZATION OF ACCREDITED TEMPERATURE DCCs

Michael Melzer, Keerthana Nattuveettil, Nanine Brunner, Marcus Thomas, Carlo Tiebe

4th International DCC Conference

www.bam.de

1

The BAM Calibration Lab - CMCs

DAkkS – accreditation D-K-11075-08

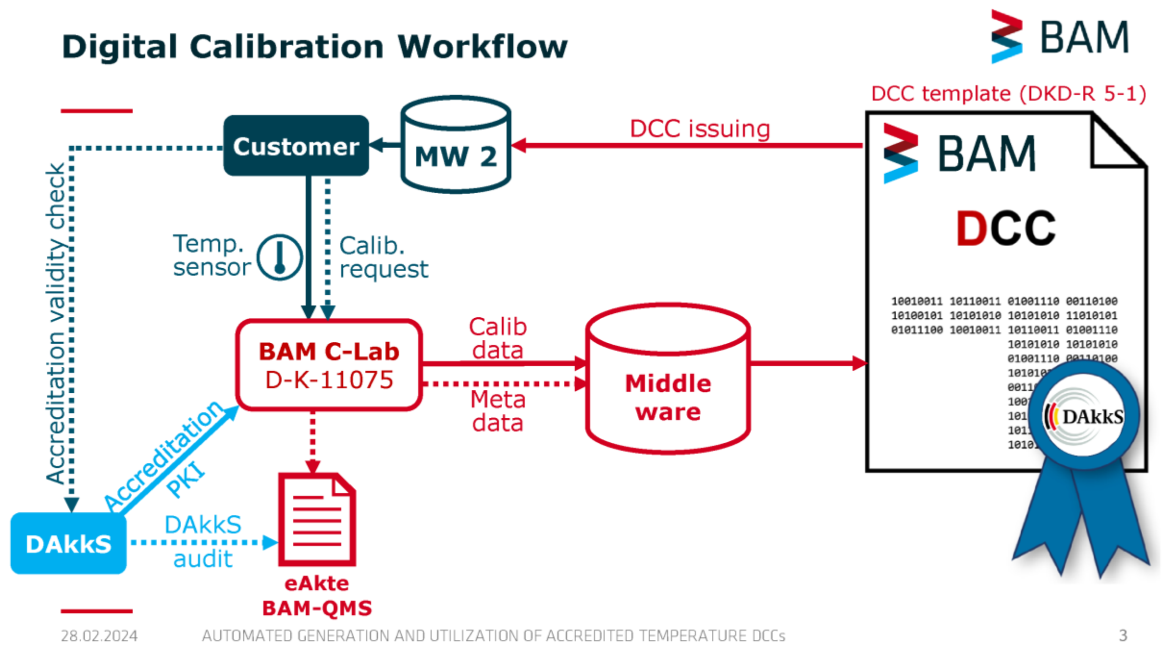
BAM

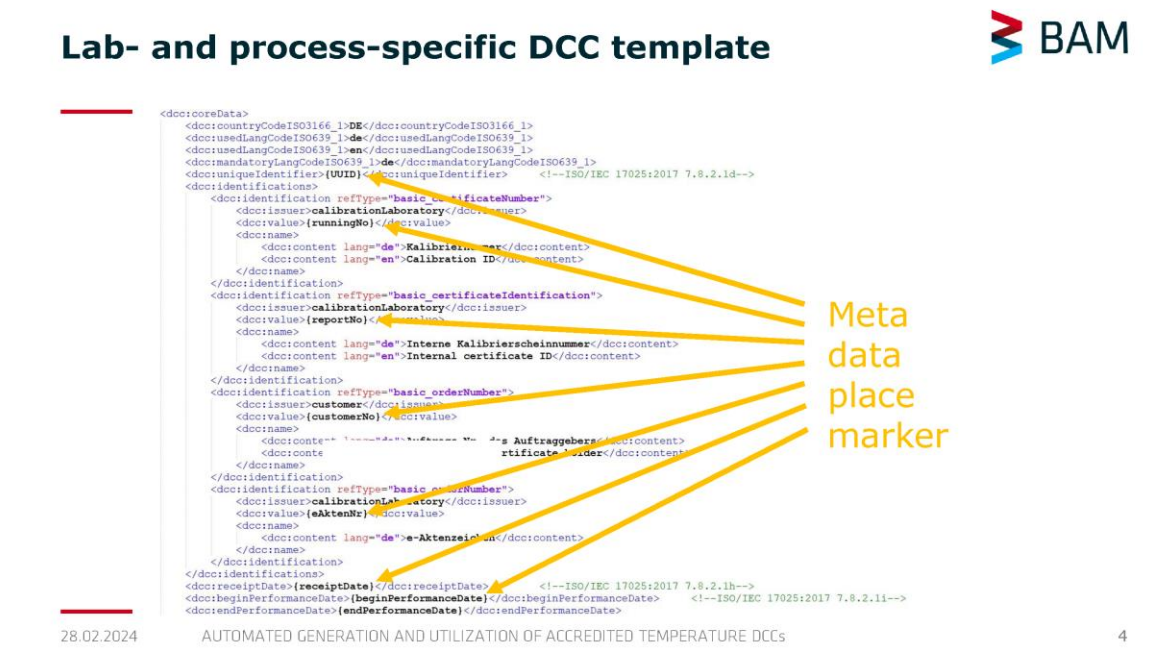
- **Force quantity:** uniaxial force transducers
  ISO 376 and DKD-R 3-3
  Range: 10 N to 5 MN (compressive: up to 21 MN possible)
  BMC: down to 0.01 % / class 0.5 or 00
- **Temperature quantity:** resistance thermometers, thermocouples and simulation (DKD-R 5-1, 5-3 and 5-5)
  Temperature range: -50 °C to 160 °C
  BMC: down to 30 mK
- **Electrical quantities:** DCU, DCI, DCR, charge voltage ratio (full-, half- and quaterbridges)
  BMC: DCU 1 µV, DCR 4 ppm, DCI 0,8 nA, U/U 0,03 µV/V
- **Total staff: 3, about 200 certificates p.a.** (99% accredited)

Calibration of electrical quantities (left), force transducer in the 5 MN force calibration machine (right)

- Establishment of DCCs in the scope of accreditation
- Pilot lab for eAttestations
- Contributing to DCC good practice definitions (via DKD)

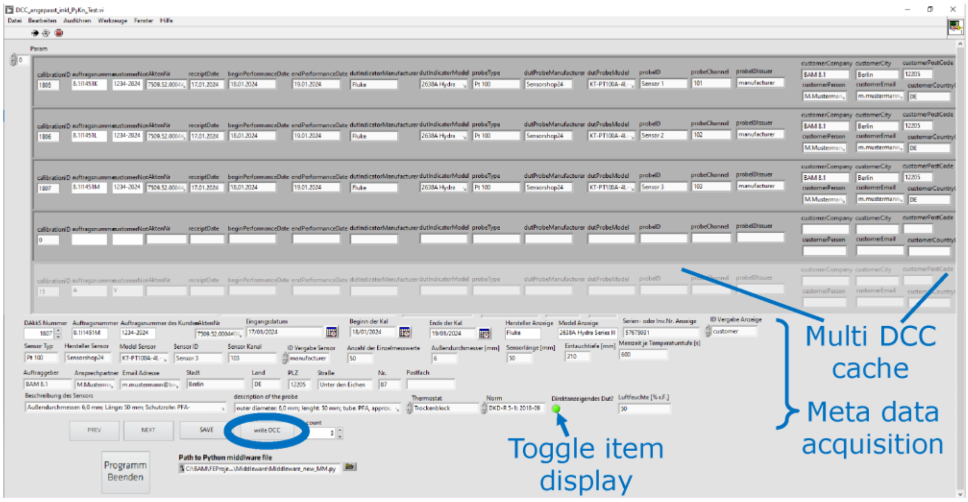
28.02.2024 https://rrr.bam.de/RRR/Navigation/DE/Kalibrierlabor/kalibrierlabor.html 2


Digital Calibration Workflow
BAM
DCC template (DKD-R 5-1)
DCC issuing
Customer
MW 2
Temp. sensor
Calib. request
Accreditation validity check
BAM C-Lab
D-K-11075
Calib data
Meta data
Middle ware
BAM
DCC
DAkkS
DAkkS
Accreditation
PKI
DAkkS audit
eAkte
BAM-QMS
28.02.2024
AUTOMATED GENERATION AND UTILIZATION OF ACCREDITED TEMPERATURE DCCs
3


Lab- and process-specific DCC template
BAM
Meta data place marker
28.02.2024
AUTOMATED GENERATION AND UTILIZATION OF ACCREDITED TEMPERATURE DCCs
4

DCC middleware with metadata acquisition for multi-item temperature calibration

BAM



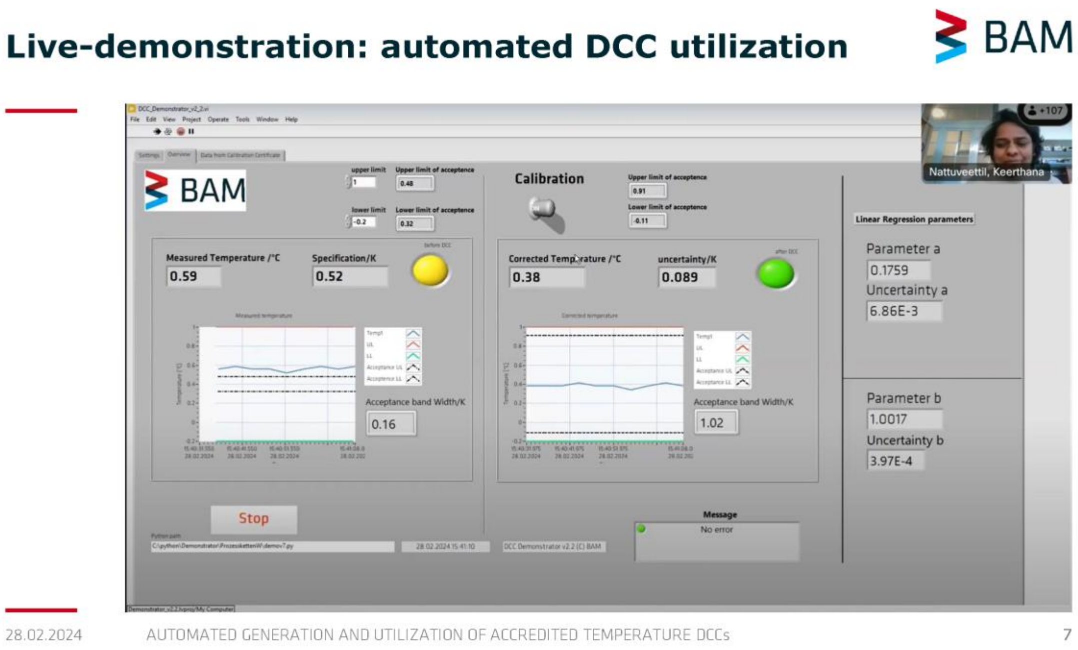
28.02.2024 AUTOMATED GENERATION AND UTILIZATION OF ACCREDITED TEMPERATURE DCCs 5

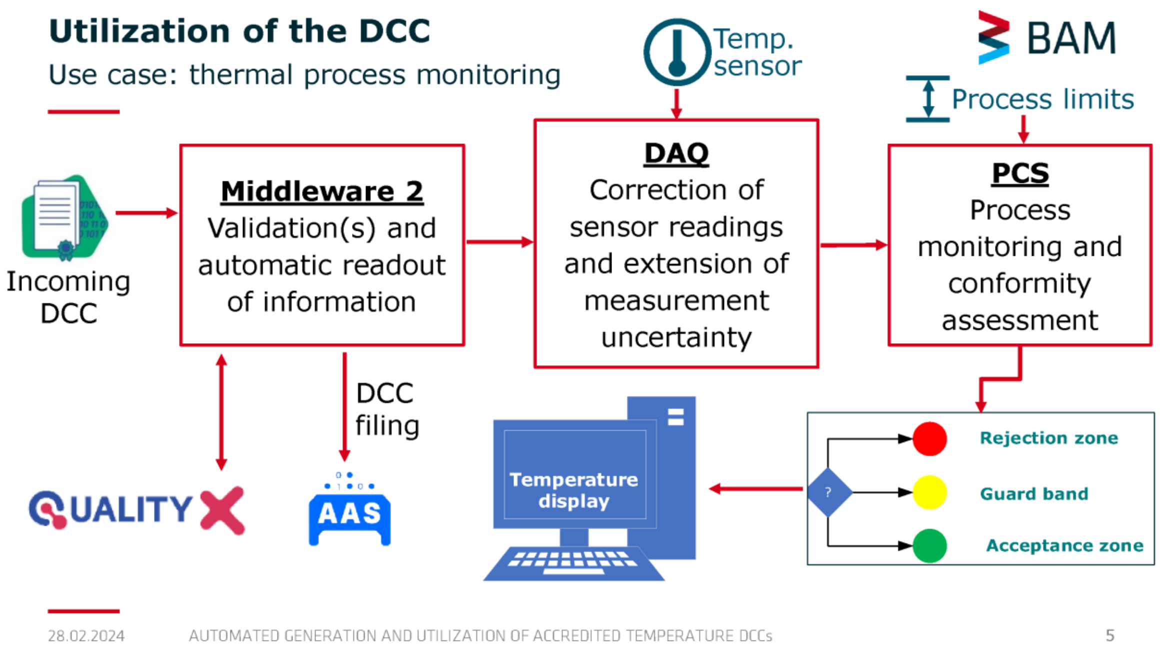
The DCC of a Pt100 thermal resistor calibration

Calibration procedure: DKD-R 5-1

- Calibrated within the accredited scope of D-K-11075-08
- Automatically generated via non-proprietary DCC middleware
- ~ 850 lines of XML code
  → Validated against DCC schema (v.3.2.1)
- D-SI incorporated
- Contains harmonized bookmarks ("refTypes")
- German and English language
- Sealed with a digital accreditation symbol (DAkkS-PKI)
  → eAttestation

28.02.2024 AUTOMATED GENERATION AND UTILIZATION OF ACCREDITED TEMPERATURE DCCs 2





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26 Consumer-centric data mapping in temperature DCCs

Presenting author: Siniša Prugovečki, LorisQ One d.o.o., Croatia
E-mail address: sinisa.prugovecki@lorisq.com
Additional authors: Mirna Lerotić mirna.lerotic@lorisq.com, Mirna Fakin mirna.fakin@metroteka.com

Abstract

Accredited (ISO/IEC 17025) calibration in the temperature field is widely available and important to the customers. Apart from all kinds of thermometers (liquid-in-glass, thermocouple-based, resistance, NTC etc.) it includes other instrument types such as temperature chambers, thermal baths, autoclaves, dry blocks, thermal imagers and much more. Future platforms that will read and interpret DCCs to bring real benefits to the human customer will need an additional level of DCC standardization. It will be necessary to understand and interpret the distinction between the calibration data formats for different types of these instruments. In other words, the platform needs to map the data in the DCC depending on the instrument type.

We will show how we solved this problem in LorisQ app and discuss the importance of this instrument-type-based DCC standardization in temperature and other calibration fields for the quicker adoption of the DCCs by the users, especially those from ISO/IEC 17025 test laboratories, manufacturing SMEs, healthcare, and non-metrology scientific institutions.

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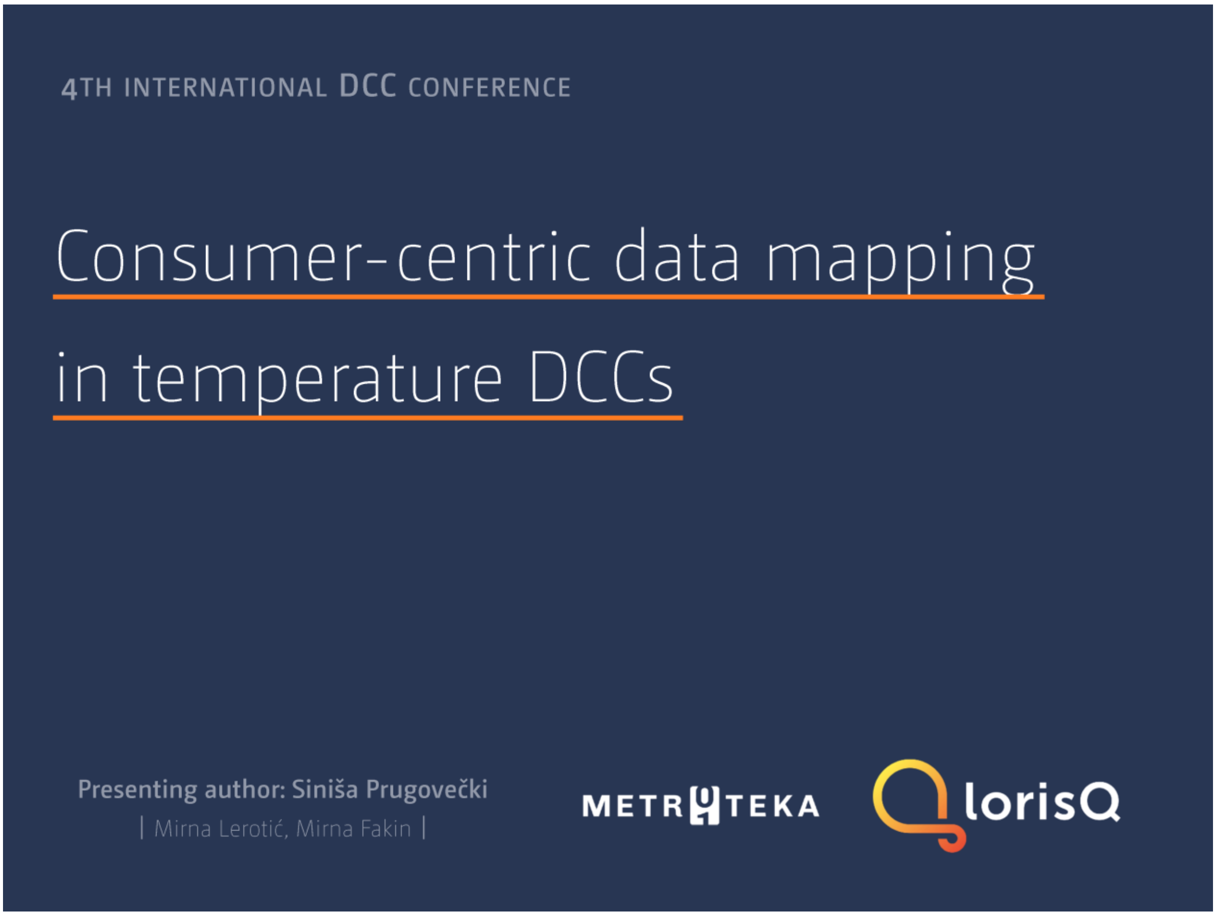
Presentation of Siniša Prugovečki



Siniša Prugovečki

- Born on World Metrology Day
- Graduated in astrophysics
- Founder, CEO and head of METROTEKA laboratory - his first startup, now a local leader in ISO/IEC 17025 accredited calibration
- Founder of LorisQ app
- IMEKO Digitalization Technical Committee (TC6) member
- President of Croatian Metrology Society

DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs
lorisQ

Where does LorisQ come from?

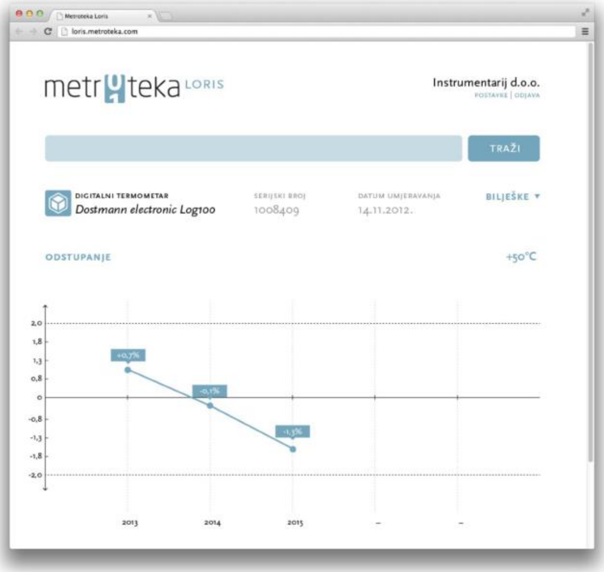
METROTEKA www.metroteka.com

- Accredited ISO 17025 calibration laboratory: temperature, relative humidity, volume, mass, chemical quantities, frequency, length, torque wrenches, density, pressure - ***37 methods*** in and out of the laboratory.
- Equipment qualification: freezers, fridges, incubators, dryers, sterilizators, furnaces, autoclaves, thermo-blocks, climatic chambers etc.
- Temperature mapping: delivery vehicles, storage areas, thermostatic rooms, temperature and climatic chambers etc.
- Education and consulting: metrology courses, Lean Six Sigma

DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs
lorisQ

Where does LorisQ come from?

- Metroteka Loris (2013)
- Breakthrough in calibration reporting - digital solution
- Cloud based app
- Real-time certificates in pdf format
- Comments and notes about calibrated instruments
- Trend graphs and corrections



DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs

lorisQ

LorisQ (2019)

lorisQ

loris Q

Smart app for small and medium enterprises which provides a management system for measuring tools and test equipment maintenance.

> Database (informations)
> Team app (people)

- Maintenance planning and monitoring
- A place to create and store records (*audit trail*)
- Individualized alarms, notifications and warnings
- Graphic display of calibraton trends (*risk analysis*)
- Improving measurement accuracy

DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs loris Q

DCC input demonstration

loris Q

Good Practice - Temperature

loris Q

Measuring tools and test equipment

Measuring tools	**thermometer, micrometer, balance ...**
Instruments for setting conditions	**fridge, torque wrench, piston pipette**
Test equipment	HPLC/UPLC, diagnostic analyzers
Reference materials	buffer solutions, standards
Consumables	piston pipette tips, silicone oil
Protective equipment	digester, metal and plastic lockers
Software support	ComSoft Basic, LogConnect

DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs

loris Q

Temperature

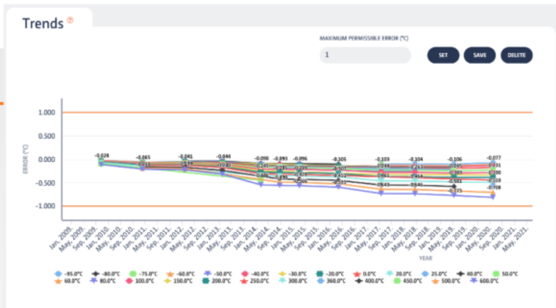
MEASURING TOOLS	INSTRUMENTS FOR SETTING CONDITIONS
Digital thermometers: resistance, thermocouple and NTC thermometers	Dry blocks
Glass thermometers	Temperature chambers
IR thermometers	Furnaces
Bimetal thermometers	Climatic chambers
Various indicators	Autoclaves

DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs

loris Q

Trends

- Displayed for 64 different instrument category
- Tracking calibration results over time
- Automatic update after calibration results input
- Warnings compliant with the set tolerance limits



DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs

loris Q

Temperature chamber

REZULTATI UMJERAVANJA • *CALIBRATION RESULTS:*

Zaslon komore *Chamber display*	Prostorna točka *Location in space*	Srednja temperatura *Average temperature*	Najmanja temperatura *Minimum temperature*	Najveća temperatura *Maximum temperature*	Odstupanje od zaslona *Deviation from display*	Prostorno odstupanje *Deviation in space*	U u točki *in space point*
+5,0°C	1	+5,45°C	+4,21°C	+6,95°C	+0,45°C	0,00°C	1,9°C
+5,0°C	2	+4,46°C	+2,44°C	+6,88°C	-0,54°C	-1,00°C	2,9°C
+5,0°C	3	+4,17°C	+2,22°C	+6,61°C	-0,83°C	-1,29°C	2,9°C
+5,0°C	4	+4,00°C	+2,08°C	+6,73°C	-1,00°C	-1,45°C	3,2°C
+5,0°C	5	+4,73°C	+2,57°C	+7,29°C	-0,27°C	-0,73°C	3,0°C
+5,0°C	6	+5,41°C	+3,94°C	+7,24°C	+0,41°C	-0,04°C	2,2°C
+5,0°C	7	+5,36°C	+3,96°C	+7,13°C	+0,36°C	-0,09°C	2,2°C
+5,0°C	8	+5,60°C	+4,42°C	+6,99°C	+0,60°C	+0,15°C	1,7°C
+5,0°C	9	+5,97°C	+4,99°C	+7,15°C	+0,97°C	+0,51°C	1,5°C

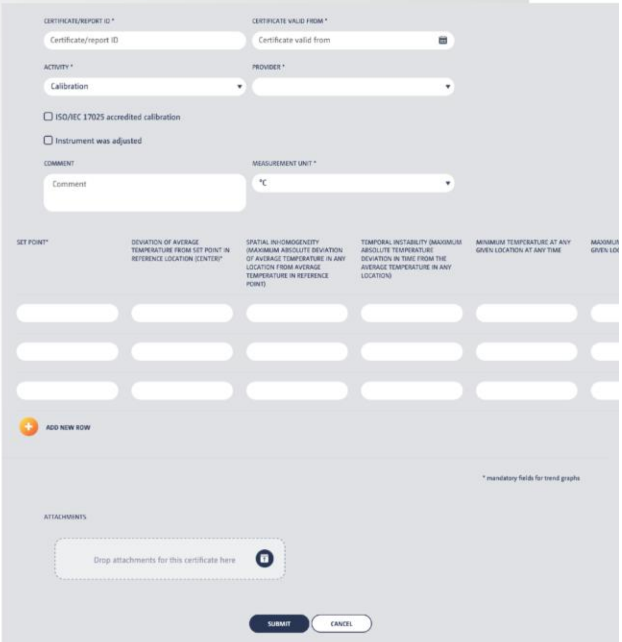
Zaslon komore - Chamber display	5,0°C
Prostorna homogenost - Spatial inhomogeneity	1,45°C
Vremenska stalnost - Temporal stability	2,73°C
Utjecaj termičkog zračenja - Thermal radiation influence	0,10°C
Utjecaj punjenja komore - Loading influence	-
Proširena (k=2) mjerna nesigurnost - Expanded measurement uncertainty	3,6°C

DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs

loris Q

Temperature chamber

- **Set point**
- **Deviation of average temperature from set point in reference location (center)**
- **Spatial inhomogeneity**
  DKD-R 5-7:2009 (Calibration of Climatic Chambers)
- **Temporal instability**
  DKD-R 5-7:2009 (Calibration of Climatic Chambers)

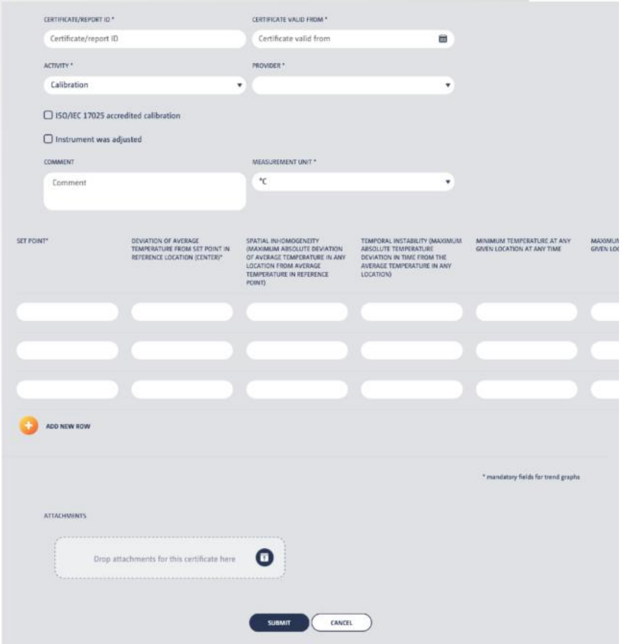


DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs

loris Q

Temperature chamber

- MINIMUM TEMPERATURE at any given location at any time
- MAXIMUM TEMPERATURE at any given location at any time
- Expanded (k=2) measurement uncertainity for temperature in the chamber



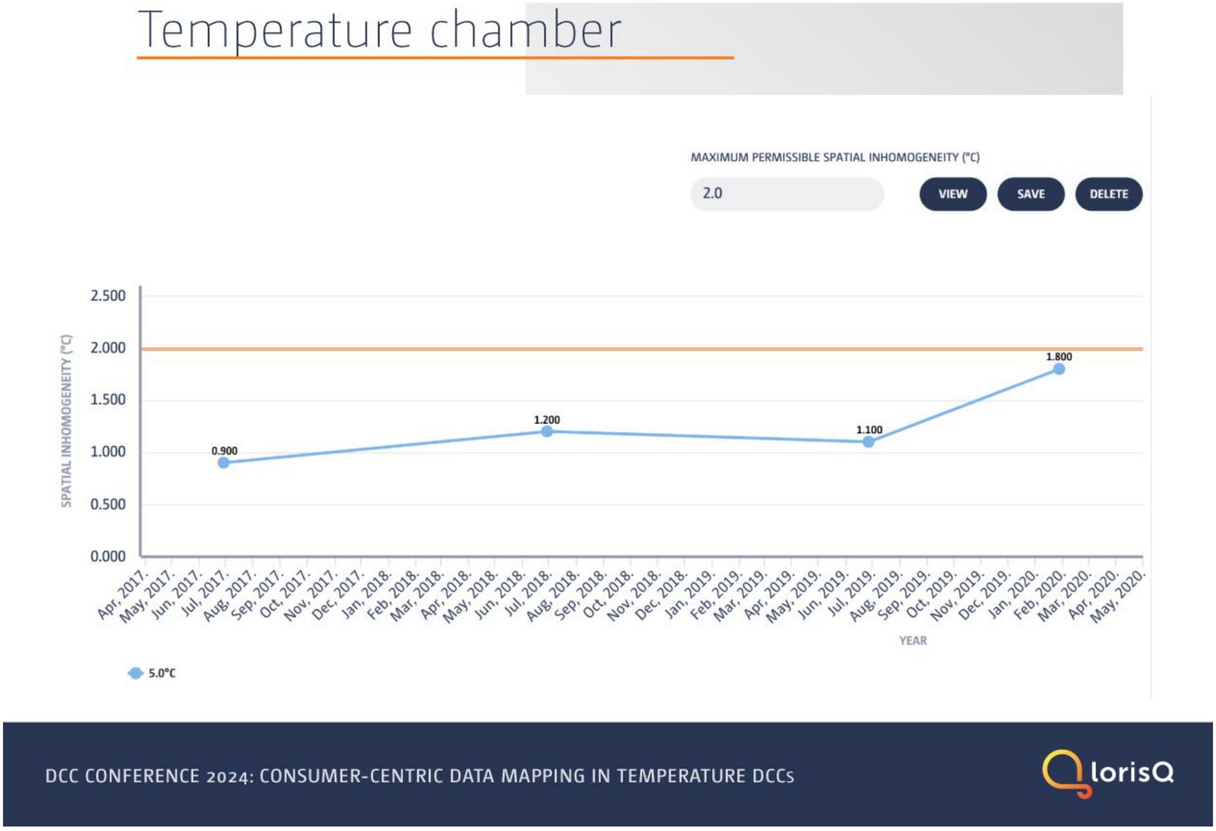
DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs

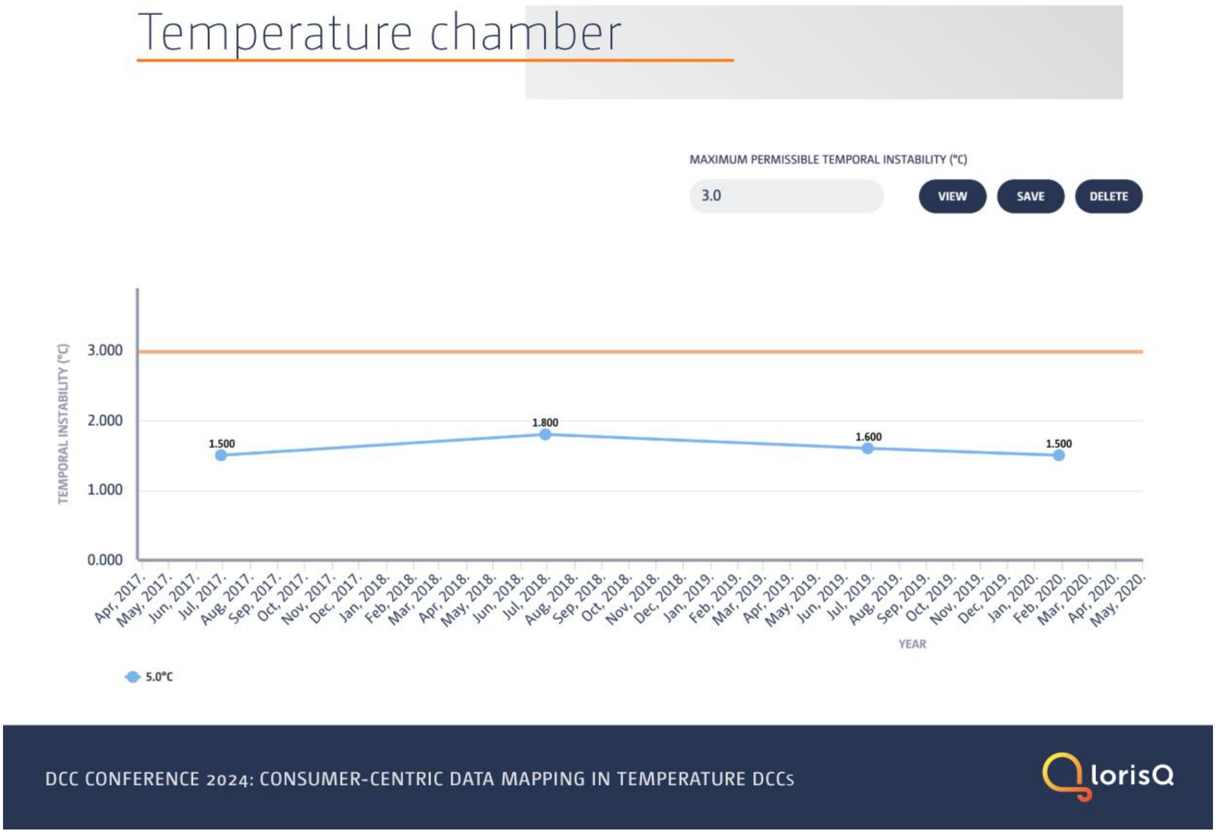
loris Q

Temperature chamber

DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs

loris Q


Temperature chamber
MAXIMUM PERMISSIBLE SPATIAL INHOMOGENEITY (°C)
2.0
VIEW
SAVE
DELETE
SPATIAL INHOMOGENEITY (°C)
2.500
2.000
1.500
1.000
0.500
0.000
0.900
1.200
1.100
1.800
YEAR
5.0°C
DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs
lorisQ


Temperature chamber
MAXIMUM PERMISSIBLE TEMPORAL INSTABILITY (°C)
3.0
VIEW
SAVE
DELETE
TEMPORAL INSTABILITY (°C)
3.000
2.000
1.000
0.000
1.500
1.800
1.600
1.500
YEAR
5.0°C
DCC CONFERENCE 2024: CONSUMER-CENTRIC DATA MAPPING IN TEMPERATURE DCCs
lorisQ

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27 Use case of digital calibration certificate implementation at VW Mexico

Presenting author: Alfonso Cotera, Volkswagen Group services, Mexico
E-mail address: alfonso.cotera2@vw.com.mx
Additional authors: Cotera A. alfonso.cotera2@vw.com.mx , Guevara D. david.guevara@vw.com.mx, Niño L. , Galván C. CENAM: Echeverría J., García A., López A, Martinez E., Dominguez I.

Abstract

The national metrology centers (NMI's), being referents of measurements, provide the quality infrastructure with traceability that allows the industry in this case to reduce the time spent on administrative processes and make their production systems more efficient with digitization. Through the digital calibration certificate (DCC) the National Metrology Center of Mexico (CENAM) and Volkswagen Mexico (VW-M) seek to trigger innovation in the value chain of the automotive industry.

This collaboration has allowed the development of the necessary tools to safely transfer the results of calibration measurements in pilot services of the magnitudes:

- DCC-Vibrometer-Acceleration
- DCC-Standard Blocks- Dimensional
- DCC-Platinum Resistance Thermometer-Thermometry

This 6-month project has generated the development of metrological tools that allow sharing the DCC generated using within the process, for example; Excel, LabVIEW and Python, so that a web application within the CENAM server generates the DCC with digital signature and in turn sent to VW-M to be read with the software developed in LabVIEW and to be integrated into the calibration process of the laboratory in the industry.

The digitization actions in collaboration between CENAM and VW-M are part of VW-M's digitization plan that aims to have the DCC information used within the different industrial levels up to the testing part of the production line.

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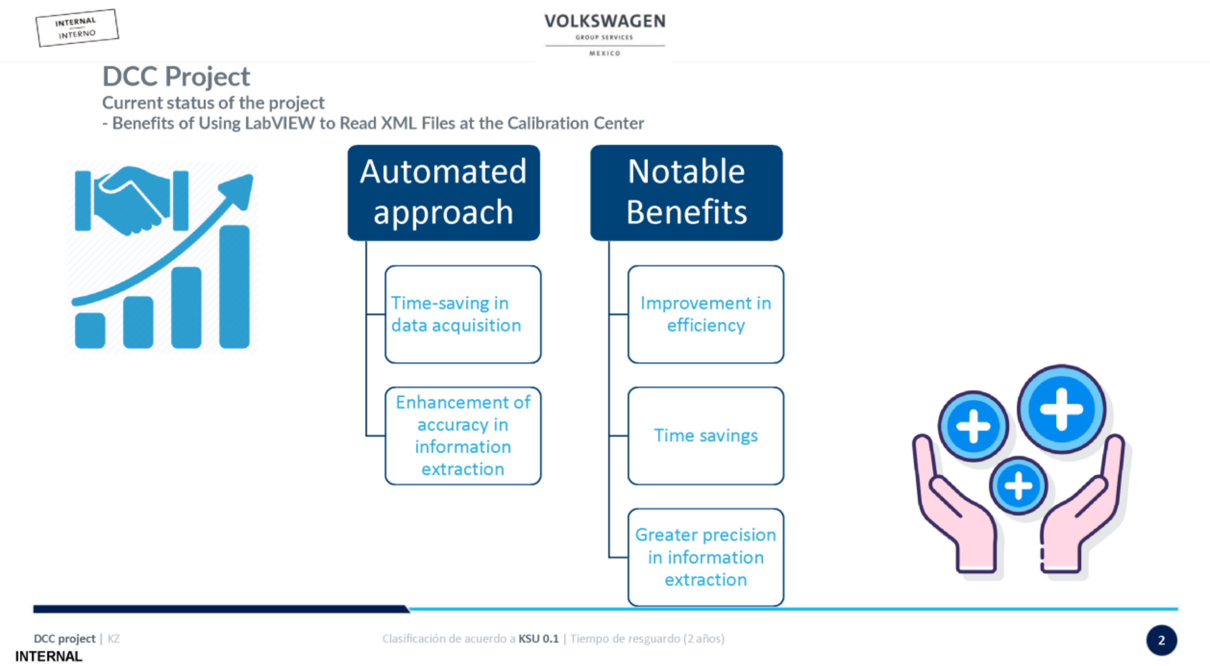
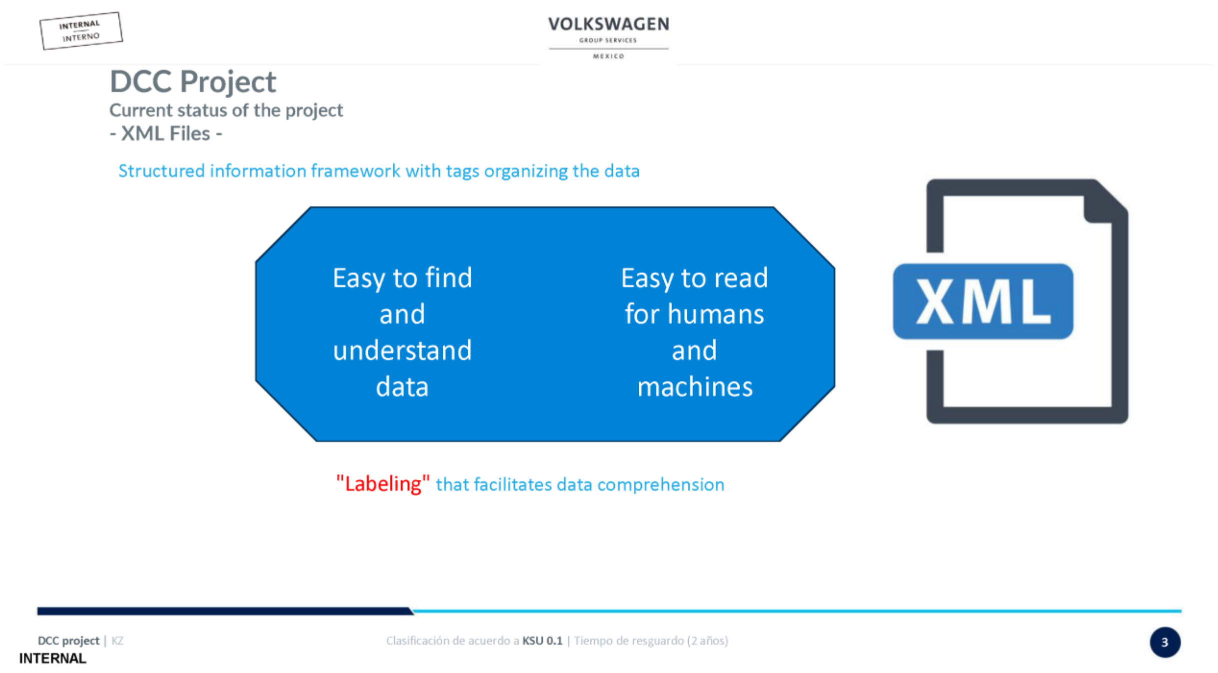
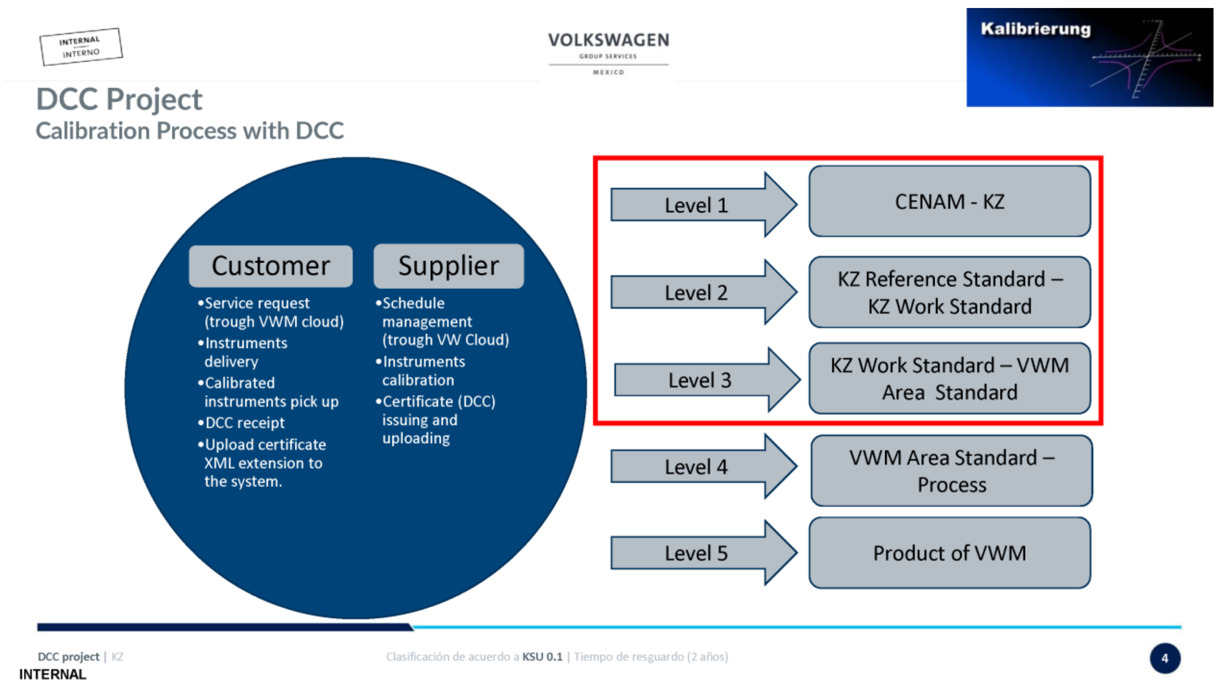
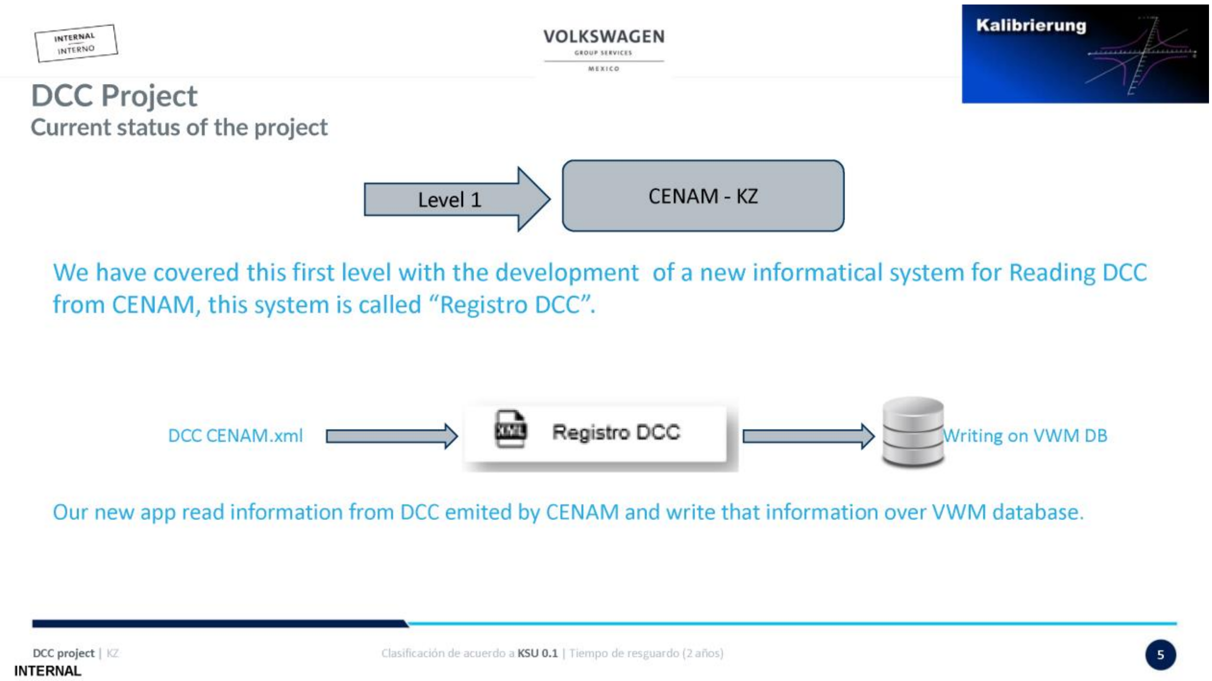
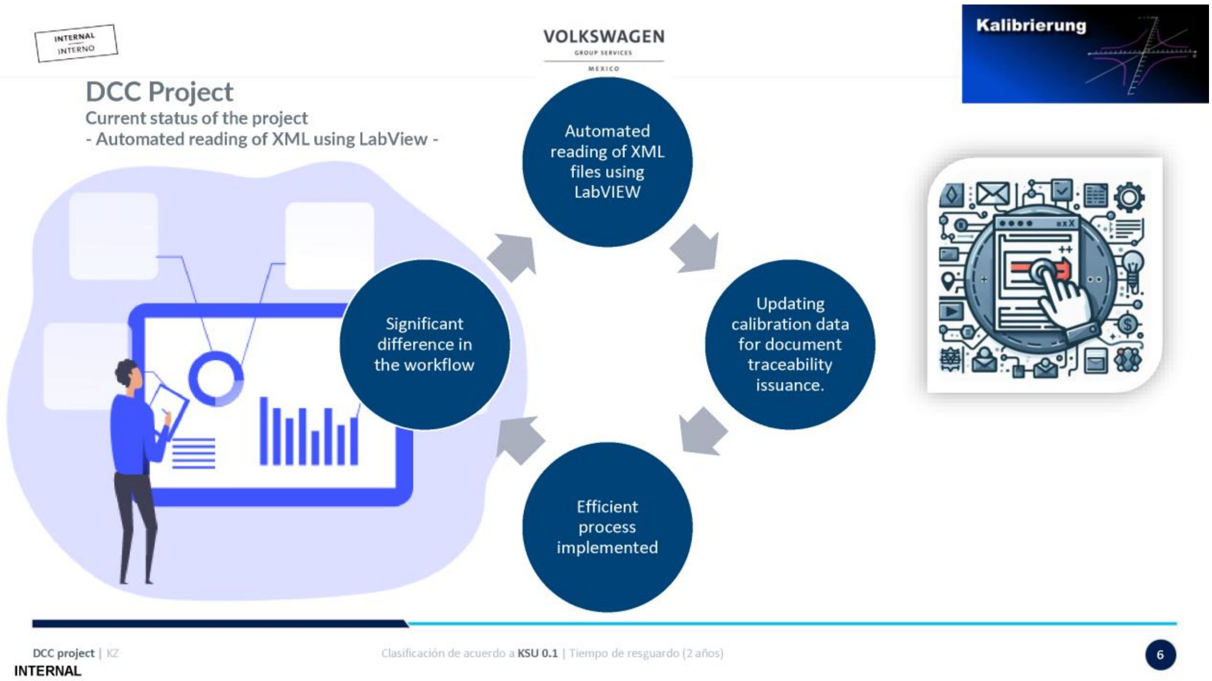
Presentation of Alfonso Cotera




INTERNAL
INTERNO
VOLKSWAGEN
DCC Project
Current status of the project
- XML Files -
Structured information framework with tags organizing the data
Easy to find and understand data
Easy to read for humans and machines
XML
"Labeling" that facilitates data comprehension
DCC project | KZ
INTERNAL
Clasificación de acuerdo a KSU 0.1 | Tiempo de resguardo (2 años)
3


INTERNAL
INTERNO
VOLKSWAGEN
Kalibrierung
DCC Project
Calibration Process with DCC
Customer
•Service request (trough VWM cloud)
•Instruments delivery
•Calibrated instruments pick up
•DCC receipt
•Upload certificate XML extension to the system.
Supplier
•Schedule management (trough VW Cloud)
•Instruments calibration
•Certificate (DCC) issuing and uploading
Level 1
CENAM - KZ
Level 2
KZ Reference Standard – KZ Work Standard
Level 3
KZ Work Standard – VWM Area Standard
Level 4
VWM Area Standard – Process
Level 5
Product of VWM
DCC project | KZ
INTERNAL
Clasificación de acuerdo a KSU 0.1 | Tiempo de resguardo (2 años)
4


INTERNAL
INTERNO
VOLKSWAGEN
GROUP SERVICES
MEXICO
Kalibrierung
DCC Project
Current status of the project
Level 1
CENAM - KZ
We have covered this first level with the development of a new informatical system for Reading DCC from CENAM, this system is called "Registro DCC".
DCC CENAM.xml
Registro DCC
Writing on VWM DB
Our new app read information from DCC emited by CENAM and write that information over VWM database.
DCC project | KZ
Clasificación de acuerdo a KSU 0.1 | Tiempo de resguardo (2 años)
5
INTERNAL


INTERNAL
INTERNO
VOLKSWAGEN
GROUP SERVICES
MEXICO
Kalibrierung
DCC Project
Current status of the project
- Automated reading of XML using LabView -
Automated reading of XML files using LabVIEW
Updating calibration data for document traceability issuance.
Efficient process implemented
Significant difference in the workflow
DCC project | KZ
Clasificación de acuerdo a KSU 0.1 | Tiempo de resguardo (2 años)
6
INTERNAL

INTERNAL
INTERNO

VOLKSWAGEN
GROUP SERVICES
MEXICO

Kalibrierung

DCC Project
Current status of the project
- Benefits -

- Improves calibration report quality and streamlines processes.
- Timely data updating thanks to automation.
- Significant progress in operability

Increase in:
- Reliability
- Precision
- Agility in updating calibration data
- Directly impacts operational effectiveness

INTERNAL
INTERNO

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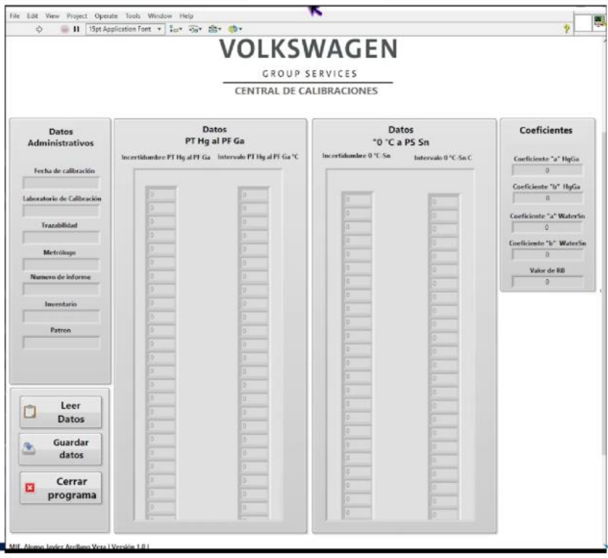
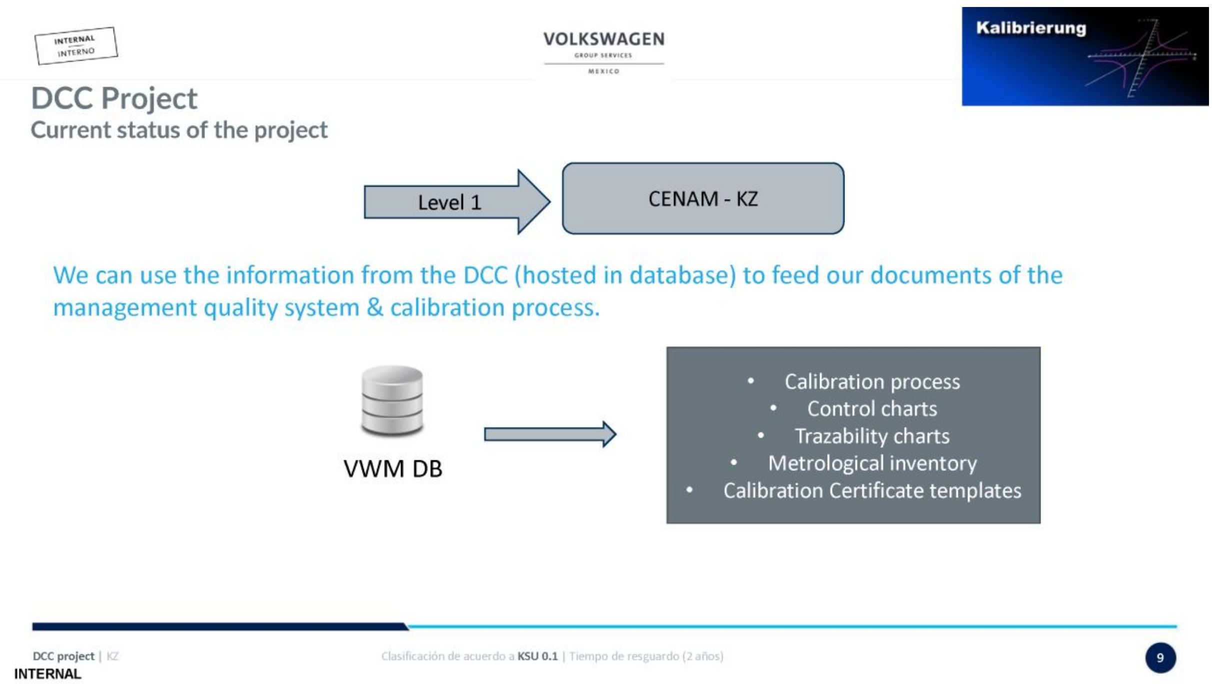
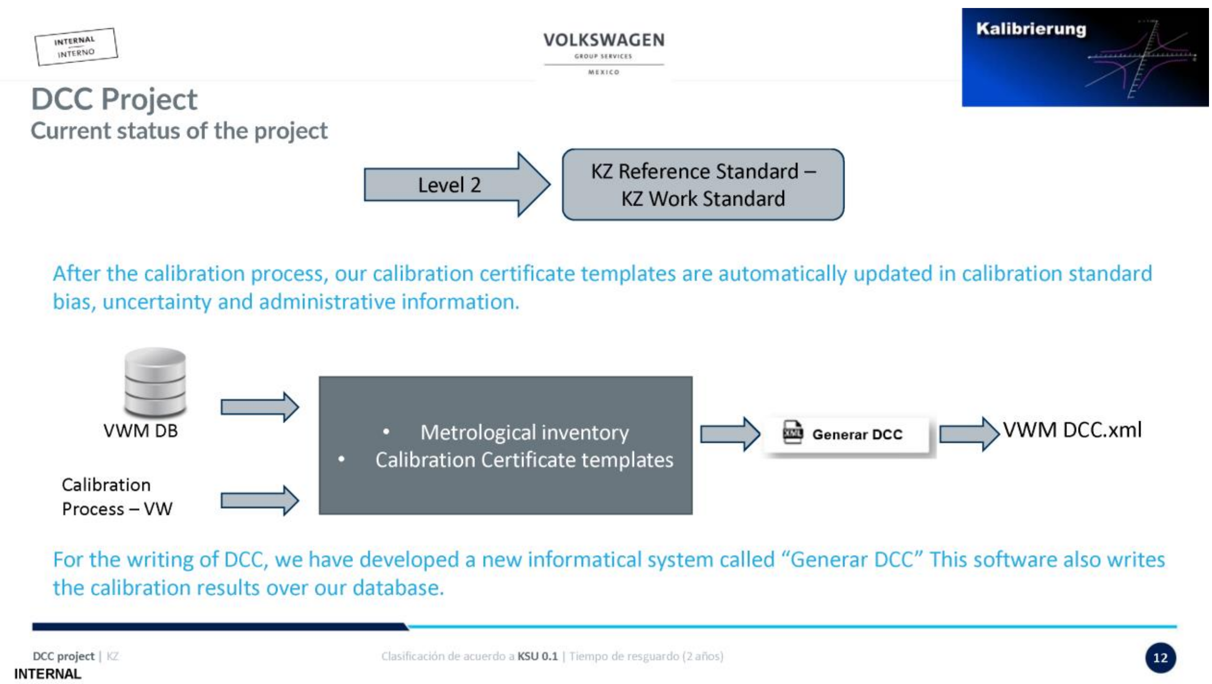
Kalibrierung

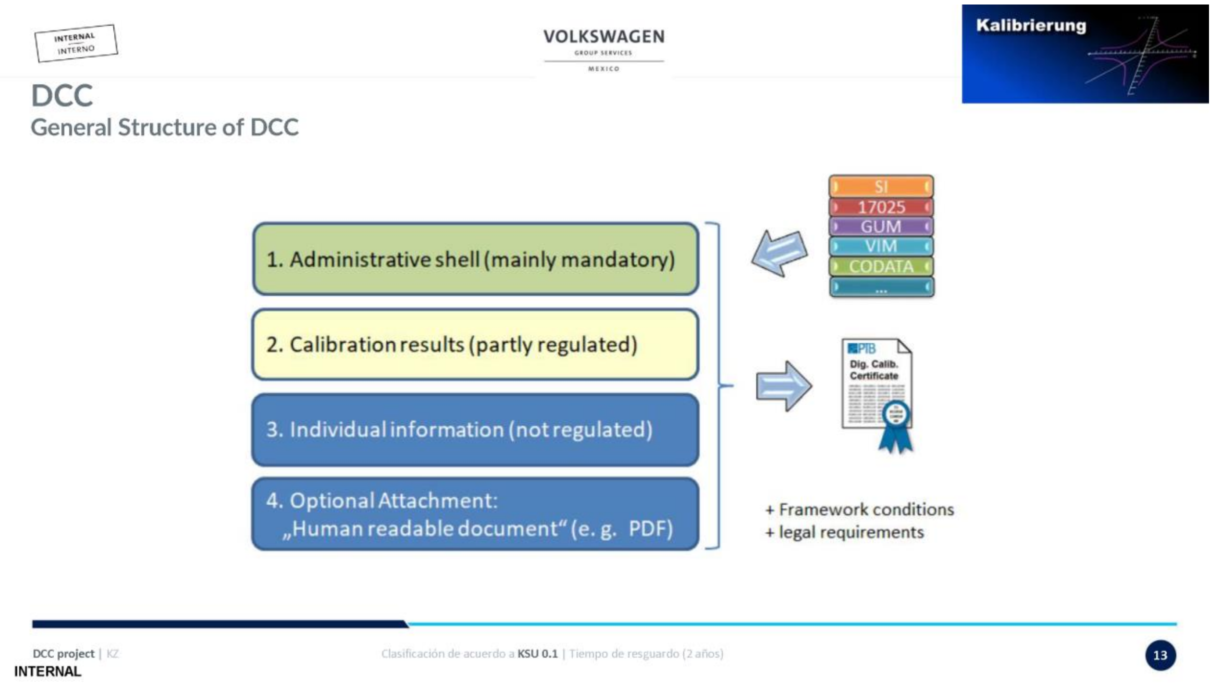
DCC Project
Current status of the project

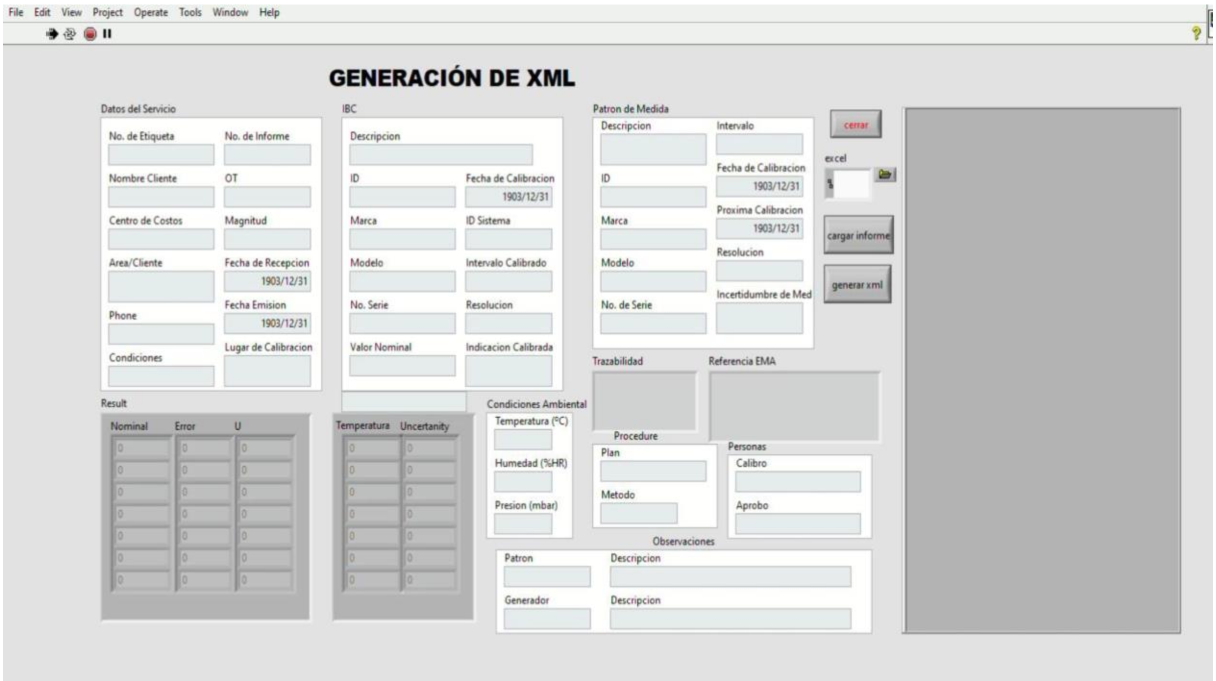
New system "Registro DCC" working.




INTERNAL
INTERNO
VOLKSWAGEN
GROUP SERVICES
MEXICO
Kalibrierung
DCC Project
Current status of the project
Level 1
CENAM - KZ
We can use the information from the DCC (hosted in database) to feed our documents of the management quality system & calibration process.
VWM DB
• Calibration process
• Control charts
• Trazability charts
• Metrological inventory
• Calibration Certificate templates
DCC project | KZ
Clasificación de acuerdo a KSU 0.1 | Tiempo de resguardo (2 años)
9
INTERNAL


INTERNAL
INTERNO
VOLKSWAGEN
GROUP SERVICES
MEXICO
Kalibrierung
DCC Project
Current status of the project
Level 2
KZ Reference Standard – KZ Work Standard
After the calibration process, our calibration certificate templates are automatically updated in calibration standard bias, uncertainty and administrative information.
VWM DB
Calibration Process – VW
• Metrological inventory
• Calibration Certificate templates
Generar DCC
VWM DCC.xml
For the writing of DCC, we have developed a new informatical system called "Generar DCC" This software also writes the calibration results over our database.
DCC project | KZ
Clasificación de acuerdo a KSU 0.1 | Tiempo de resguardo (2 años)
12
INTERNAL


INTERNAL
INTERNO
VOLKSWAGEN
GROUP SERVICES
MEXICO
Kalibrierung
DCC
General Structure of DCC
1. Administrative shell (mainly mandatory)
2. Calibration results (partly regulated)
3. Individual information (not regulated)
4. Optional Attachment:
„Human readable document“ (e. g. PDF)
SI
17025
GUM
VIM
CODATA
...
PTB
Dig. Calib.
Certificate
+ Framework conditions
+ legal requirements
DCC project | KZ
Clasificación de acuerdo a KSU 0.1 | Tiempo de resguardo (2 años)
13
INTERNAL


File Edit View Project Operate Tools Window Help
GENERACIÓN DE XML
Datos del Servicio
No. de Etiqueta
No. de Informe
Nombre Cliente
OT
Centro de Costos
Magnitud
Area/Cliente
Fecha de Recepcion
1903/12/31
Fecha Emision
1903/12/31
Phone
Lugar de Calibracion
Condiciones
IBC
Descripcion
ID
Fecha de Calibracion
1903/12/31
Marca
ID Sistema
Modelo
Intervalo Calibrado
No. Serie
Resolucion
Valor Nominal
Indicacion Calibrada
Patron de Medida
Descripcion
Intervalo
ID
Fecha de Calibracion
1903/12/31
Marca
Proxima Calibracion
1903/12/31
Modelo
Resolucion
No. de Serie
Incertidumbre de Med
cerrar
excel
cargar informe
generar xml
Trazabilidad
Referencia EMA
Result
Nominal
Error
U
Temperatura
Uncertanity
Condiciones Ambiental
Temperatura (ºC)
Humedad (%HR)
Presion (mbar)
Procedure
Plan
Metodo
Personas
Calibro
Aprobo
Observaciones
Patron
Descripcion
Generador
Descripcion

INTERNAL INTERNO

VOLKSWAGEN GROUP SERVICES MEXICO

Kalibrierung

DCC Project

Current status of the project

Level 3 → KZ Work Standard – VWM Area Standard

For this level we use the same metodology used in the Level 2 but aplied to VWM area standards

V

Calibration Process – VW

- Metrological inventory
- Calibration Certificate templates

Generar DCC

VW AREA DCC.xml

DCC project | KZ   Clasificación de acuerdo a **KSU 0.1** | Tiempo de resguardo (2 años)   15

INTERNAL

INTERNAL INTERNO

VOLKSWAGEN GROUP SERVICES MEXICO

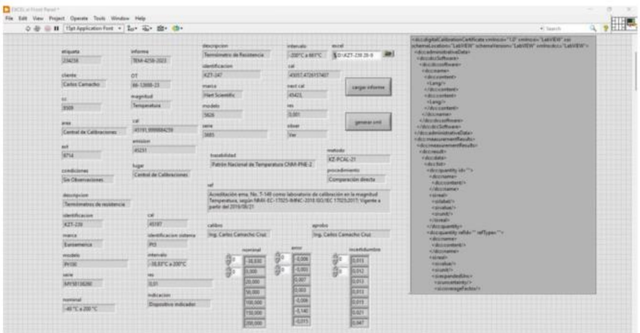
Kalibrierung

DCC Project

Current status of the project

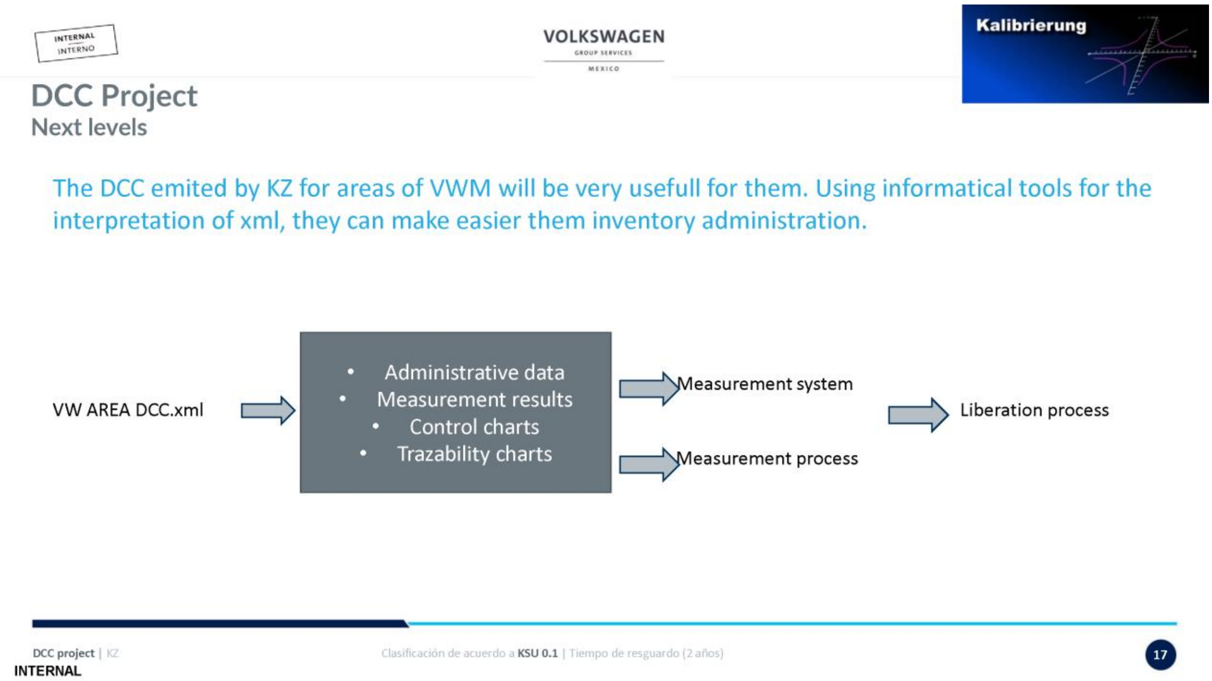
Level 3 → CENAM - KZ

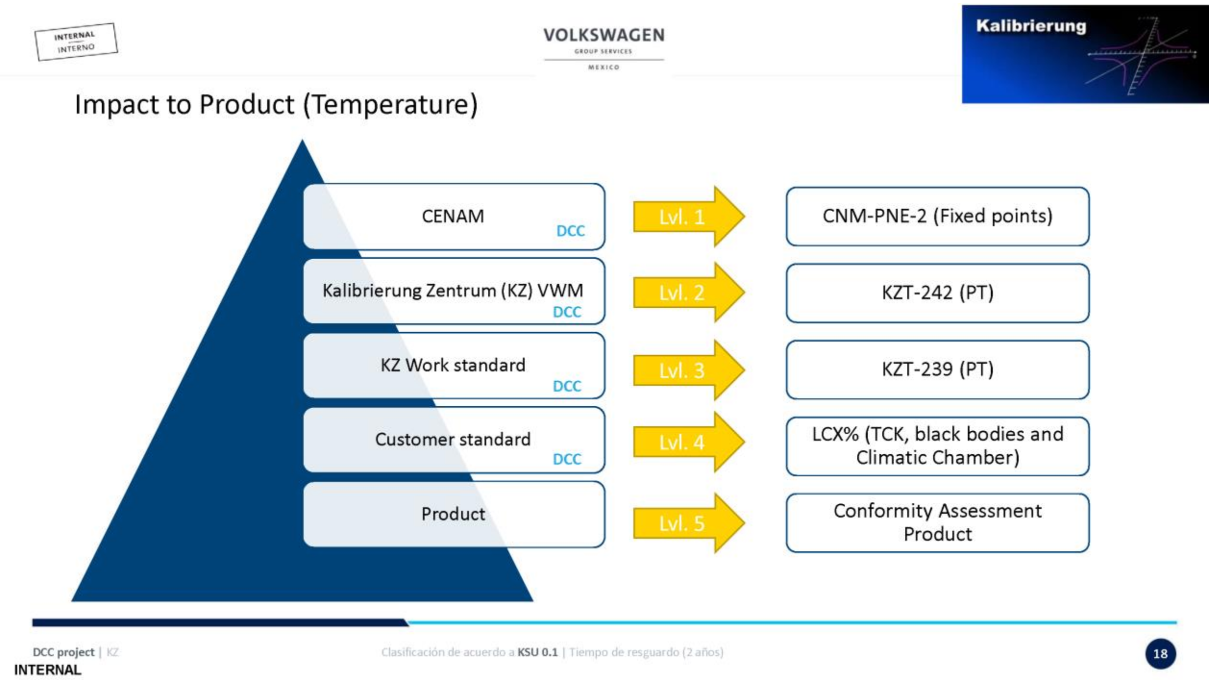
New system “Generar DCC” working



DCC project | KZ   Clasificación de acuerdo a **KSU 0.1** | Tiempo de resguardo (2 años)   16

INTERNAL


INTERNAL
INTERNO
VOLKSWAGEN
GROUP SERVICES
MEXICO
Kalibrierung
DCC Project
Next levels
The DCC emited by KZ for areas of VWM will be very usefull for them. Using informatical tools for the interpretation of xml, they can make easier them inventory administration.
VW AREA DCC.xml
Administrative data
Measurement results
Control charts
Trazability charts
Measurement system
Measurement process
Liberation process
DCC project | KZ
Clasificación de acuerdo a KSU 0.1 | Tiempo de resguardo (2 años)
17
INTERNAL


INTERNAL
INTERNO
VOLKSWAGEN
GROUP SERVICES
MEXICO
Kalibrierung
Impact to Product (Temperature)
CENAM
DCC
Lvl. 1
CNM-PNE-2 (Fixed points)
Kalibrierung Zentrum (KZ) VWM
DCC
Lvl. 2
KZT-242 (PT)
KZ Work standard
DCC
Lvl. 3
KZT-239 (PT)
Customer standard
DCC
Lvl. 4
LCX% (TCK, black bodies and Climatic Chamber)
Product
Lvl. 5
Conformity Assessment Product
DCC project | KZ
Clasificación de acuerdo a KSU 0.1 | Tiempo de resguardo (2 años)
18
INTERNAL

INTERNAL
INTERNO

VOLKSWAGEN
GROUP SERVICES
MEXICO

Challenges :

- Capitalize the DCC project in VWM.
- Safeguarding the data integrity and confidentiality.
- Compliance to standard VDA 5, VDA 6.1, ISO 9000, NMX-17025
- Conformity assessment through DCC and Metrological System.
- Infrastructure integration to implement the Metrological System in VWM.

DCC project | KZ
Clasificación de acuerdo a KSU 0.1 | Tiempo de resguardo (2 años)
19
INTERNAL

INTERNAL
INTERNO

VOLKSWAGEN
GROUP SERVICES
MEXICO

Benefits of the project

Quality
- Positive results on Audits
- Compliance to standard VDA 5
- Correction in measurements
- Optimal calibration intevals
- Automated EMP inventory

RH
- Reduce operations
- Lean administration
- Efficiency
- Specialized service

Finance
- Automated Purchase Order (PO)
- Optimal resources

DCC project | KZ
Clasificación de acuerdo a KSU 0.1 | Tiempo de resguardo (2 años)
20
INTERNAL

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28 Machine interpretable DCC structure exemplified for pipettes

Presenting author: Søren Kynde, DFM – Danish National Metrology Institute
E-mail address: srk@dfm.dk
Additional authors: David Balslev-Harder dbh@dfm.dk

Abstract

Reliable automatic transfer of calibration data from laboratory to customer is the main objective for a DCC. For the automation to add value to the customer, the process should be identical or at least very similar for all calibration areas and for data from all providers.

We showcase an example of how such a data transaction can occur. The example governs calibration of pipettes, but all labeling of data is generic and extensible to the vast majority of calibration areas. Customer specific requirements are as far as possible handled by the customer in the ordering process without interfering with the standard procedure at the laboratory. Extra information and statements provided by the laboratory do not alter the location of the data of specific interest to the customer.

The software and tools for creating and reading DCC's are available on https://github.com/TC-IM- 1448/DCC-Tables/

This presentation serves as an introduction to this material and as an invitation for the audience to go and try it out for their own calibration area.

Outline of presentation

- Generating a mapping table for data that the customer wants to extract
- Excel production user-interface for generating DCC task order
- Excel production user-interface for reading DCC task order and generating an DCC. Description of the structure of the DCC as related to schema.
- Tool for extracting specific data from DCC.
- What is known from structure vs task? What will vary between different calibration areas, providers and clients?

DFM's work is supported by funds from The Danish Agency for Institutions and Educational Grants.

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Presentation of Søren Kynde

Machine interpretable DCC structure exemplified for pipettes

4th International DCC-conference 2024

By Søren R. Kynde & David Balslev-Harder

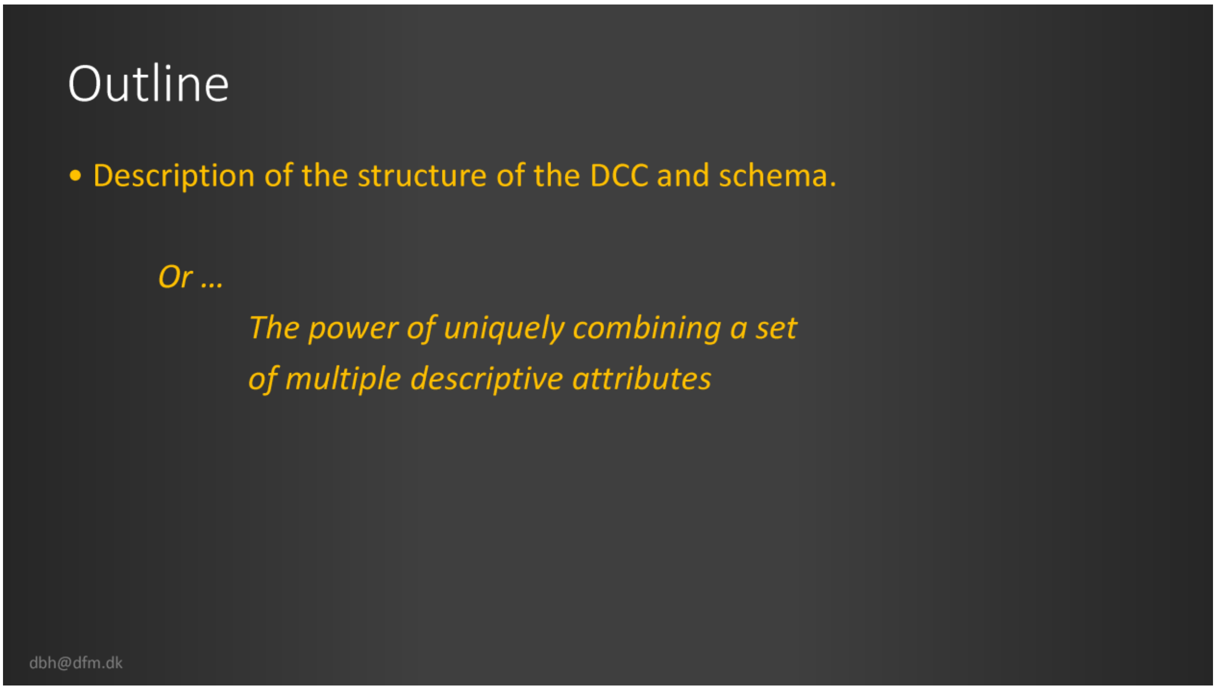
DFM
Danish National Metrology Institute

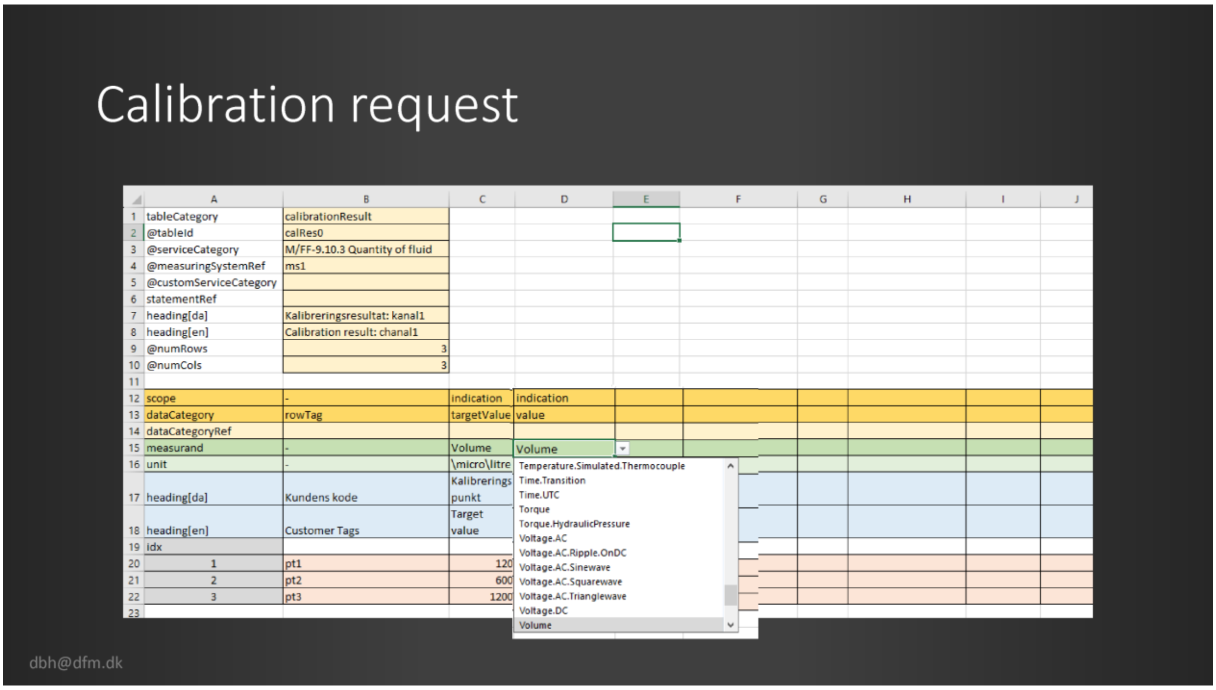
DFM receives funding by:
Danish Agency for Institutions and Educational Grants

Outline

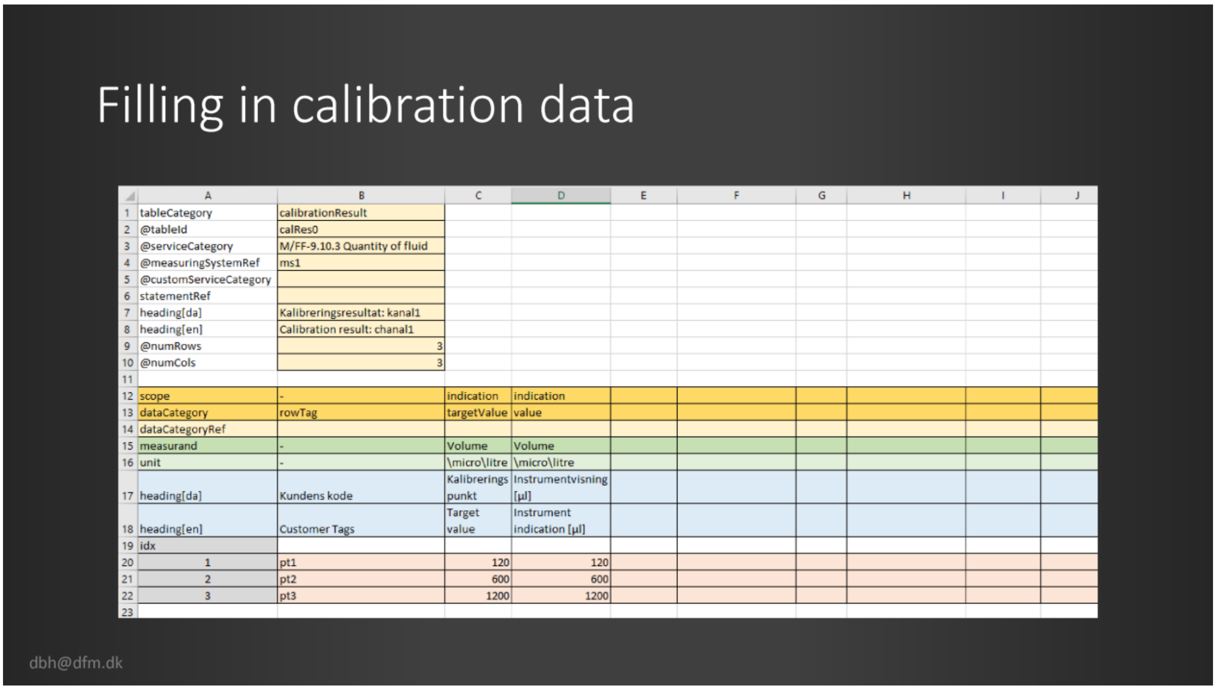
- Generating a mapping table for data that the customer wants to extract
- Excel production user-interface for generating DCC task order
- Excel production user-interface for reading DCC task order and generating an DCC.
- Description of the structure of the DCC and schema.
- Tool for extracting specific data from DCC. What is known from structure vs task?
- What will vary between different calibration areas, providers and clients

dbh@dfm.dk

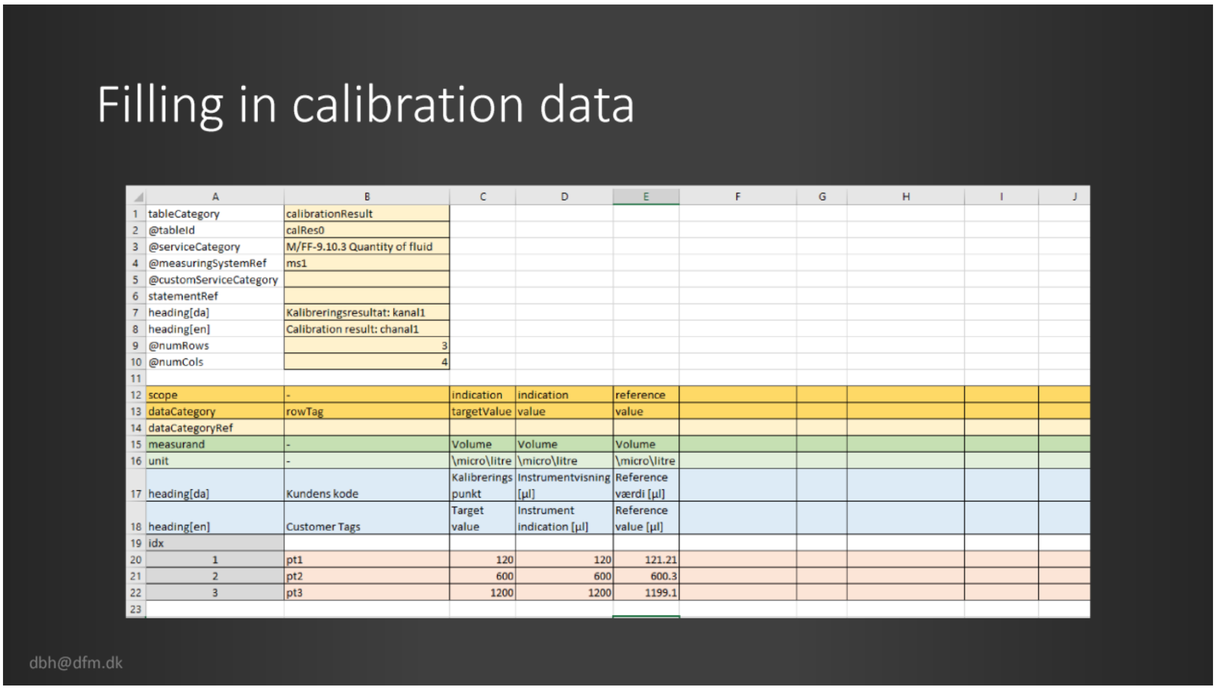




	A	B	C	D	E	F	G	H	I	J
1	tableCategory	calibrationResult								
2	@tableId	calRes0								
3	@serviceCategory	M/FF-9.10.3 Quantity of fluid								
4	@measuringSystemRef	ms1								
5	@customServiceCategory									
6	statementRef									
7	heading[da]	Kalibreringsresultat: kanal1								
8	heading[en]	Calibration result: chanal1								
9	@numRows	3								
10	@numCols	3								
11										
12	scope	-	indication	indication						
13	dataCategory	rowTag	targetValue	value						
14	dataCategoryRef									
15	measurand	-	Volume	Volume						
16	unit	-	\micro\litre							
17	heading[da]	Kundens kode	Kalibrerings punkt							
18	heading[en]	Customer Tags	Target value							
19	idx									
20	1	pt1	120							
21	2	pt2	600							
22	3	pt3	1200							
23										



	A	B	C	D	E	F	G	H	I	J
1	tableCategory	calibrationResult								
2	@tableId	calRes0								
3	@serviceCategory	M/FF-9.10.3 Quantity of fluid								
4	@measuringSystemRef	ms1								
5	@customServiceCategory									
6	statementRef									
7	heading[da]	Kalibreringsresultat: kanal1								
8	heading[en]	Calibration result: chanal1								
9	@numRows	3								
10	@numCols	3								
11										
12	scope	-	indication	indication						
13	dataCategory	rowTag	targetValue	value						
14	dataCategoryRef									
15	measurand	-	Volume	Volume						
16	unit	-	\micro\litre	\micro\litre						
17	heading[da]	Kundens kode	Kalibrerings punkt	Instrumentvisning [µl]						
18	heading[en]	Customer Tags	Target value	Instrument indication [µl]						
19	idx									
20	1	pt1	120	120						
21	2	pt2	600	600						
22	3	pt3	1200	1200						
23										



	A	B	C	D	E	F	G	H	I	J
1	tableCategory	calibrationResult								
2	@tableId	calRes0								
3	@serviceCategory	M/FF-9.10.3 Quantity of fluid								
4	@measuringSystemRef	ms1								
5	@customServiceCategory									
6	statementRef									
7	heading[da]	Kalibreringsresultat: kanal1								
8	heading[en]	Calibration result: chanal1								
9	@numRows	3								
10	@numCols	4								
11										
12	scope	-	indication	indication	reference					
13	dataCategory	rowTag	targetValue	value	value					
14	dataCategoryRef									
15	measurand	-	Volume	Volume	Volume					
16	unit	-	\micro\litre	\micro\litre	\micro\litre					
17	heading[da]	Kundens kode	Kalibrerings punkt	Instrumentvisning [µl]	Reference værdi [µl]					
18	heading[en]	Customer Tags	Target value	Instrument indication [µl]	Reference value [µl]					
19	idx									
20	1	pt1	120	120	121.21					
21	2	pt2	600	600	600.3					
22	3	pt3	1200	1200	1199.1					
23										

Filling in calibration data

	A	B	C	D	E	F	G	H	I	J
1	tableCategory	calibrationResult								
2	@tableId	calRes0								
3	@serviceCategory	M/FF-9.10.3 Quantity of fluid								
4	@measuringSystemRef	ms1								
5	@customServiceCategory									
6	statementRef									
7	heading[da]	Kalibreringsresultat: kanal1								
8	heading[en]	Calibration result: chanal1								
9	@numRows	3								
10	@numCols	5								
11										
12	scope	-	indication	indication	reference	bias				
13	dataCategory	rowTag	targetValue	value	value	value				
14	dataCategoryRef									
15	measurand	-	Volume	Volume	Volume	Volume				
16	unit	-	\micro\litre	\micro\litre	\micro\litre	\micro\litre				
17	heading[da]	Kundens kode	Kalibrerings punkt	Instrumentvisning [µl]	Reference værdi [µl]	Visningsfejl [µl]				
18	heading[en]	Customer Tags	Target value	Instrument indication [µl]	Reference value [µl]	Systematic Error [µl]				
19	idx									
20	1	pt1	120	120	121.21	1.21				
21	2	pt2	600	600	600.3	0.3				
22	3	pt3	1200	1200	1199.1	-0.9				
23										

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Filling in calibration data

	A	B	C	D	E	F	G	H	I	J
1	tableCategory	calibrationResult								
2	@tableId	calRes0								
3	@serviceCategory	M/FF-9.10.3 Quantity of fluid								
4	@measuringSystemRef	ms1								
5	@customServiceCategory									
6	statementRef									
7	heading[da]	Kalibreringsresultat: kanal1								
8	heading[en]	Calibration result: chanal1								
9	@numRows	3								
10	@numCols	6								
11										
12	scope	-	indication	indication	reference	bias	bias			
13	dataCategory	rowTag	targetValue	value	value	value	value			
14	dataCategoryRef									
15	measurand	-	Volume	Volume	Volume	Volume	Volume			
16	unit	-	\micro\litre	\micro\litre	\micro\litre	\micro\litre	\percent			
17	heading[da]	Kundens kode	Kalibrerings punkt	Instrumentvisning [µl]	Reference værdi [µl]	Visningsfejl [µl]	Visnings fejl [%]			
18	heading[en]	Customer Tags	Target value	Instrument indication [µl]	Reference value [µl]	Systematic Error [µl]	Systema tic Error [%]			
19	idx									
20	1	pt1	120	120	121.21	1.21	1.01			
21	2	pt2	600	600	600.3	0.3	0.05			
22	3	pt3	1200	1200	1199.1	-0.9	-0.08			
23										

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Filling in calibration data

	A	B	C	D	E	F	G	H	I	J
1	tableCategory	calibrationResult								
2	@tableId	calRes0								
3	@serviceCategory	M/FF-9.10.3 Quantity of fluid								
4	@measuringSystemRef	ms1								
5	@customServiceCategory									
6	statementRef									
7	heading[da]	Kalibreringsresultat: kanal1								
8	heading[en]	Calibration result: chanal1								
9	@numRows	3								
10	@numCols	7								
11										
12	scope	-	indication	indication	reference	bias	bias	bias		
13	dataCategory	rowTag	targetValue	value	value	value	value	repeatability		
14	dataCategoryRef									
15	measurand	-	Volume	Volume	Volume	Volume	Volume	Volume		
16	unit	-	\micro\litre	\micro\litre	\micro\litre	\micro\litre	\percent	\percent		
17	heading[da]	Kundens kode	Kalibrerings punkt	Instrumentvisning [µl]	Reference værdi [µl]	Visningsfejl [µl]	Visnings fejl [%]	Tilfældig fejl [%]		
18	heading[en]	Customer Tags	Target value	Instrument indication [µl]	Reference value [µl]	Systematic Error [µl]	Systema tic Error [%]	Random Error [%]		
19	idx									
20	1	pt1	120	120	121.21	1.21	1.01	0.11		
21	2	pt2	600	600	600.3	0.3	0.05	0.04		
22	3	pt3	1200	1200	1199.1	-0.9	-0.08	0.04		
23										

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Filling in tolerances

bias	bias	bias	bias	bias					
value	value	repeatability	toleranceLimitLower	toleranceLimitUpper					
Volume	Volume	Volume	Volume	Volume					
\micro\litre	\percent	\percent	\percent	\percent					
Visningsfejl [µl]	Visnings fejl [%]	Tilfældig fejl [%]	Nedre tolrancegrænse for visningsfejl [%]	Øvre tolrancegrænse for visningsfejl [%]					
Systematic Error [µl]	Systema tic Error [%]	Random Error [%]	Lower tolerance limit for systematic error [%]	Upper tolerance limit for systematic error [%]					
1.21	1.01	0.11	-2	2					
0.3	0.05	0.04	-2	2					
-0.9	-0.08	0.04	-2	2					

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Filling in tolerances

bias	bias	bias	bias	bias	bias	bias			
value	value	repeatability	toleranceLimitLower	toleranceLimitUppe	toleranceLimitLower	toleranceLimitUpper			
Volume	Volume	Volume			Volume	Volume			
\micro\litre	\percent	\percent			\percent	\percent			
Visningsfejl [µl]	Visnings fejl [%]	Tilfældig fejl [%]		ænse for [%]	Nedre tolerancegrænse for repeterbarhed [%]	Øvre tolerancegrænse for repeterbarhed [%]			
Systematic Error [µl]	Systema tic Error [%]	Random Error [%]		ance stematic	Lower tolerance limit for repeatability [%]	Nedre tolerance limit for repeatability [%]			
1.21	1.01	0.11		2	-0.2	0.2			
0.3	0.05	0.04	-2	2	-0.2	0.2			
-0.9	-0.08	0.04	-2	2	-0.2	0.2			

dataCategoryType
-
value
targetValue
expandedUncertainty
repeatability
correction
conformity
correlation
rowTag
usedReferenceRef
methodRef

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Filling in tolerances

bias	bias	bias	bias	bias	bias	bias			
value	value	repeatability	toleranceLimitLower	toleranceLimitUpper	toleranceLimitLower	toleranceLimitUpper			
			value	value	repeatability	repeatability			
Volume	Volume	Volume	Volume	Volume	Volume	Volume			
\micro\litre	\percent	\percent	\percent	\percent	\percent	\percent			
Visningsfejl [µl]	Visnings fejl [%]	Tilfældig fejl [%]	Nedre tolrancegrænse for visningsfejl [%]	Øvre tolrancegrænse for visningsfejl [%]	Nedre tolerancegrænse for repeterbarhed [%]	Øvre tolerancegrænse for repeterbarhed [%]			
Systematic Error [µl]	Systema tic Error [%]	Random Error [%]	Lower tolerance limit for systematic error [%]	Upper tolerance limit for systematic error [%]	Lower tolerance limit for repeatability [%]	Nedre tolerance limit for repeatability [%]			
1.21	1.01	0.11	-2	2	-0.2	0.2			
0.3	0.05	0.04	-2	2	-0.2	0.2			
-0.9	-0.08	0.04	-2	2	-0.2	0.2			

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Filling in tolerances

bias	bias	bias	bias	bias	bias	bias	bias	bias	
value	value	repeatability	toleranceLimitLower	toleranceLimitUpper	toleranceLimitLower	toleranceLimitUpper	conformity	decisionRuleRef	
			value	value	repeatability	repeatability			
Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	
\micro\litre	\percent	\percent	\percent	\percent	\percent	\percent			
Visningsfejl [µl]	Visnings fejl [%]	Tilfældig fejl [%]	Nedre tolrancegrænse for visningsfejl [%]	Øvre tolrancegrænse for visningsfejl [%]	Nedre tolerancegrænse for repeterbarhed [%]	Øvre tolerancegrænse for repeterbarhed [%]	Overensstemmelseserklæring	Basis for overens-stemmels-erklæring	
Systematic Error [µl]	Systematic Error [%]	Random Error [%]	Lower tolerance limit for systematic error [%]	Upper tolerance limit for systematic error [%]	Lower tolerance limit for repeatability [%]	Nedre tolerance limit for repeatability [%]	Conformity assesment	Basis for confor-mity statement	
1.21	1.01	0.11	-2	2	-0.2	0.2	pass	con01	
0.3	0.05	0.04	-2	2	-0.2	0.2	pass	con01	
-0.9	-0.08	0.04	-2	2	-0.2	0.2	Pass	con01	

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Filling in uncertainties

	A	B	C	D	E	F	G	H	I
1	tableCategory	calibrationResult							
2	@tableId	calRes0							
3	@serviceCategory	M/FF-9.10.3 Quantity of fluid							
4	@measuringSystemRef	ms1							
5	@customServiceCategory								
6	statementRef								
7	heading[da]	Kalibreringsresultat: kanal1							
8	heading[en]	Calibration result: chanal1							
9	@numRows	3							
10	@numCols	13							
11									
12	scope	-	indication	indication	reference	bias			bias
13	dataCategory	rowTag	targetValue	value	value	value			value
14	dataCategoryRef								
15	measurand	-	Volume	Volume	Volume	Volume			Volu
16	unit	-	\micro\litre	\micro\litre	\micro\litre	\micro\litre			\perc
17	heading[da]	Kundens kode	Kalibreringspunkt	Instrumentvisning [µl]	Reference værdi [µl]	Visningsfejl [µl]			Visni fejl [%
18	heading[en]	Customer Tags	Target value	Instrument indication [µl]	Reference value [µl]	Systematic Error [µl]			Systetic Er [%]
19	idx								
20	1	pt1	120	120	121.21	1.21			
21	2	pt2	600	600	600.3	0.3			
22	3	pt3	1200	1200	1199.1	-0.9			

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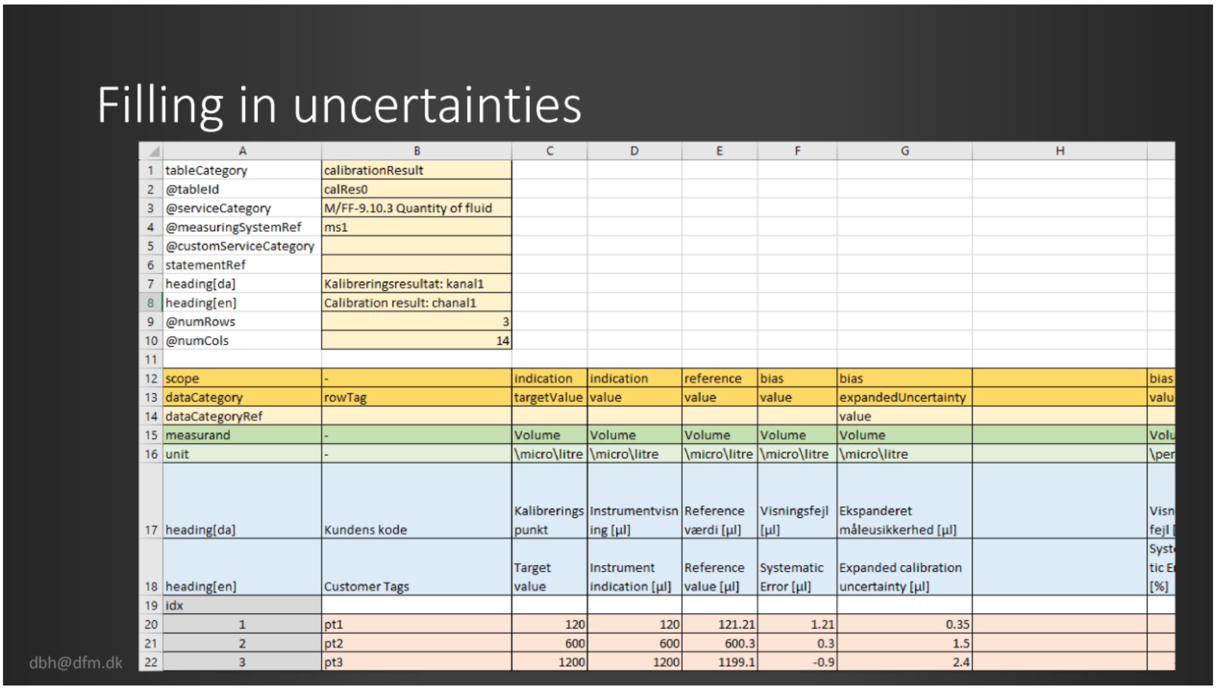

Filling in uncertainties

	A	B	C	D	E	F	G	H	I
1	tableCategory	calibrationResult							
2	@tableId	calRes0							
3	@serviceCategory	M/FF-9.10.3 Quantity of fluid							
4	@measuringSystemRef	ms1							
5	@customServiceCategory								
6	statementRef								
7	heading[da]	Kalibreringsresultat: kanal1							
8	heading[en]	Calibration result: chanal1							
9	@numRows	3							
10	@numCols	14							
11									
12	scope	-	indication	indication	reference	bias	bias		bias
13	dataCategory	rowTag	targetValue	value	value	value	expandedUncertainty		valu
14	dataCategoryRef						value		
15	measurand	-	Volume	Volume	Volume	Volume	Volume		Volu
16	unit	-	\micro\litre	\micro\litre	\micro\litre	\micro\litre	\micro\litre		\per
17	heading[da]	Kundens kode	Kalibrerings punkt	Instrumentvisning [µl]	Reference værdi [µl]	Visningsfejl [µl]	Ekspanderet måleusikkerhed [µl]		Visn fejl [
18	heading[en]	Customer Tags	Target value	Instrument indication [µl]	Reference value [µl]	Systematic Error [µl]	Expanded calibration uncertainty [µl]		Syste tic E [%]
19	idx								
20	1	pt1	120	120	121.21	1.21	0.35		
21	2	pt2	600	600	600.3	0.3	1.5		
22	3	pt3	1200	1200	1199.1	-0.9	2.4		

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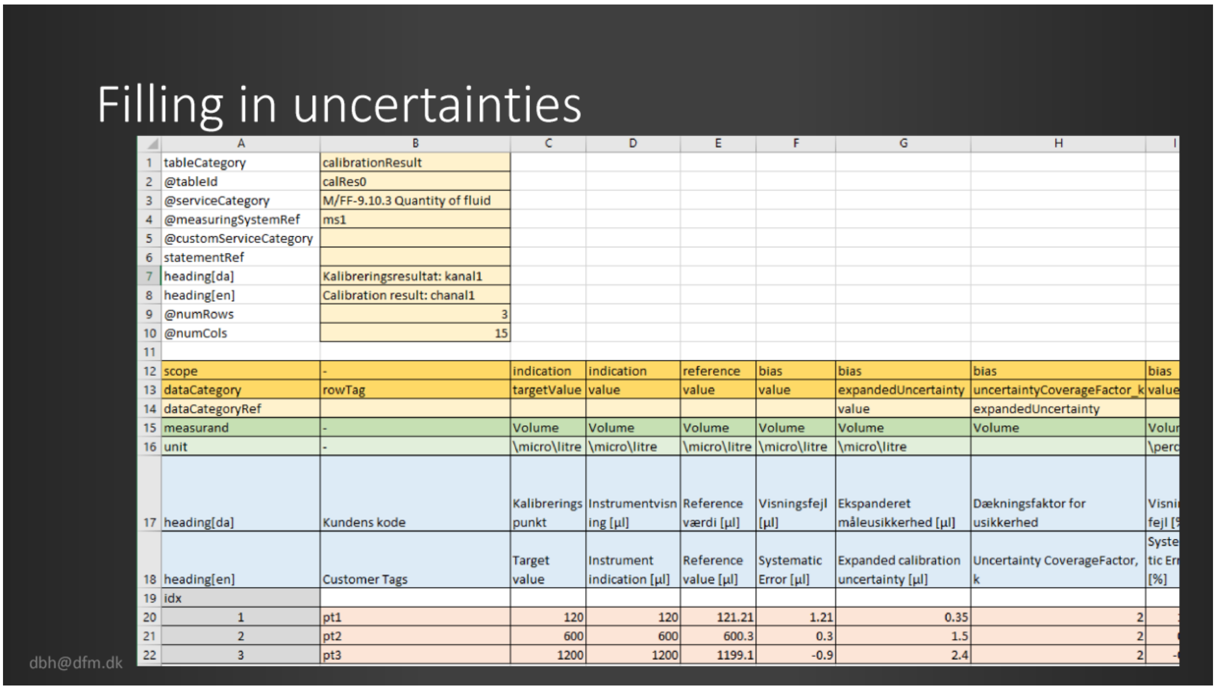

Filling in uncertainties

	A	B	C	D	E	F	G	H	I
1	tableCategory	calibrationResult							
2	@tableId	calRes0							
3	@serviceCategory	M/FF-9.10.3 Quantity of fluid							
4	@measuringSystemRef	ms1							
5	@customServiceCategory								
6	statementRef								
7	heading[da]	Kalibreringsresultat: kanal1							
8	heading[en]	Calibration result: chanal1							
9	@numRows	3							
10	@numCols	15							
11									
12	scope	-	indication	indication	reference	bias	bias	bias	bias
13	dataCategory	rowTag	targetValue	value	value	value	expandedUncertainty	uncertaintyCoverageFactor_k	value
14	dataCategoryRef						value	expandedUncertainty	
15	measurand	-	Volume	Volume	Volume	Volume	Volume	Volume	Volur
16	unit	-	\micro\litre	\micro\litre	\micro\litre	\micro\litre	\micro\litre		\perc
17	heading[da]	Kundens kode	Kalibrerings punkt	Instrumentvisning [µl]	Reference værdi [µl]	Visningsfejl [µl]	Ekspanderet måleusikkerhed [µl]	Dækningsfaktor for usikkerhed	Visni fejl [9
18	heading[en]	Customer Tags	Target value	Instrument indication [µl]	Reference value [µl]	Systematic Error [µl]	Expanded calibration uncertainty [µl]	Uncertainty CoverageFactor, k	Syste tic Er [%]
19	idx								
20	1	pt1	120	120	121.21	1.21	0.35	2	
21	2	pt2	600	600	600.3	0.3	1.5	2	
22	3	pt3	1200	1200	1199.1	-0.9	2.4	2	

dbh@dfm.dk

Export the table

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	tableCategory	calibrationResult														
2	@tableId	calRes0														
3	@serviceCategory	M/FF-9.10.3 Quantity of fluid														
4	@measuringSystemRef	ms1														
5	@customServiceCategory															
6	statementRef															
7	heading[da]	Kalibreringsresultat: kanal1														
8	heading[en]	Calibration result: chanal1														
9	@numRows	3														
10	@numCols	15														
11																
12	scope	-	indication	indication	reference	bias	bias	bias	bias	bias	bias	bias	bias	bias	bias	bias
13	dataCategory	rowTag	targetValue	value	value	value	expandedUncertainty	uncertaintyCoverageFactor_k	value	repeatability	toleranceLimitLower	toleranceLimitUpper	toleranceLimitLower	toleranceLimitUpper	conformity	decisionRuleRef
14	dataCategoryRef						value	expandedUncertainty			value	value	repeatability	repeatability		
15	measurand	-	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume
16	unit	-	\micro\litre	\micro\litre	\micro\litre	\micro\litre	\micro\litre		\percent	\percent	\percent	\percent	\percent	\percent		
17	heading[da]	Kundens kode	Kalibrerings punkt	Instrumentvisning [µl]	Reference værdi [µl]	Visningsfejl [µl]	Ekspanderet måleusikkerhed [µl]	Dækningsfaktor for usikkerhed	Visnings fejl [%]	Tilfældig fejl [%]	Nedre tolrancegrænse for visningsfejl [%]	Øvre tolrancegrænse for visningsfejl [%]	Nedre tolerancegrænse for repeterbarhed [%]	Øvre tolerancegrænse for repeterbarhed [%]	Overensstemmelseserklæring	Basis for overens-stemmels-erklæring
18	heading[en]	Customer Tags	Target value	Instrument indication [µl]	Reference value [µl]	Systematic Error [µl]	Expanded calibration uncertainty [µl]	Uncertainty CoverageFactor, k	Systematic Error [%]	Random Error [%]	Lower tolerance limit for systematic error [%]	Upper tolerance limit for systematic error [%]	Lower tolerance limit for repeatability [%]	Nedre tolerance limit for repeatability [%]	Conformity assesment	Basis for confor-mity statement
19	idx															
20	1	pt1	120	120	121.21	1.21	0.35	2	1.01	0.11	-2	2	-0.2	0.2	pass	con01
21	2	pt2	600	600	600.3	0.3	1.5	2	0.05	0.04	-2	2	-0.2	0.2	pass	con01
22	3	pt3	1200	1200	1199.1	-0.9	2.4	2	-0.08	0.04	-2	2	-0.2	0.2	Pass	con01

DCC EXCEL UI Tool

load excel-file

IS/SRK/Møder/2024/4'th DCCconference/DCC_pipette_1.

load DCC.xml

exported to: output.xml

Export DCC from GUI

dbh@dfm.dk

Export the table

n	indication	reference	bias
lue	value	value	value
	-	-	-
	Volume	Volume	Volume
itre	\micro\litre	\micro\litre	\micro\litre
ings	Instrumentvisning [µl]	Reference værdi [µl]	Visningsfejl [µl]
	Instrument indication [µl]	Reference value [µl]	Systematic Error [µl]
120	120	121.21	1.21
600	600	600.3	0.3
200	1200	1199.1	-0.9

```
<dcc:column scope="indication" dataCategoryRef="-" measurand="Volume">
  <dcc:heading lang="da">Instrumentvisning [µl]</dcc:heading>
  <dcc:heading lang="en">Instrument indication [µl]</dcc:heading>
  <dcc:unit>\micro\litre</dcc:unit>
  <dcc:dataList>
    <dcc:value>
      <dcc:row idx="1">120</dcc:row>
      <dcc:row idx="2">600</dcc:row>
      <dcc:row idx="3">1200</dcc:row>
    </dcc:value>
  </dcc:dataList>
</dcc:column>
<dcc:column scope="reference" dataCategoryRef="-" measurand="Volume">
  <dcc:heading lang="da">Reference værdi [µl]</dcc:heading>
  <dcc:heading lang="en">Reference value [µl]</dcc:heading>
  <dcc:unit>\micro\litre</dcc:unit>
  <dcc:dataList>
    <dcc:value>
      <dcc:row idx="1">121.21</dcc:row>
      <dcc:row idx="2">600.3</dcc:row>
      <dcc:row idx="3">1199.1</dcc:row>
    </dcc:value>
  </dcc:dataList>
</dcc:column>
<dcc:column scope="bias" dataCategoryRef="-" measurand="Volume">
  <dcc:heading lang="da">Visningsfejl [µl]</dcc:heading>
  <dcc:heading lang="en">Systematic Error [µl]</dcc:heading>
  <dcc:unit>\micro\litre</dcc:unit>
  <dcc:dataList>
    <dcc:value>
```

dbh@dfm.dk

Example: Mass-callibration

	A	B	C	D	E	F	G	H	I
1	tableCategory	calibrationResult							
2	@tableId	calRes							
3	@serviceCategory	M/Mass-1.1.1 Mass standard							
4	@measuringSystemRef	ms1							
5	@customServiceCategory								
6	statementRef								
7	heading[da]	Kalibreringsresultat: lodsæt							
8	heading[en]	Calibration result: Set of Weights							
9	@numRows	5							
10	@numCols	8							
11									
12	scope	-	indication	indication	bias	bias	bias	bias	bias
13	dataCategory	rowTag	value	value	correction	correction	expandedUncertainty	expandedUncertainty	uncertaintyCoverageFactor_k
14	dataCategoryRef	-	-	-	-	-	value	value	expandedUncertainty
15	measurand	-	Mass.Conventional	Mass.True	Mass.Conventional	Mass.True	Mass.Conventional	Mass.True	-
16	unit	-	\kilo\gram	\kilo\gram	\milli\gram	\milli\gram	\milli\gram	-	-
17	heading[da]	Kundens kode	Instrumentvisning [kg]	Instrumentvisning [kg]	Korrektion [mg]	Korrektion [mg]	Usikkerhed konventionel masse	Usikkerhed konventionel masse	Dækningsfaktor for usikkerhed
18	heading[en]	Customer Tags	Instrument indication [kg]	Instrument indication [kg]	Correction: True mass [mg]	Correction: True mass [mg]	Uncertainty conventional mass	Uncertainty conventional mass	Uncertainty CoverageFactor, k
19	idx								
20	1	20kg_1	20	20	7.3	27	3.1	53	2
21	2	20kg_2	20	20	2.7	21	3.1	53	2
22	3	20kg_3	20	20	5.4	25	3.1	53	2
23	4	20kg_4	20	20	3.2	22	3.1	53	2
24	5	20kg_5	20	20	-0.2	23	3.1	53	2

dbh@dfm.dk

Summary

- The 2-dimensional layout of the data-table makes it:
  - Easy for people to understand
  - Easy to display (on paper or in a worksheet)
- The uniqueness of the identifying attributes makes it:
  - Simple to implement read/write-algorithms
- The generic names of the attributes makes the system applicable in all fields of calibration

Thank You

dbh@dfm.dk

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Session “Schema”
(Chair: Thomas Krah)

29 What`s New in the DCC Schema Pre-Release v3.3.0-rc.1

Presenting author: Benjamin Gloger, PTB Germany
E-mail address: Benjamin.Gloger@ptb.de
Additional authors: Siegfried Hackel siegfried.hackel@ptb.de, Gamze Söylev Öktem gamze.soeylev-oektem@ptb.de, Shanna Schönhals shanna.schoenhals@ptb.de , Justin Jagieniak Justin.Jagieniak@ptb.de, Lutz Doering lutz.doering@ptb.de, Jan Loewe jan.loewe@ptb.de, Muhammed Ali Demir muhammed.demir@ptb.de, Moritz Jordan moritz.jordan@ptb.de, Kai Mienert kai.mienert@ptb.de, Christian Keilholz christian.keilholz@ptb.de (all PTB)

A pre-release with version 3.3.0-rc.1 has been available since mid-December 2023.

The plan is to publish it as a new DCC schema in version 3.3.0 in mid-April 2024. Backwards compatibility with version 3.0.0 is guaranteed.

Almost a year has passed since the last release, during which time many DCCs were created with schema 3.2.1. All changes are of course fully downward compatible. In this presentation we will first discuss the conditions for downward compatibility. The changes will then be checked for this. We will also take a closer look at the changes.

The versions to be compared are:

- - DCC Schema 3.2.1 (https://www.ptb.de/dcc/v3.2.1/dcc.xsd)
- - DCC Schema 3.3.0-rc.1 (https://www.ptb.de/dcc/v3.3.0-rc.1/dcc.xsd)

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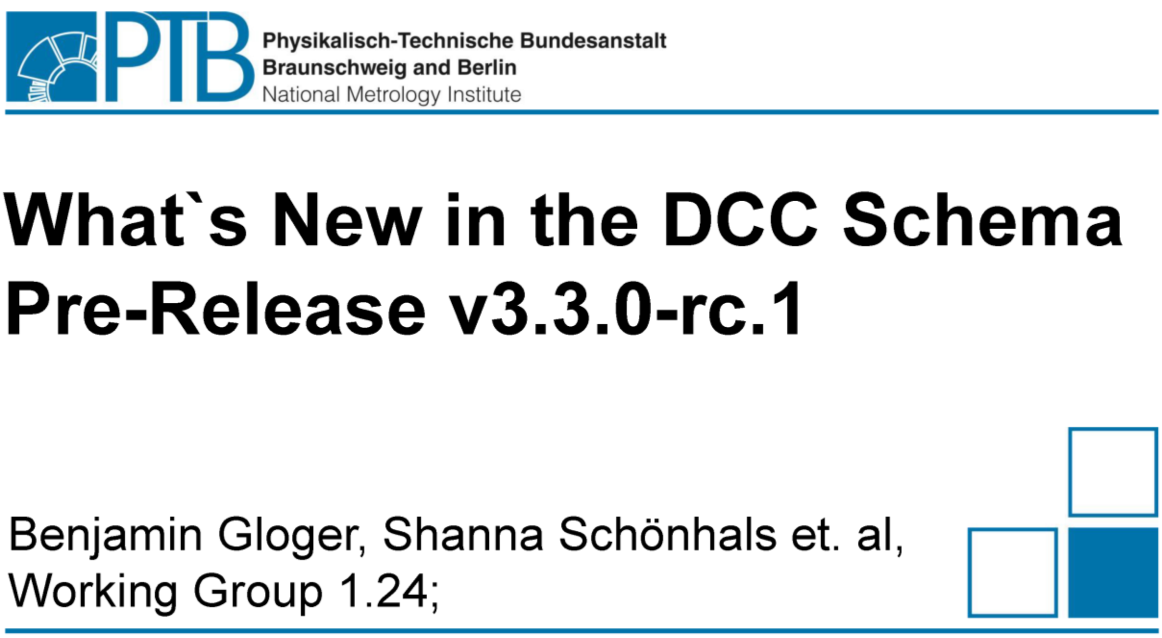
Presentation of Benjamin Gloger



Pre-Release v3.3.0-rc.1

- **DCC** Pre-Release v3.3.0-rc.1
  - Pre-release from 2023-12-14
  - Time target for release mid-June 2024
- Link to scheme version "3.2.1“:https://www.ptb.de/dcc/dcc.xsd
- Link to RC1 Schema: https://www.ptb.de/dcc/v3.3.0-rc.1/dcc.xsd
- Link to Dokumentation: https://gitlab.com/ptb/dcc/xsd-dcc/-/compare/master...pre-release?from_project_id=29509837&straight=false

Improvements

- **Update the D-Si version to 2.2.0**
- **Extension of the dcc:locationType by building, floor and room.**
- **Extention of the dcc:itemType by the attribute refId.**
- **Extention of the dcc:contactType, dcc:contactNotStrictType and dcc:statementMetaDataType by a dcc:link Element.**

D-SI: Integration of the new schema version 2.2.0

- Change:
  - Link has been changed to the new D-SI scheme.
- Reason:
  - To be able to use the functions of the new D-SI in DCC as quickly as possible. Many of the changes in D-SI come from the DCC community.
- D-SI link: https://gitlab1.ptb.de/d-ptb/d-si/xsd-d-si
-

```
<xs:import
        namespace="https://ptb.de/si"
        schemaLocation="https://ptb.de/si/v2.2.0/SI_Format.xsd"/>

<xs:import
    namespace="http://www.w3.org/2000/09/xmldsig#"
    schemaLocation="https://www.ptb.de/dcc/d-sig/xmldsig-core-schema.xsd"/>
```

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D-SI: Integration of the new schema version 2.2.0

- Change:
  - Addition of the new D-SI element si:complexListXMLList in dcc:quantity and dcc:primitiveQuantity.
- Reason:
  - The element is new and would not have been usable by DCC users without direct integration.

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D-SI: Integration of the new schema version 2.2.0

- si:complexListXMLList in dcc:quantity
- and dcc:primitiveQuantity

```
<xs:complexType name="primitiveQuantityType">
    <xs:annotation>
        <xs:documentation>
            This type contains measurable value(s).
        </xs:documentation>
    </xs:annotation>
    <xs:sequence>
        <xs:element name="name" type="dcc:textType" minOccurs="0"/>
        <xs:element name="description" type="dcc:richContentType" minOccurs="0"/>
        <xs:choice>
            <xs:element name="noQuantity" type="dcc:richContentType"/>
            <xs:element name="charsXMLList" type="dcc:charsXMLListType"/>
            <xs:element ref="si:real"/>
            <xs:element ref="si:hybrid"/>
            <xs:element ref="si:complex"/>
            <xs:element ref="si:constant"/>
            <xs:element ref="si:realListXMLList"/>
            <xs:element ref="si:complexListXMLList"/>
        </xs:choice>
    </xs:sequence>
    <xs:attribute name="id" type="xs:ID" use="optional"/>
    <xs:attribute name="refId" type="xs:IDREFS" use="optional"/>
    <xs:attribute name="refType" type="dcc:refTypesType" use="optional"/>
</xs:complexType>
```

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Extension of the dcc:locationType

- Change:
  - Building, floor and room have been added to dcc:locationType.
- Reason:
  - This information can be useful for specifying the calibration location. When implementing some examples, it was noticed that the dcc:futher element was often used to specify the added information. Although this allows additional information to be specified, it is not as easy to analyse as using the new elements.

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Extension of the dcc:locationType

- Building, floor and room have been added

```
<xs:complexType name="locationType">
    <xs:choice maxOccurs="unbounded">
        <xs:element name="city" type="dcc:notEmptyStringType"/>
        <xs:element name="countryCode" type="dcc:stringISO3166Type"/>
        <xs:element name="postCode" type="dcc:notEmptyStringType"/>
        <xs:element name="postOfficeBox" type="dcc:notEmptyStringType"/>
        <xs:element name="state" type="dcc:notEmptyStringType"/>
        <xs:element name="street" type="dcc:notEmptyStringType"/>
        <xs:element name="streetNo" type="dcc:notEmptyStringType"/>
        <xs:element name="building" type="dcc:notEmptyStringType"/>
        <xs:element name="floor" type="dcc:notEmptyStringType"/>
        <xs:element name="room" type="dcc:notEmptyStringType"/>
        <xs:element name="further" type="dcc:richContentType"/>
        <xs:element name="positionCoordinates" type="dcc:positionCoordinatesType"/>
    </xs:choice>
</xs:complexType>
```

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Extention of the dcc:itemType by the attribute refId

- **Change:**
  - **Extension of the dcc:itemType by the attribute refId**
- **Reason:**
  - **For more complex calibration objects where results only relate to a specific area of the calibration object, an addressing option for these sub-areas (subItem) is required. For this purpose, it must be possible to describe a subItem.Example perforated plate:An example from coordinate measuring technology is the perforated plate. The perforated plate is the main object with its own identification; it must be possible to address each hole in the perforated plate individually in the DCC in order to assign the results to the holes. For this purpose, each hole and also the perforated plate is given an ID in order to create a corresponding link, the holes would refer to the ID of the perforated plate with a refId. As the holes and their affiliation are an unchangeable property of the calibration object ‘Hole plate’, this description belongs in the item area of the calibration certificate.**

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Extention of the dcc:itemType by the attribute refId

```
<xs:complexType name="itemType">
    <xs:annotation>
        <xs:documentation>
            An item that is calibrated in this DCC.
        </xs:documentation>
    </xs:annotation>
    <xs:sequence>
        <xs:element name="name" type="dcc:textType"/>
        <xs:element name="equipmentClass" type="dcc:equipmentClassType" minOccurs="0"
maxOccurs="unbounded"/>
        <xs:element name="description" type="dcc:richContentType" minOccurs="0"/>
        <xs:element name="installedSoftwares" type="dcc:softwareListType" minOccurs="0" />
        <xs:element name="manufacturer" type="dcc:contactNotStrictType" minOccurs="0" />
        <xs:element name="model" type="dcc:notEmptyStringType" minOccurs="0"/>
        <xs:element name="identifications" type="dcc:identificationListType"/>
        <xs:element name="itemQuantities" type="dcc:itemQuantityListType" minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="id" type="xs:ID" use="optional"/>
    <xs:attribute name="refId" type="xs:IDREFS" use="optional"/>
    <xs:attribute name="refType" type="dcc:refTypesType" use="optional"/>
</xs:complexType>
```


Extention of some Types by a dcc:link Element

- **Change:**
  - **Addition of elements for specifying external links in the dcc:contactType, dcc:contactNotStrictType and the dcc:statementMetaDataType**
- **Reason:**
  - **With both dcc:contact...Types, a homepage of the respective company is often inserted. If this is inserted in a separate element, it can be processed better than in a free text description element.This element is required in the dcc:statementMetaDataType to add a link to a statement. A lot of different information can be accommodated in the statement and the addition of a dcc:link element makes it easier to specify the source or find the source. PID can also be accommodated in this element.**

Extention of some Types by a dcc:link Element

- **Example:**
  - **Reference to a CMC from the CIPM or ILAC if each CMC has its own PID.**
  - **This can be used to create a direct link between the DCC and the CMC of the issuing organisation.**

Extention of some Types by a dcc:link Element

- **Extention of dcc:contactNotStrictType by a dcc:link Element.**

```
<xs:complexType name="contactNotStrictType">
    <xs:sequence>
        <xs:element name="name" type="dcc:textType"/>
        <xs:element name="eMail" type="dcc:notEmptyStringType" minOccurs="0"/>
        <xs:element name="phone" type="dcc:notEmptyStringType" minOccurs="0"/>
        <xs:element name="fax" type="dcc:notEmptyStringType" minOccurs="0"/>
        <xs:element name="link" type="dcc:notEmptyStringType" minOccurs="0"/>
        <xs:element name="location" type="dcc:locationType" minOccurs="0"/>
        <xs:element name="descriptionData" type="dcc:byteDataType" minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="id" type="xs:ID" use="optional"/>
    <xs:attribute name="refId" type="xs:IDREFS" use="optional"/>
    <xs:attribute name="refType" type="dcc:refTypesType" use="optional"/>
</xs:complexType>
```

Extention of some Types by a dcc:link Element

- **Extention of the dcc:contactType by a dcc:link Element.**

```xml
<xs:complexType name="contactType">
    <xs:sequence>
        <xs:element name="name" type="dcc:textType"/>
        <xs:element name="eMail" type="dcc:notEmptyStringType" minOccurs="0"/>
        <xs:element name="phone" type="dcc:notEmptyStringType" minOccurs="0"/>
        <xs:element name="fax" type="dcc:notEmptyStringType" minOccurs="0"/>
        <xs:element name="link" type="dcc:notEmptyStringType" minOccurs="0"/>
        <xs:element name="location" type="dcc:locationType"/>
        <xs:element name="descriptionData" type="dcc:byteDataType" minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="id" type="xs:ID" use="optional"/>
</xs:complexType>
```

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Extention of some Types by a dcc:link Element

- **Extention of dcc:statementMetaDataType by a dcc:link Element.**

XML Instance Representation

```
<...
id="xs:ID [0..1]"
refId="xs:IDREFS [0..1]"
refType="dcc:refTypesType [0..1]">
<dcc:name> dcc:textType </dcc:name> [0..1]
<dcc:description> dcc:richContentType </dcc:description> [0..1]
<dcc:countryCodeISO3166_1> dcc:stringISO3166Type </dcc:countryCodeISO3166_1> [0..*]
<dcc:convention> dcc:notEmptyStringType </dcc:convention> [0..1]
<dcc:traceable> xs:boolean </dcc:traceable> [0..1]
<dcc:norm> dcc:notEmptyStringType </dcc:norm> [0..*]
<dcc:reference> dcc:notEmptyStringType </dcc:reference> [0..*]
<dcc:link> dcc:notEmptyStringType </dcc:link> [0..1]
<dcc:declaration> dcc:richContentType </dcc:declaration> [0..1]
Start Choice [0..1]
<dcc:valid> xs:boolean </dcc:valid> [1]
<dcc:validXMLList> dcc:booleanXMLListType </dcc:validXMLList> [1]
End Choice
<dcc:date> xs:date </dcc:date> [0..1]
<dcc:period> xs:duration </dcc:period> [0..1]
<dcc:respAuthority> dcc:contactType </dcc:respAuthority> [0..1]
Start Choice [0..1]
<dcc:conformity> dcc:stringConformityStatementStatusType </dcc:conformity> [1]
<dcc:conformityXMLList> dcc:stringConformityStatementStatusXMLListType </dcc:conformityXMLList> [1]
End Choice
<dcc:data> dcc:dataType </dcc:data> [0..1]
<dcc:nonSIDefinition> dcc:notEmptyStringType </dcc:nonSIDefinition> [0..1]
<dcc:nonSIUnit> dcc:notEmptyStringType </dcc:nonSIUnit> [0..1]
<dcc:location> dcc:locationType </dcc:location> [0..1]
</...>
```

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Thank you for your attention!

Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
Bundesallee 100
38116 Braunschweig

More questions? Please contact:

Shanna Schönhals
Telefon: +49 (0) 531 592-1240
E-Mail: shanna.schoenhals@ptb.de

www.ptb.de

Status: 2024-02

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30 DCC in Thailand: DCC conversion, schema validation and accessibility control process

Presenting author: Praiya Thongluang, NIMT, Thailand
E-mail address: praiyat@nimt.or.th
Additional authors: Jariya Buajarern

Abstract

NIMT's primary tool for issuing calibration certificates has been Microsoft Excel. At the early stage of DCC project, we relied on developer functions as a bridge to transform MS Excel based calibration certificates to XML based calibration certificate. However, the developer function in MS Excel has limitation due to complexity of XML schema if the content in excel file is required to export in XML file. This prompted us to seek another solution and to develop a tool for schema validation. To overcome this hurdle, we adopted Python for DCC creation approach.

Our initiative involved designing a schema that is complied with requirements in ISO/IEC 17025. This schema served as a blueprint guiding the design of MS Excel template used in measurement result calculation. Additionally, through our developed programming, we devised a process to extract content from MS Excel files, to convert MS Excel file into XML format, and to present the XML in human-readable HTML format.

To validate schema, we collaborate with the Electronic Transactions Development Agency (ETDA), a government body dedicated to advancing Thailand's digital economy and society. ETDA provides a platform, serving as both a database management system and a public service platform. We registered and uploaded "NIMT's schema version 1.0" onto ETDA's schema repository, enabling NIMT's customers or users of DCC to easily validate the XML based DCC through the validation.teda.th website.

This strategy enables DCC to be created from MS Excel files with fewer limitations. Moreover, schema can be validated by users from anywhere under the user-friendly ETDA platform.

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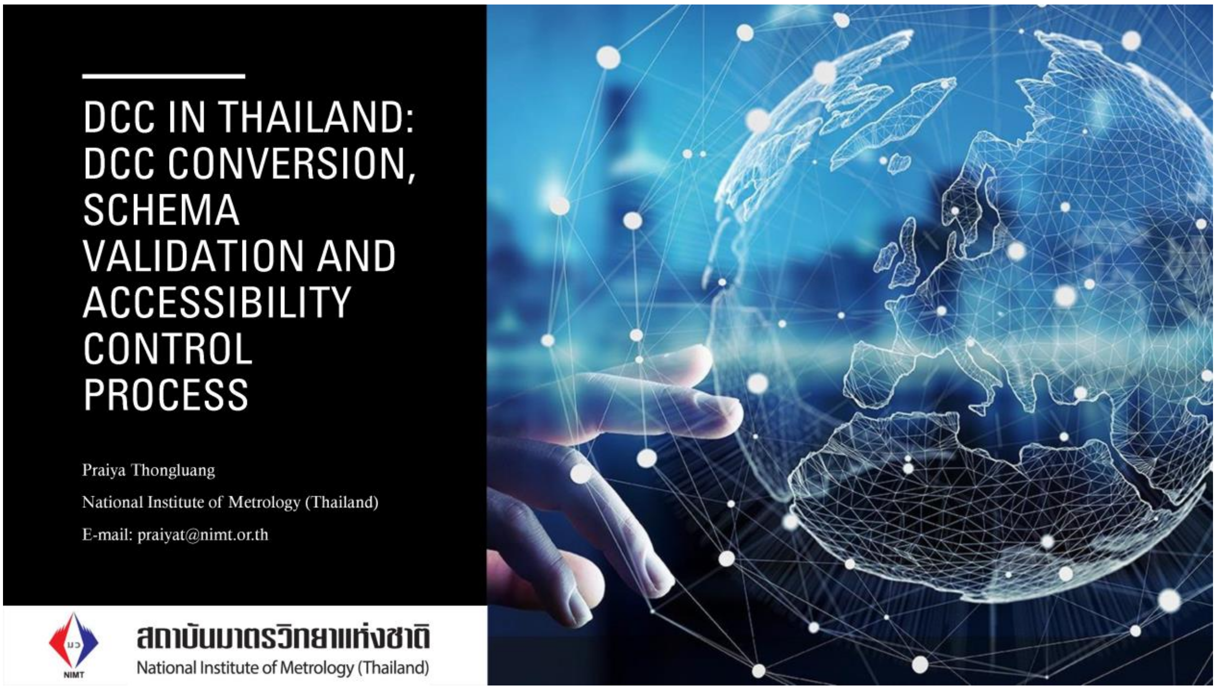
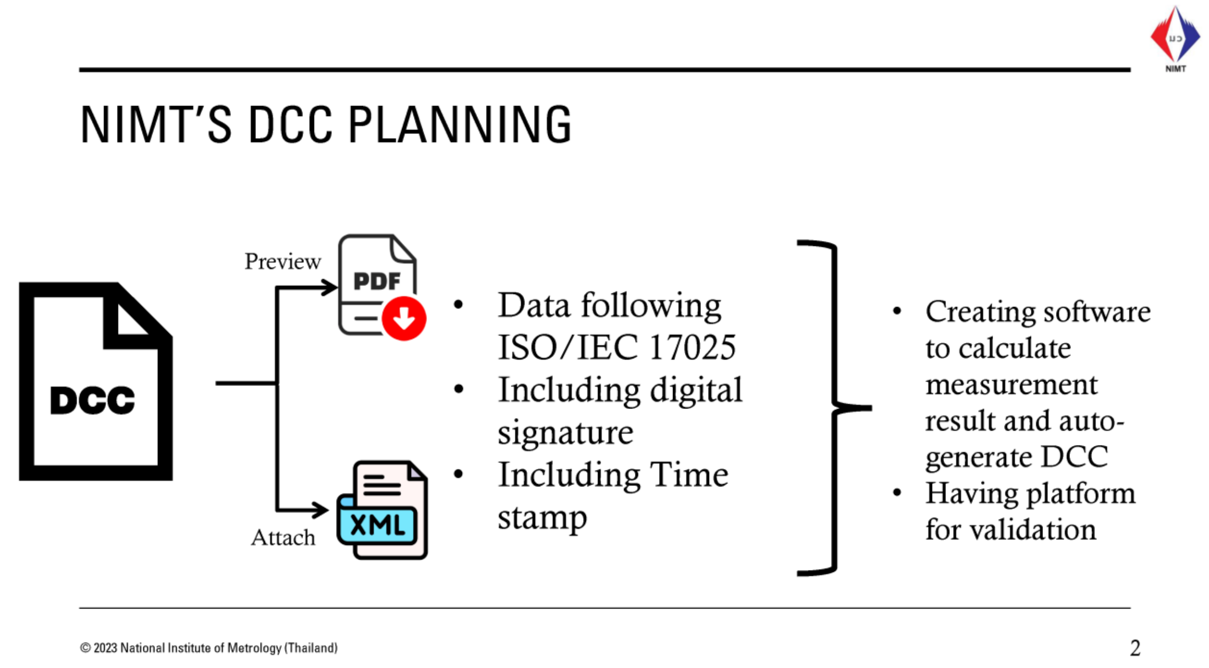
Presentation of Praiya Thongluang





OBJECTIVE

✓To develop software for generating the DCC and to design a schema which are user friendly.

✓To identify platform for validating schema and controlling accessibility.

✓To strengthen the cooperation of QI in Thailand.

OUTLINE

- How to create a DCC
  - Previous Method: Developer function in MS Excel
  - Present Method: Python
- Schema validation with ETDA
  - Who is ETDA?
  - Case study of ETDA
  - Collaborating with NIMT

PREVIOUS METHODOLOGY

Pros

- Most of NIMT staffs use MS Excel to compute measurement results and issue calibration certificates
- MS Excel has 'Developer' function to automatically generate XML Schema and to export to XML file
- MS Excel is a user-friendly software

Cons

- This function has limitation of importing and exporting the complex XML schema file
- It requires long time to move data in MS Excel into XML template

PRESENT METHODOLOGY

python™

PREPARING PROCESS

1. Creating template in MS Excel for preparing the data to transfer process
2. Converting excel file to XML fille via Python
3. Previewing DCC in human-readable format (HTML)

NIMT

EXCEL TEMPLATE

1. Administrative data
2. Measurement statement
3. Measurement results

	A	B
1	element	data
2	title	Calibration Certificate
3	uniqueIdentifier	DW-22-00XX
4	calibrationLaboratoryDe	Dimensional Metrology Department
5	calibrationLaboratoryGr	Primary Length Standard Group
6	calibrationLaboratoryLat	Wavelength Laboratory
7	itemsName	Laser Interferometer (Laser Head)
8	itemsManufacturer	RENISHAW
9	itemsModel	XL-80
10	itemsIdentification	XXCMXX
11	customerName	Innovation and Measuring Devices Development Group, National Institute of Metrology (Thailand)
12	customerAddress	3/4-5 Moo 3, Klong 5, Klong Lung, Pathumthani 12120
13	beginPerformanceDate	2022-11-24
14	endPerformanceDate	2022-11-25
15	coreDataIdentification	I-DMCXXXX-01/22
16	issueDate	2022-12-14
17	authorized	Authorized
18	personInCharge	Person in charge


```
#1 Load Excel data into a pandas DataFrame
import pandas as pd
data = pd.read_excel('newreal_cert.xlsx', sheet_name='administrativeData
measure = pd.read_excel('newreal_cert.xlsx', sheet_name='measurement')
result = pd.read_excel('newreal_cert.xlsx', sheet_name='result-template'
statements = pd.read_excel('newreal_cert.xlsx', sheet_name='statement')

#2 Convert result to dict
result_dict = {}

for i in range(len(result.columns.tolist())):
    if i%2==0: #i mod 2 = 0 that mean it is an even number
        unit = result.values.tolist()[0][i+1] #row ที่ 0 และ column ที่ i+1
        result_dict[result.columns.tolist()[i]] = [" ".join([str(a[i]) f
print(result_dict)

{'Wavelegth': ['632.9905805', '\\nano\\metre'], 'Stability': ['9.3e-10', '\

#3 Create XML file
import xml.etree.ElementTree as ET

# Define XML namespace
nsdcc = {'dcc': 'administrativeData'}
nssi = {'si': 'measurementResults'}

# Create the root element of the XML tree
root = ET.Element('{'+nsdcc['dcc']+'}digitalcalibrationCertificate')
row_element = ET.SubElement(root, '{'+nsdcc['dcc']+'}administrativeData'
row_element_measurement = ET.SubElement(root, '{'+nsdcc['dcc']+'}measure
statelist = ET.SubElement(row_element, '{'+nsdcc['dcc']+'}statementLists


# Loop through the dictionary and create XML elements
for row in statements.values:
    statement = ET.SubElement(statelist, '{'+nsdcc['dcc']+'}statements')
    col_element = ET.SubElement(statement, '{'+nsdcc['dcc']+'}'+ 'name')
    col_element.text = row[0]

    col_element = ET.SubElement(statement, '{'+nsdcc['dcc']+'}'+ 'declea
    col_element.text = row[1]
```


PYTHON STEPS

1. **Load data** - Loading data from Excel file use Pandas library
2. **Manipulate data** – Preparing data before create XML file
3. **Generate XML** – Creating an XML file use the xml.etree.ElementTree library
4. **Customize XML file** – Rearrange some part of XML file to design pattern
5. **Preview in HTML** – Converting an XML file into HTML

CUSTOMIZE XML FILE

Before

```
<si:results>
    <si:name>Nominal Length</si:name>
    <si:value>150 175 200</si:value>
    <si:unit>\milli\metre</si:unit>
  </si:results>
<si:results>
    <si:name>Identification number</si:name>
    <si:value>160851 160578 160950</si:value>
    <si:unit>\nan</si:unit>
  </si:results>
<si:results>
    <si:name>Deviation of Central length from nominal length, Dlc</si:name>
    <si:value>0.01 0.16 -0.1</si:value>
    <si:unit>\micro\metre</si:unit>
  </si:results>
<si:results>
    <si:name>Uncertainty</si:name>
    <si:value>0.15 0.17 0.19</si:value>
    <si:unit>\micro\metre</si:unit>
  </si:results>
```

Expectation result

```
<si:results>
    <si:name>Nominal Length</si:name>
    <si:unit>\milli\metre</si:unit>
    <si:value>150</si:value>
    <si:value>175</si:value>
    <si:value>200</si:value>
  </si:results>
<si:results>
    <si:name>Identification number</si:name>
    <si:unit>\nan</si:unit>
    <si:value>160851</si:value>
    <si:value>160578</si:value>
    <si:value>160950</si:value>
  </si:results>
<si:results>
    <si:name>Deviation of Central length from nominal length, Dlc</si:name>
    <si:unit>\micro\metre</si:unit>
    <si:value>0.01</si:value>
    <si:value>0.16</si:value>
    <si:value>-0.1</si:value>
  </si:results>
<si:results>
    <si:name>Uncertainty</si:name>
    <si:unit>\micro\metre</si:unit>
    <si:value>0.15</si:value>
    <si:value>0.17</si:value>
    <si:value>0.19</si:value>
  </si:results>
```


9

PREVIEW IN HTML

National Institute of Metrology (Thailand)
Ministry of Higher Education, Science, Research and Innovation

NIMT

Certificate of Calibration

CIPM MRA

Certificate No. : DE-0021-23
Issued by : Dimensional Metrology
: Primary length standard
: Length

Page 1 of 3 Pages

MEASUREMENT ITEM : 3 Gauge block made of Steel

MENUFACTURER : Mitutoyo

MODEL/TYPR : -

SERIAL NUMBER : See identification number

CUSTOMER : Department of Science Service
75/7,Rama VI Rd., Thung Phaya Thai,Ratchathewi,Bangkok 10400

MEASUREMENT DATE : April 20-28, 2023

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. This calibration certificate may not be produced other than in full except with the permission of the Director of National Institue of Metrology (Thailand)

Reference: Date: Approved by: Performed by:

This certificate is consistent with the capabilities that are included in Appendix C of the MRA drawn up by the CIPM. Under the MRA, all participating institutes recognize the validity of each other's calibration and measurement certificates for the quantities, ranges and measurement uncertainties specified in Appendix C (for details see http://www.bipm.org).

Technopolis Office,3/4-5 Moo 3, Klong 5, Klong Luang, Pathumthani 12120 Thailand, Telephone 66 2577 5100, Facsimile: 66 2577 3659

Page 2 of 3 Pages

Continuation of Certificate of Calibration Number DE-0021-23

ENVIRONMENTAL CONDITION

Ambient conditions in the laboratory are as follows : Temparature : (20.0 ± 0.3) °C, Relative Humidity : (50 ± 10) %

MEASUREMENT METHOD

Gauge block had been examined for flatness of the measuring faces and was found to comply with the ISO 3650. The gauge block was wrung with an optical flat by applying slight pressure. Neither interference fringe nor bright spot was observed.

Measurement of length

The length of gauge block under test was determined by comparison with a reference gauge block having the same length, using a Universal Length Measuring Machine (ULM). Both gauge blocks were placed in a horizontal position on the ULM. For the determining the deviations of central length from the nominal length is measured at the center point. The thermal expansion coefficient for steel (10.8±1)x10-6 K-1 was applied to the length of each gauge blocks.

UNCERTAINTIES OF MEASUREMENT

The measurement uncertainty stated is the expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2. It has been determined in accordance with the EA Publication EA-4/02 M "Evaluation of the Uncertainty of Measurement in Calibration", or JCGM 100 "Evaluation of Measurement Data Guide to The Expression of Uncertainty in Measurement". The value of the measurand lies within the assigned range of values with a probability of approximately 95%.

TRACEABILITY

This certificate provides traceability of measurement to recognized national standard, and to the realization of the Internation System of Units (SI).

Page 3 of 3 Pages

Continuation of Certificate of Calibration Number DE-0021-23

Measurement Results

Nominal Length (\milli\metre)	Identification number (\nan)	Deviation of Central length from nominal length, Dlc (\micro\metre)	Uncertainty (\micro\metre)
150	160851	0.01	0.15
175	160578	0.16	0.17
200	160950	-0.1	0.19

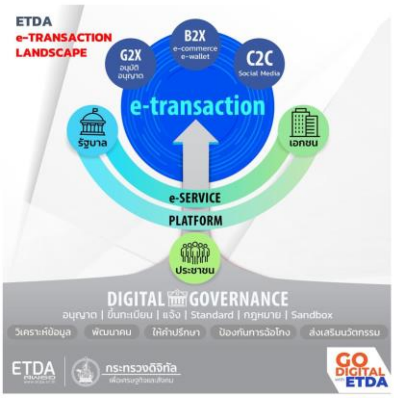
10

SUMMARY - PYTHON

- Advantages
  - Support complex schema
  - Approach the limitation issue on developer function in MS Excel
  - Python is an open source

- Disadvantages
  - Require coding knowledge

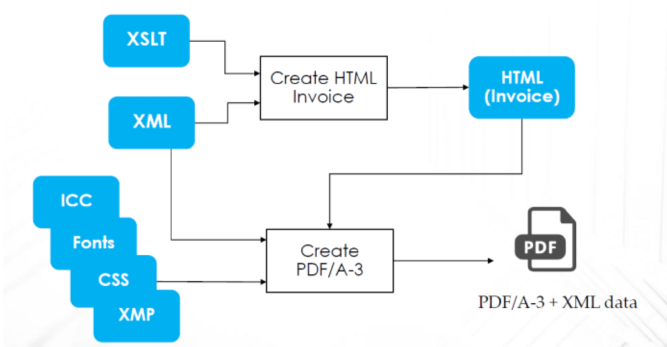
ELECTRONIC TRANSACTIONS DEVELOPMENT AGENCY (ETDA)



CASE STUDY: E-TAX INVOICE (PDF/A3)

- Benefits

1. Decrease costs of physical document storage.
2. Reduce the problem of incomplete VAT documentation.
3. Reduce the time and cost of document delivery.
4. Lower use of paper and printing ink, making it more environmentally friendly.
5. Increase data integrity, accuracy, and consistency in VAT documentation.
6. Enable analysis of information.



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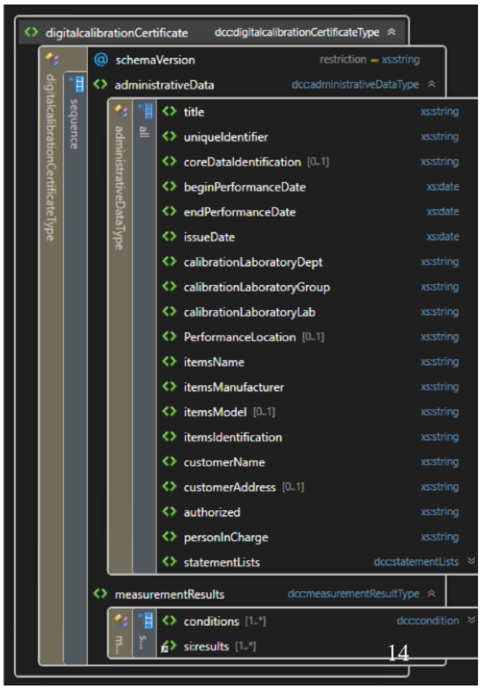
NIMT'S SCHEMA V.1.0 COMPONENTS

XML Schema element divided into 2 main parts

1. Administrative Data
   - Complying with requirements in ISO17025
2. Measurement Result
   - Conditions
     - Name
     - Declaration
   - Result
     - Name
     - Value
     - Unit



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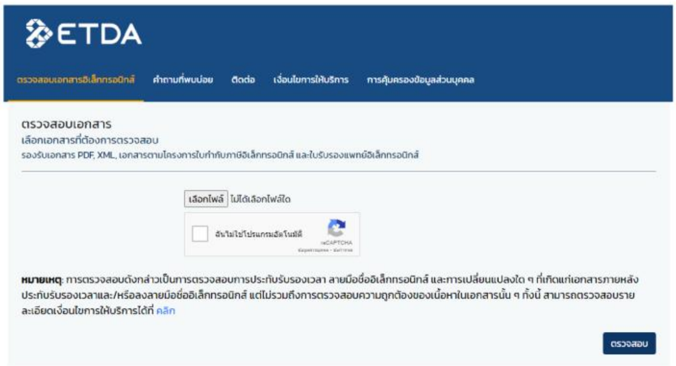
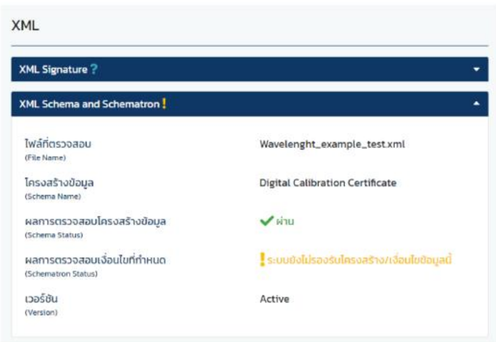
ETDA'S PLATFORM

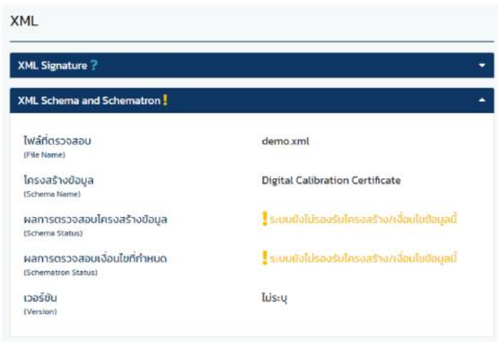


RESULT

Correct



Incorrect



CONCLUSION

- NIMT created the 'NIMT's schema version 1.0' and deployed on ETDA's platform to schema validation.
- ETDA's platform
  - Serving as both a database management system and a public service platform
  - NIMT's customer enable to validate the XML based DCC through the validation.teda.th website

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THANK YOU

NIMT

For further information please contact:
praiyat@nimt.or.th

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31 Developing the DCC Ontology: A Progress Report and Methodological Insights

Presenting author: Moritz Jordan, PTB Germany
E-mail address: moritz.jordan@ptb.de
Additional authors:

Abstract:

This presentation provides a comprehensive overview of the ongoing development of the Digital Calibration Certificate (DCC) ontology, a framework aimed at enhancing the structured representation and interoperability of digital calibration information. Attendees will gain insights into the current state of the ontology, its key components, and the methodology applied in its creation.

The DCC ontology is designed to provide a standardized and interoperable representation of digital calibration certificates, facilitating seamless integration into various domains. The presentation will outline the ontological constructs and relationships that underpin the DCC ontology, emphasizing its adaptability and utility in diverse contexts.

The methodology employed in crafting the DCC ontology will be explained, highlighting a systematic approach that combines domain expertise with semantic technologies. This method ensures a robust representation of digital calibration certificates, allowing for clear and unambiguous communication of calibration-related metadata.

In addition to discussing the DCC ontology's development, the presentation will draw parallels with related works such as the Digital SI (System of International Units) ontology. This work provides valuable context, contributing to the refinement of the DCC ontology and fostering interoperability within the broader digital calibration landscape.

Looking to the future, the presentation will explore the potential for utilizing the DCC ontology in the development of a knowledge graph specifically focused on force and torque calibrations. This initiative aims to leverage the ontology's standardized representation to create a cohesive and interconnected knowledge graph, enhancing our understanding and application offeree and torque calibration practices.

Attendees can anticipate a detailed exploration of the DCC ontology's methodology, challenges faced during development, and potential applications in real-world scenarios. The presentation aims to engage the audience in discussions about the evolving landscape of digital calibration certificates and encourages collaboration for further advancements in this critical domain.

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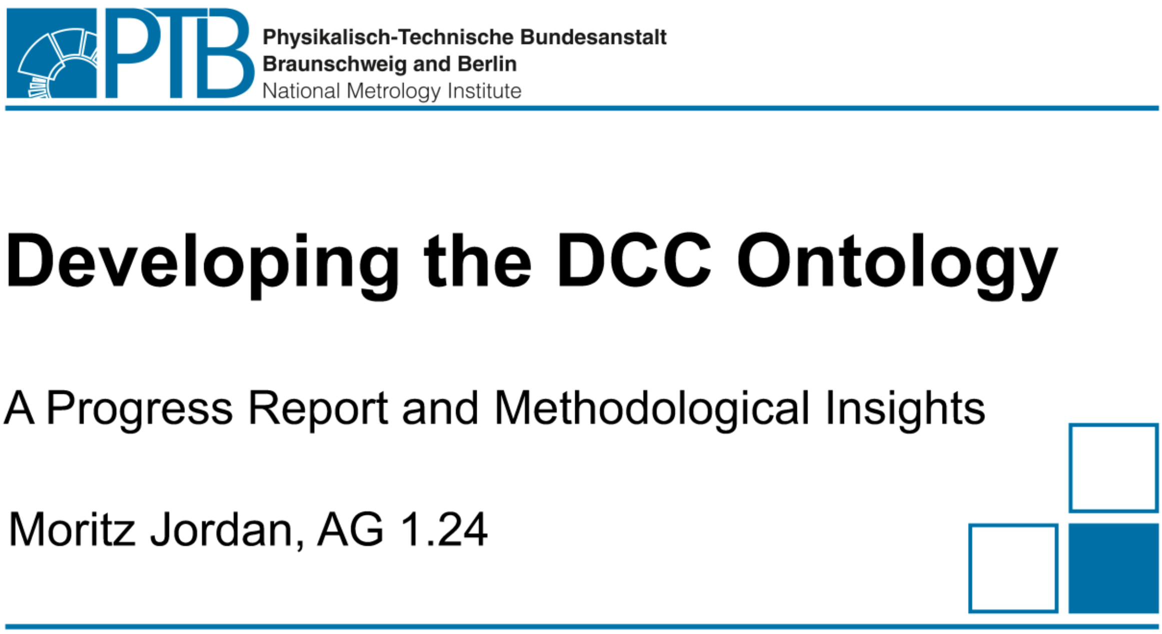
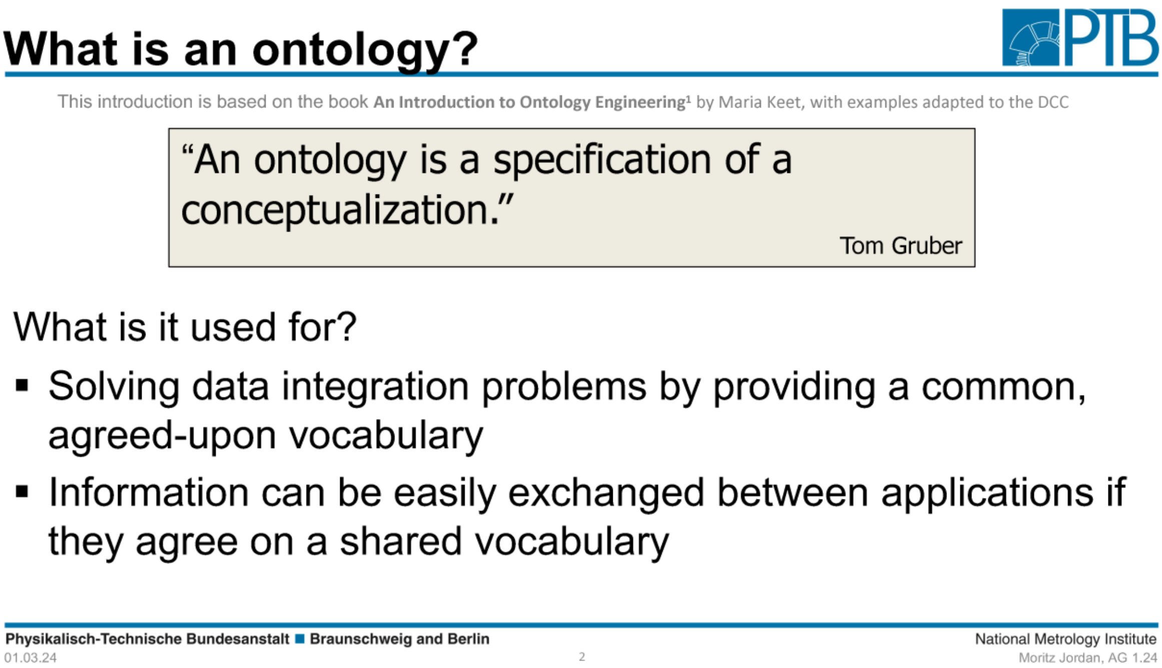
Presentation of Moritz Jordan





What is an ontology?

This introduction is based on the book **An Introduction to Ontology Engineering**[1] by Maria Keet, with examples adapted to the DCC

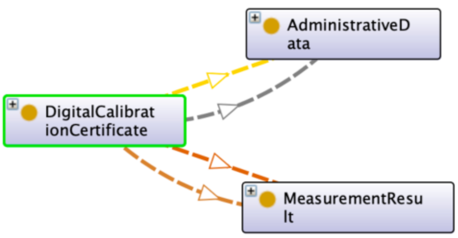
> "A textfile containing structured knowledge about a particular subject domain."
> Maria Keet

What is it used for?

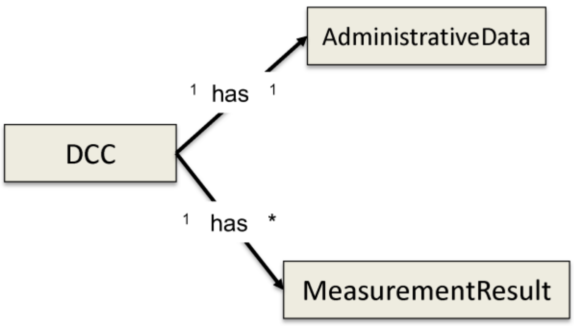
- Solving data integration problems by providing a common, agreed-upon vocabulary
- Information can be easily exchanged between applications if they agree on a shared vocabulary

What does an ontology look like?

This introduction is based on the book **An Introduction to Ontology Engineering**[1] by Maria Keet, with examples adapted to the DCC



Protégé screenshot



UML diagram

```
Each DCC has 1 AdministrativeData section
and at least 1 MeasurementResult
```

Ontology real-world scenario

This introduction is based on the book **An Introduction to Ontology Engineering**[1] by Maria Keet, with examples adapted to the DCC

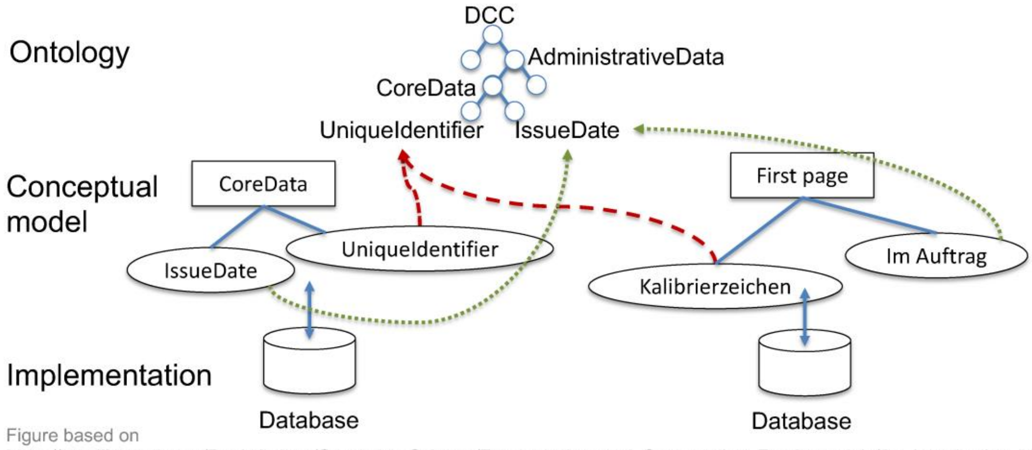


Figure based on https://eng.libretexts.org/Bookshelves/Computer_Science/Programming_and_Computation_Fundamentals/An_Introduction_to_Ontology_Engineering_(Keet)/02%3A_Introduction_to_Ontology_Engineering/2.04%3A_What_is_the_Usefulness_of_an_Ontology

Ontology Introduction

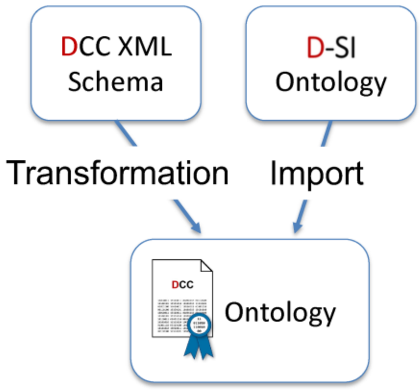
- OWL formal language for defining ontologies
- Built upon Resource Description Framework (RDF)
- Everything is expressed in triples:

$$\underbrace{\texttt{CoreData}}_{\text{Subject}}\ \underbrace{\texttt{hasPerformanceLocation}}_{\text{Predicate}}\ \underbrace{\texttt{PerformanceLocation}}_{\text{Object}}$$

```
http://www.semanticweb.org/jordan07/ontologies/2023/8/dcc#CoreData
http://www.semanticweb.org/jordan07/ontologies/2023/8/dcc#hasPerformanceLocation
http://www.semanticweb.org/jordan07/ontologies/2023/8/dcc#PerformanceLocation
```

How to create the DCC Ontology?

- Reuse of domain ontologies: DSI, VIM, QUDT, MetaData4Ing
- Use of top-level ontologies: BFO
- Classes, entities, relationships and datatypes in the DCC ontology derived from the DCC XML schema



Methodology

Mapping: DCC XML Schema → OWL

XML element	Ontology entity
Complex type	Class
Simple type	Datatype
XSD:native data type	XSD:native data type
Complex type contains other complex type	Object property
Complex type contains simple type	Data property

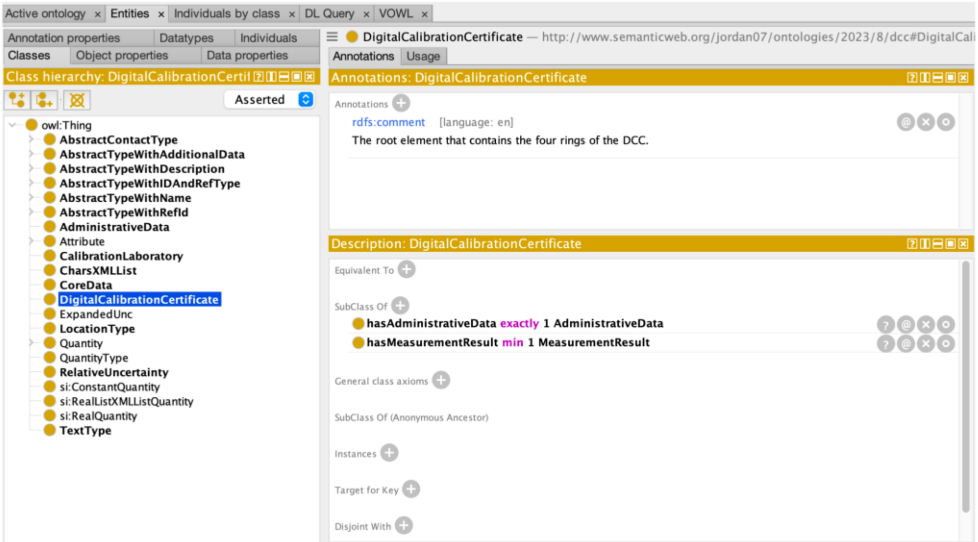
Example: administrativeData (XML Schema)

```
<xs:complexType name="administrativeDataType">
    <xs:all>
        <xs:element name="dccSoftware" type="dcc:softwareListType"/>
        <xs:element name="refTypeDefinitions"
type="dcc:refTypeDefinitionListType" minOccurs="0"/>
        <xs:element name="coreData" type="dcc:coreDataType"/>
        …
    </xs:all>
</xs:complexType>
```

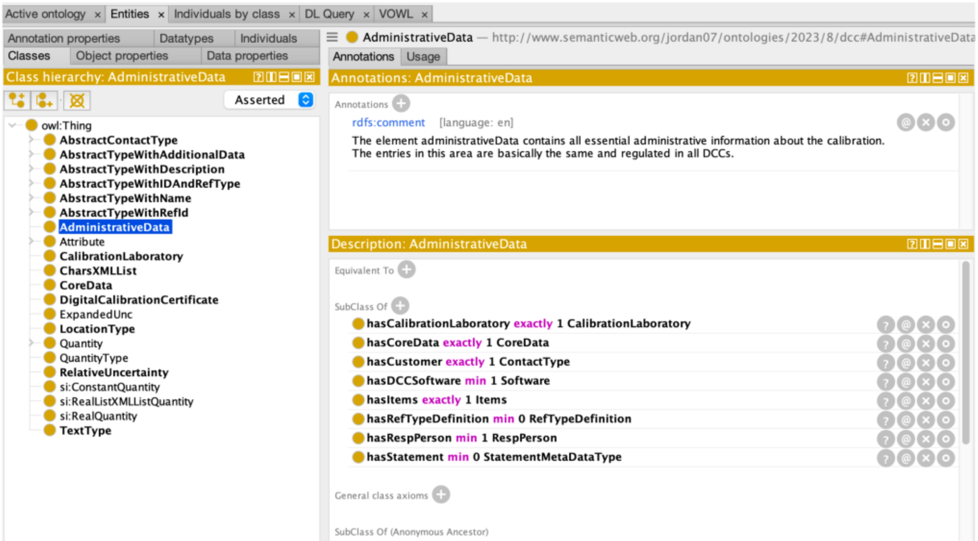

Example: administrativeData (Ontology)

- hasCalibrationLaboratory **exactly** 1 CalibrationLaboratory
- hasCoreData **exactly** 1 CoreData
- hasCustomer **exactly** 1 ContactType
- hasDCCSoftware **min** 1 Software
- hasItems **exactly** 1 Items
- hasRefTypeDefinition **min** 0 RefTypeDefinition
- hasRespPerson **min** 1 RespPerson
- hasStatement **min** 0 StatementMetaDataType

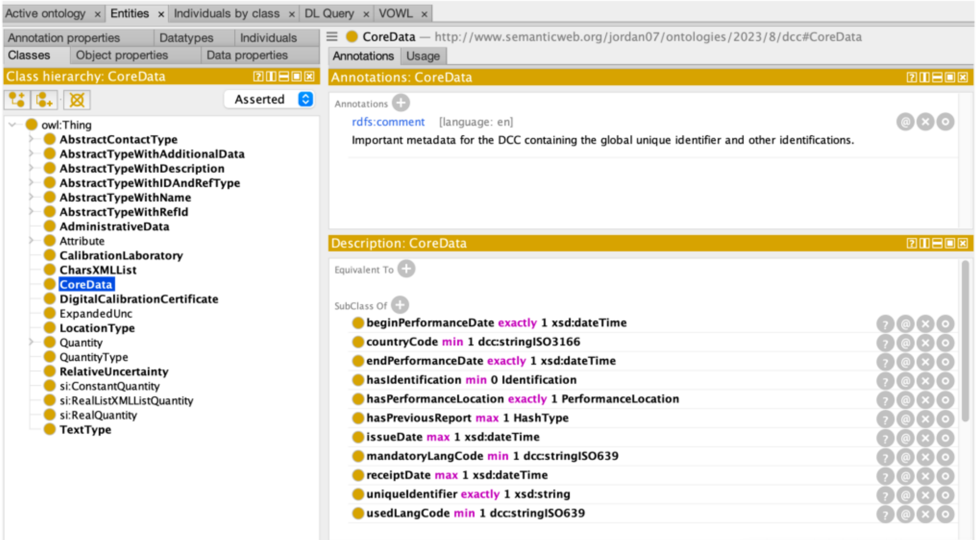
Let's have a glimpse at the DCC Ontology!



Let's have a glimpse at the DCC Ontology!



Let's have a glimpse at the DCC Ontology!



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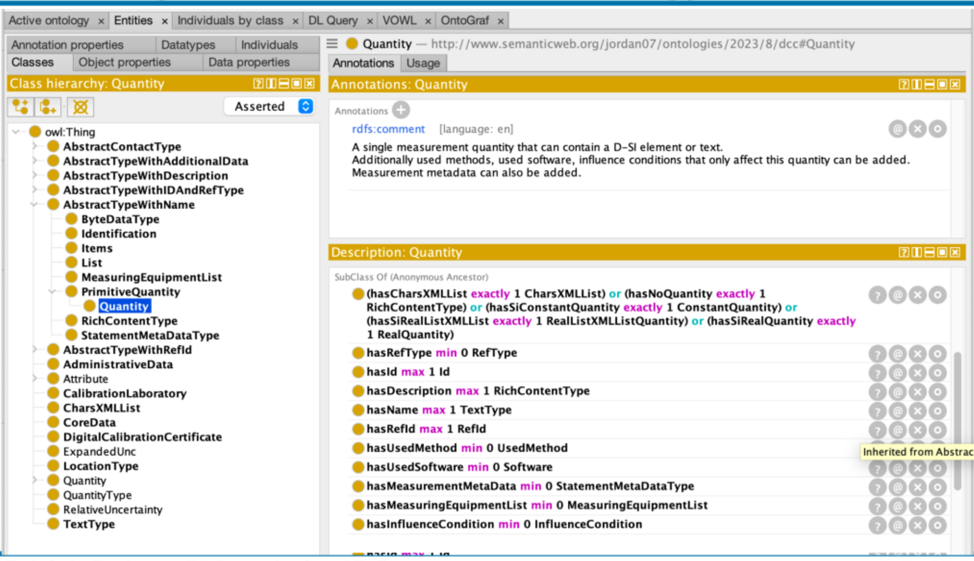
National Metrology Institute
Moritz Jordan, AG 1.24

Let's have a glimpse at the DCC Ontology!



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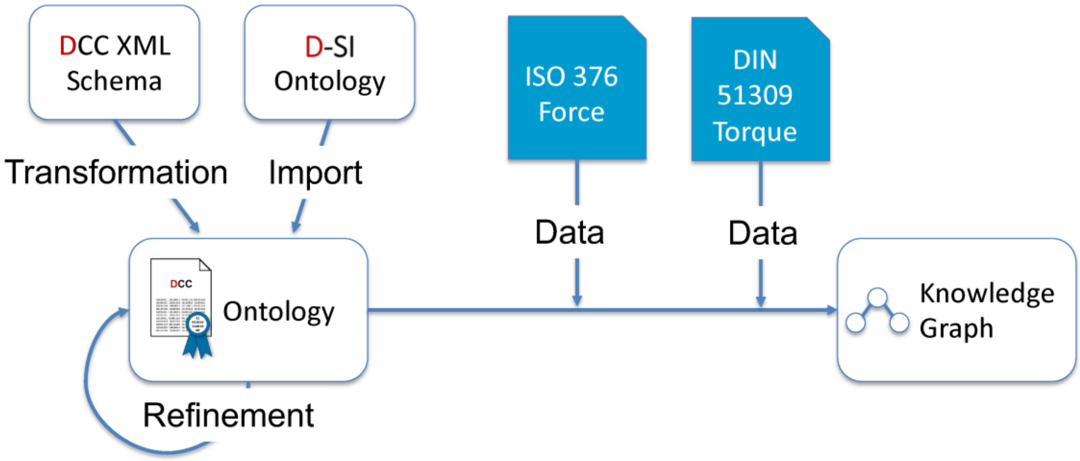
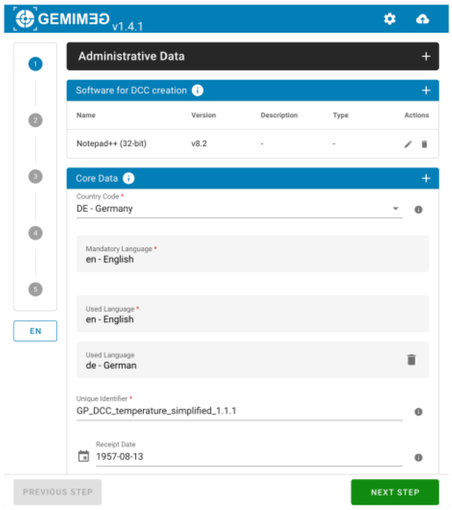
National Metrology Institute
Moritz Jordan, AG 1.24

Next steps



Applications for the Knowledge Graph

- Proof-of-concept: Use it in a graphical user interface such as the GEMIMEG Tool to provide enhanced user guidance
- Automatically create the structure of a DCC according to a certain standard



Thank you for your attention!

Do you have any questions or comments?

Moritz Jordan,
AG 1.24

About

Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
Bundesallee 100
38116 Braunschweig
Moritz Jordan
Telefon: 0531 592-1245
E-Mail: moritz.jordan@ptb.de
www.ptb.de

Stand: 02/24

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32 The Digital NIST: Update on the Digital Transformation of Reference Materials

Presenting author: Dinis Camara, NIST, USA
E-mail address: dinis.camara@nist.gov
Additional authors: Itzel Domínguez Mendoza, CENAM, Mexico

Abstract:

At the beginning of 2022, NIST embarked on a pilot project to produce a few examples digital calibration reports and certificates of analysis for the purpose of assessing the scope and challenges of digital transformation in these measurement services. After completion of the pilot project, it was determined that a Digital Reference Material Certificate (DRMC) will require a new model for the data and schema. NIST identified the modelling of Reference Material Data and creation of a database to store the values contained in current certificates as a first step towards digital transformation of Reference Materials. To dive deeper into modelling the types of values, NIST and CENAM collaborated throughout the year. Utilizing the vast scope of over 1,100 NIST Standard Reference Materials (SRM) available, a sample of more than 130 different SRM were reviewed to determine the relationship between the data. The analysis led to a structure able to accommodate the wide variety of values, multipart materials, serialized materials, traceability statements, and other information related to measured values currently expressed in Reference Material Certificates.

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Presentation of Dinis Camara

What Goes in a DRMC

NIST

Current Draft of Schema
- Organization Identification
- Reference Material Identification
- Material Information
  - Unit Description
  - Usage Information
  - Measurement Information
  - Additional Information
- Context
- Provenance
- References

Based On:

ISO 17034

ISO Guide 31/ISO 33401:2024

NIST Quality Manual

NIST Policy

Customer Input

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NIST SRM Overview

NIST

>1100 SRM Products

- Ferrous Metals
- Nonferrous Metals
- Microanalysis
- High Purity Materials
- Health and Industrial Hygiene
- Inorganics
- Primary Gas Mixtures
- Fossil and Alternative Fuels
- Organics
- Food and Agriculture
- Geological Materials and Ores
- Ceramics and Glasses
- Cement
- Engine Wear Materials
- Forensics
- Ion Activity
- Polymeric Properties
- Thermodynamic Properties
- Optical Properties
- Radioactivity
- Electrical Properties
- Metrology, Liquids and Glasses
- X-Ray Diffraction
- Sizing
- Surface Finish
- Fire Research
- Nanomaterials
- Miscellaneous Performance Engineering Materials

4

Types of Values

- **Values with uncertainties**
- **Sequences**
- **Formulas**

Table 1. Certified Mass Fraction Value for SRM 2454a Hydrogen in Titanium Alloy

Constituent	Mass Fraction (mg/kg)	95 % Coverage Interval (mg/kg)
Hydrogen (H)	216.0	207.6 to 224.4

RM 8671 Heavy Chain Amino Acid Sequence

QVTLRESGPALVKPTQTLTLTCTFSGFSLSTAGMSVGWIRQPPGKALEWLADIWWDDKKHYNPSLKDRLTIS
KDTSKNQVVLKVTNMDPADTATYYCARDMIFNFYFDVWGQGTTVTVSS ASTKGPSVFPLAPSSKSTSGGTA
ALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVD
KRV *EPKSCDKTHTCPPCP* **APELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGV**
EVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPS
REEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCS
VMHEALHNHYTQKSLSLSPGK

RM 8671 Light Chain Amino Acid Sequence

DIQMTQSPSTLSASVGDRVTITCSASSRVGYMHWYQQKPGKAPKLLIYDTSKLASGVPSRFSGSGSGTEFTLT
ISSLQPDDFATYYCFQGSGYPFTFGGGTKVEIK RTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKV
QWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC

Figure A1. Primary amino acid sequence for RM 8671 with variable fragment antigen-binding (Fab) region in normal font, constant Fab region underlined, hinge region in italics, and Fc region in bold.

$$\lambda = -1.97313\times10^{-3} + 1.99227\times10^{-5}\rho + 1.07923\times10^{-4}T \pm 1.0\ \%\ (k = 2)$$

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Data vs. Format

Table 1. Certified Mass Fraction Value for Total Extractable Fat in SRM 2387

	Mass Fraction (g/100 g)
Fat (extractable)	51.6 ± 1.4

Table 2. Certified Mass Fraction Values for Elements in SRM 2387

	Mass Fraction (mg/kg)
Calcium (Ca)	411 ± 18
Copper (Cu)	4.93 ± 0.15
Iron (Fe)	16.4 ± 0.8
Magnesium (Mg)	1680 ± 70
Manganese (Mn)	16.0 ± 0.6
Phosphorus (P)	3378 ± 92
Potassium (K)	6070 ± 200
Sodium (Na)	4890 ± 140
Zinc (Zn)	26.3 ± 1.1

Table 3. Certified Mass Fraction Values for Tocopherols in SRM 2387

	Mass Fraction (mg/kg)
δ-Tocopherol	10 ± 3
γ- + β-Tocopherol	100 ± 19

RM 8671 Heavy Chain Amino Acid Sequence

QVTLRESGPALVKPTQTLTLTCTFSGFSLSTAGMSVGWIRQPPGKALEWLADIWWDDKKHYNPSLKDRLTIS
KDTSKNQVVLKVTNMDPADTATYYCARDMIFNFYFDVWGQGTTVTVSS ASTKGPSVFPLAPSSKSTSGGTA
ALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVD
KRV *EPKSCDKTHTCPPCP* **APELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGV**
EVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPS
REEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCS
VMHEALHNHYTQKSLSLSPGK

RM 8671 Light Chain Amino Acid Sequence

DIQMTQSPSTLSASVGDRVTITCSASSRVGYMHWYQQKPGKAPKLLIYDTSKLASGVPSRFSGSGSGTEFTLT
ISSLQPDDFATYYCFQGSGYPFTFGGGTKVEIK RTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKV
QWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC

Figure A1. Primary amino acid sequence for RM 8671 with variable fragment antigen-binding (Fab) region in normal font, constant Fab region underlined, hinge region in italics, and Fc region in bold.

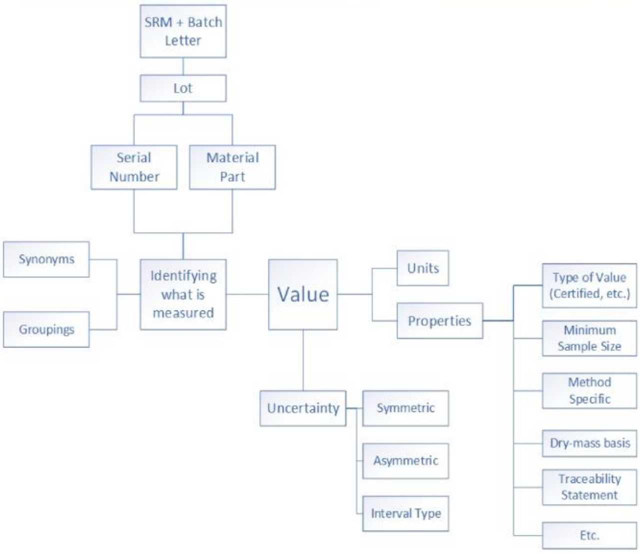
Table 2. Reference Values for SRM 1d Limestone, Argillaceous

Constituent	Mass Fraction (%)	Expanded Uncertainty (%)
C	11.50	0.25[b]
TiO_2	0.0306	0.0065[b]
Cr_2O_3	0.0012	0.0002[b]
BaO	0.0033	0.0011[b]
Loss on Ignition (1000 °C)	41.57	0.06[a]

Preparation of Material: All chemicals used in the preparation of this SRM were of the highest purity available and were obtained from a commercial source. The amino acid solution was prepared by weighing the individual amino acids, concentrated HCl, and water and mixing until the amino acids were completely dissolved. The total mass of this solution was measured. The concentration of each amino acid was calculated using the measured density of the 0.1 mol/L HCl solution at 20 °C of 1.00123 g/mL. Corrections were made to the calculated amino acid concentrations based on purity as determined by LC with absorbance detection with confirmatory data provided by the manufacturer. The purity of each amino acid was also evaluated by elemental analysis at Galbraith Laboratories (Knoxville, TN). Moisture content for all

Values and Their Data

NIST



Values and Uncertainties

NIST

SRM: 2387

Srm Number	Batch	Name
2387		Peanut Butter

Identifications | Lot | Certificate | Groups | Mixtures | Files

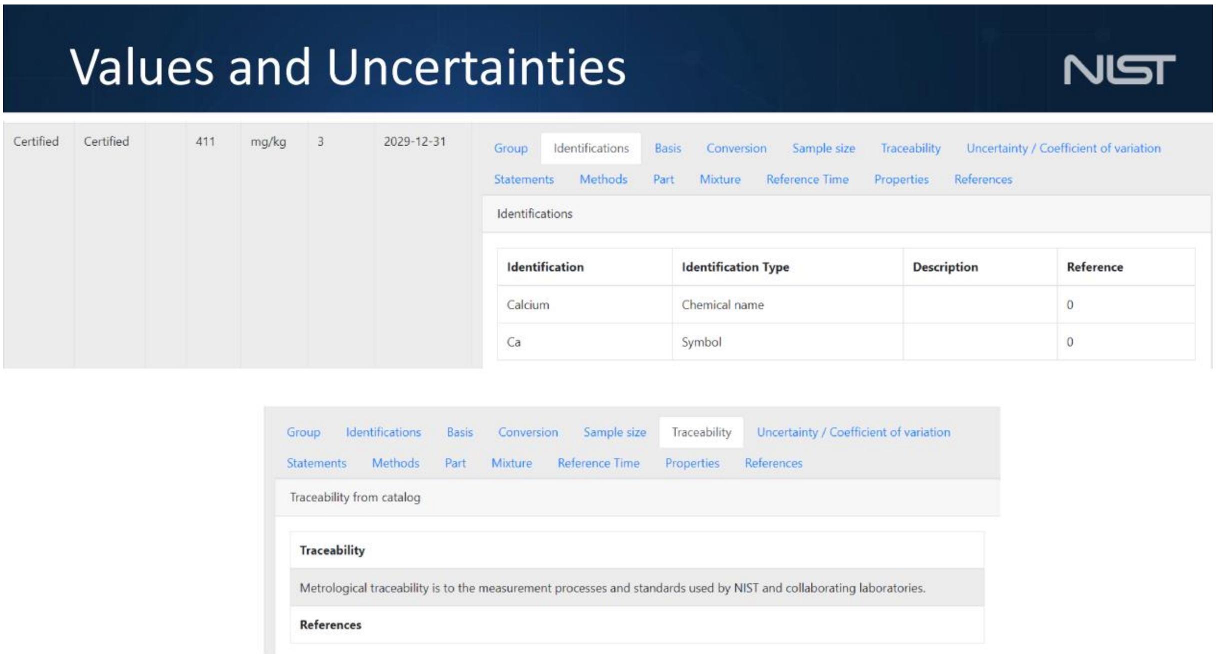
Lot

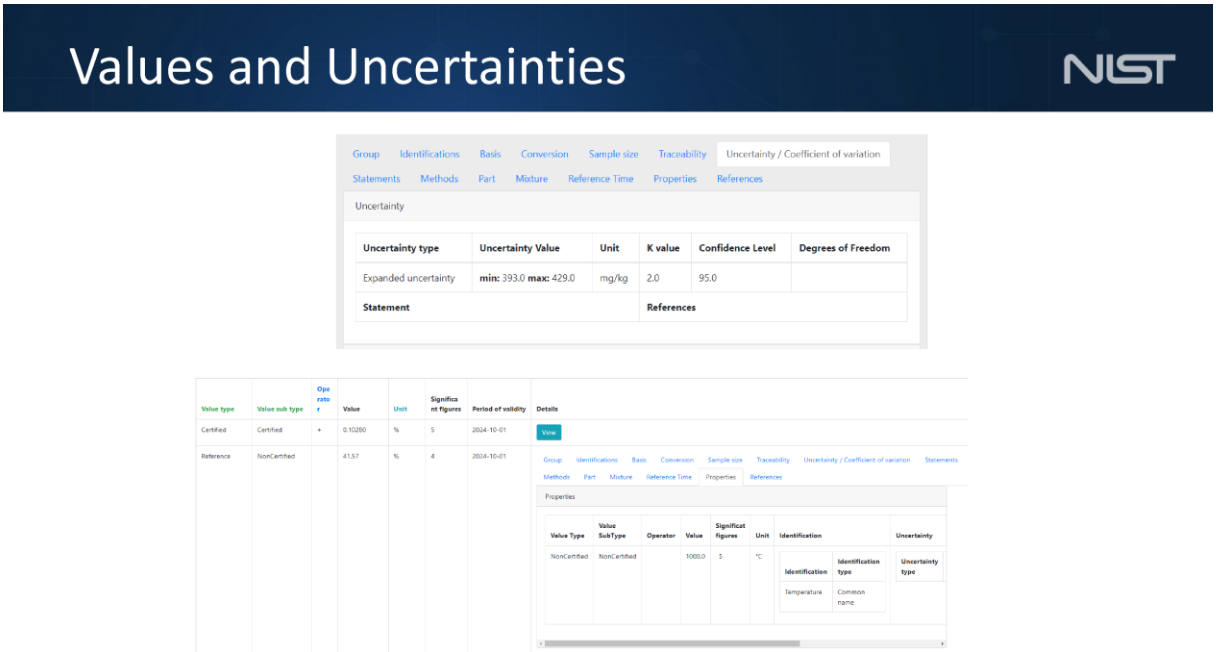
Lot	Parts							
	Quantity In Unit	Part Id	Title	Title short	Title certificate	Amount	Unit	Source
LOT 1	3	A	peanut butter		peanut butter	170.0	g	SRM

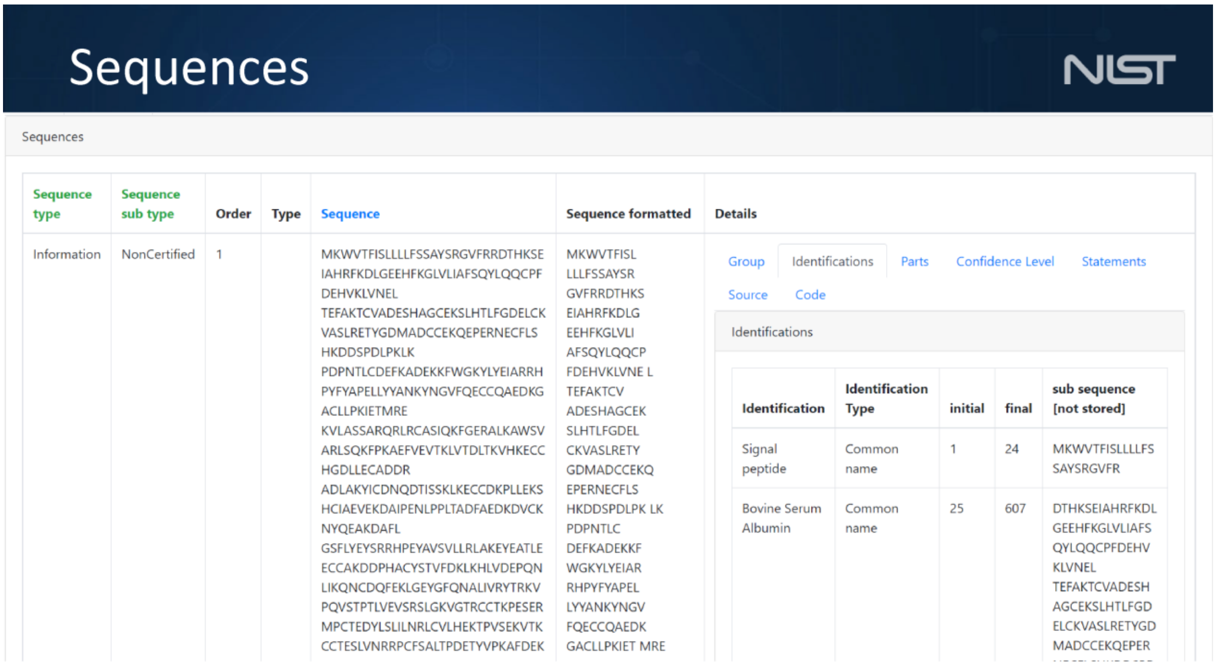
Value | Sequences | Formula

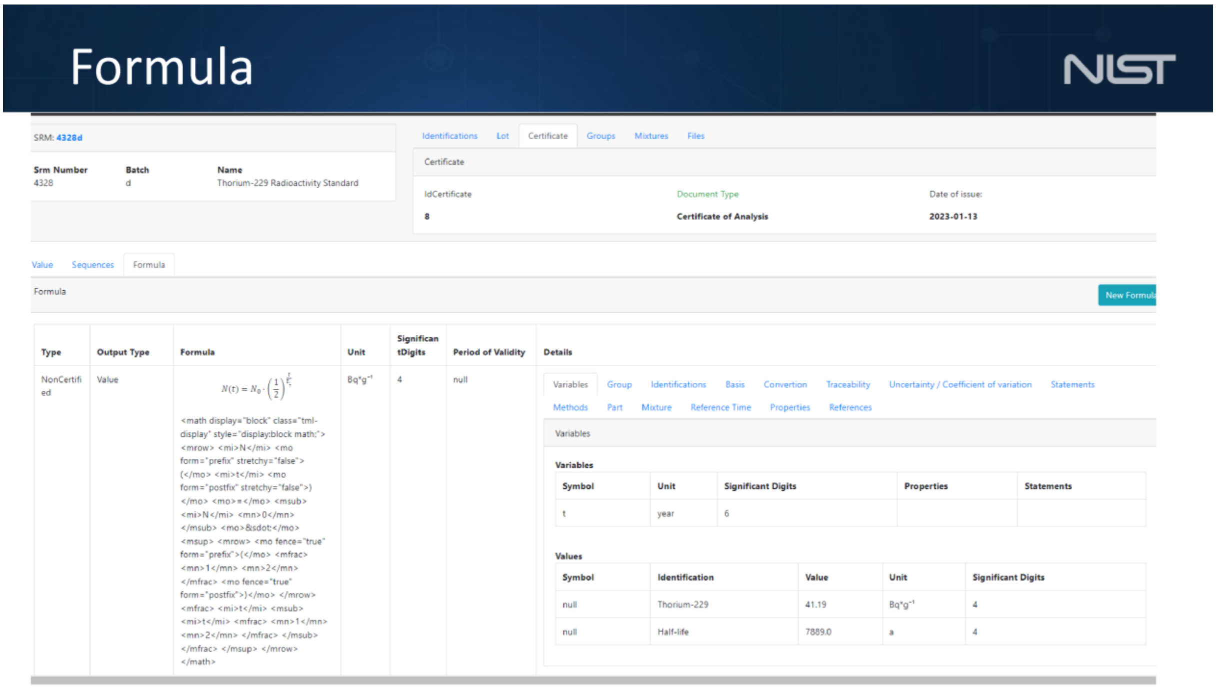
Values

Value type	Value sub type	Operator	Value	Unit	Significant figures	Period of validity	Details
Certified	Certified		411	mg/kg	3	2029-12-31	View
Certified	Certified		51.6	g/100 g	3	2029-12-31	View
Certified	Certified		4.93	mg/kg	3	2029-12-31	View


Values and Uncertainties
NIST
Certified
Certified
411
mg/kg
3
2029-12-31
Group
Identifications
Basis
Conversion
Sample size
Traceability
Uncertainty / Coefficient of variation
Statements
Methods
Part
Mixture
Reference Time
Properties
References
Identifications
Identification
Identification Type
Description
Reference
Calcium
Chemical name
0
Ca
Symbol
0
Traceability from catalog
Traceability
Metrological traceability is to the measurement processes and standards used by NIST and collaborating laboratories.
References

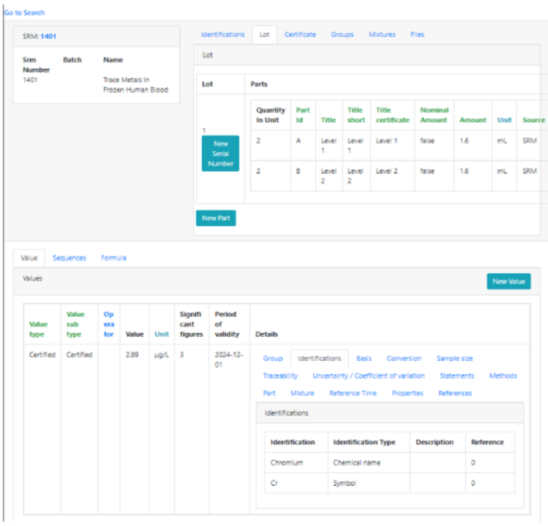

Values and Uncertainties
NIST
Uncertainty
Uncertainty type
Uncertainty Value
Unit
K value
Confidence Level
Degrees of Freedom
Expanded uncertainty
min: 393.0 max: 429.0
mg/kg
2.0
95.0
Statement
References
Value type
Value sub type
Operator
Value
Unit
Significant figures
Period of validity
Details
Certified
Certified
+
0.10280
%
5
2024-10-01
View
Reference
NonCertified
41.57
%
4
2024-10-01
Properties
Value Type
Value SubType
Operator
Value
Significat figures
Unit
Identification
Uncertainty
NonCertified
NonCertified
1000.0
5
°C
Identification
Identification type
Temperature
Common name
Uncertainty type


Sequences
NIST
Sequences
Sequence type
Sequence sub type
Order
Type
Sequence
Sequence formatted
Details
Information
NonCertified
1
MKWVTFISLLLLFSSAYSRGVFRRDTHKSE
IAHRFKDLGEEHFKGLVLIAFSQYLQQCPF
DEHVKLVNEL
TEFAKTCVADESHAGCEKSLHTLFGDELCK
VASLRETYGDMADCCEKQEPERNECFLS
HKDDSPDLPKLK
PDPNTLCDEFKADEKKFWGKYLYEIARRH
PYFYAPELLYYANKYNGVFQECCQAEDKG
ACLLPKIETMRE
KVLASSARQRLRCASIQKFGERALKAWSV
ARLSQKFPKAEFVEVTKLVTDLTKVHKECC
HGDLLECADDR
ADLAKYICDNQDTISSKLKECCDKPLLEKS
HCIAEVEKDAIPENLPPLTADFAEDKDVCK
NYQEAKDAFL
GSFLYEYSRRHPEYAVSVLLRLAKEYEATLE
ECCAKDDPHACYSTVFDKLKHLVDEPQN
LIKQNCDQFEKLGEYGFQNALIVRYTRKV
PQVSTPTLVEVSRSLGKVGTRCCTKPESER
MPCTEDYLSLILNRLCVLHEKTPVSEKVTK
CCTESLVNRRPCFSALTPDETYVPKAFDEK
MKWVTFISL
LLLFSSAYSR
GVFRRDTHKS
EIAHRFKDLG
EEHFKGLVLI
AFSQYLQQCP
FDEHVKLVNE L
TEFAKTCV
ADESHAGCEK
SLHTLFGDEL
CKVASLRETY
GDMADCCEKQ
EPERNECFLS
HKDDSPDLPK LK
PDPNTLC
DEFKADEKKF
WGKYLYEIAR
RHPYFYAPEL
LYYANKYNGV
FQECCQAEDK
GACLLPKIET MRE
Group
Identifications
Parts
Confidence Level
Statements
Source
Code
Identifications
Identification
Identification Type
initial
final
sub sequence [not stored]
Signal peptide
Common name
1
24
MKWVTFISLLLLFS SAYSRGVFR
Bovine Serum Albumin
Common name
25
607
DTHKSEIAHRFKDL GEEHFKGLVLIAFS QYLQQCPFDEHV KLVNEL TEFAKTCVADESH AGCEKSLHTLFGD ELCKVASLRETYGD MADCCEKQEPER


Formula
NIST
SRM: 4328d
Srm Number
4328
Batch
d
Name
Thorium-229 Radioactivity Standard
Identifications
Lot
Certificate
Groups
Mixtures
Files
Certificate
IdCertificate
8
Document Type
Certificate of Analysis
Date of issue:
2023-01-13
Value
Sequences
Formula
Formula
New Formula
Type
Output Type
Formula
Unit
SignificantDigits
Period of Validity
Details
NonCertified
Value
$N(t) = N_0 \cdot \left(\frac{1}{2}\right)^{\frac{t}{t_{\frac{1}{2}}}}$
<math display="block" class="tml-display" style="display:block math;"> <mrow> <mi>N</mi> <mo form="prefix" stretchy="false">(</mo> <mi>t</mi> <mo form="postfix" stretchy="false">)</mo> <mo>=</mo> <msub> <mi>N</mi> <mn>0</mn> </msub> <mo>⋅</mo> <msup> <mrow> <mo fence="true" form="prefix">(</mo> <mfrac> <mn>1</mn> <mn>2</mn> </mfrac> <mo fence="true" form="postfix">)</mo> </mrow> <mfrac> <mi>t</mi> <msub> <mi>t</mi> <mfrac> <mn>1</mn> <mn>2</mn> </mfrac> </msub> </mfrac> </msup> </mrow> </math>
Bq*g-1
4
null
Variables
Group
Identifications
Basis
Convertion
Traceability
Uncertainty / Coefficient of variation
Statements
Methods
Part
Mixture
Reference Time
Properties
References
Variables
Variables
Symbol
Unit
Significant Digits
Properties
Statements
t
year
6
Values
Symbol
Identification
Value
Unit
Significant Digits
null
Thorium-229
41.19
Bq*g-1
4
null
Half-life
7889.0
a
4

Database Creation

- **Accommodates Values (Numbers), Sequences, and Formulas**
- **Accommodates NIST reported values and most of the additional values in certificates**
- **Created to integrate with current SRM IT applications and DBs**
- **Additional functionality added that will enhance other SRM applications**
- **Version 1**



Screenshot of prototype web interface for DB

Future Work

- **Complete the Documentation of the Model**
- **Creation of usable XML Schema from modeling**
- **Expansion of other Measurement Information like Usage Information**
- **Best way to sign and secure certificates**
  - Centralized Signatory
  - Blockchain
- **Continued International Discussions**

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33 Development of digital calibration certificates for coordinate metrology applications

Presenting author: Katharina Janzen, PTB Germany
E-mail address: katharina.janzen@ptb.de
Additional authors: Daniel Heißelmann; daniel.heisselmann@ptb.de

Abstract:

Traceability in calibration hierarchies within the dimensional metrology is partly established via measurement standards such as spheres, ring gauges as well as ball and hole plates. A standardized representation of results for characteristics of these standards in the DCC schema is essential for the fully digital exchange of information enabling a traceable and robust machine-to-machine interaction.

In the BMWK-funded lighthouse project GEMiMEG-II, we have developed digital calibration certificates for a selection of frequently used measurement standards in coordinate metrology following the evolution of the DCC capabilities. Therefore, we have analyzed the special requirements and needs for reporting measurement results in dimensional metrology. Based on this analysis, we have proposed solutions for a machine-interpretable representation of the results within the current DCC structure. The DCC solutions for the investigated standards correspond to the current DCC schema and are under test for use in fully digitalized processes.

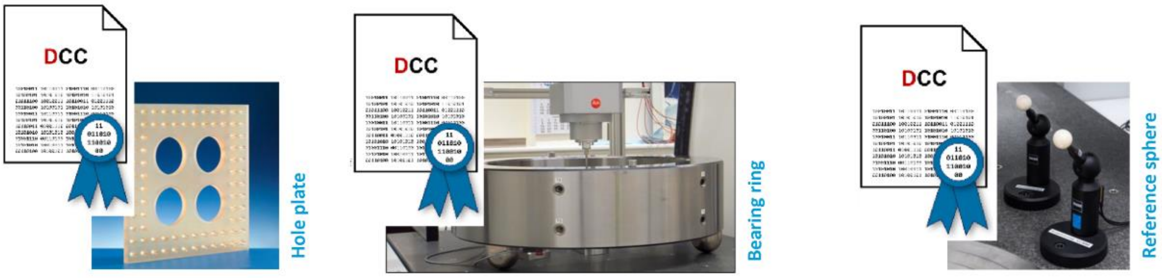
We will present a selection of common result structures from coordinate metrology and the corresponding solutions representing these results within a DCC. This comprises both, simple and rather sophisticated demands arising from the variety of tasks in dimensional measurements. Furthermore, we take equal account of the needs of the issuer and the user of the DCC with regard to the representation and interpretation of the measurement results.

Back to "Table of Contents" above

Presentation of Katharina Janzen

Measurement standards

In coordinate metrology, measurement standards…



… ensure traceability to the SI unit meter
… and parametrization of D-MTs

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Example: reference sphere

```xml
<dcc:administrativeData>
    <dcc:refTypeDefinitions>...</dcc:refTypeDefinitions>
    <dcc:dccSoftware>...</dcc:dccSoftware>
    <dcc:coreData>...</dcc:coreData>
    <dcc:items>
        <dcc:item refType ="length_sphere" id ="I123">
            <dcc:name>
                <dcc:content lang="en">Reference sphere</dcc:content>
            </dcc:name>
            <dcc:description>...</dcc:description>
            <dcc:manufacturer>...</dcc:manufacturer>
            <dcc:identifications>...</dcc:identifications>
            <dcc:itemQuantities>...</dcc:itemQuantities>
        </dcc:item>
    </dcc:items>
    <dcc:calibrationLaboratory>...</dcc:calibrationLaboratory>
    <dcc:respPersons>...</dcc:respPersons>
    <dcc:customer>...</dcc:customer>
</dcc:administrativeData>
<dcc:measurementResults>
    <dcc:measurementResult refType="length_linearDimensions">
        <dcc:name>...</dcc:name>
        <dcc:description>...</dcc:description>
        <dcc:usedMethods>...</dcc:usedMethods>
        <dcc:measuringEquipments>...</dcc:measuringEquipments>
        <dcc:influenceConditions>...</dcc:influenceConditions>
        <dcc:results>
            <dcc:result refId="I123">
                <dcc:name>...</dcc:name>
                <dcc:data>
                    <dcc:list refType="length_diameter">...</dcc:list>
                    <dcc:list refType="length_roundnes">...</dcc:list>
                </dcc:data>
            </dcc:result>
        </dcc:results>
        <dcc:measurementMetaData>...</dcc:measurementMetaData>
    </dcc:measurementResult>
```

Kalibrierschein
Calibration certificate

Gegenstand *Object*	Kugelnormal (Keramik) *Calibration sphere (ceramics)*
Hersteller *Manufacturer*	-
Typ *Type*	∅ 30

1. **Kalibrieraufgabe / *Calibration task***

An dem Kugelnormal wurde der Durchmesser und die Rundheitsabweichung (RON
The calibration sphere was calibrated for its diameter and roundness deviation (RONt).

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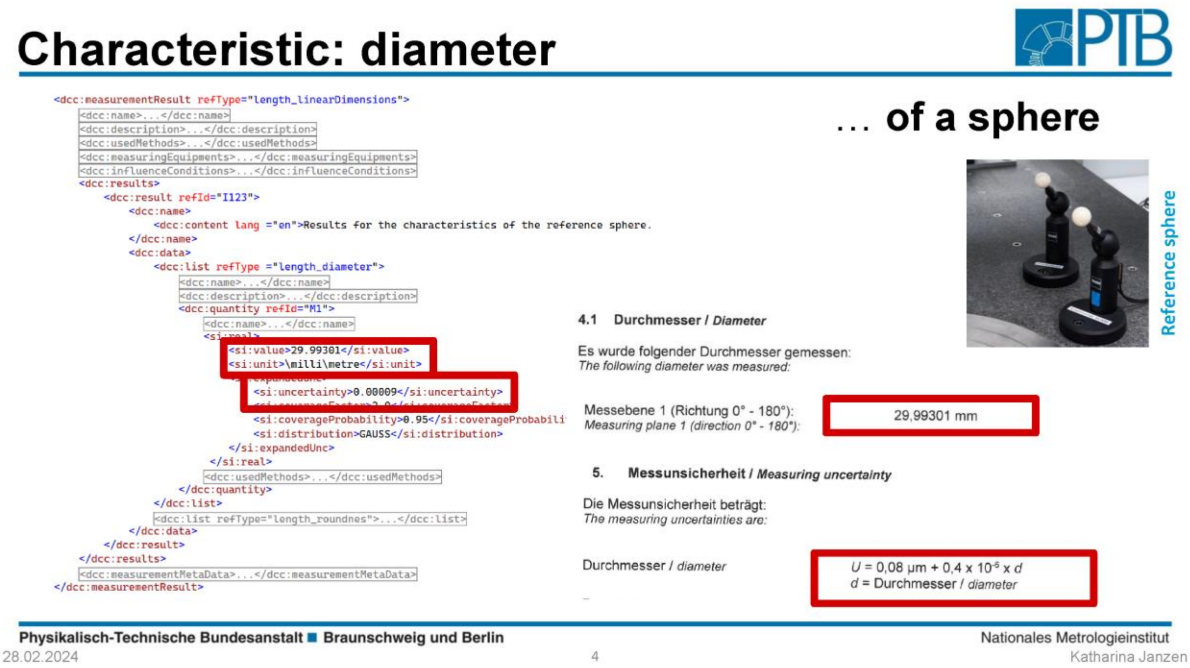
Characteristic: diameter
PTB
… of a sphere
Reference sphere
<dcc:measurementResult refType="length_linearDimensions">
<dcc:name>...</dcc:name>
<dcc:description>...</dcc:description>
<dcc:usedMethods>...</dcc:usedMethods>
<dcc:measuringEquipments>...</dcc:measuringEquipments>
<dcc:influenceConditions>...</dcc:influenceConditions>
<dcc:results>
<dcc:result refId="I123">
<dcc:name>
<dcc:content lang ="en">Results for the characteristics of the reference sphere.
</dcc:name>
<dcc:data>
<dcc:list refType ="length_diameter">
<dcc:name>...</dcc:name>
<dcc:description>...</dcc:description>
<dcc:quantity refId="M1">
<dcc:name>...</dcc:name>
<si:value>29.99301</si:value>
<si:unit>\milli\metre</si:unit>
<si:uncertainty>0.00009</si:uncertainty>
<si:coverageProbability>0.95</si:coverageProbabili
<si:distribution>GAUSS</si:distribution>
</si:expandedUnc>
</si:real>
<dcc:usedMethods>...</dcc:usedMethods>
</dcc:quantity>
</dcc:list>
<dcc:list refType="length_roundnes">...</dcc:list>
</dcc:data>
</dcc:result>
</dcc:results>
<dcc:measurementMetaData>...</dcc:measurementMetaData>
</dcc:measurementResult>
4.1 Durchmesser / Diameter
Es wurde folgender Durchmesser gemessen:
The following diameter was measured:
Messebene 1 (Richtung 0° - 180°):
Measuring plane 1 (direction 0° - 180°):
29,99301 mm
5. Messunsicherheit / Measuring uncertainty
Die Messunsicherheit beträgt:
The measuring uncertainties are:
Durchmesser / diameter
U = 0,08 µm + 0,4 x 10-6 x d
d = Durchmesser / diameter
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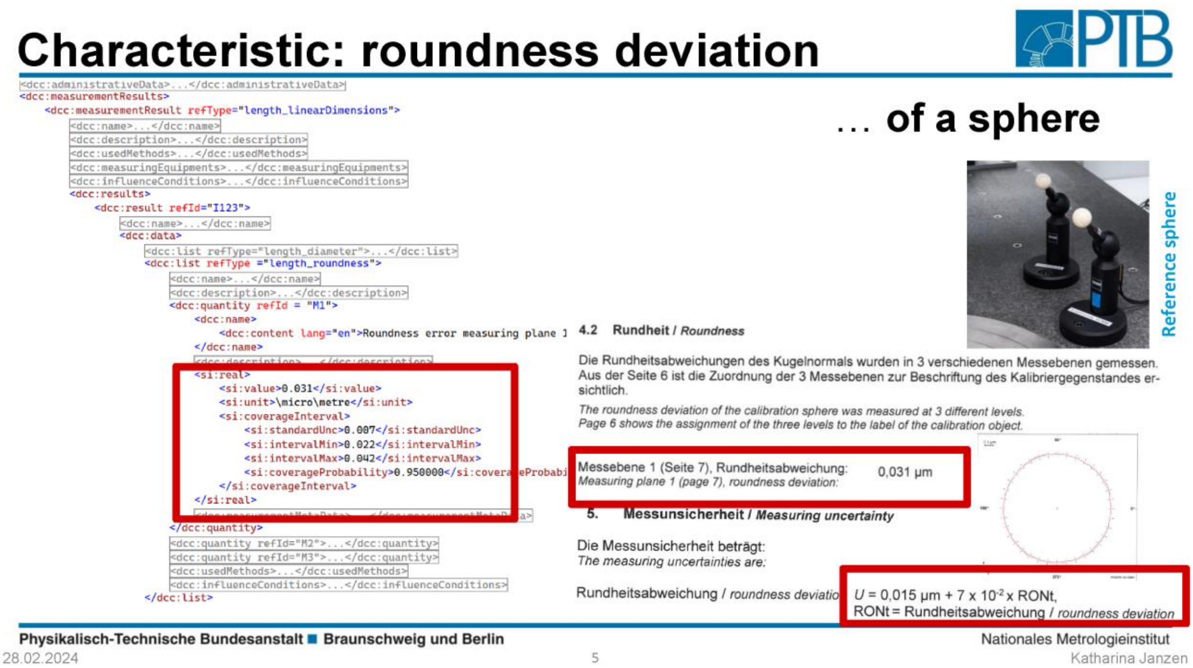
Characteristic: roundness deviation
PTB
… of a sphere
Reference sphere
<dcc:administrativeData>...</dcc:administrativeData>
<dcc:measurementResults>
<dcc:measurementResult refType="length_linearDimensions">
<dcc:name>...</dcc:name>
<dcc:description>...</dcc:description>
<dcc:usedMethods>...</dcc:usedMethods>
<dcc:measuringEquipments>...</dcc:measuringEquipments>
<dcc:influenceConditions>...</dcc:influenceConditions>
<dcc:results>
<dcc:result refId="I123">
<dcc:name>...</dcc:name>
<dcc:data>
<dcc:list refType="length_diameter">...</dcc:list>
<dcc:list refType ="length_roundness">
<dcc:name>...</dcc:name>
<dcc:description>...</dcc:description>
<dcc:quantity refId = "M1">
<dcc:name>
<dcc:content lang="en">Roundness error measuring plane 1
</dcc:name>
<si:real>
<si:value>0.031</si:value>
<si:unit>\micro\metre</si:unit>
<si:coverageInterval>
<si:standardUnc>0.007</si:standardUnc>
<si:intervalMin>0.022</si:intervalMin>
<si:intervalMax>0.042</si:intervalMax>
<si:coverageProbability>0.950000</si:coverageProbabi
</si:coverageInterval>
</si:real>
</dcc:quantity>
<dcc:quantity refId="M2">...</dcc:quantity>
<dcc:quantity refId="M3">...</dcc:quantity>
<dcc:usedMethods>...</dcc:usedMethods>
<dcc:influenceConditions>...</dcc:influenceConditions>
</dcc:list>
4.2 Rundheit / Roundness
Die Rundheitsabweichungen des Kugelnormals wurden in 3 verschiedenen Messebenen gemessen. Aus der Seite 6 ist die Zuordnung der 3 Messebenen zur Beschriftung des Kalibriergegenstandes ersichtlich.
The roundness deviation of the calibration sphere was measured at 3 different levels. Page 6 shows the assignment of the three levels to the label of the calibration object.
Messebene 1 (Seite 7), Rundheitsabweichung:
Measuring plane 1 (page 7), roundness deviation:
0,031 µm
5. Messunsicherheit / Measuring uncertainty
Die Messunsicherheit beträgt:
The measuring uncertainties are:
Rundheitsabweichung / roundness deviatio
U = 0,015 µm + 7 x 10-2 x RONt,
RONt = Rundheitsabweichung / roundness deviation
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Characteristic: roundness deviation

PTB

```
<dcc:administrativeData>...</dcc:administrativeData>
<dcc:measurementResults>
    <dcc:measurementResult refType="length_linearDimensions">
        <dcc:name>...</dcc:name>
        <dcc:description>...</dcc:description>
        <dcc:usedMethods>...</dcc:usedMethods>
        <dcc:measuringEquipments>...</dcc:measuringEquipments>
        <dcc:influenceConditions>...</dcc:influenceConditions>
        <dcc:results>
            <dcc:result refId="I123">
                <dcc:name>...</dcc:name>
                <dcc:data>
                    <dcc:list refType="length_diameter">...</dcc:list>
                    <dcc:list refType ="length_roundness">
                        <dcc:name>...</dcc:name>
                        <dcc:description>...</dcc:description>
                        <dcc:quantity refId = "M1">
                            <dcc:name>
                                <dcc:content lang="en">Roundness error measuring plane
                            </dcc:name>
                            <dcc:description>...</dcc:description>
                            <si:real>
                                <si:value>0.031</si:value>
                                <si:unit>\micro\metre</si:unit>
                                <si:coverageInterval>...</si:coverageInterval>
                            </si:real>
                            <dcc:measurementMetaData>...</dcc:measurementMetaData>
                        </dcc:quantity>
                        <dcc:quantity refId = "M2">
                            <dcc:name>...</dcc:name>
                            <si:real>
                                <si:value>0.037</si:value>
                                <si:unit>\micro\metre</si:unit>
                                <si:coverageInterval>...</si:coverageInterval>
                            </si:real>
                            <dcc:measurementMetaData>...</dcc:measurementMetaData>
                        </dcc:quantity>
                        <dcc:quantity refId = "M3">
```

… **of a sphere**

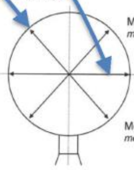
Reference sphere

4.2 Rundheit / *Roundness*

Die Rundheitsabweichungen des Kugelnormals wurden in 3 verschiedenen Messebenen gemessen. Aus der Seite 6 ist die Zuordnung der 3 Messebenen zur Beschriftung des Kalibriergegenstandes ersichtlich.

The roundness deviation of the calibration sphere was measured at 3 different levels. Page 6 shows the assignment of the three levels to the label of the calibration object.

Messebene 1 (Seite 7), Rundheitsabweichung: *Measuring plane 1 (page 7), roundness deviation:*	0,031 µm
Messebene 2 (Seite 8), Rundheitsabweichung: *Measuring plane 2 (page 8), roundness deviation:*	0,037 µm
Messebene 3 (Seite 9), Rundheitsabweichung: *Measuring plane 3 (page 9), roundness deviation:*	0,032 µm



Characteristic: roundness deviation

PTB

```
    <dcc:influenceCondition refType = "length_subStructures">
        <dcc:name>
            <dcc:content lang ="en">Measuring planes</dcc:content>
        </dcc:name>
        <dcc:description>...</dcc:description>
        <dcc:data>
            <dcc:quantity id ="M1">
                <dcc:name>
                    <dcc:content lang ="en">Measuring plane 1</dcc:content>
                </dcc:name>
                <dcc:description>
                    <dcc:content lang ="en">Angle between equator and plane</dcc:content>
                </dcc:description>
                <si:real>
                    <si:value>0</si:value>
                    <si:unit>\degree</si:unit>
                </si:real>
            </dcc:quantity>
            <dcc:quantity id="M2">...</dcc:quantity>
            <dcc:quantity id="M3">...</dcc:quantity>
        </dcc:data>
    </dcc:influenceCondition>
</dcc:influenceConditions>
<dcc:results>
    <dcc:result refId="I123">
        <dcc:name>...</dcc:name>
        <dcc:data>
            <dcc:list refType="length_diameter">...</dcc:list>
            <dcc:list refType ="length_roundness">
                <dcc:name>...</dcc:name>
                <dcc:description>...</dcc:description>
                <dcc:quantity refId = "M1">
                    <dcc:name>
                        <dcc:content lang="en">Roundness error measuring plane 1</dcc:
                    </dcc:name>
                    <dcc:description>
```

… **of a sphere**

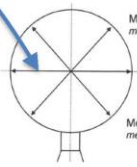
Reference sphere

4.2 Rundheit / *Roundness*

Die Rundheitsabweichungen des Kugelnormals wurden in 3 verschiedenen Messebenen gemessen. Aus der Seite 6 ist die Zuordnung der 3 Messebenen zur Beschriftung des Kalibriergegenstandes ersichtlich.

The roundness deviation of the calibration sphere was measured at 3 different levels. Page 6 shows the assignment of the three levels to the label of the calibration object.

Messebene 1 (Seite 7), Rundheitsabweichung: *Measuring plane 1 (page 7), roundness deviation:*	0,031 µm
Messebene 2 (Seite 8), Rundheitsabweichung: *Measuring plane 2 (page 8), roundness deviation:*	0,037 µm
Messebene 3 (Seite 9), Rundheitsabweichung: *Measuring plane 3 (page 9), roundness deviation:*	0,032 µm



Example: gauge block(s)

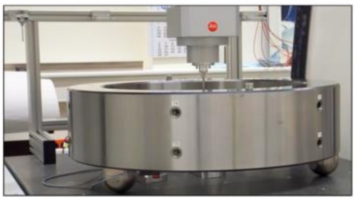
```xml
<dcc:administrativeData>
    <dcc:items>
        <dcc:name>
            <dcc:content lang="en">Set of gauge blocks</dcc:content>
        </dcc:name>
        <dcc:item refType ="length_gaugeBlock" id="I_0">
            <dcc:name>...</dcc:name>
            <dcc:identifications>...</dcc:identifications>
            <dcc:itemQuantities>...</dcc:itemQuantities>
        </dcc:item>
        <dcc:item refType ="length_gaugeBlock" id="I_1">
            <dcc:name>...</dcc:name>
            <dcc:identifications>...</dcc:identifications>
            <dcc:itemQuantities>...</dcc:itemQuantities>
        </dcc:item>
    </dcc:items>
</dcc:administrativeData>
<dcc:measurementResults>
    <dcc:measurementResult refType="length_linearDimensions">
        <dcc:name>...</dcc:name>
        <dcc:usedMethods>...</dcc:usedMethods>
        <dcc:measuringEquipments>...</dcc:measuringEquipments>
        <dcc:influenceConditions>...</dcc:influenceConditions>
        <dcc:results>
            <dcc:result refId="I_0">
                <dcc:name>...</dcc:name>
                <dcc:data>...</dcc:data>
            </dcc:result>
            <dcc:result refId="I_1">
                <dcc:name>...</dcc:name>
                <dcc:data>...</dcc:data>
            </dcc:result>
        </dcc:results>
        <dcc:measurementMetaData>...</dcc:measurementMetaData>
    </dcc:measurementResult>
</dcc:measurementResults>
```

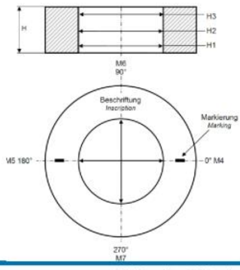

Reference sphere


Gauge blocks

Example: ring gauge

Prüfmerkmal *Feature*	Messposition *Measurement Position*
Durchmesser 0° - 180° *Diameter 0° - 180°*	Höhe 2 *Height 2*
Rundheitsabweichung *Roundness Error*	Höhe 1 *Height 1*
Rundheitsabweichung *Roundness Error*	Höhe 2 *Height 2*
Rundheitsabweichung *Roundness Error*	Höhe 3 *Height 3*
Geradheitsabweichung *Straightness Error*	Mantellinie 4 (0°) *Surface line 4 (0°)*
Geradheitsabweichung *Straightness Error*	Mantellinie 5 (180°) *Surface line 5 (180°)*
Parallelitätsabweichung *Parallelism Error*	Mantellinie 4 // 5 (0° - 180°) *Surface line 4 // 5 (0°- 180°)*
Geradheitsabweichung *Straightness Error*	Mantellinie 6 (90°) *Surface line 6 (90°)*
Geradheitsabweichung *Straightness Error*	Mantellinie 7 (270°) *Surface line 7 (270°)*
Parallelitätsabweichung *Parallelism Error*	Mantellinie 6 // 7 (90° -270°) *Surface line 6 // 7 (90°-270°)*

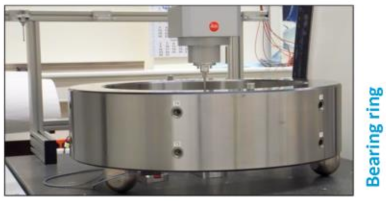

Bearing ring

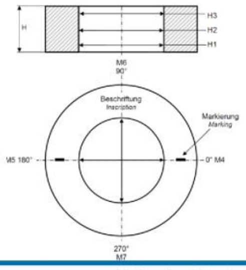


Example: ring gauge

```
<dcc:administrativeData>
    <dcc:refTypeDefinitions>...</dcc:refTypeDefinitions>
    <dcc:dccSoftware>...</dcc:dccSoftware>
    <dcc:coreData>...</dcc:coreData>
    <dcc:items>
        <dcc:item refType="length_internal" id="I_4">...</dcc:item>
    </dcc:items>
    <dcc:calibrationLaboratory>...</dcc:calibrationLaboratory>
    <dcc:respPersons>...</dcc:respPersons>
    <dcc:customer>...</dcc:customer>
</dcc:administrativeData>
<dcc:measurementResults>
    <dcc:measurementResult refType="length_linearDimensions">
        <dcc:name>...</dcc:name>
        <dcc:usedMethods>...</dcc:usedMethods>
        <dcc:measuringEquipments>...</dcc:measuringEquipments>
        <dcc:influenceConditions>
            <dcc:influenceCondition refType="length_itemTemp">...</dcc:influ
            <dcc:influenceCondition refType = "length_subStructures">
                <dcc:name>...</dcc:name>
                <dcc:description>...</dcc:description>
                <dcc:data>
                    <dcc:quantity id="H1">...</dcc:quantity>
                    <dcc:quantity id="H2">...</dcc:quantity>
                    <dcc:quantity id="H3">...</dcc:quantity>
                    <dcc:quantity id="M4">...</dcc:quantity>
                    <dcc:quantity id="M5">...</dcc:quantity>
                    <dcc:quantity id="M6">...</dcc:quantity>
                    <dcc:quantity id="M7">...</dcc:quantity>
                </dcc:data>
            </dcc:influenceCondition>
        </dcc:influenceConditions>
        <dcc:results>
            <dcc:result refId="I_4">
                <dcc:name>...</dcc:name>
                <dcc:data>
                    <dcc:list refType="length_diameter">...</dcc:list>
                    <dcc:list refType="length_roundnes">...</dcc:list>
```

Höhe 1 *Height 1*
Höhe 2 *Height 2*
Höhe 3 *Height 3*
Mantellinie 4 (0°) *Surface line 4 (0°)*
Mantellinie 5 (180°) *Surface line 5 (180°)*
Mantellinie 6 (90°) *Surface line 6 (90°)*
Mantellinie 7 (270°) *Surface line 7 (270°)*

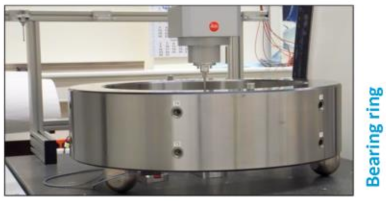




Characteristic: diameter & roundness error

… of a cylinder

```
<dcc:administrativeData>...</dcc:administrativeData>
<dcc:measurementResults>
    <dcc:measurementResult refType="length_linearDimensions">
        <dcc:name>...</dcc:name>
        <dcc:usedMethods>...</dcc:usedMethods>
        <dcc:measuringEquipments>...</dcc:measuringEquipments>
        <dcc:influenceConditions>...</dcc:influenceConditions>
        <dcc:results>
            <dcc:result refId="I_4">
                <dcc:name>...</dcc:name>
                <dcc:data>
                    <dcc:list refType="length_diameter">
                        <dcc:quantity refId="H2">
                            <si:real>
                                <si:value>29.99946</si:value>
                                <si:unit>\milli\metre</si:unit>
                                <si:expandedUnc>...</si:expandedUnc>
                            </si:real>
                        </dcc:quantity>
                    </dcc:list>
                        <dcc:quantity refId="H1">...</dcc:quantity>
                        <dcc:quantity refId = "H3">
                            <dcc:name>
                                <dcc:content lang="en">Roundness error measuring plane 3</dcc:cont
                            </dcc:name>
                            <dcc:description>...</dcc:description>
                            <si:real>
                                <si:value>0.19</si:value>
                                <si:unit>\micro\metre</si:unit>
                                <si:coverageInterval>...</si:coverageInterval>
                            </si:real>
                            <dcc:measurementMetaData>...</dcc:measurementMetaData>
                        </dcc:quantity>
                        <dcc:influenceConditions>...</dcc:influenceConditions>
                    </dcc:list>
```

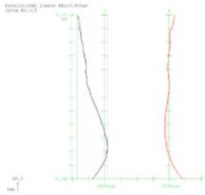


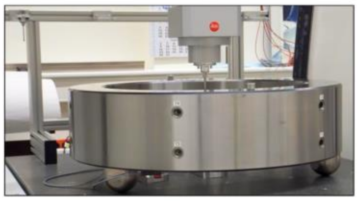
Prüfmerkmal *Feature*	Messposition *Measurement Position*	Messergebnis *Measurement Result*	Einheit *Dimension*
Durchmesser 0° - 180° *Diameter 0° - 180°*	Höhe 2 *Height 2*	29,99946	mm
Rundheitsabweichung *Roundness Error*	Höhe 1 *Height 1*	0,22	µm
Rundheitsabweichung *Roundness Error*	Höhe 2 *Height 2*	0,25	µm
Rundheitsabweichung *Roundness Error*	Höhe 3 *Height 3*	0,19	µm

Characteristic: parallelism error

```
<dcc:administrativeData>...</dcc:administrativeData>
<dcc:measurementResults>
    <dcc:measurementResult refType="length_linearDimensions">
        <dcc:name>...</dcc:name>
        <dcc:usedMethods>...</dcc:usedMethods>
        <dcc:measuringEquipments>...</dcc:measuringEquipments>
        <dcc:influenceConditions>...</dcc:influenceConditions>
        <dcc:results>
            <dcc:result  refId="I_4">
                <dcc:name>...</dcc:name>
                <dcc:data>
                    <dcc:list refType="length_diameter">...</dcc:list>
                    <dcc:list refType="length_roundnes">...</dcc:list>
                    <dcc:list refType="length_straight">...</dcc:list>
                    <dcc:list refType="length_parallelism">
                        <dcc:name>
                            <dcc:content lang="en">Parallelism error</dcc:content>
                        <dcc:quantity refId="M4 M5">
                            <si:real>
                                <si:value>0.94</si:value>
                                <si:unit>\micro\metre</si:unit>
                                <si:expandedUnc>...</si:expandedUnc>
                            </si:real>
                        </dcc:quantity>
                        <dcc:quantity refId="M6 M7">
                            <si:real>
                                <si:value>0.88</si:value>
                                <si:unit>\micro\metre</si:unit>
                                <si:expandedUnc>...</si:expandedUnc>
                            </si:real>
                        </dcc:quantity>
                    </dcc:list>
                </dcc:data>
            </dcc:result>
        </dcc:results>
        <dcc:measurementMetaData>...</dcc:measurementMetaData>
    </dcc:measurementResult>
```

…of two lines on a cylinder

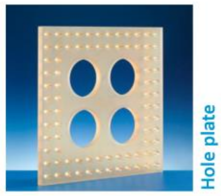




Geradheitsabweichung *Straightness Error*	Mantellinie 5 (180°) *Surface line 5 (180°)*	0,56	µm
Parallelitätsabweichung *Parallelism Error*	Mantellinie 4 // 5 (0° - 180°) *Surface line 4 // 5 (0°- 180°)*	0,94	µm
Geradheitsabweichung *Straightness Error*	Mantellinie 6 (90°) *Surface line 6 (90°)*	0,45	µm
Geradheitsabweichung *Straightness Error*	Mantellinie 7 (270°) *Surface line 7 (270°)*	0,48	µm
Parallelitätsabweichung *Parallelism Error*	Mantellinie 6 // 7 (90° -270°) *Surface line 6 // 7 (90°-270°)*	0,88	µm

Example: Hole plate – item(s)

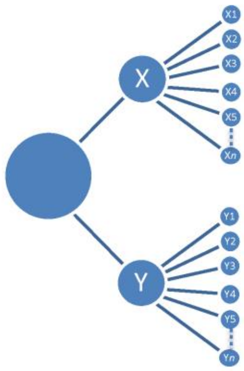
```
<dcc:administrativeData>
    <dcc:refTypeDefinitions>...</dcc:refTypeDefinitions>
    <dcc:dccSoftware>...</dcc:dccSoftware>
    <dcc:coreData>...</dcc:coreData>
    <dcc:items>
        <dcc:item refType ="length_holePlate" id ="standard">
            <dcc:name>
                <dcc:content lang="de">Hole Plate</dcc:content>
            </dcc:name>
            <dcc:description>...</dcc:description>
            <dcc:manufacturer>...</dcc:manufacturer>
            <dcc:identifications>...</dcc:identifications>
            <dcc:itemQuantities>...</dcc:itemQuantities>
        </dcc:item>
        <dcc:item id="H1" refType="length_internal">...</dcc:item
        <dcc:item id="H2" refType="length_internal">...</dcc:item
        <dcc:item id="H3" refType="length_internal">...</dcc:item
        <dcc:item id="H4" refType="length_internalCylinder">
            <dcc:name>
                <dcc:content lang="de">Hole 4</dcc:content>
            </dcc:name>
            <dcc:manufacturer>...</dcc:manufacturer>
            <dcc:identifications>...</dcc:identifications>
        </dcc:item>
        <dcc:item id="H5" refType="length_internal">...</dcc:item
        <dcc:item id="H6" refType="length_internal">...</dcc:item
        <dcc:item id="H7" refType="length_internal">...</dcc:item
        <dcc:item id="H8" refType="length_internal">...</dcc:item
```



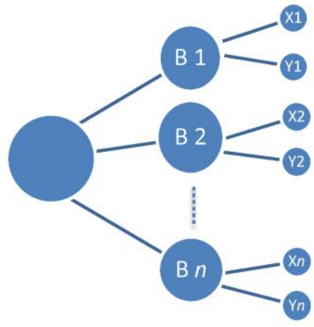
Hole	X	Y
1	0,0000	0,0000
2	49,9977	-0,0023
3	100,0000	-0,0017
4	149,9916	-0,0020
5	199,9931	-0,0019
6	249,9939	-0,0011
7	299,9989	-0,0022
8	349,9974	-0,0018

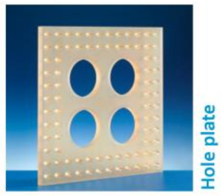
Example: Hole plate - table

in columns



in rows



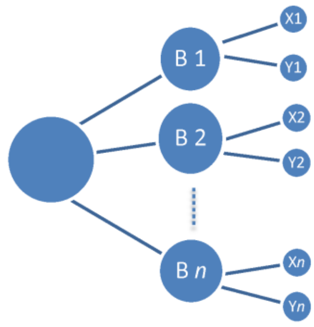


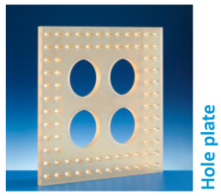
Hole	X	Y
1	0,0000	0,0000
2	49,9977	-0,0023
3	100,0000	-0,0017
4	149,9916	-0,0020
5	199,9931	-0,0019
6	249,9939	-0,0011
7	299,9989	-0,0022
8	349,9974	-0,0018

Example: Hole plate - table

```
<dcc:list refType="length_coordinates">
    <dcc:list refId="H1">...</dcc:list>
    <dcc:list refId="H2">...</dcc:list>
    <dcc:list refId="H3">...</dcc:list>
    <dcc:list refId ="H4">
        <dcc:name>
            <dcc:content lang="en">Hole 4</dcc:content>
        </dcc:name>
        <dcc:quantity refType="length_coordinateX">
            <dcc:name>
                <dcc:content lang ="de">x</dcc:content>
            </dcc:name>
            <si:real>
                <si:value>149.9916</si:value>
                <si:unit>\milli\metre</si:unit>
            </si:real>
        </dcc:quantity>
        <dcc:quantity refType="length_coordinateY">
            <dcc:name>
                <dcc:content lang ="de">y</dcc:content>
            </dcc:name>
            <si:real>
                <si:value>-0.0020</si:value>
                <si:unit>\milli\metre</si:unit>
            </si:real>
        </dcc:quantity>
    </dcc:list>
```

in rows



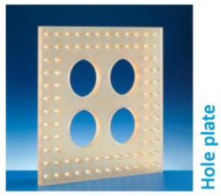


Hole	X	Y
1	0,0000	0,0000
2	49,9977	-0,0023
3	100,0000	-0,0017
4	149,9916	-0,0020
5	199,9931	-0,0019
6	249,9939	-0,0011
7	299,9989	-0,0022
8	349,9974	-0,0018

Example: Hole plate - uncertainty

```xml
<dcc:list refType="length_coordinates">
    <dcc:list refId="H1">...</dcc:list>
    <dcc:list refId="H2">...</dcc:list>
    <dcc:list refId="H3">...</dcc:list>
    <dcc:list refId ="H4">
        <dcc:name>
            <dcc:content lang="en">Hole 4</dcc:content>
        </dcc:name>
        <dcc:quantity refType="length_coordinateX">
            <dcc:name>
                <dcc:content lang ="de">x</dcc:content>
            </dcc:name>
            <si:real>
                <si:value>149.9916</si:value>
                <si:unit>\milli\metre</si:unit>
            </si:real>
        </dcc:quantity>
        <dcc:quantity refType="length_coordinateY">
            <dcc:name>
                <dcc:content lang ="de">y</dcc:content>
            </dcc:name>
            <si:real>
                <si:value>-0.0020</si:value>
                <si:unit>\milli\metre</si:unit>
            </si:real>
        </dcc:quantity>
    </dcc:list>
</dcc:list>
```

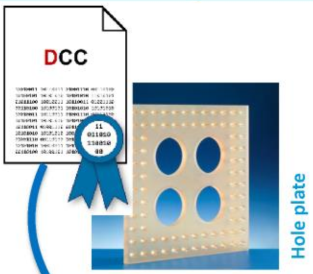
```xml
<dcc:list refType="length_distances">
    <dcc:name>
        <dcc:content lang ="en">Distances between the centres of the holes<,
    </dcc:name>
    <dcc:description>...</dcc:description>
    <dcc:quantity refId ="H1 H2" >
        <dcc:name>
            <dcc:content lang="en">D(1,2)</dcc:content>
        </dcc:name>
        <si:real>
            <si:value>49.9922E-3</si:value>
            <si:unit>\metre</si:unit>
            <si:expandedUnc>
                <si:uncertainty>4.01E-7</si:uncertainty>
                <si:coverageFactor>2</si:coverageFactor>
                <si:coverageProbability>0.95</si:coverageProbability>
            </si:expandedUnc>
        </si:real>
    </dcc:quantity>
    <dcc:quantity refId ="H1 H3">
        <dcc:name>
            <dcc:content lang="en">D(1,3)</dcc:content>
        </dcc:name>
        <si:real>
            <si:value>100.0033E-3</si:value>
            <si:unit>\metre</si:unit>
            <si:expandedUnc>
                <si:uncertainty>4.03E-7</si:uncertainty>
                <si:coverageFactor>2</si:coverageFactor>
                <si:coverageProbability>0.95</si:coverageProbability>
            </si:expandedUnc>
        </si:real>
    </dcc:quantity>
</dcc:list>
```



Hole	X	Y
1	0,0000	0,0000
2	49,9977	-0,0023
3	100,0000	-0,0017
4	149,9916	-0,0020
5	199,9931	-0,0019
6	249,9939	-0,0011
7	299,9989	-0,0022
8	349,9974	-0,0018

$$U(L) = \sqrt{(0.4\ \mu\text{m})^2 + (0.5 \cdot 10^{-6} \cdot L)^2}$$

Summary and Outlook



- DCC for measurement standards in length metrology
- DCC as input and output for Digital-Metrological Twins

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Bundesallee 100
38116 Braunschweig
Katharina Janzen
Phone: 0531 592-5352
E-Mail: katharina.janzen@ptb.de
www.ptb.de

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Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages

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34 Digital Certificate of Conformity as the Key Means for the Digitalization of Certification

Presenting author: Tatyana Sheveleva, PTB Germany
E-mail address: tatyana.sheveleva@ptb.de
Additional authors:

Abstract:

The ongoing digitalization of the quality infrastructure brings with it many challenges. One of these challenges is the realisation of clear and seamless communication between all parties involved. In this case, communication takes place primarily through the transmission or exchange of relevant documents. Communication in the digital environment in turn requires the existence of documents that can be read and interpreted by a technical application. The development of a digital Certificate of Conformity (d-CoC) is intended to contribute to the realization of digitally supported communication between all parties involved in a conformity assessment and to completely replace existing paperbased certificates.

The d-CoC is one of the digitalization subprojects within the QI-Digital initiative and is being developed as part of the "Reliable hydrogen filling stations" pilot project. It is a certificate of conformity that is issued for legally regulated measuring instruments as part of the conformity assessment procedures according to the Measures and Verification Act (MessEG), the Measures and Verification Ordinance (MessEV) and the European Directive for non-automatic weighing instruments (2014/31/EU), the Measuring Instruments Directive 2014/32/EU, the Directive for the equipment and protective systems intended for use in potentially explosive atmospheres (2014/34/EU) and as its national implementation Product Safety Act (ProdSG) and 11. Explosion Protection Products Ordinance (11. ProdSV). It focuses on the conformity assessment modules for a type examination (Module B), quality assurance in production (Module D) and product testing (Module F).

The d-CoC is realised as a complex data structure that is intended to cover the entire content of a conformity assessment certificate. It is modular and contains three sub-data structures, each representing a specific content module of a certificate of conformity. Two of the following data structures have a generalised structure and are therefore suitable for cross-system use. These are "certification data" with the general information on the certification, the certification body, the manufacturer and the object of conformity assessment and the “comment” area in which all necessary certification-relevant comments are realised. The third sub-data structure is intended for the presentation of information specific to conformity assessment procedures, e.g. type examination. It is planned to create a separate sub-data structure for each of the certification schemes. This makes the global data structure of the d-CoC adaptable to different conformity assessment systems and schemes by exchanging the specified partial data structure as required.

As the d-CoC is intended to be integrated into the QI, its structure must be adaptable to the other QI relevant data structures. For this reason, existing data structures will be taken into account during development and integrated as far as possible. For example, the complete Digital System of Units (DSI) has already been integrated into the partial data structure of the Type Examination Certificate.

The d-CoC is available in XML format, whereby its data structure can also be transferred to other formats such as JSON or OWL. The aim is also to harmonise the concept of the d-CoC with the DCC so that both data structures can be integrated into a higher-level system that may be required.

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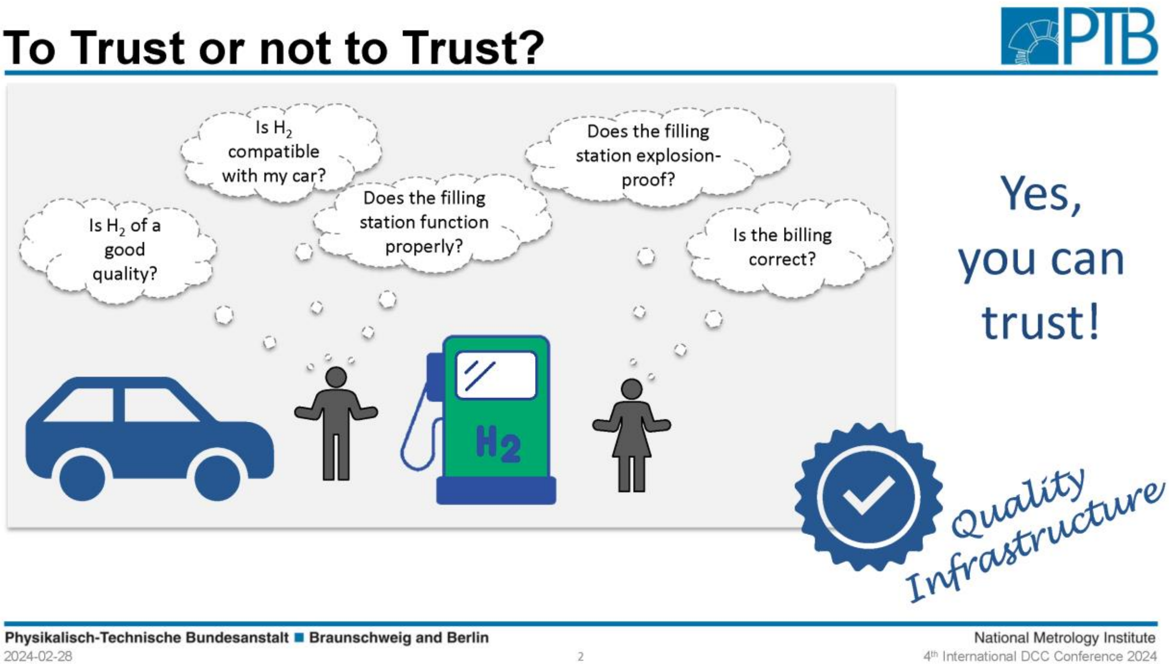
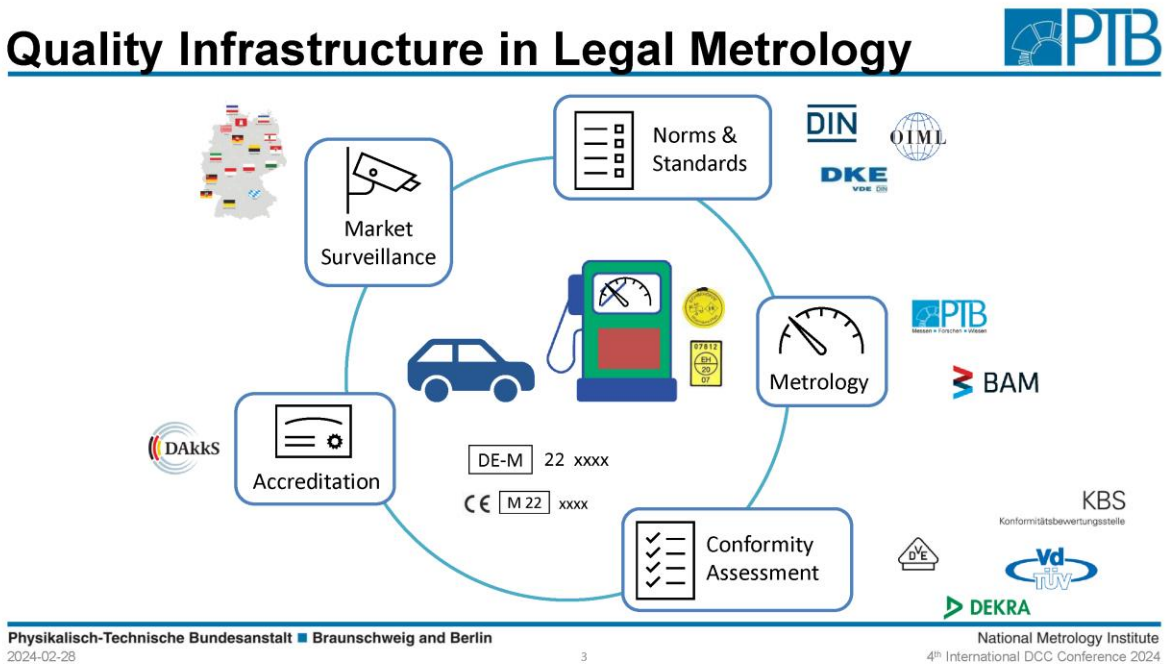
Presentation of Tatyana Sheveleva




Quality Infrastructure in Legal Metrology
PTB
Norms & Standards
DIN
OIML
DKE
Market Surveillance
Metrology
PTB
BAM
Accreditation
DAkkS
DE-M 22 xxxx
CE M 22 xxxx
Conformity Assessment
KBS
Konformitätsbewertungsstelle
VdTÜV
DEKRA
Physikalisch-Technische Bundesanstalt ■ Braunschweig and Berlin
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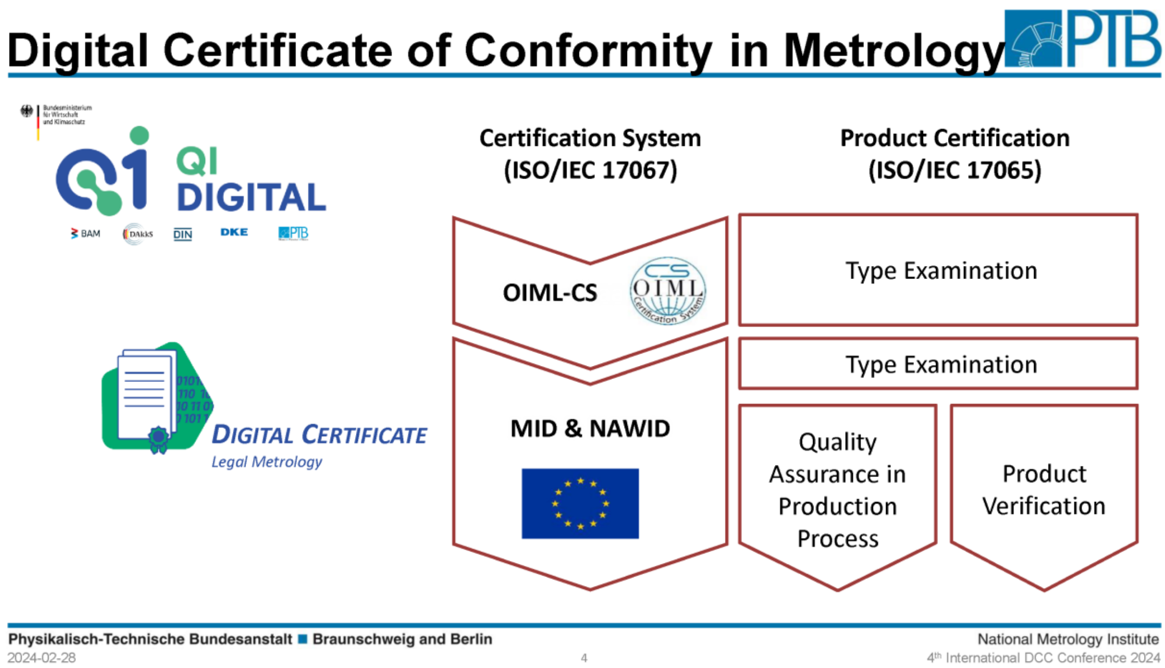
National Metrology Institute
4th International DCC Conference 2024


Digital Certificate of Conformity in Metrology
PTB
QI DIGITAL
BAM
DAkkS
DIN
DKE
PTB
DIGITAL CERTIFICATE
Legal Metrology
Certification System (ISO/IEC 17067)
Product Certification (ISO/IEC 17065)
OIML-CS
OIML
Type Examination
MID & NAWID
Type Examination
Quality Assurance in Production Process
Product Verification
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2024-02-28
4
National Metrology Institute
4th International DCC Conference 2024

Project Goals

QI DIGITAL

DIGITAL CERTIFICATE M/EX

Legal Metrology & Explosion Protection

1. **data structure** - certification information for conformity assessment in accordance with the Measuring Instruments Directive, the Directive for non-automatic weighing instruments (MID) and the Measurement and Verification Act and Ordinance (NAWID)
2. **practical implementation** - digital data structure and tools for creating, editing and viewing (based on DCC)
3. **standardization** - draft standard for digital data structure
4. **addition** - inclusion of explosion protection in accordance with the ATEX Directive
   Similar certificates (for type examination, quality assurance, ...)

Development of Data Structure

Collaboration

NoBOMet – European Coordination Group for Notified Bodies in Legal Metrology

Notified Bodies in Legal Metrology

Project group
"Digital Certificates in Metrology " established in 2021

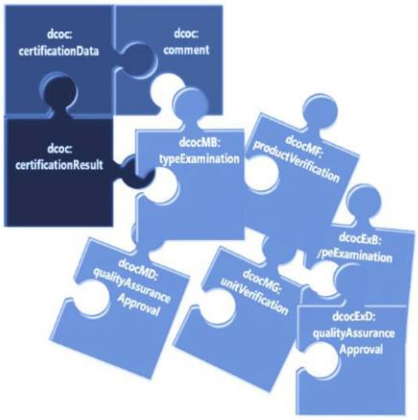
Considering

Mandatory/optional details according to

- Directives MID, NAWID
- technical standards ISO/IEC 17067, ISO/IEC 17065 related to conformity assessment
- WELMEC Guide 8.3 (specified template for type examination certificate)
- product specific mandatory details

Modular Structure

- general certification information
- suitable for all product and certification types



content specific for the relevant conformity assessment module

Adaptable for other certification systems

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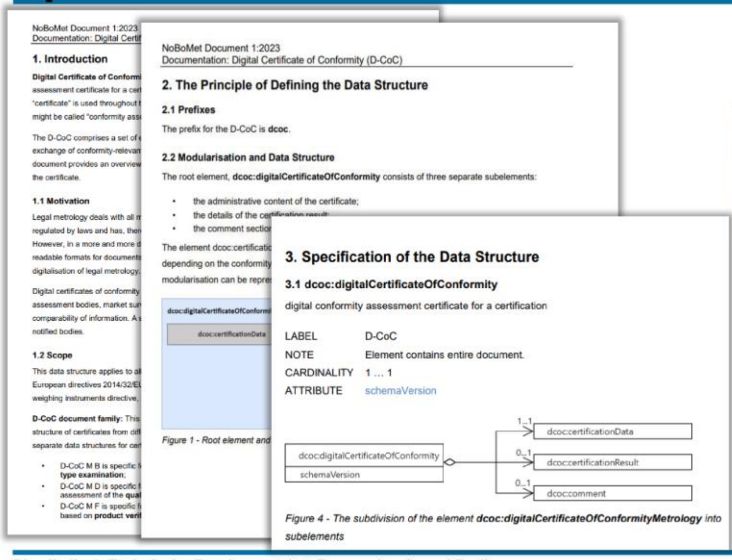
Specification



published on 10.05.2023 at:

https://circabc.europa.eu/webdav/CircaBC/nbg/NoBoMet%20(Notified%20Bodies%20in%20Legal%20Metrology)/Information/news_5ba7ba0a-bf8b-4421-8078-2f757d68a80b/NoBoMet_Documentation_D-CoC_V1.2.pdf

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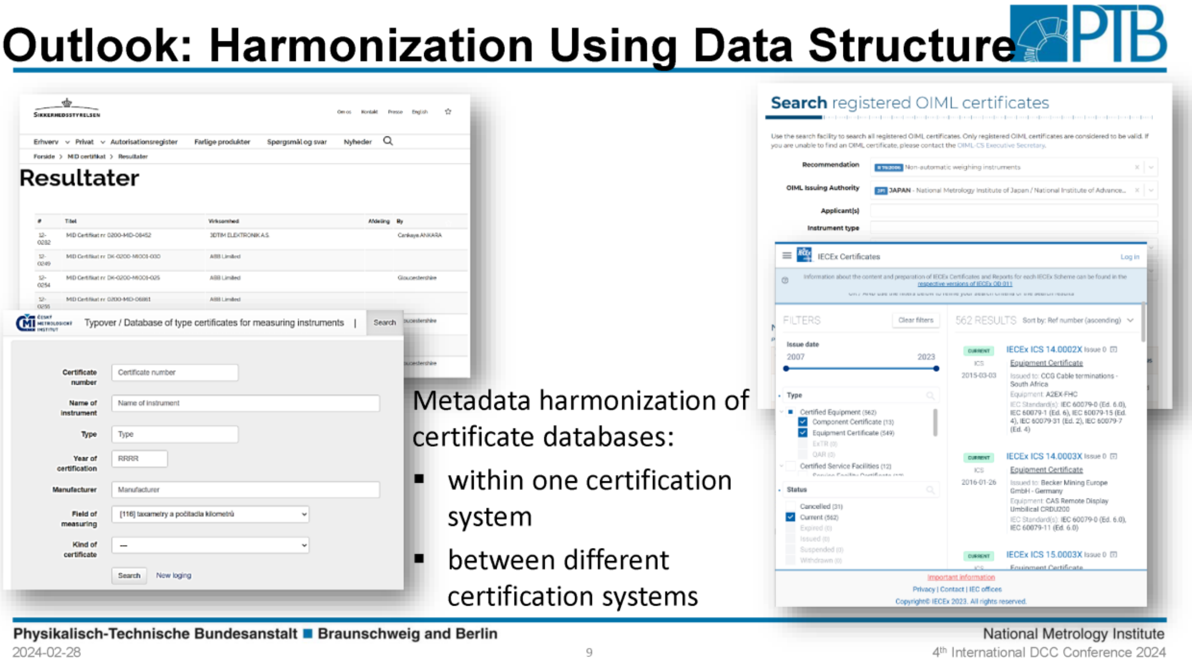

About

Thanks to entire team!

Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
Bundesallee 100
38116 Braunschweig
Telefon: 0531 592-1132
E-Mail: d-coc@ptb.de
www.ptb.de

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35 Pilot Implementation of DCC at primary acceleration laboratory at CENAM

Presenting author: Aldo A.Garcia González, CENAM Metrology Institute; Mexico
E-mail address: algarcia@cenam.mx
Additional authors: Arellano Pérez Hugo A. josehugoarellanoperez@gmail.com, Marín Quebrado Neftalí, Rueda Ruiz Arturo, Gonzalez Duran Manuel A, Andres E. Pérez Matzumoto

Abstract:

Following the digital transformation strategic vision at CENAM, the group of acoustics and vibrations has implemented the usage of structured XML in the Digital Calibration Certificate (DCC) to improve the calibration process, reducing time and human error. Also, this development was used for a CABUREK project as a delivery and then showed the benefits of DCC to our stakeholders in México as a quality infrastructure strategy.

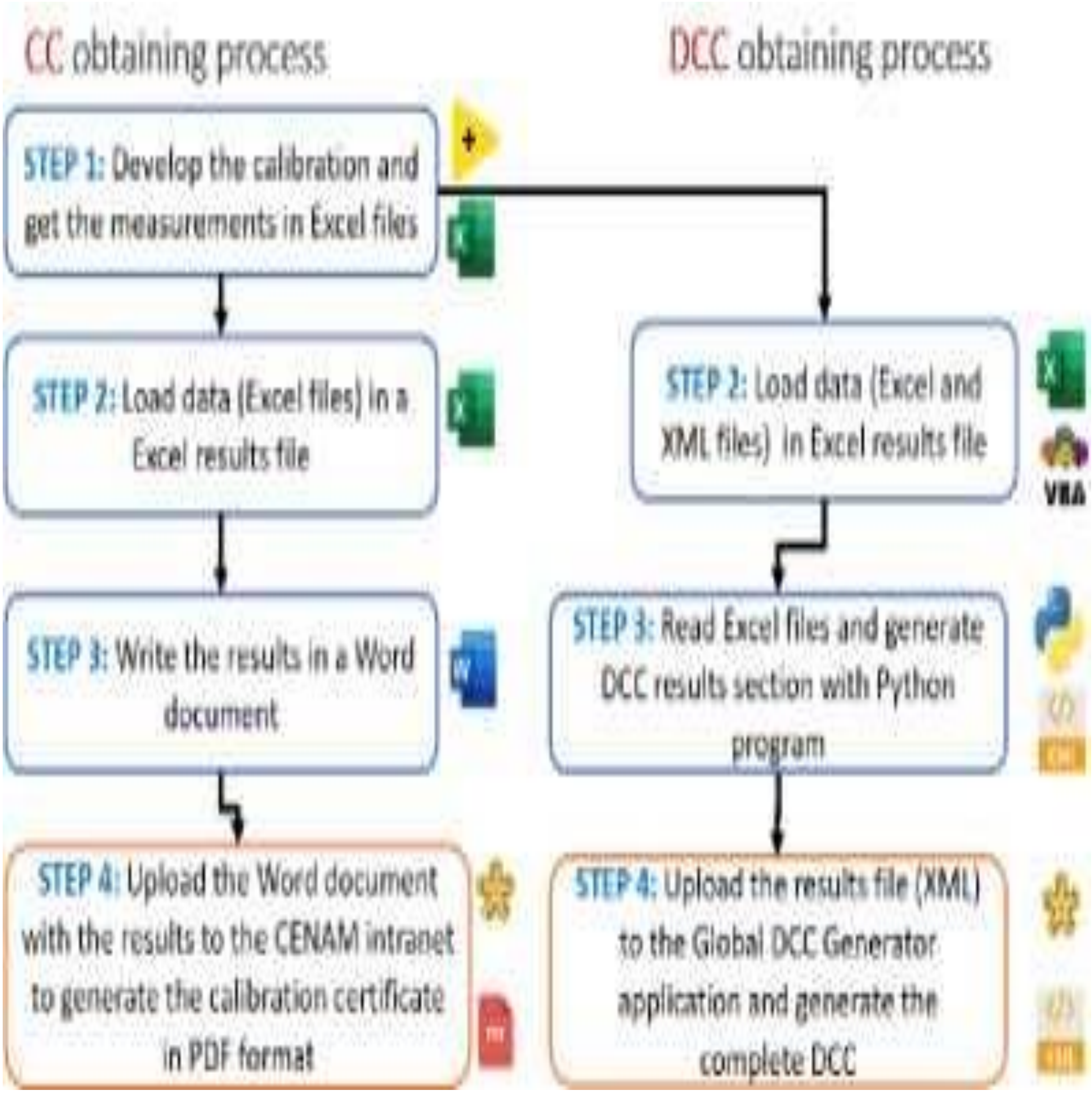
The strategy to generate a full DCC was planned as this:

1. Find a calibration service to implement the DCC to the industry.
2. The DCC will be generated with:
   a. Administrative sub-scheme with CENAM database from industrial services.
   b. Results sub-scheme with results from primary calibration laboratory.
   c. Will implement a digital signature.
   d. Must be compatible with the developed platform that generates the complete DCC as mentioned in the related paper called “Global System for DCC at CENAM”.

The implementation of the DCC will allow us to improve the following:

1. Traceability between laboratories in acceleration quantities (primary to secondary)
2. Reduction of error inside the calibration process
3. Enabling tools to have communicated systems (Ambient conditions and calibration process)
4. Implementation of a methodology to develop the project.

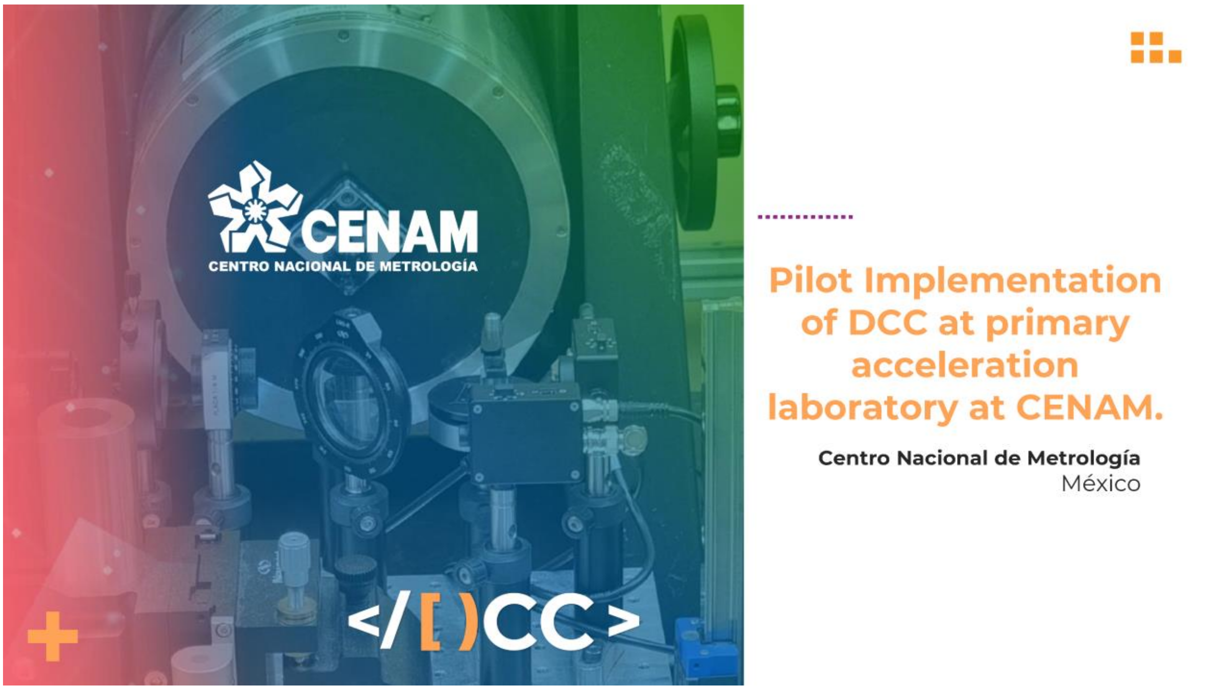
We compare the calibration process between actual calibration certificate against digital calibration certificate.

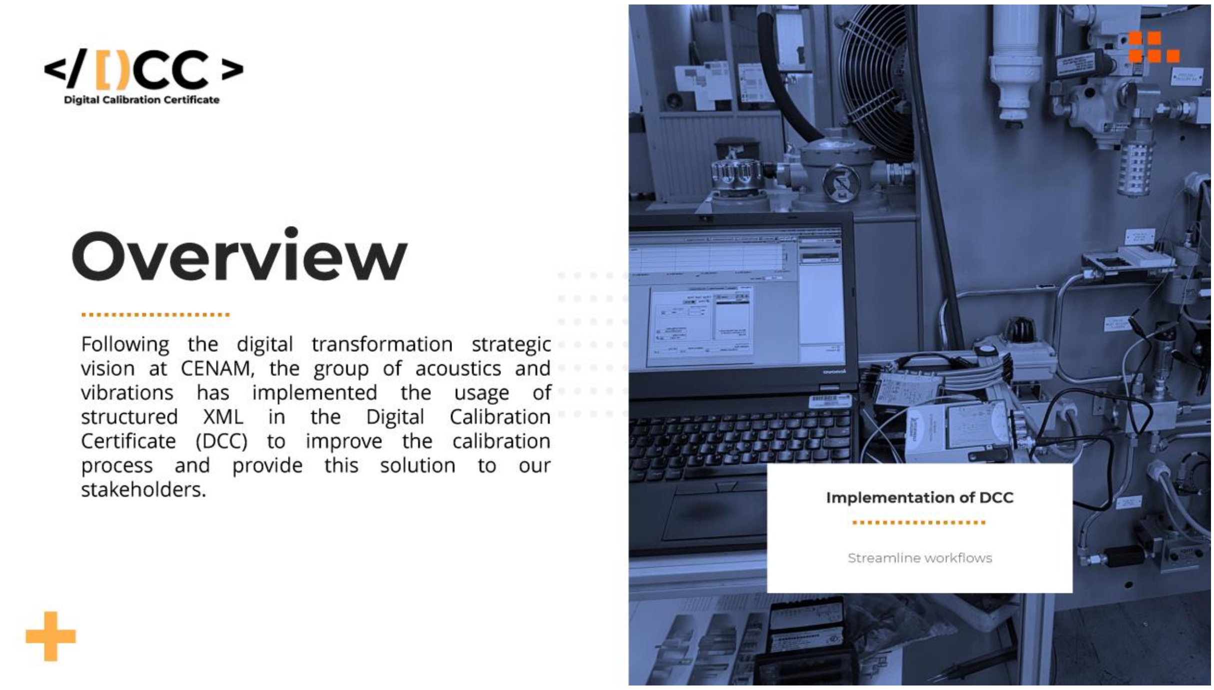


With this project some software was developed:
1. XML generators (excel, python), with DCC result sub-schemes.
2. XML readers (excel, python)

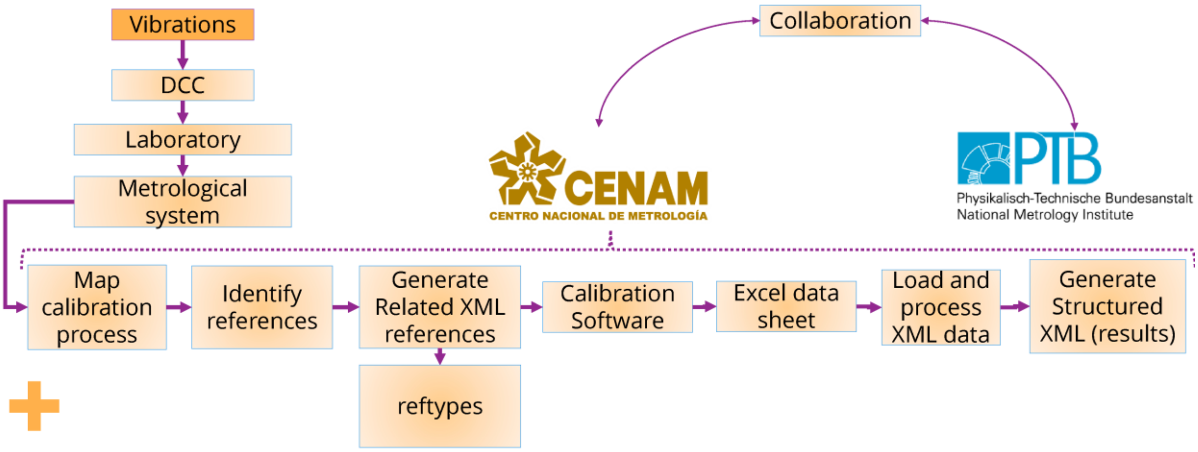
[Back to "Table of Contents" above]

Presentation of Aldo A.Garcia González





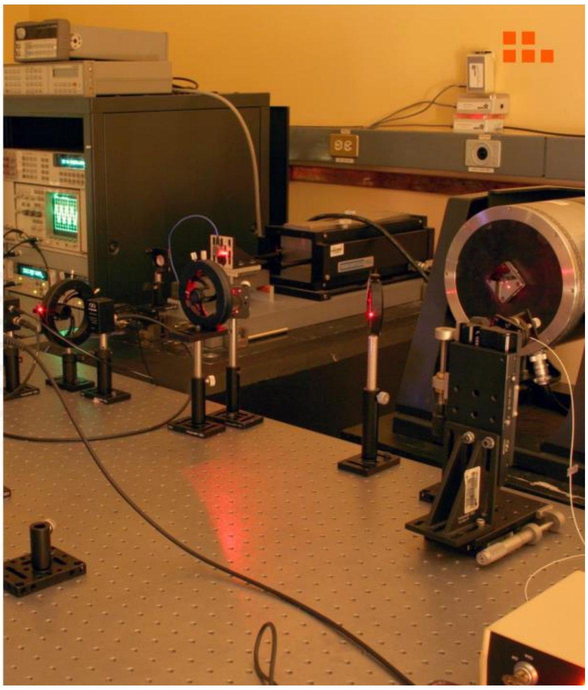
Strategy of implementation

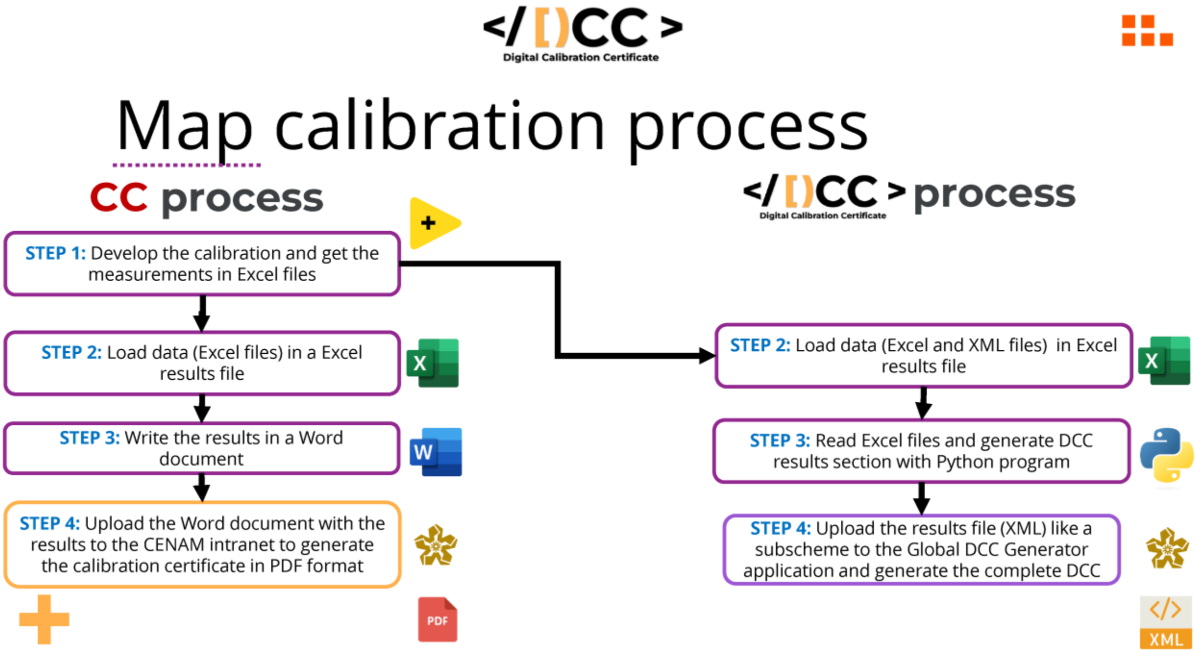


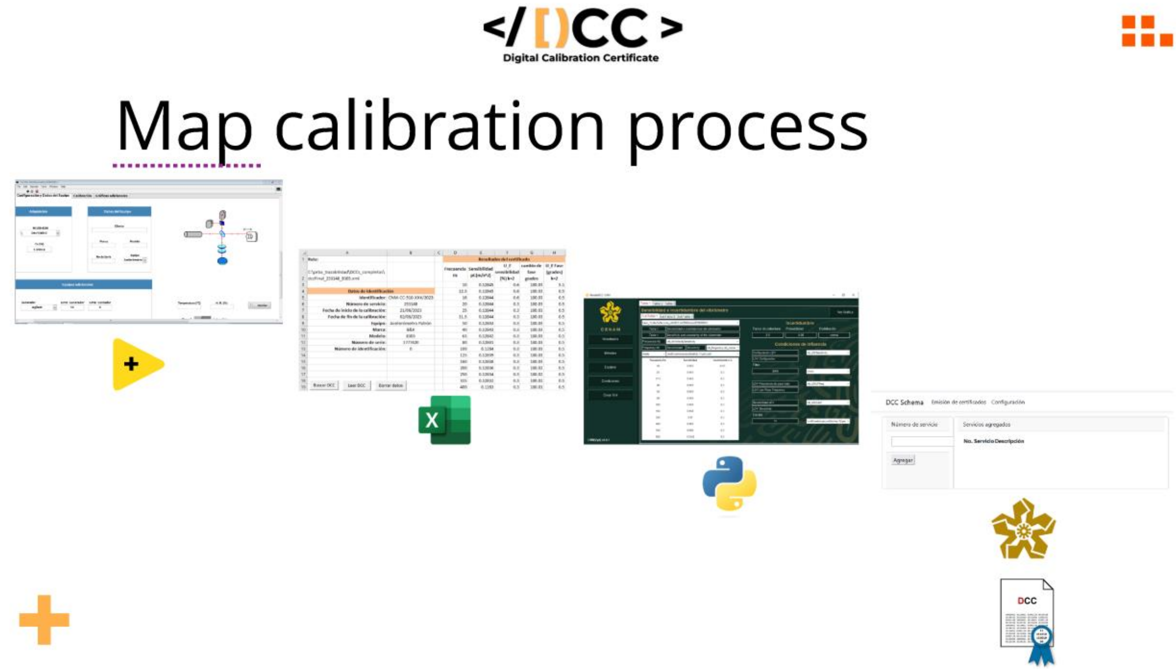
Primary Laboratory

Vibrometers

Reference Accelerometers B&K 8305

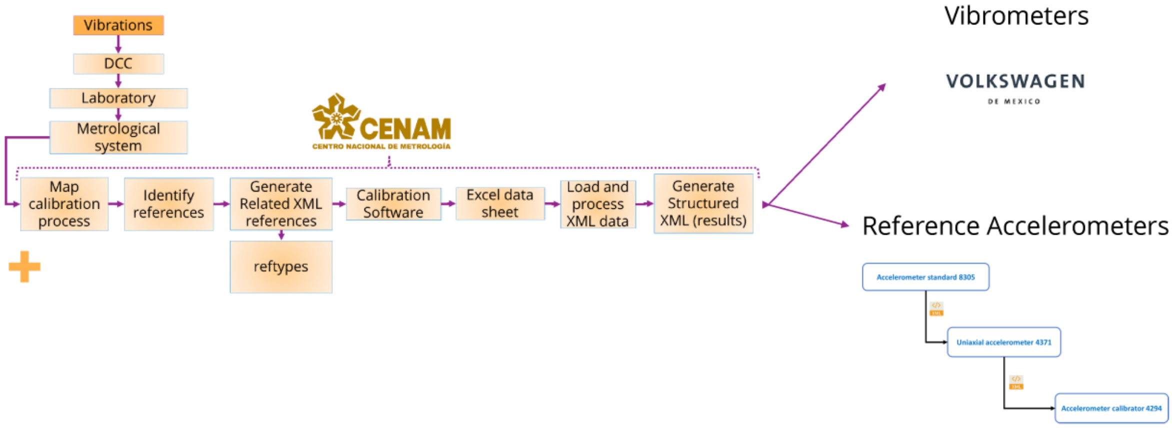



</ [ ]CC >
Digital Calibration Certificate
Map calibration process
CC process
STEP 1: Develop the calibration and get the measurements in Excel files
STEP 2: Load data (Excel files) in a Excel results file
STEP 3: Write the results in a Word document
STEP 4: Upload the Word document with the results to the CENAM intranet to generate the calibration certificate in PDF format
PDF
</ [ ]CC > process
STEP 2: Load data (Excel and XML files) in Excel results file
STEP 3: Read Excel files and generate DCC results section with Python program
STEP 4: Upload the results file (XML) like a subscheme to the Global DCC Generator application and generate the complete DCC
XML


</ [ ]CC >
Digital Calibration Certificate
Map calibration process
DCC Schema
DCC

Digital Calibration Certificate

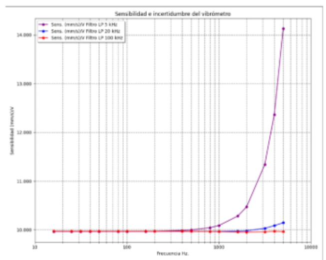
Traceability chain

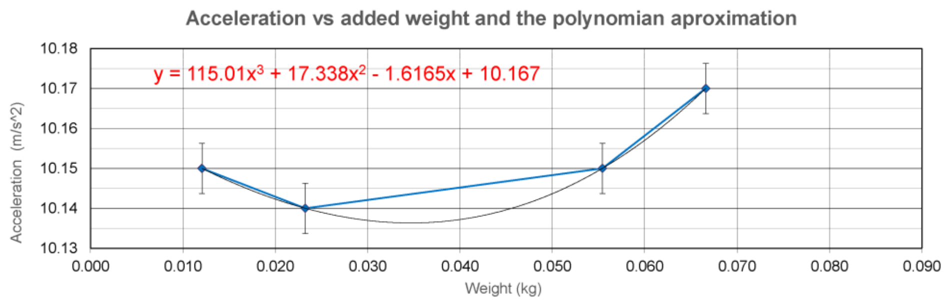


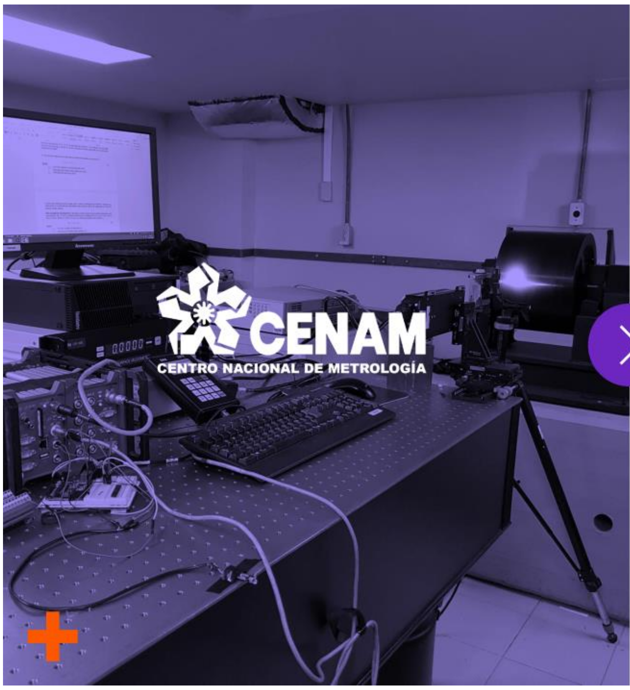
Digital Calibration Certificate

Next Steps

- Enable TemaTres for reftypes
- Include Web e-services
- Include Formulas at DCC
- Develop required DCC traceability Charts







Closing

The implementation of the DCC will allow us to improve the following:

1. Traceability between laboratories in acceleration quantities (primary to secondary)
2. Reduction of error inside the calibration process
3. Enabling tools to have communicated systems (Ambient conditions and calibration process)
4. Implementation of a methodology to develop the project.

Digital Calibration Certificate

Digital Calibration Certificate

Team Members

Aldo García Gonzalez
Metrologist
algarcia@cenam.mx

Arellano Pérez Hugo A
Developer

CENAM
CENTRO NACIONAL DE METROLOGÍA

Arturo Ruiz Rueda
Metrologist

Marín Quebrado Neftalí
Student-Developer

Manuel Alejandro G.
Metrologist

Andrés E. Pérez
Metrologist

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36 Use case: DCC captured and transmitted using blockchain technology.

Presenting author: Inga Urbina, Keysight Tecnologies Industry; Espania
E-mail address: inga_urbina3@keysight.com
Additional authors:

Abstract:

Keysight Technologies provides today all of its customers with access to calibration certificates through an online customer portal where they can view it online and can download it in pdf or xml format. Last year the company wanted to explore via a proof-of-concept the creation of Digital Calibration Certificates (DCCs) but using blockchain technology to capture the calibration information and the delivery of the certificate; understanding that soon the conventional pdf and paper certificates will be something of the past. We began with a hypothesis wondering if the data produced for conventional calibration reports could be captured using the DCC standardized format and be securely transmitted to customers using blockchain technology. We also wanted to explore the required infrastructure to be able to process, store and securely transmit this FAIR (Findable, Accessible, Interoperable and Reusable) data. The capture and transmission of data using Blockchain technology offers traceability, trust, and reliability. It can also be used and considered as a single source of truth.

If true, the resulting digital file can lower forgery risk and provide vendor-neutral machine readability. By using DCC Schema definition they can also be a standardized way of sharing calibration information between a calibration laboratory, its customers, with certification bodies, and other ecosystem members in a distributed, permissioned private ledger.

We also assumed that DCC had to had additional security requirement, meaning that DCCs had to be trusted, from a verifiable source, had to be securely transmitted and any alteration could be spotted.

The objectives of the PoC were:

- Explore the creation of a blockchain-based system for calibration data/ certificates.
- Provide customers with a DCC.
- To be able to certify the authenticity of DCC and track its provenance.
- Check the information of the DCC is complete and accurate.

We teamed up with Amazon Managed Blockchain Services who helped design the infrastructure. We built the infrastructure that sits on top of Hyperledger Fabric infrastructure using Amazon microservices, integrating to our infrastructure using APIs (Application Protocol Interfaces).

At the end of our first Proof of concept we proved that it is possible to link information across databases (or nodes) with API's and share it securely on-demand with customer databases (or nodes) via a private permissioned network. We successfully built a front-end prototype of the DCC portal and proved that we were able to spot forgeries or files issued by an unauthorized source by using a distributed ledger system visible to Keysight or the end user with varying levels of permission. We tested the PoC with forgeries and were able determine if the original file had been changed and by whom.

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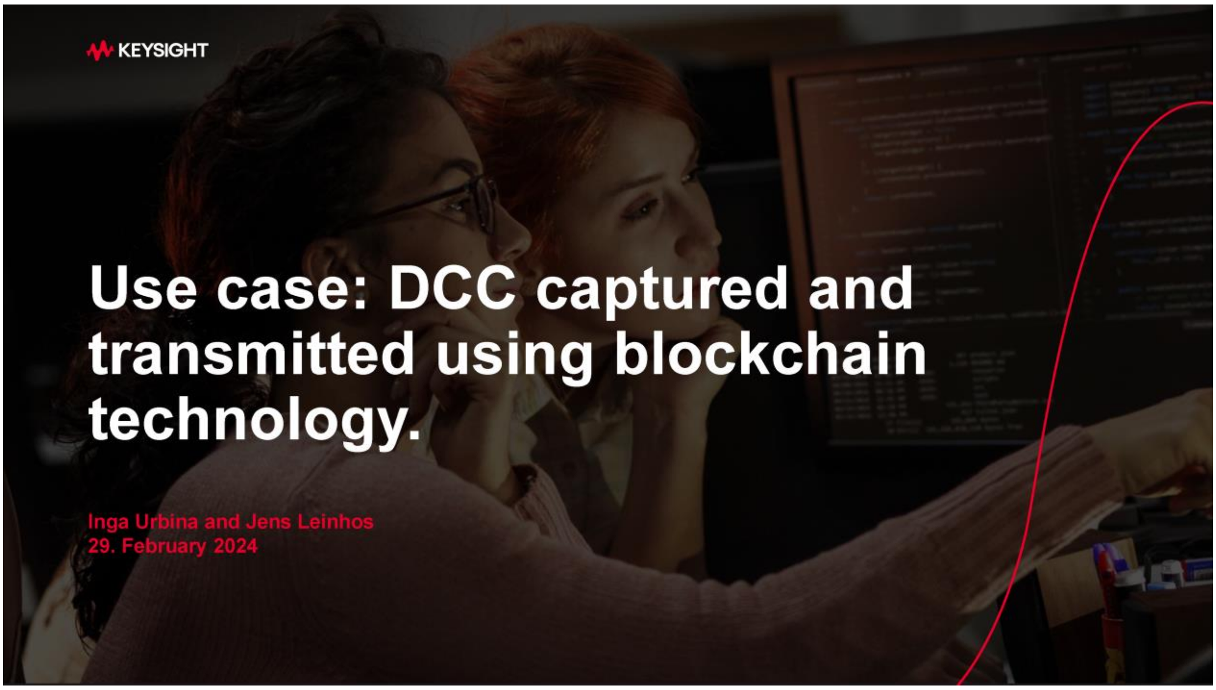
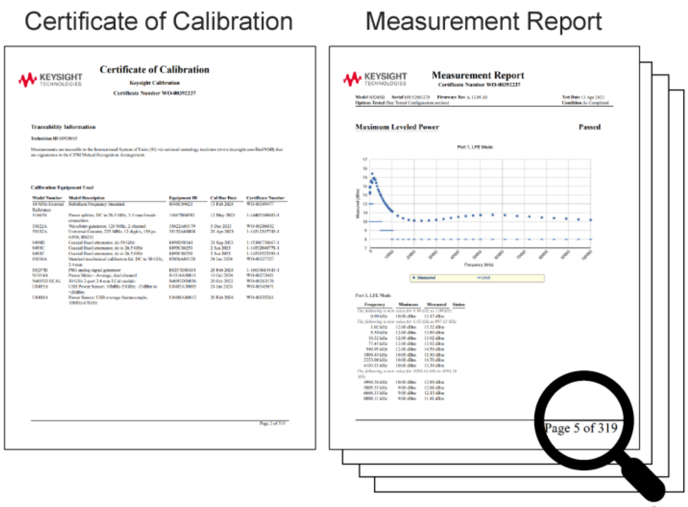
Presentation of Inga Urbina



Use case: DCC captured and transmitted using blockchain technology.

Today's praxis: non-machine-readable calibration certificates

- The quality monitoring processes are (especially from the customer's point of view) cumbersome.
- The use of the data by a manual copy is time-consuming and prone to errors.
- The data is not forgery-proof.

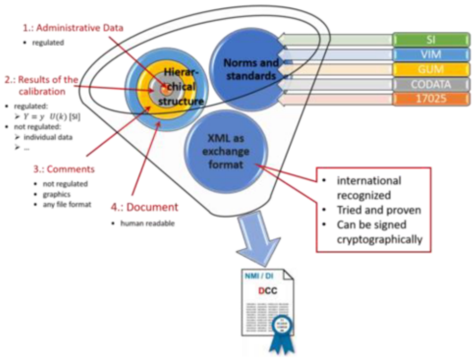


KEYSIGHT 2

Use case: DCC captured and transmitted using blockchain technology.

Future requirements for calibration certificates

- Support of machine readability and thus automated quality control processes
- Secure and error-free data transmission
- Automatic transfer of data to digital processes
- Communicate the DCC to customer using secure mechanisms
- Perform check of DCC validity
- Traceability

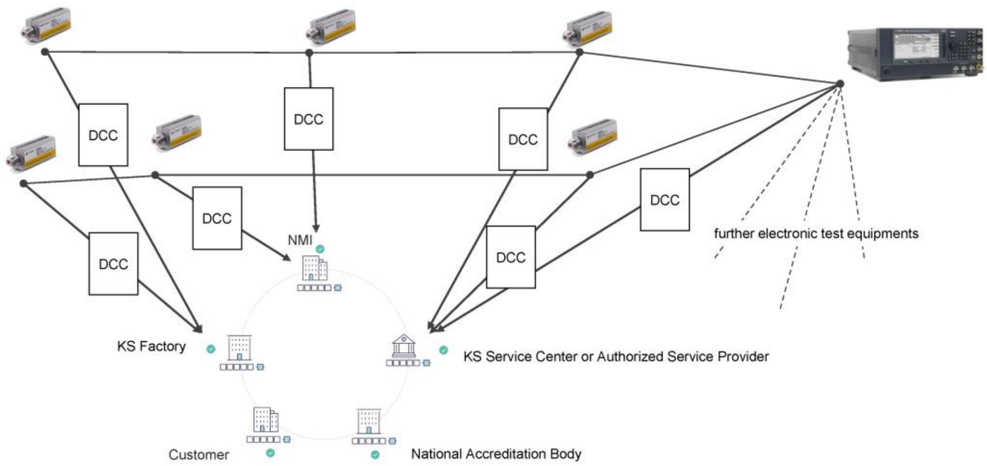


© DCC schema: www.ptb.de

KEYSIGHT 3

Use case: DCC captured and transmitted using blockchain technology.

Blockchain-enabled traceability

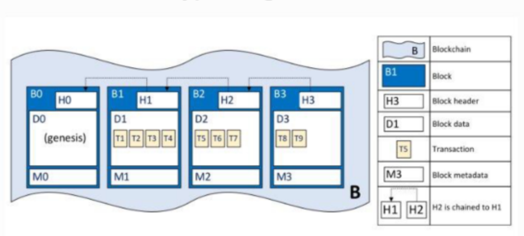


© Blockchain network: https://hyperledger-fabric.readthedocs.io/en/latest/blockchain.html#what-is-a-blockchain

KEYSIGHT 4

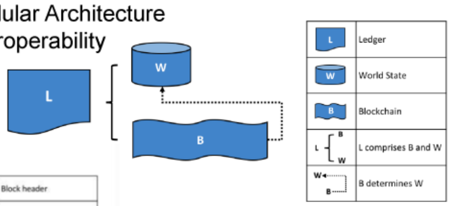
Use case: DCC captured and transmitted using blockchain technology.

Blockchain & Hyperledger Fabric



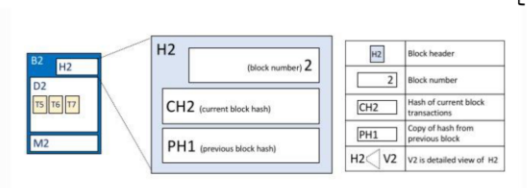
Hyperledger Fabric features

- Identity Management (Membership Service Provider)
- Privacy & Confidentiality
- Business Logic
- Governance
- Modular Architecture
- Interoperability



Benefits of blockchain technology

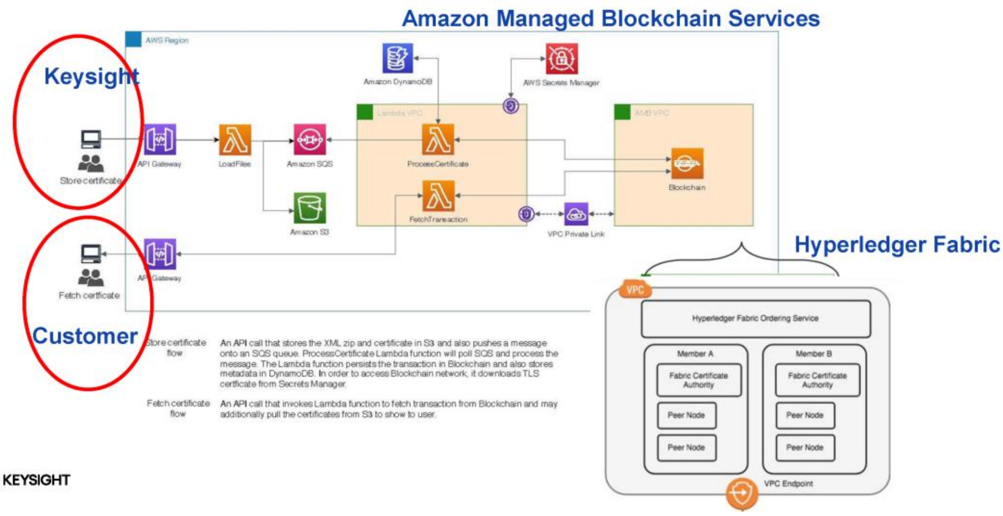
- Decentralization
- Immutability
- Transparency
- Traceability
- Auditability
- Encrypted



KEYSIGHT © Images: https://hyperledger-fabric.readthedocs.io/en/latest/ledger/ledger.html 5

Use case: DCC captured and transmitted using blockchain technology.

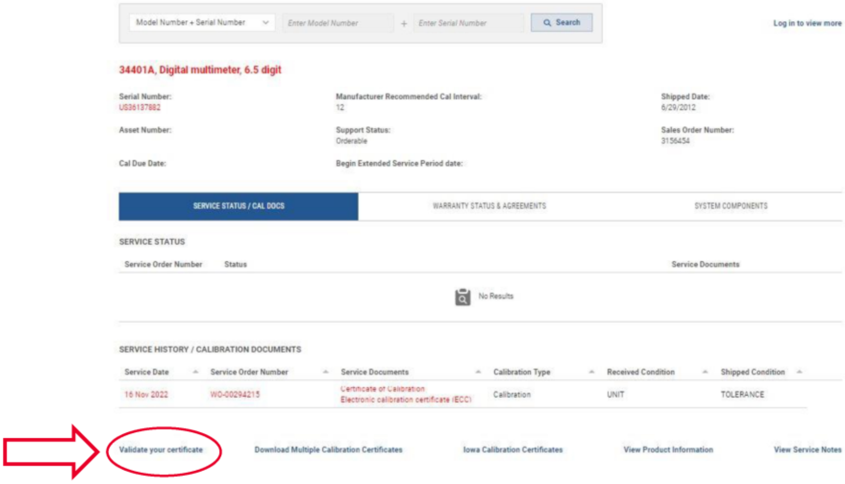
Blockchain infrastructure using AWS II



KEYSIGHT 6

Use case: DCC captured and transmitted using blockchain technology.

DCX portal mock-up



KEYSIGHT

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Use case: DCC captured and transmitted using blockchain technology.

Summary and outlook

- With a proof-of-concept, it could be shown that digital calibration certificates (FAIR data) can be exchanged, stored and processed securely with the help of blockchain technology.
- The main advantage of the presented infrastructure is the increased transparency, efficiency, and traceability in the process, as well as reduced costs and time.
- In the upcoming project phase, we would like to expand and test the infrastructure with further cooperation partners.

Contact: Inga Urbina, inga_urbina3@keysight.com
Jens Leinhos, jens.leinhos@keysight.com

KEYSIGHT

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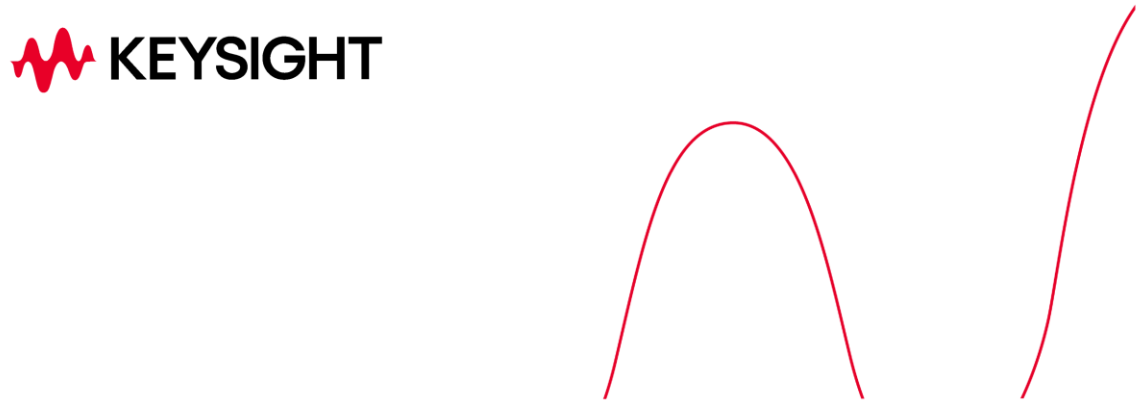

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37 UN/CEFACT update on interoperable conformity data exchange in a digital quality infrastructure

Presenting author: Brett Hyland, Project Lead at UN/CEFACT
E-mail address: Brett.Hyland@nata.com.au
Additional authors:

Abstract:

Conformity data related to traded goods differs in fundamental ways compared with equipment assurance data, yet there are potential payoffs if a degree of interoperability could be achieved. This is especially true given that the national accreditation bodies (ABs) and, in some cases the conformity assessment bodies (CABs) involved, are the same. The United Nations Trade Facilitation and E-business group (UN/CEFACT) has been advancing a work stream dealing with the exchange of product conformity attestations in the context of a digital trading environment based on electronic product passports. A Business Requirements Specification titled *Digital Product Conformity Certificate Exchange* is currently under development and an update on this work will be provided. Building upon previous UN/CEFACT outputs, the work conceptualises a platform-independent 'digital envelope' issued by CABs that may be linked to by product passport registries, while remaining verifiable back to the issuing body and providing insight into the assurance type, regardless of whether the 'enclosed' certificate is analogue, digital, or hybrid and whether this certificate is made accessible to external parties or not. It is hoped that increased awareness of these developments may facilitate discussion regarding digitalisation matters between the scientific and trade measurement community and the wider conformity community.

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Presentation of Brett Hyland

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Product conformity data in trade - a changing landscape

Sustainability goals are driving rapid shifts in regulations affecting product data.

Digital verification of product data is becoming a central objective.

In response, digitalization initiatives in trade are multiplying. For example, around 70 groups are examining implementations of Digital Product Passports (DPP) alone.

UN / CEFACT

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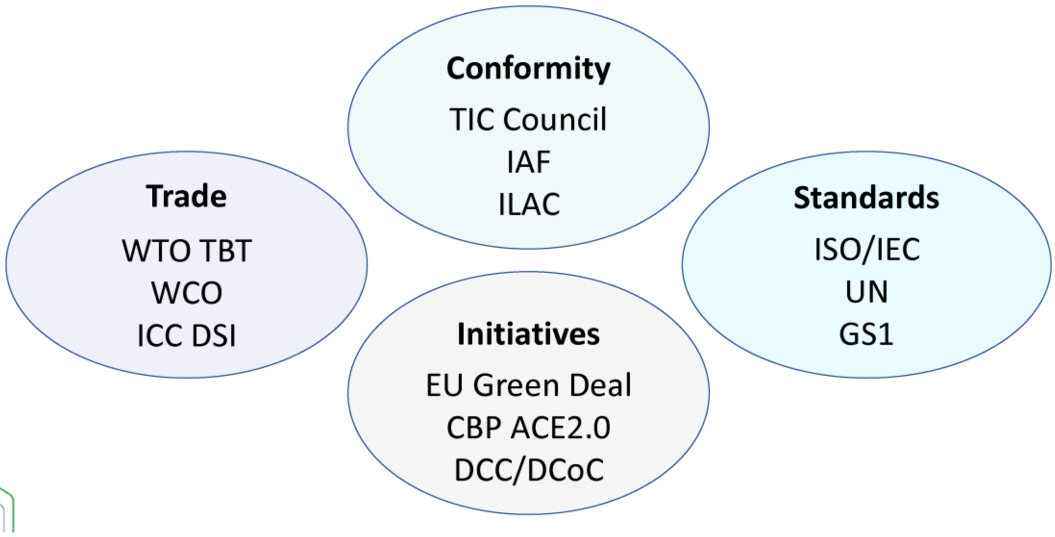
Trade-related data – a complex space!



UN / CEFACT

Verifying product conformity assessment data

Product claims are typically substantiated by testing, inspection, certification and so on - which we collectively refer to as conformity assessment (CA)

Hence the need for verifying conformity attestations:

- Is the conformity attestation real and current?
- Does it relate to the delivered product?
- Was it issued under a credible authority?
- Can robust verification processes be reconciled with data confidentiality/sensitivity issues?

Different emphasis compared to calibration data …yet there is some common ground

Common need to **link data with physical objects** (item under test, traded goods)

Certificates/reports are **subject to revision** by issuing CAB

Common need for **reliable access** to uniquely identified certificates/reports

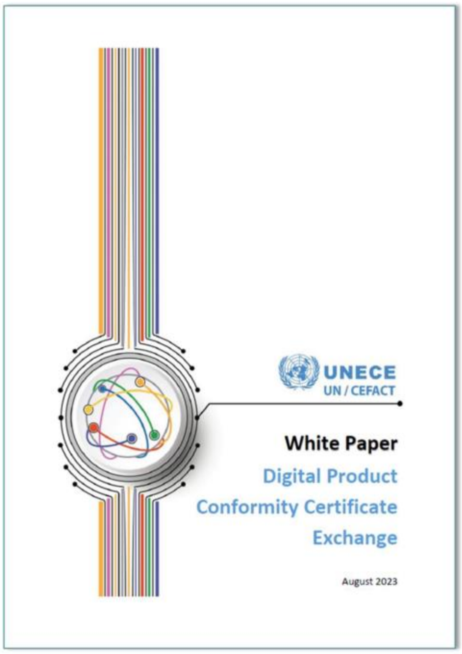
A common **accreditation structure** exists (ILAC MRA coverage)

Data confidentiality may not suit **publicly accessible registers**

UN Centre for Trade Facilitation and eBusiness (UN/CEFACT)

Facilitating national and international trade through underpinning standards/processes/definitions

Promoting UN Sustainable Development Goals, including work on product circularity projects linked to Digital Product Passports (DPP)



https://unece.org/trade/uncefact/guidance-material

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DPCCE - focusing on verifiable linkages

Attestation issuers (CABs) can act as ‘trust anchors’ in supply chains

- Making an **independent record** of any **verifiable identifier** for the product (or organization) that was the object of the assessment
- Attestations discoverable in a manner that is **verifiable back to the issuer** (or to an authoritative repository of attestations, like the IAF)
- Attestations verifiably digitally linked to any **external authority** (accreditation or regulatory) under which they were issued

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DPCCE 2 - Business Requirements Specification

Objective: Prepare an implementable specification for industry for the exchange of product conformity data in the context of global digital trade

Progress: Public comment release expected by April 2024

Some key concepts:

- respecting CAB autonomy & confidentiality demands of their customers
- product data carriers, open-source data exchange & linked registries
- encasing shell for certificates (regardless if digital/analogue/hybrid)
- flexible level of meta data insight into certificate content (eg, to support digital product passports)

UN / CEFACT

Flexible meta data insights

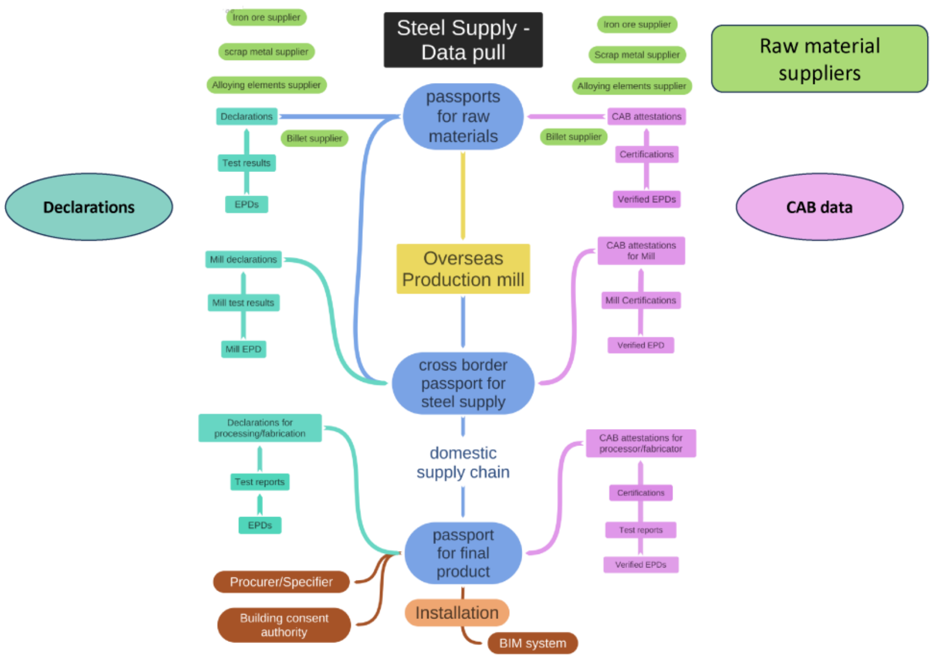
1. Simple level (no CA details, no encryption)

2. Optional digital capture of ID for the CA objects, ID of schemes & standards (via URI), accreditation/regulatory approval (via URI)

3. Generalised Data Model – Optional file encryption, optional digital capture of CA details + outcomes such as numerical/non-numerical results and/or specification compliance, *e.g. if digital capture of key elements is required for non-digital certificates*

Some thoughts on use

- Not proposing a schema for digitalising certificates, only a mechanism for exchange and verification to support trade (with manual verification still needed if 100% assurance is needed)
- No intention to create Calibration-related conformity data fields (keeping a trade focus + DCC renders this redundant anyway)
- Voluntary adoption in certain trade contexts does not preclude other concurrent processes for conformity data exchange
- Adoption of this model by parties could occur on any timeframe, at any level (eg, individual CAB, Scheme or regulatory program) and for any selected certificate categories, without disrupting existing trade provisions
- Since the provision of conformity assessment data is a relatively self-contained element of trade data, the approach could become a modular component of some overall digital trade processes.



World Wide Web Consortium verifiable credentials

- Independent from platform or software provider (and open source)
- Tamper-evident and can be transmitted and stored by external parties without losing verifiability or integrity (useful for external parties having to provide information demanded by authorities or buyers)
- Can be accessed directly (such as from a product passport registry) and include further links to externally-hosted data
- Can be combined with analogue processes (eg, barcode scanning) so that the data is accessible by parties having no digital capacity or in pure machine environments (and can even be selectively redacted by a transmitting parties)

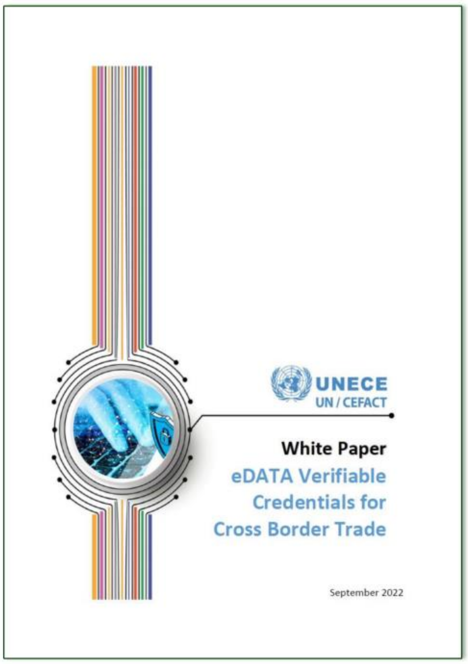
And, most critically: **Revoked once, revoked everywhere**

Microsoft implementation of W3C VCs

Microsoft Entra Verified ID Service (launched August 2022)

> *"An issuance and verification service in Azure and a REST API for W3C Verifiable Credentials that are signed with the* did:web *method.*
>
> *They enable identity owners to generate, present, and verify claims. This forms the basis of trust between users of the systems."*

https://learn.microsoft.com/en-us/entra/verified-id/decentralized-identifier-overview#what-are-verifiable-credentials

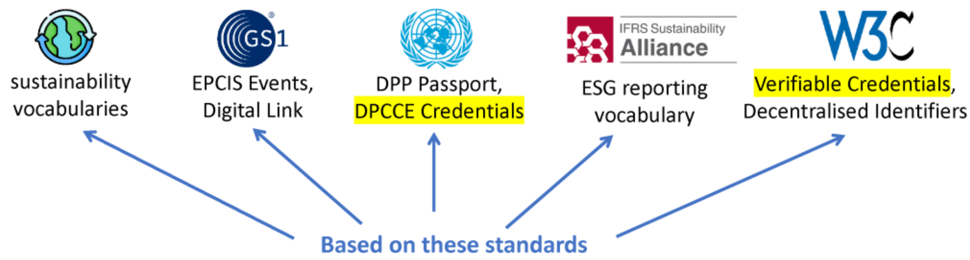


https://unece.org/trade/uncefact/guidance-material

```javascript
import axios from "axios";
import { universityDegreeCredential } from "./credentials";

// Credential subject (JSON payload)
const credentialPayload = {
  id: "did:example:ebfeb1f712ebc6f1c276e12ec21",
  degree: {
    type: "BachelorDegree",
    name: "Bachelor of Science and Arts",
  },
};

// Add the payload to the credential
const constructedCredential = {
  ...universityDegreeCredential,
  credentialSubject: credentialPayload,
};

// Issue and return the credential
const verifiableCredential = axios
  .post("https://api.vckit.showthething.com/credentials/issue", {
    credential: constructedCredential,
  })
  .then((response) => response.data);
```

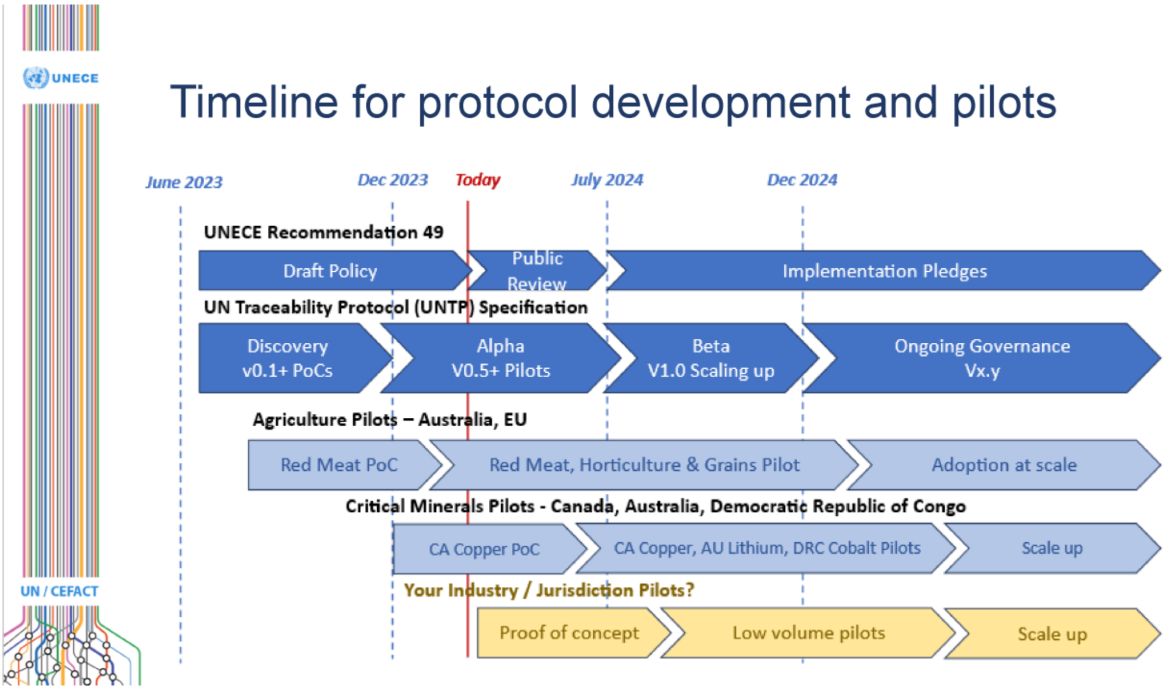
Attribution:
GoSource Pty Ltd

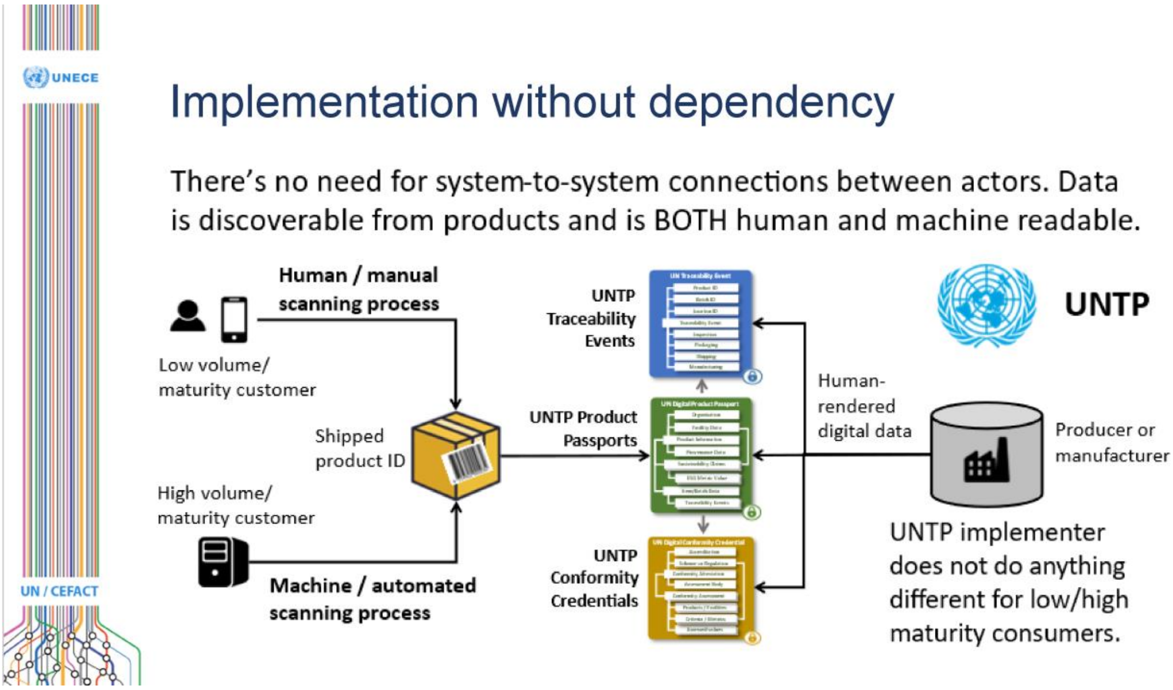
UNECE recommendation 49
“*Transparency at Scale*”



UNECE Recommendation 49

https://unece.org/sites/default/files/2023-10/Rec49_ToR-v0.8.pdf


UNECE
UN / CEFACT
Timeline for protocol development and pilots
June 2023
Dec 2023
Today
July 2024
Dec 2024
UNECE Recommendation 49
Draft Policy
Public Review
Implementation Pledges
UN Traceability Protocol (UNTP) Specification
Discovery v0.1+ PoCs
Alpha V0.5+ Pilots
Beta V1.0 Scaling up
Ongoing Governance Vx.y
Agriculture Pilots – Australia, EU
Red Meat PoC
Red Meat, Horticulture & Grains Pilot
Adoption at scale
Critical Minerals Pilots - Canada, Australia, Democratic Republic of Congo
CA Copper PoC
CA Copper, AU Lithium, DRC Cobalt Pilots
Scale up
Your Industry / Jurisdiction Pilots?
Proof of concept
Low volume pilots
Scale up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Implementation without dependency
There's no need for system-to-system connections between actors. Data is discoverable from products and is BOTH human and machine readable.
Human / manual scanning process
Low volume/ maturity customer
Shipped product ID
High volume/ maturity customer
Machine / automated scanning process
UNTP Traceability Events
UNTP Product Passports
UNTP Conformity Credentials
Human-rendered digital data
UNTP
Producer or manufacturer
UNTP implementer does not do anything different for low/high maturity consumers.

Some thoughts on CAB data in a digital trade context

- CABs retaining **autonomy over their data**, including preserving confidentiality requirements of their customers
- Digital shell provides for **gradual transition to digital certificates**
- CABs not uploading data to platforms in **vendor-stipulated formats**
- CABs **retaining flow-on value** of connections made from conformity data to the physical world
- CABs could issue such credentials directly, or have these issued by external parties (eg, AB, Scheme Owner)

What is the relevance to DCC?

An opportunity to provide awareness of related developments, noting that:

- Many CABs are involved in both testing and calibration activities, most accreditation bodies work in both testing and calibration (often certification as well)
- Exchanging ideas with other sectors might enhance compatibility and assist in planning for future directions (are there preferred fora for engaging in cross-sector dialogue?)
- Please let me know if you have any thoughts!!

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Thank you!

Brett Hyland

dpccebrs@gmail.com

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Session "Tools & Sofware II" (Chair: Jakob Fester)

38 PyDCC

Presenting author: Andreas Tobola, Siemens AG, Germany
E-mail address: andreas.tobola@siemens.com
Additional authors:

Abstract:

For the programming language Python, an array of support libraries exists for almost every data structure and interface. This diversity facilitates the rapid creation of new applications. In this context, PyDCC emerges as a valuable library. Developed as part of the GEMIMEG-II project in collaboration with various partners, PyDCC is designed for handling Digital Calibration Certificates (DCCs). The software component, PyDCC, has undergone further development and is now available as an open-source project under the MIT license.

To explore and contribute to PyDCC, visit its repository on GitHub:
https://github.com/siemens/pydcc

This talk introduces PyDCC and delves into its practical applications. With its open-source nature, PyDCC encourages collaboration and paves the way for an accelerated development process for applications centered around DCCs.

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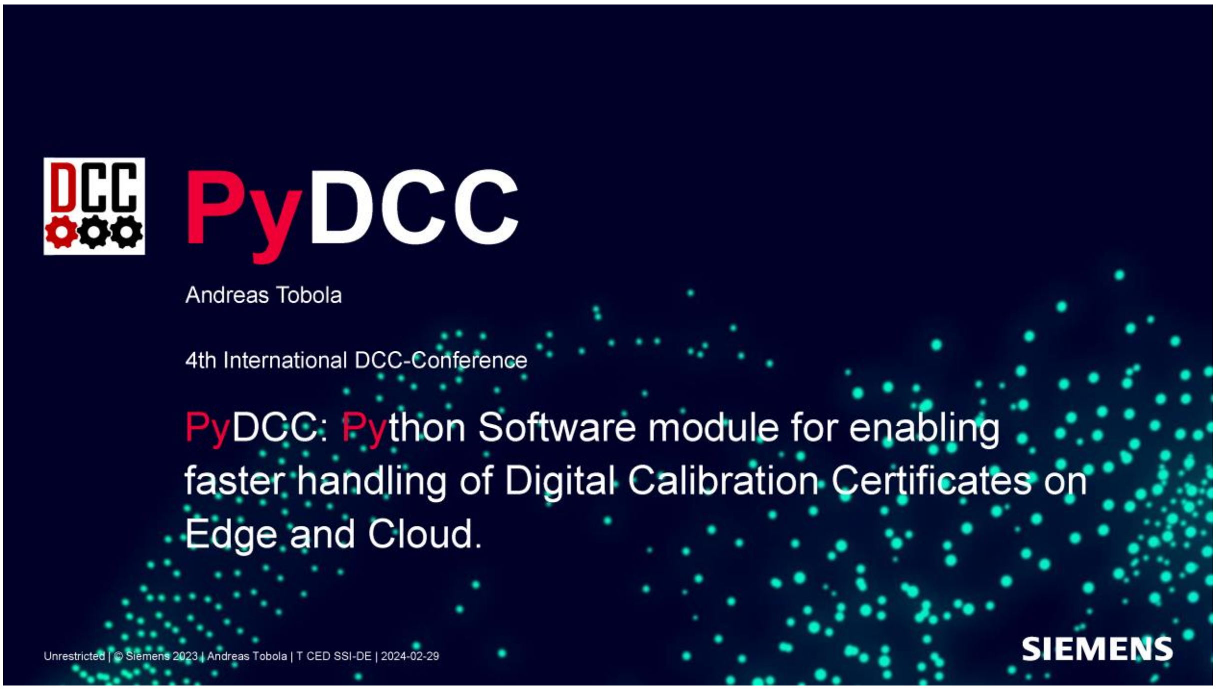
Presentation of Andreas Tobola



PyDCC
Key Information

Development was started with project members of the funded project GEMIMEG-II in January 2021

Public repository: **https://github.com/siemens/pydcc**

Open-source software license: **MIT**

You are welcome to participate: **pydcc.t@siemens.com**

Watch the video for first steps: **http://tinyurl.com/pydccintro**

PyDCC
Initial Core Team

- Andreas Tobola, Siemens AG
- Kai Mienert, PTB
- Katharina Janzen, PTB
- Anupam Prasad Vedurmudi, PTB
- Caroline Bender, Deutsche Telekom Security GmbH
- Robin Fay, Deutsche Telekom Security GmbH
- Tobias Messinger, Digiraster (affiliation until April 2022)
- Andreas Mucha, Siemens AG
- Daniel Heißelmann, PTB
- Benjamin Gloger, PTB

PyDCC
Structure of Digital Calibration Certificates (DCC)

1) Administrative Data mandatory
- Unique ID
- Calibration laboratory
- Calibration date
- Link to previous documents
- …

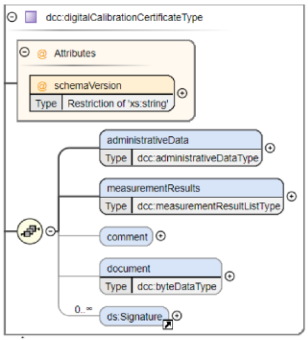
mandatory **2) Results of the Calibration**
- Calibration conditions
- Calibration table
- Calibration parameters
- Adjustment parameters

DCC

3) Comments
Non formal section containing user data
optional

optional **4) Document**
- Human readable document
- Printout conform with DIN 17025

5) Signature (new since version 3.2, developed in GEIMEG-II) optional

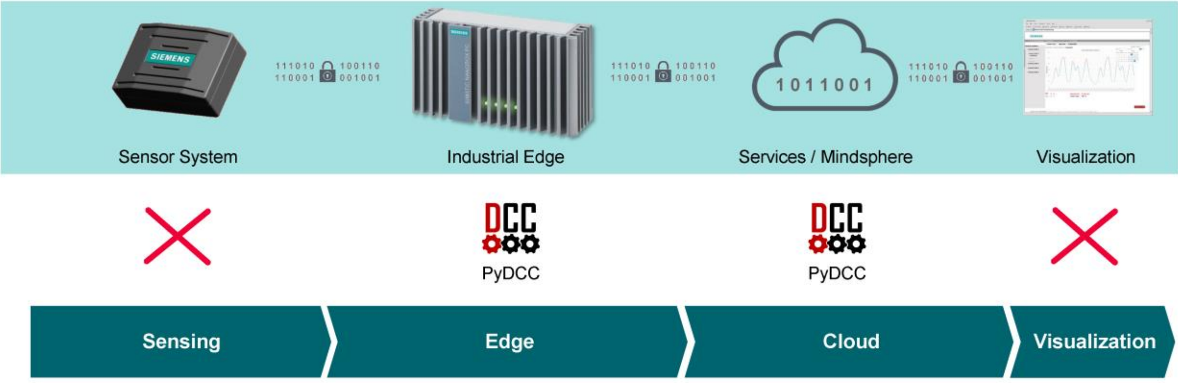


 https://www.ptb.de/dcc SIEMENS

PyDCC
What is the purpose of PyDCC?

1. Enable faster development of applications for processing of DCCs on Edge and Cloud
2. Key driver: Reusable software
3. Verify the DCC
   - XML schema (DCC schema, D-SI schema)
   - Signature
4. Read contents from
   - Administrative data section (DCC IDs, Version, Date, Sensor ID, …)
   - Measurement results section (Precision, Accuracy, …)
5. Provide common data preprocessing features
   - Days since last calibration
   - Measurement results processing

Application Example
Where to you use PyDCC?



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PyDCC
Software Management

Feature Implementation

Implemented				Ongoing	In Discussion
Read DCC from file	DCC version	DCC Repository LE	Verify signature		Sign DCC
Read DCC from stream	Calibration date	Read from Repository	Previous DCC		Uncertainty Computing
Read DCC compressed	Days since last calibration	Item IDs			Adjustment Functions
Compress DCC	Read measure ment results	Verify DCC schema			Calibration Lab

Administration

Implemented				Ongoing	In Discussion
Unit tests	3rd Party Lic. Clearing	Continuous Test	Open Source Publication		Demo Container
Open Source License	Contributing Guide	Test Coverage Measurement			
External Repository	Py Module Packaging	Developer Team Building			

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PyDCC
Code Example

```
from dcc import DCC
xml_file_name = '../data/siliziumkugel.xml' # Example from PTB
dcco = DCC(xml_file_name) # Load DCC and crate DCC object
if dcco.verify_dcc_xml():
    print("XML schema is valid.")
else:
    print("XML schema is invalid.")
uid = dcco.uid()
print('DCC UID: %s' % uid)
calib_date = dcco.calibration_date()
print('Calibration date: %s' % calib_date.strftime("%d. %B %Y") )
days_since_calibration = dcco.days_since_calibration()
print('%d days since calibration' % days_since_calibration)

if (days_since_calibration > 365):
    print('=> Recalibration required according to QMS.')

if dcco.is_signed():
    print('Signature available.')
    if dcco.is_signature_valid():
        print('Signature is valid.')
    else:
        print('Signature could not be verified.')
else:
    print('DCC is not signed.')

embdcc = dcco.generate_compressed_dcc()
```

Output

```
XML schema is valid.
Calibration date: 12. October 2018
917 days since calibration
DCC UID: PTB - 11129 18
=> Recalibration required according to QMS.
DCC is not signed.

Uncertainty (95 %)
Masse +/-0.00000005 m³
Volume +/-0.000018 g

Embedded DCC generation for constraint
devices
DCC size 30926 bytes
Compressed DCC size 5324 bytes
Embedded DCC compression ratio 17.2%
```

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Contact

Published by Siemens AG

Andreas Tobola

Senior Key Expert Engineer

T CED SSI
Günther-Scharowsky-Str. 1
91058 Erlangen, Deutschland
Germany

E-mail pydcc.t@siemens.com

Introduction Video with Code Example:
http://tinyurl.com/pydccintro

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39 GEMIMEG Tool Advancements

Presenting author: Muhammed-Ali Demir, PTB Germany
E-mail address: muhammed.demir@ptb.de
Additional authors: Moritz Jordan moritz.jordan@ptb.de, Jan Loewe jan.loewe@ptb.de,
Justin Jagieniak Justin.Jagieniak@ptb.de

Abstract:

This presentation highlights the latest strides in the development of the GEMIMEG Tool, a user-friendly software designed to simplify the creation of Digital Calibration Certificates (DCCs) without the need for XML expertise. The tool's recent advancements focus on improving user experience, enhancing the Human Readable, introducing signature features, and transitioning to a complete single-page application.

The GEMIMEG Tool has undergone careful layout improvements, offering users an intuitive and streamlined interface for creating DCCs. The enhanced layout guides users through the DCC creation process, ensuring a more user-friendly experience and accommodating individuals with varying levels of technical proficiency.

The Human Readable feature in the GEMIMEG Tool has been expanded to accommodate a broader range of versions for the digital calibration certificate. This extension ensures that the human-readable representation remains adaptable and inclusive, supporting various versions of Good Practice examples. Researchers and stakeholders can now benefit from a more comprehensive and flexible interpretation of the digital calibration certificate, fostering usability and accessibility across different versions and standards.

A noteworthy addition to the GEMIMEG Tool is the ability to display signatures of signed DCCs, contributing to increased transparency and trustworthiness of the generated calibration certificates.

In response to user feedback, the GEMIMEG Tool has transitioned into a complete single-page application. This transformation enhances the tool's performance and responsiveness, allowing users to seamlessly create DCCs and adjust the settings within a unified interface.

The presentation aims to showcase these advancements in the GEMIMEG Tool, providing insights into the tool's evolution and its role in promoting standardized digital calibration practices. Attendees will gain a deeper understanding of how these improvements contribute to a more accessible, transparent, and efficient process for creating digital calibration certificates.

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Presentation of Muhammed-Ali Demir

Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

GEMIMEG

GEMIMEG Tool Advancements

A Software for Creating Digital Calibration Certificates (DCCs)

Muhammed-Ali Demir, Moritz Jordan, Jan Henry Loewe, Justin Jagieniak
Working Group 1.24

Scope

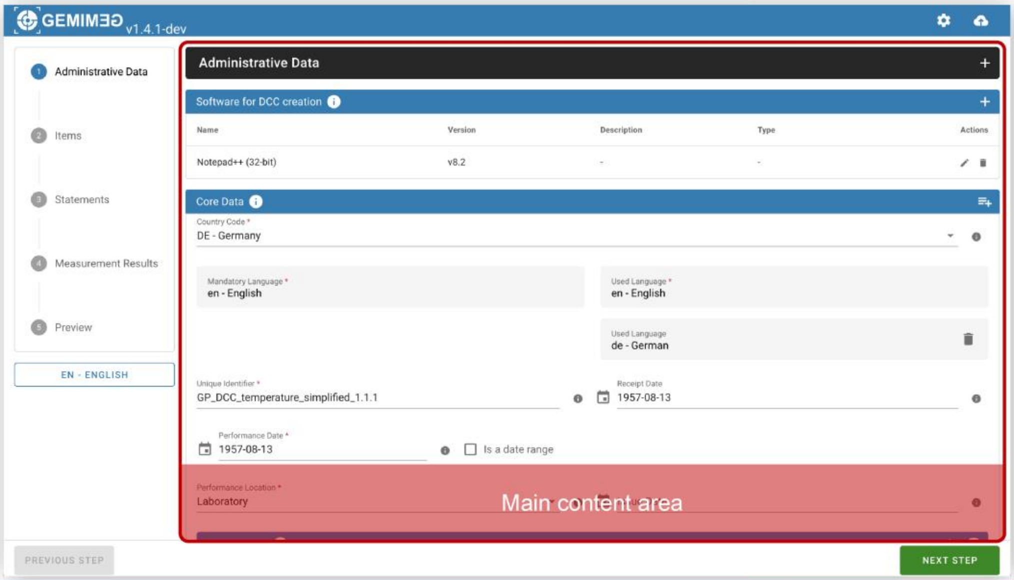
- Graphical user interface for creating and editing DCCs
- Software for the “DCC Beginner”
- Convenient tool for drafting a new DCC (template)
- Open/Read/Edit existing DCCs
- The following Good Practice Examples are built-in:
  - Temperature
  - Air Pressure
  - Humidity

23.05.2024 2 Muhammed-Ali Demir, Moritz Jordan, Jan Henry Loewe

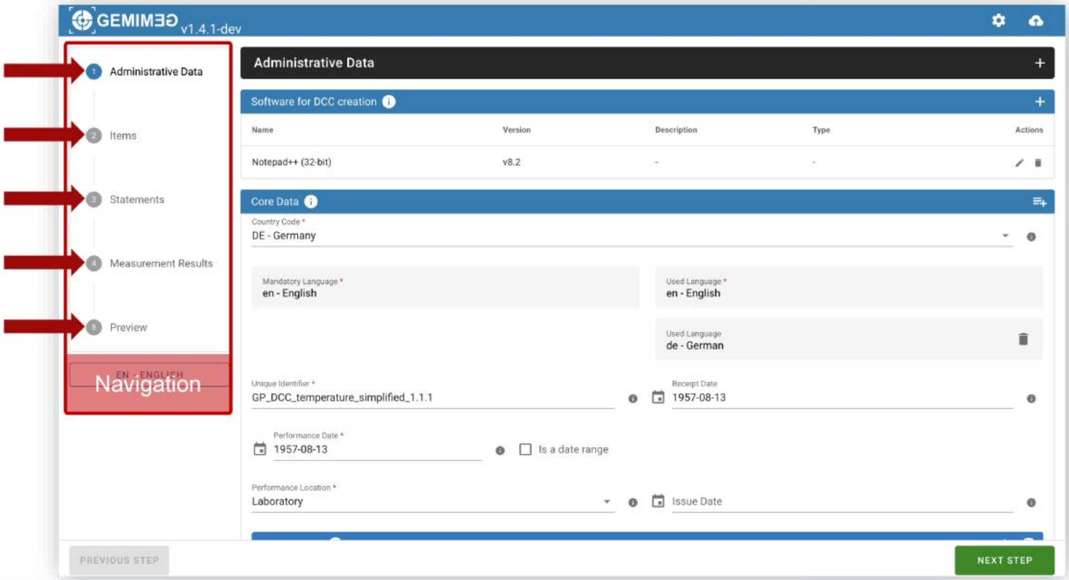
Features

- Available as web & desktop application
- Automatic schema validation (v3.x.x)
- View inline signatures
- File attachment
- Human readable generation using XSLT
- DCC file viewer
- Built-in wiki links

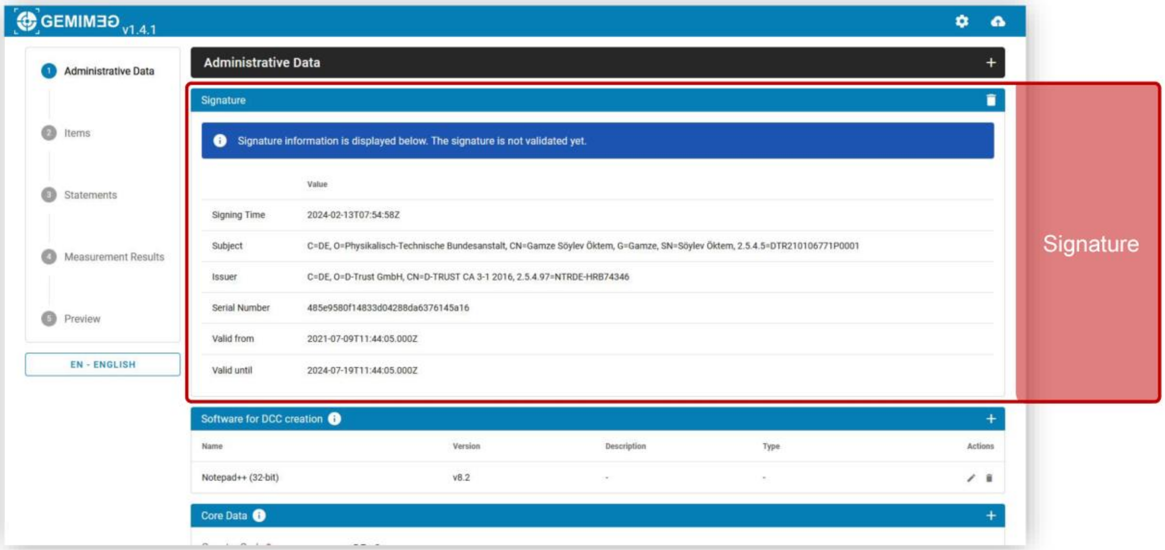
Layout of the GEMIMEG Tool



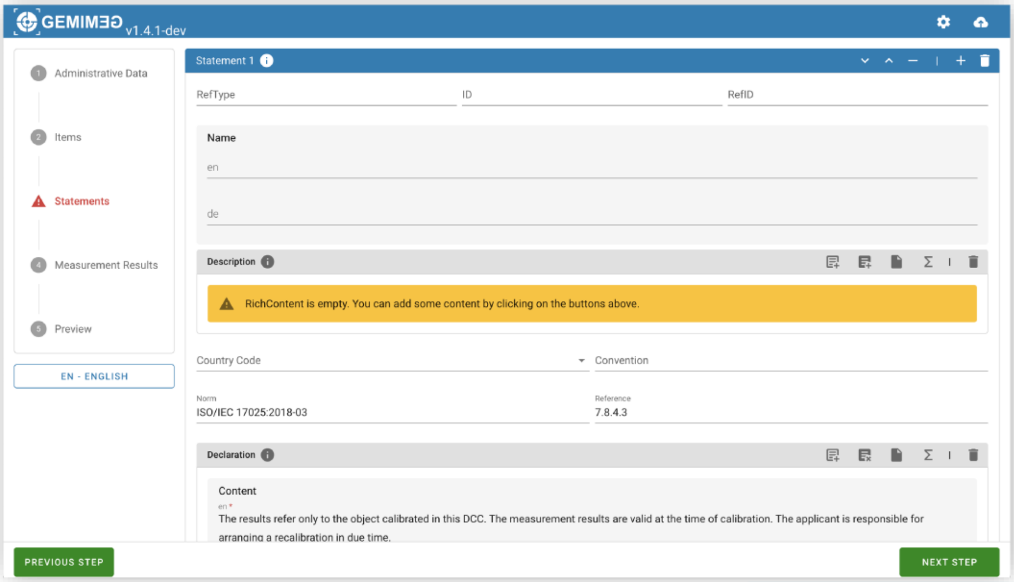
Layout of the GEMIMEG Tool



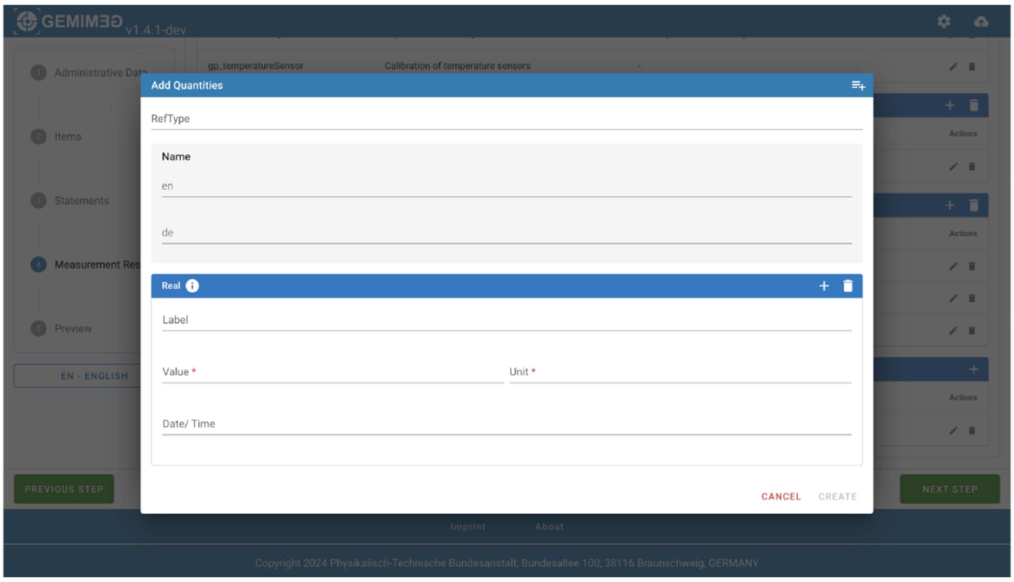
Loading a DCC with Signature



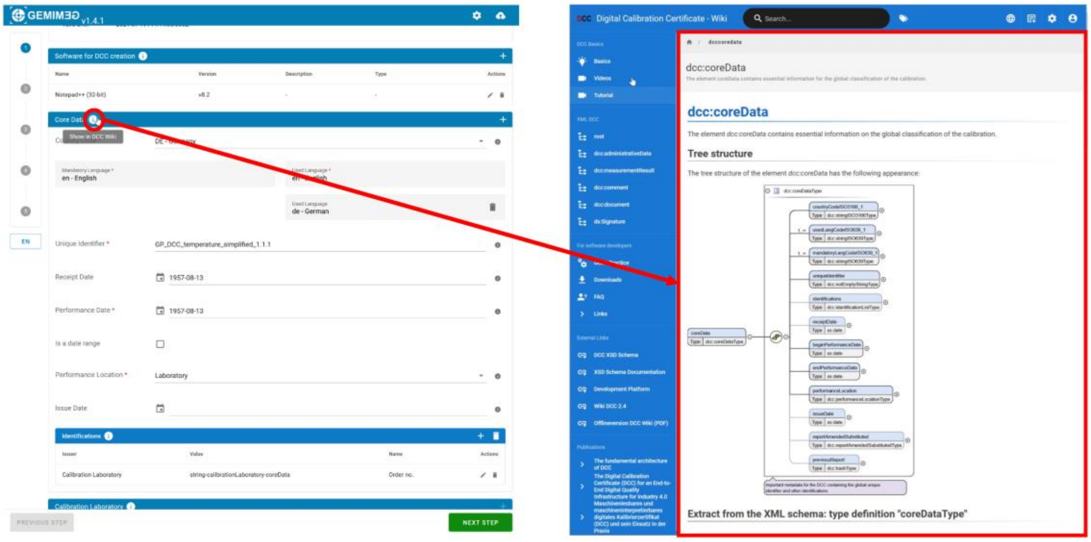
Non-mandatory elements in drop-down menu



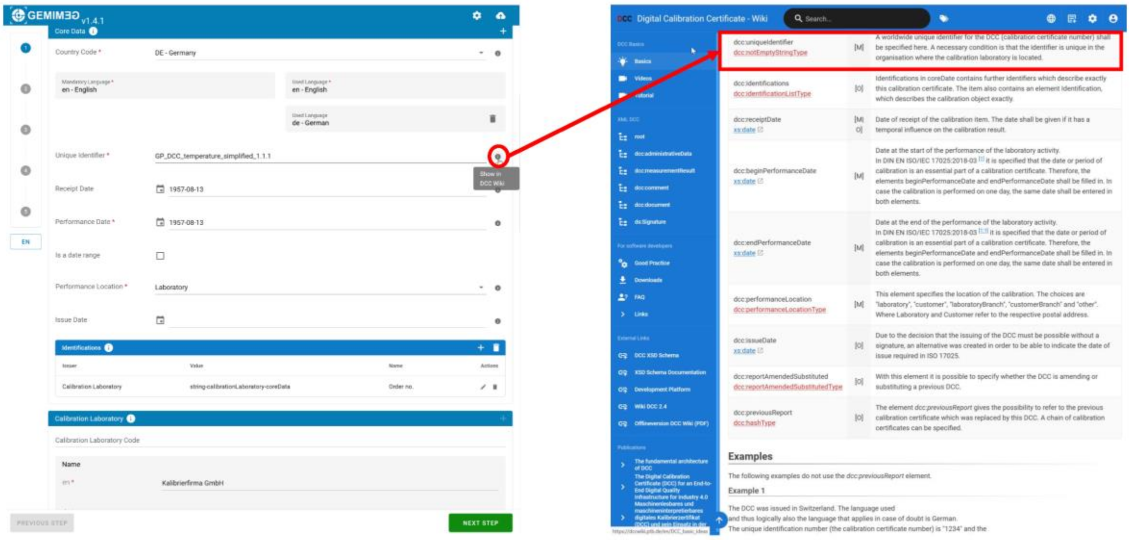
Choice in drop-down menu



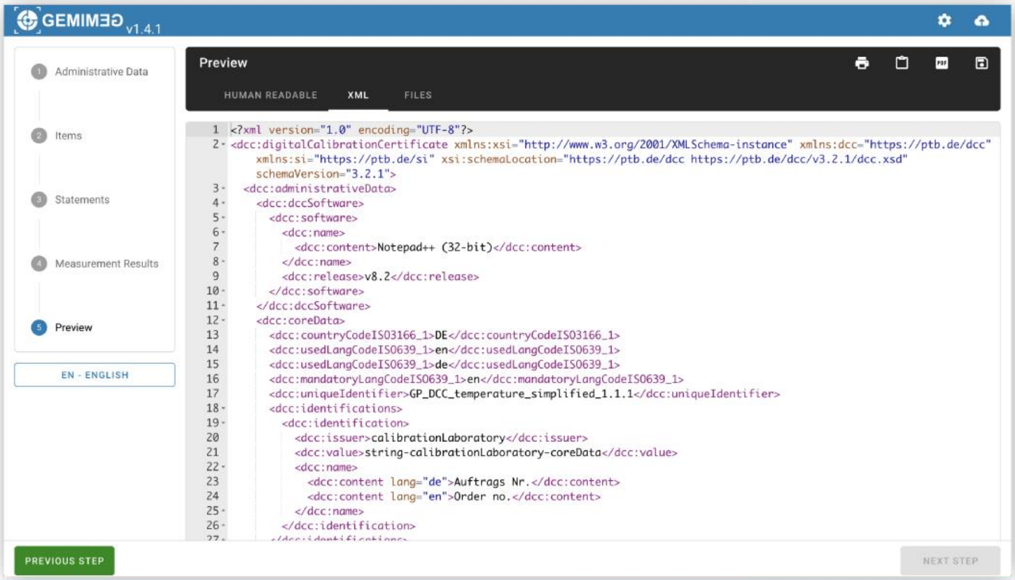
Direct Link to DCC Wiki



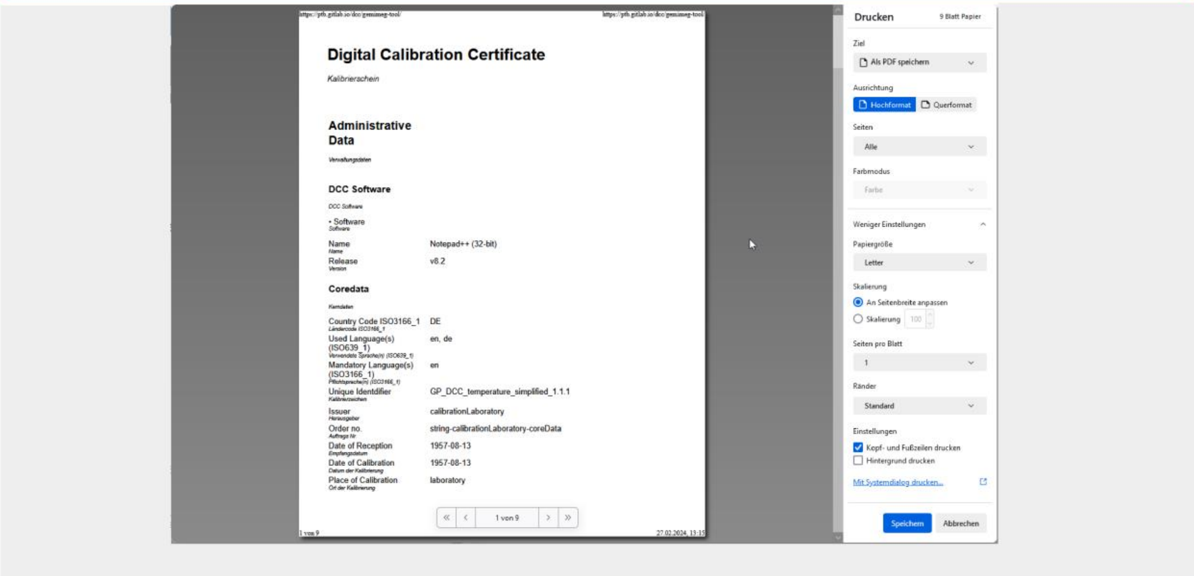
Direct Link to DCC Wiki



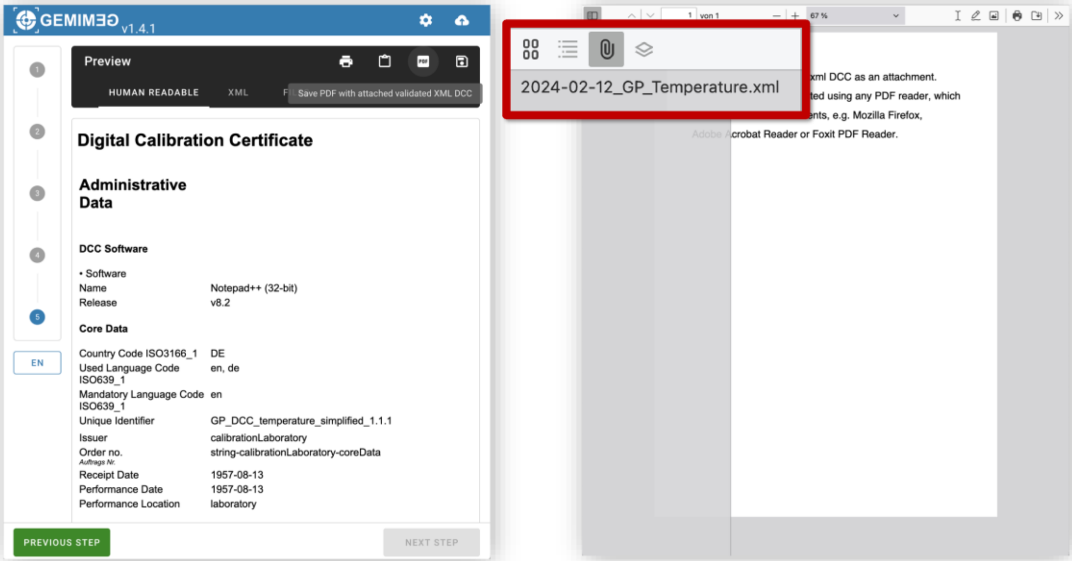
XML Preview



Human-Readable



Export PDF with attached XML DCC



Try it Yourself!

Stable version:
https://www.gemimeg.ptb.de/gemimeg-tool

Desktop version:
https://gitlab.com/ptb/dcc/gemimeg-tool-desktop/-/releases

Latest features:
https://ptb.gitlab.io/dcc/gemimeg-tool

Future of the GEMIMEG-Tool

PTB

- XSLT Exchange (currently in development)
- Adding MathML support
- Extension API
- RefType Assistant

Please contribute to the project by creating an issue on
https://gitlab.com/ptb/dcc/gemimeg-tool

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Nationales Metrologieinstitut

GEMIMEG

Moritz Jordan
Phone: +49 531 592-1245
Email: moritz.jordan@ptb.de

Jan Loewe
+49 531 592-1018
jan.loewe@ptb.de

Muhammed-Ali Demir
Phone: +49 531 592-1241
Email: muhammed.demir@ptb.de

Justin Jagieniak
+49 531 592-1016
justin.jagieniak@ptb.de

Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

Thank you for your attention!

Do you have any questions or comments?

Moritz Jordan, Muhammed-Ali Demir, Jan Loewe
Working Group 1.24

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41 Generating a Torque Digital Calibration Certificate (DCC) according to DIN 51309 using Python"

Presenting author: Kai Mienert, PTB Germany
E-mail address: kai.mienert@ptb.de

Abstract:

This presentation focuses on the utilization of Python for the generation of a Digital Calibration Certificate (DCC) specifically tailored for torque calibrations in accordance with the DIN 51309 standard. The GEMIMEG-II Project, dedicated to advancing reliable and robust calibrated measurement systems in the realm of digital transformation, employed the Digital Competence Center for Wind Energy at PTB Braunschweig as a practical testbed.

The talk covers the creation of a DIN 51309-aligned DCC. A software library was written in Python for this purpose. This enables the processing of measured values in accordance with DIN 51309. This data was then copied into the Measurements result area of a DCC template. The development of the python library is not yet complete. A graphical user interface has not been implemented.

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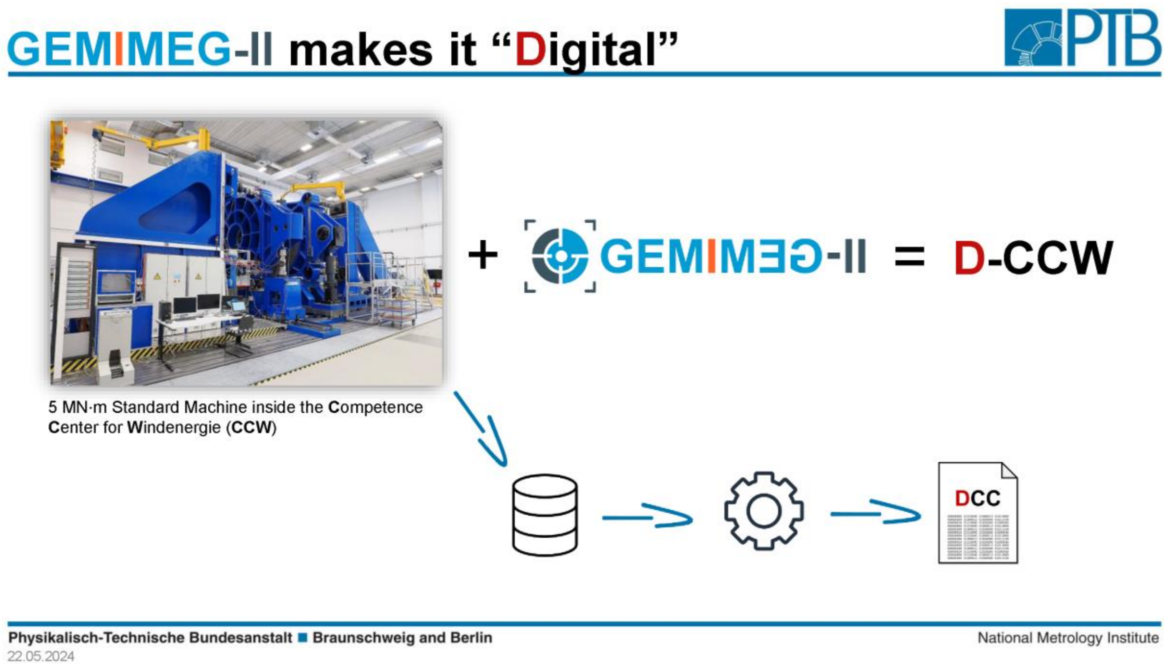
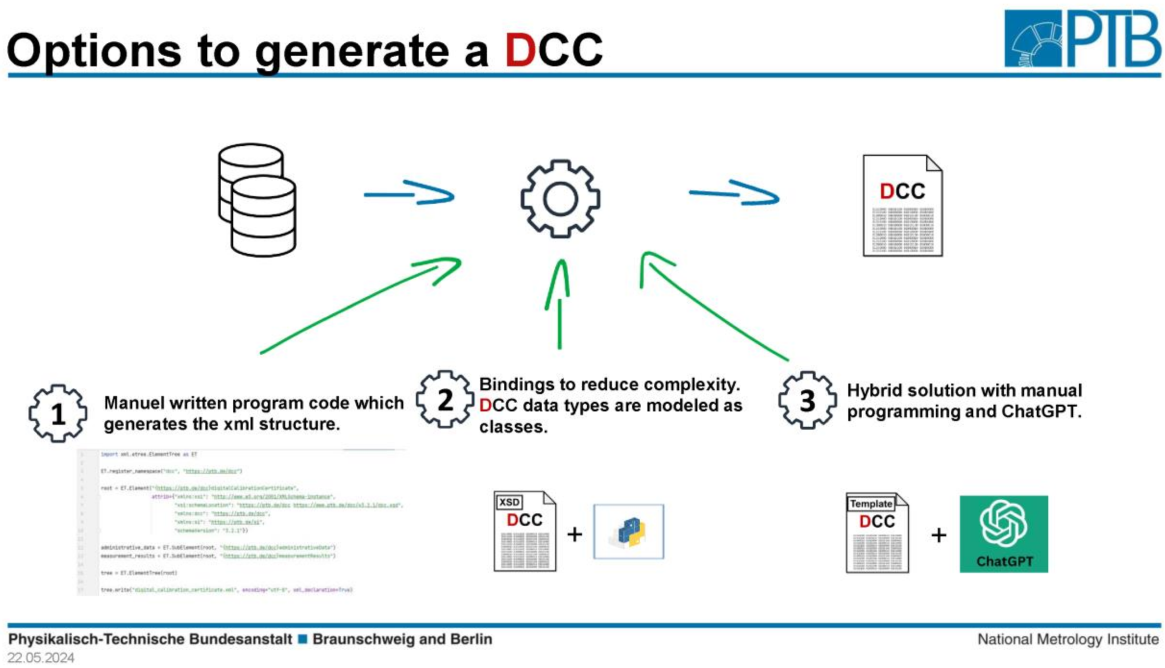
Presentation of Kai Mienert


GEMIMEG-II makes it "Digital"
PTB
+ GEMIMEG-II = D-CCW
5 MN·m Standard Machine inside the Competence Center for Windenergie (CCW)
DCC
Physikalisch-Technische Bundesanstalt ■ Braunschweig and Berlin
22.05.2024
National Metrology Institute


Options to generate a DCC
PTB
DCC
1 Manuel written program code which generates the xml structure.
2 Bindings to reduce complexity. DCC data types are modeled as classes.
3 Hybrid solution with manual programming and ChatGPT.
XSD DCC +
Template DCC + ChatGPT
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22.05.2024
National Metrology Institute

Manual generation

1 Python module xml.etree.

```python
import xml.etree.ElementTree as ET

ET.register_namespace("si", "https://ptb.de/si"), ET.register_namespace("dcc","https://ptb.de/dcc")

# Create the root element
root = ET.Element("{https://ptb.de/dcc}digitalCalibrationCertificate",
                  attrib={"xmlns:xsi": "http://www.w3.org/2001/XMLSchema-instance",
                          "xsi:schemaLocation": "https://ptb.de/dcc https://www.ptb.de/dcc/v3.2.1/dcc.xsd",
                          "xmlns:dcc": "https://ptb.de/dcc",
                          "xmlns:si": "https://ptb.de/si",
                          "schemaVersion": "3.2.1"})

# Create administrativeData element
administrative_data = ET.SubElement(root, "{https://ptb.de/dcc}administrativeData")
# Create calibrationLaboratory element
calibration_lab = ET.SubElement(administrative_data, "{https://ptb.de/dcc}calibrationLaboratory")
# Create contact element
contact = ET.SubElement(calibration_lab, "{https://ptb.de/dcc}contact")
# Create name element
name = ET.SubElement(contact, "{https://ptb.de/dcc}name")
# Create content element inside name
content = ET.SubElement(name, "{https://ptb.de/dcc}content")
content.text = "PlaceholerName"
# Create location element inside contact
location = ET.SubElement(contact, "{https://ptb.de/dcc}location")
# Create measurementResults element
measurement_results = ET.SubElement(root, "{https://ptb.de/dcc}measurementResults")
# Create XML tree
tree = ET.ElementTree(root)
# Write XML to file
tree.write("digital_calibration_certificate.xml", encoding="utf-8", xml_declaration=True)
```

Python

```xml
<?xml version='1.0' encoding='utf-8'?>
<dcc:digitalCalibrationCertificate xmlns:dcc="https://ptb.de/dcc"
                                   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
                                   xsi:schemaLocation="https://ptb.de/dcc https://www.ptb.de/dcc/v3.2.1/dcc.xsd"
                                   xmlns:dcc="https://ptb.de/dcc"
                                   xmlns:si="https://ptb.de/si"
                                   schemaVersion="3.2.1">
    <dcc:administrativeData>
        <dcc:calibrationLaboratory>
            <dcc:contact>
                <dcc:name>
                    <dcc:content>PlaceholerName</dcc:content>
                </dcc:name>
                <dcc:location/>
            </dcc:contact>
        </dcc:calibrationLaboratory>
    </dcc:administrativeData>
    <dcc:measurementResults/>
</dcc:digitalCalibrationCertificate>
```

XML

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22.05.2024

Python XML Schema Bindings

2

~~PyXB~~ → PyXB-X
update on pypi.org : 22.02.2024

"PyXB-X ("pixbix") is a pure Python package that generates Python source code for classes that correspond to data structures defined by XMLSchema."

"The purpose of this project is to keep PyXB running on newer Python releases, and provide minor bug fixes that do not break backwards compatibility with the last official release of PyXB (1.2.6)."

Apache License Version 2.0, January 2004

https://pypi.org/project/PyXB-X/

https://github.com/renalreg/PyXB-X

xsData
update on pypi.org : 19.02.2024

"xsData is a complete data binding library for python allowing developers to access and use XML and JSON documents as simple objects rather than using DOM.

The code generator supports XML schemas, DTD, WSDL definitions, XML & JSON documents. It produces simple dataclasses with type hints and simple binding metadata.

The included XML and JSON parser/serializer are highly optimized and adaptable, with multiple handlers and configuration properties."

MIT License

https://pypi.org/project/xsdata/

generateDS
update on pypi.org : 02.11.2023

"generateDS.py generates Python data structures (for example, class definitions) from an XML Schema document. These data structures represent the elements in an XML document described by the XML Schema. It also generates parsers that load an XML document into those data structures. In addition, a separate file containing subclasses (stubs) is optionally generated. The user can add methods to the subclasses in order to process the contents of an XML document."

MIT License

https://pypi.org/project/generateDS/

■ ■ ■

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Bindings Example

2


```
bindings_xsdata
  dcc_3_1_1
    __init__.py
    dcc_3_1_1.py
    si_format.py
  dcc_3_2_1
    dcc_3_2_1.py
    si_format.py
    xmldsig_core_schema.py
  __init__.py
  generate.sh
```

```python
from pathlib import Path
from xsdata.formats.dataclass.parsers import XmlParser
from xsdata.formats.dataclass.serializers import XmlSerializer
from xsdata.formats.dataclass.serializers.config import SerializerConfig
from bindings_xsdata.dcc_3_2_1 import dcc_3_2_1
from bindings_xsdata.dcc_3_1_1 import dcc_3_1_1
import requests
def example_read_and_write():

    # Download a good practice
    url = 'https://dccwiki.ptb.de/goodpractice/temperature/dcc_gp_temperature_simplified_v12.xml'
    xml_string = requests.get(url).text

    # Create a parser to parse the downloaded good practice
    parser = XmlParser()
    myDCC = parser.from_string(xml_string, dcc_3_1_1.DigitalCalibrationCertificateType)

    # Now you can access the xml data
    print(myDCC.schema_version)
    print(myDCC.administrative_data.dcc_software.software[0].name.content[0].value)

    config = SerializerConfig(ignore_default_attributes=True, pretty_print=True,
                              schema_location="https://ptb.de/dcc https://ptb.de/dcc/v3.1.1/dcc.xsd")

    serializer = XmlSerializer(config=config)
    path = Path("myDCC_from_xsdata_download_gp.xml")

    with path.open("w") as fp:
        serializer.write(fp, myDCC, ns_map={"dcc": "https://ptb.de/dcc", "si": "https://ptb.de/si"})
```

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22.05.2024

Hybrid solution (modularization)

3


```xml
<dcc:measurementResults>
    <dcc:measurementResult>
        <dcc:name...>
        <dcc:usedMethods...>
        <dcc:measuringEquipments...>
        <dcc:influenceConditions...>
        <dcc:results>
            <dcc:result refType="gemimeg_DIN-51309-2022-8.CalibrationResult"...>
            <dcc:result refType="gemimeg_DIN-51309-2022-8.Classification"...>
            <dcc:result refType="gemimeg_DIN-51309-2022-8.Regressions"...>
            <dcc:result refType="gemimeg_DIN-51309-2022-8.ClassificationCriteria"...>
            <dcc:result refType="gemimeg_DIN-51309-2022-8.Measurements"...>
            <dcc:result refType="gemimeg_DIN-51309-2022-8.Diagrams"...>
        </dcc:results>
        <dcc:measurementMetaData...>
    </dcc:measurementResult>
</dcc:measurementResults>
</dcc:digitalCalibrationCertificate>
```

Split into individual elements to generate source code for each element.

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Hybrid solution (Generate code)

3

- Use individual elements of the template to generate program code.
- The information in the XML should be anonymized. Measured values are replaced with placeholders.

You

Generate a Python programm that use xml.etree module to create these xml structure:

```xml
<dcc:itemQuantity refType="refTypeName">
  <dcc:name>
    <dcc:content lang="de">German Name</dcc:content>
    <dcc:content lang="en">English Name</dcc:content>
  </dcc:name>
  <si:real>
    <si:value>999</si:value>
    <si:unit>\basic\si\unit</si:unit>
  </si:real>
</dcc:itemQuantity>
```

ChatGPT

Here's a Python program that uses the `xml.etree.ElementTree` module to create the specified XML structure:

python Copy code

```python
import xml.etree.ElementTree as ET

# Create the root element
item_quantity = ET.Element('dcc:itemQuantity', refType='refTypeName')

# Create dcc:name element
name = ET.SubElement(item_quantity, 'dcc:name')

# Add dcc:content for German name
german_content = ET.SubElement(name, 'dcc:content', lang='de')
german_content.text = 'German Name'

# Add dcc:content for English name
english_content = ET.SubElement(name, 'dcc:content', lang='en')
english_content.text = 'English Name'

# Create si:real element
real = ET.SubElement(item_quantity, 'si:real')

# Add si:value
value = ET.SubElement(real, 'si:value')
value.text = '999'

# Add si:unit
unit = ET.SubElement(real, 'si:unit')
unit.text = '\\basic\\si\\unit'

# Create XML tree
tree = ET.ElementTree(item_quantity)

# Write XML tree to a file
tree.write('item_quantity.xml', encoding='utf-8', xml_declaration=True)

print('XML structure has been created and saved to item_quantity.xml')
```

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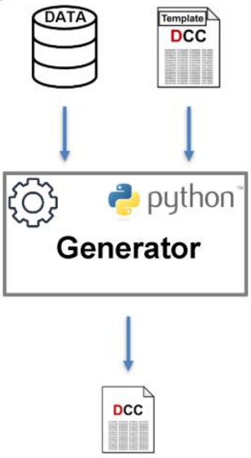
22.05.2024

Hybrid solution (Build the DCC)

3



DCC template xml tree

```python
def insert_classicifation_criteria(tree: Et.ElementTree, data: DIN51309DataStringType):
    # Search for "gemimeg_DIN-51309-2022-8.ClassificationCriteria"
    classification_criteria_element = tree.find(
        ".//{https://ptb.de/dcc}result[@refType = 'gemimeg_DIN-51309-2022-8.ClassificationCriteria']")

    # ========= Clockwise torque =========
    cw_element = classification_criteria_element.find(
        ".//{https://ptb.de/dcc}list[@refType = 'gemimeg_DIN-51309-2022-8.Cw']")

    # Delete elements gemimeg_DIN-51309-2022-8.Case1, gemimeg_DIN-51309-2022-8.Case2 und gemimeg_DIN-51309-2022-8.Table
    cw_element.remove(cw_element.find(".//{https://ptb.de/dcc}list[@refType = 'gemimeg_DIN-51309-2022-8.Case1']"))
    cw_element.remove(cw_element.find(".//{https://ptb.de/dcc}list[@refType = 'gemimeg_DIN-51309-2022-8.Case2']"))
    cw_element.remove(cw_element.find(".//{https://ptb.de/dcc}list[@refType = 'gemimeg_DIN-51309-2022-8.Table']"))
    cw_element.append(_gemimeg_din_51309_2022_8_cw_case1(data))
    cw_element.append(_gemimeg_din_51309_2022_8_cw_case2(data))
    cw_element.append(_gemimeg_din_51309_2022_8_cw_resolution_table(data))
```

DATA

```python
    # Add data to the third set of dcc:quantity elements
    add_quantity_elements(quantity7, name_de: "Kalibrierdrehmoment", name_en: "reference torque",
                          data.RelUmkehrspanneC2.torque, data.RelUmkehrspanneC2.torque_dsi_unit)
    add_quantity_elements(quantity8, name_de: "relative Umkehrspanne", name_en: "relative reversal range",
                          data.RelUmkehrspanneC2.result, data.RelUmkehrspanneC2.result_dsi_unit)
```

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Conclusion

Is it difficult to generate a DCC ? No if …

- there is a good practice,
- software,
- data

So what is the challenge ?

- Compatibility with regulations worldwide
- Standardization
- Software to work with DCCs (read and write)

suggestions
comments
questions
?

Physikalisch-Technische Bundesanstalt ■ Braunschweig and Berlin
22.05.2024
National Metrology Institute

Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
Bundesallee 100
38116 Braunschweig
Kai Mienert
Telefon: 0531 592-1278
E-Mail: kai.mienert@ptb.de
www.ptb.de

Stand: 02/24

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42 Parameter Extraction from Digital Calibration Certificates for Sensor Data Quality Analysis

Presenting author: Tim Ruhland, Siemens AG; Germany
E-mail address: tim.ruhland@siemens.com

Abstract:

The digitalization of the Quality Infrastructure (QI) has led to a paradigm shift in the way we perceive and manage data quality, particularly in the realm of IoT sensor systems. Digital certificates and reports have opened new avenues for enhancing sensor data accuracy, timeliness, consistency, and completeness based on the ISO/IEC 25000 and ISO 8000 standards. This paper focuses on extracting parameters from digital calibration certificates (DCC) and using them for sensor data quality analysis.

We present an implementation of a DCC using the open-source pyDCC library, which provides explicit parameters. These parameters are extracted and utilized for data quality algorithms and machine learning, thereby providing a framework for sensor data quality. Our use case involves an IoT sensor box with acceleration and temperature sensors, a typical setup in many modern IoT applications. The extraction of parameters and hyperparameters from DCCs provides valuable information that preconfigures data quality algorithms and machine learning models. The use of the pyDCC library simplifies this process, making it accessible to a broader range of applications.

The results of our implementation demonstrate the effectiveness of this approach to the ongoing efforts in the digitalization of QI, with significant improvements in the sensors' data quality.

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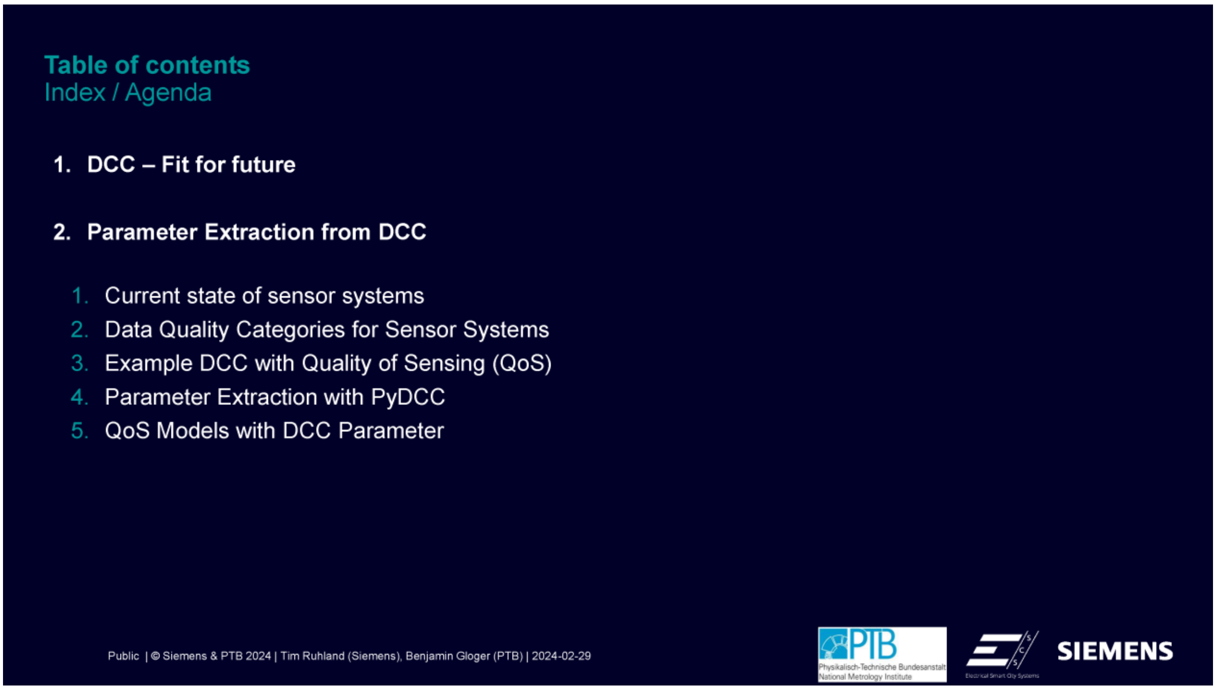
Presentation of Tim Ruhland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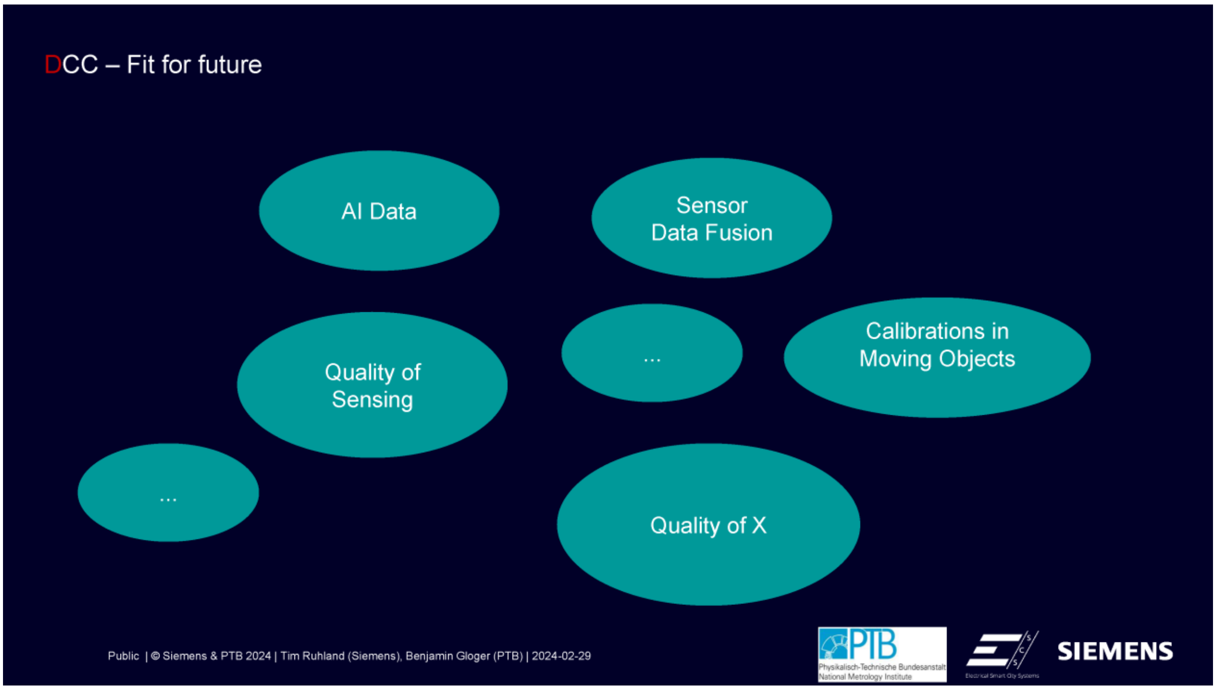
DCC – Fit for future
AI Data
Sensor
Data Fusion
Quality of
Sensing
...
Calibrations in
Moving Objects
...
Quality of X
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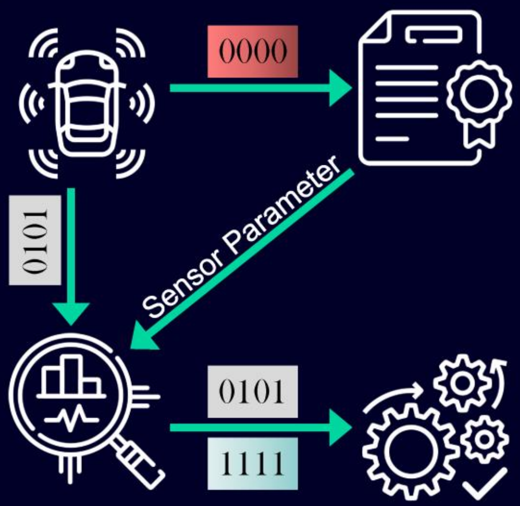
DCC – Fit for future

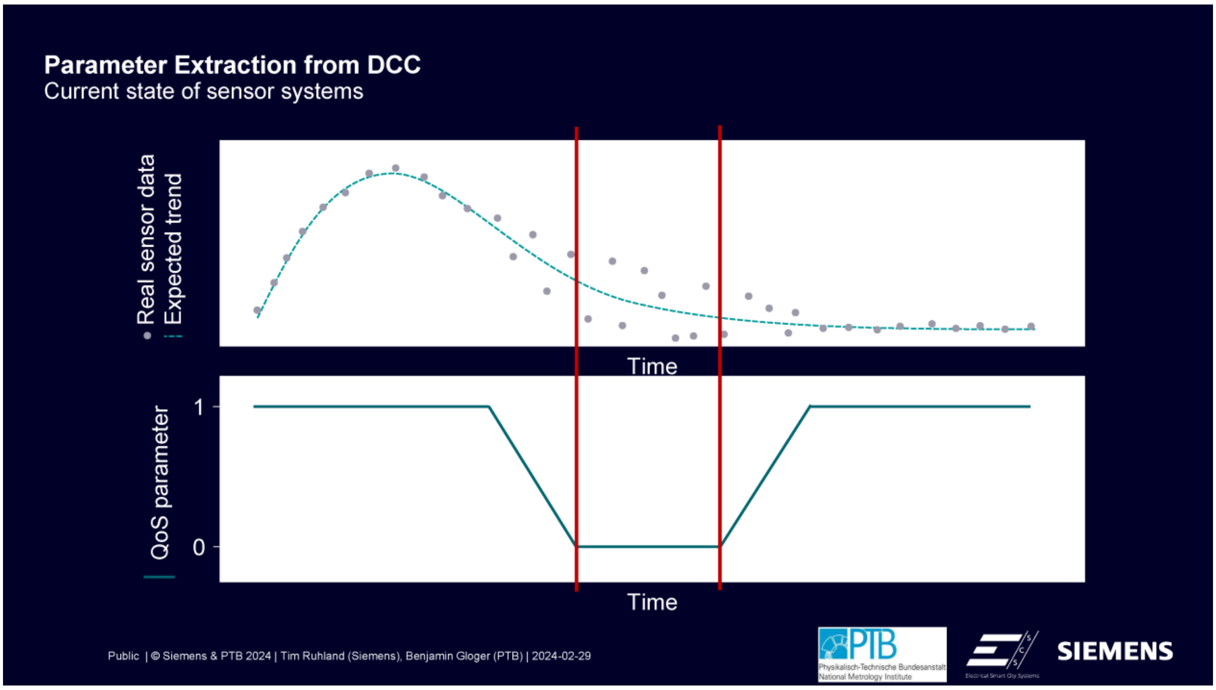
How did we prepare for this?

Storage of large amounts of data is possible
Assignment of information possible
- global
- to each measured value

Dynamic location information possible

Parameter Extraction from DCC
Current state of sensor systems




Parameter Extraction from DCC
Current state of sensor systems
Real sensor data
Expected trend
Time
QoS parameter
1
0
Time
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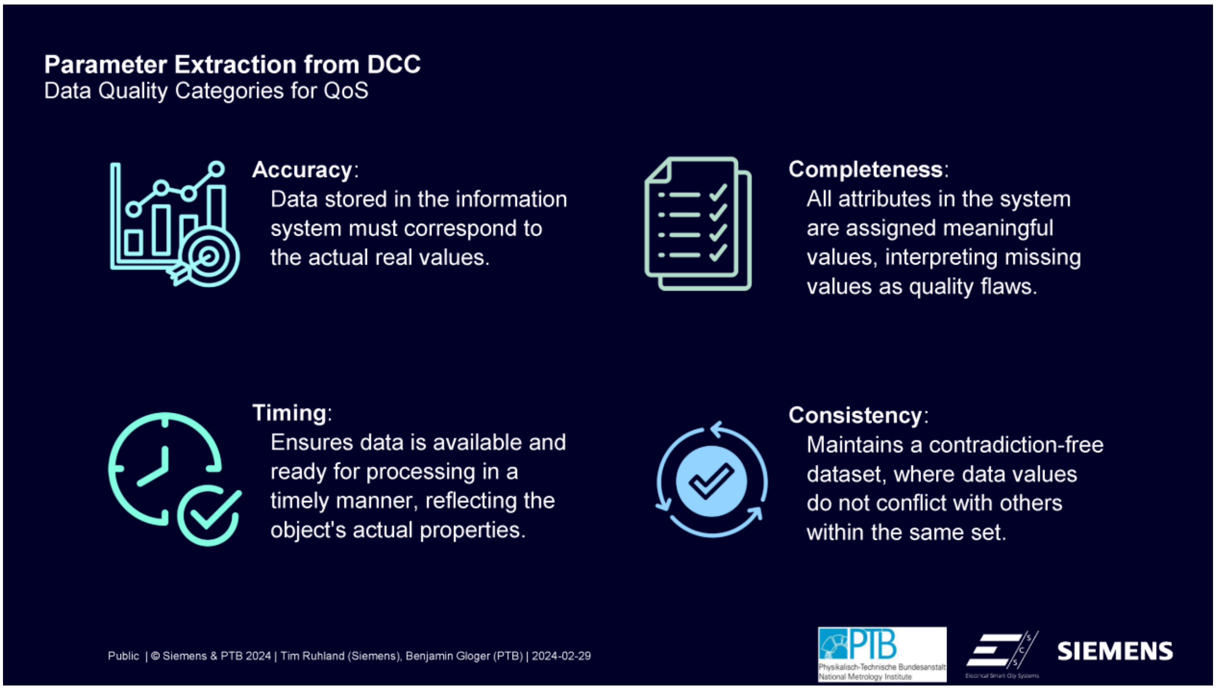
Parameter Extraction from DCC
Data Quality Categories for QoS
Accuracy:
Data stored in the information system must correspond to the actual real values.
Completeness:
All attributes in the system are assigned meaningful values, interpreting missing values as quality flaws.
Timing:
Ensures data is available and ready for processing in a timely manner, reflecting the object's actual properties.
Consistency:
Maintains a contradiction-free dataset, where data values do not conflict with others within the same set.
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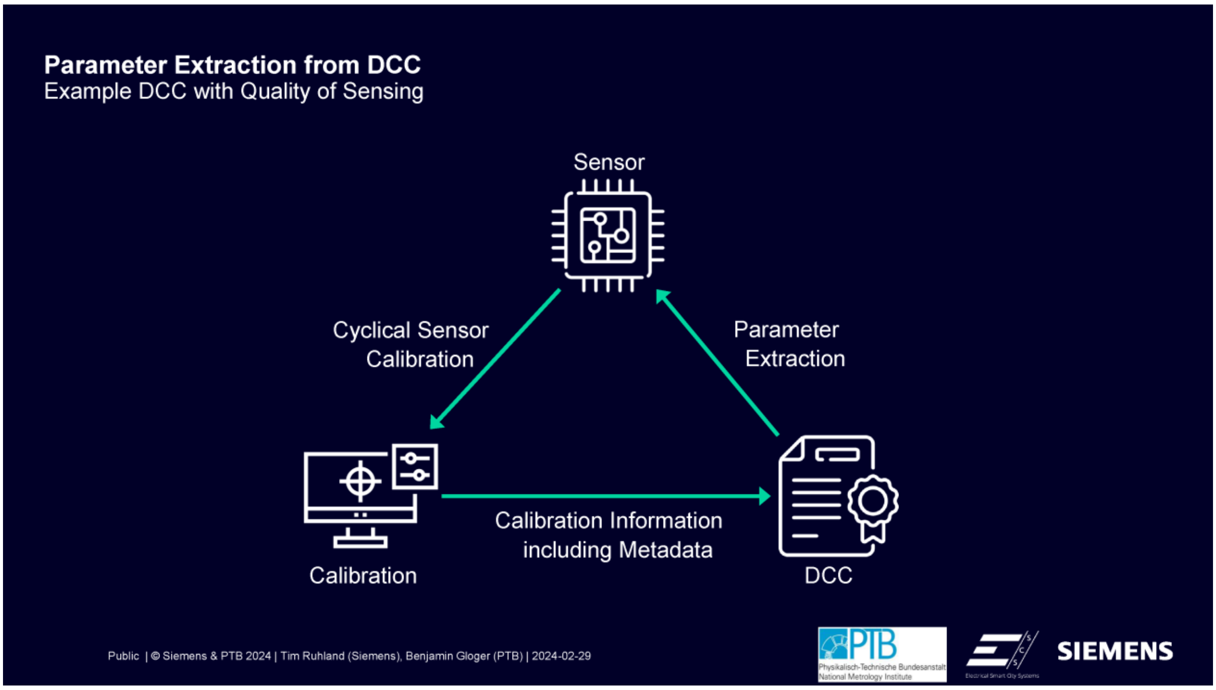
Parameter Extraction from DCC
Example DCC with Quality of Sensing
Sensor
Cyclical Sensor Calibration
Parameter Extraction
Calibration
Calibration Information including Metadata
DCC
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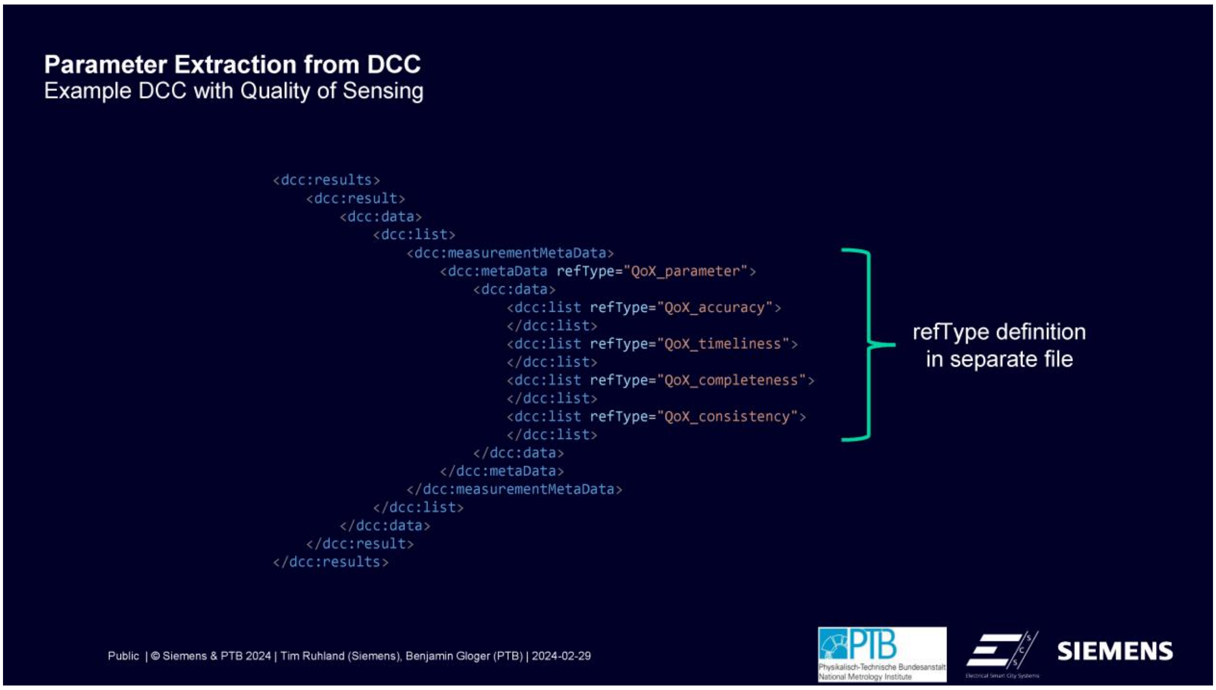
Parameter Extraction from DCC
Example DCC with Quality of Sensing
<dcc:results>
<dcc:result>
<dcc:data>
<dcc:list>
<dcc:measurementMetaData>
<dcc:metaData refType="QoX_parameter">
<dcc:data>
<dcc:list refType="QoX_accuracy">
</dcc:list>
<dcc:list refType="QoX_timeliness">
</dcc:list>
<dcc:list refType="QoX_completeness">
</dcc:list>
<dcc:list refType="QoX_consistency">
</dcc:list>
</dcc:data>
</dcc:metaData>
</dcc:measurementMetaData>
</dcc:list>
</dcc:data>
</dcc:result>
</dcc:results>
refType definition in separate file
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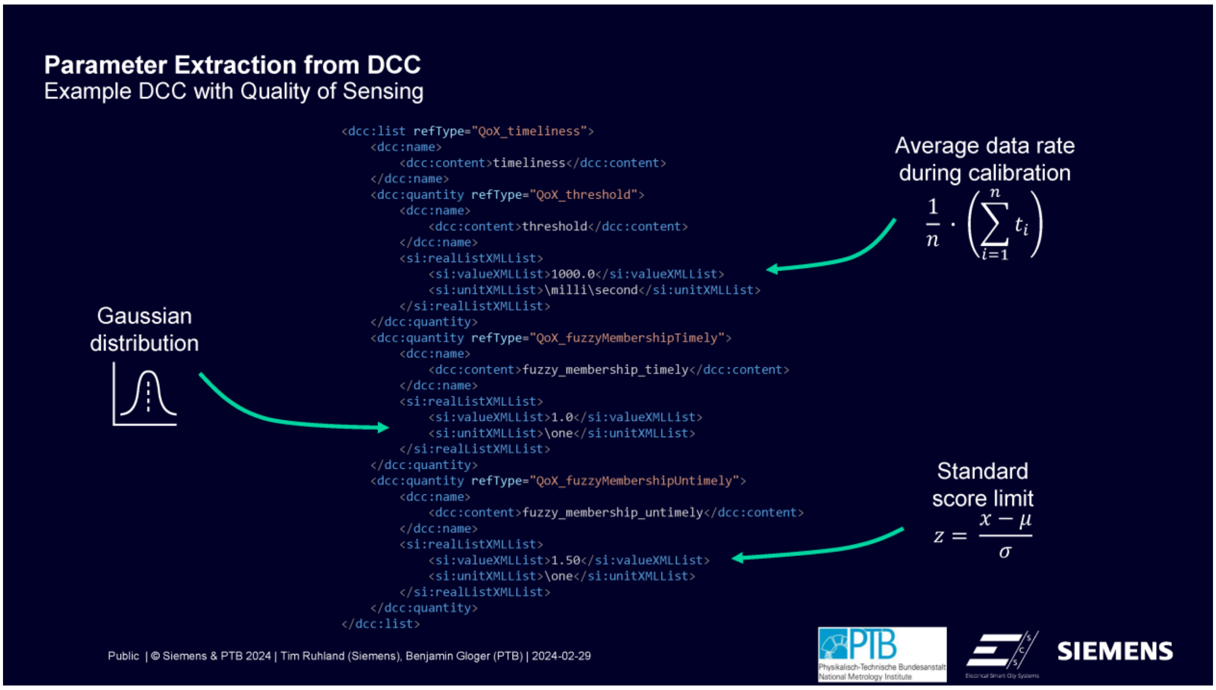
Parameter Extraction from DCC
Example DCC with Quality of Sensing
<dcc:list refType="QoX_timeliness">
<dcc:name>
<dcc:content>timeliness</dcc:content>
</dcc:name>
<dcc:quantity refType="QoX_threshold">
<dcc:name>
<dcc:content>threshold</dcc:content>
</dcc:name>
<si:realListXMLList>
<si:valueXMLList>1000.0</si:valueXMLList>
<si:unitXMLList>\milli\second</si:unitXMLList>
</si:realListXMLList>
</dcc:quantity>
<dcc:quantity refType="QoX_fuzzyMembershipTimely">
<dcc:name>
<dcc:content>fuzzy_membership_timely</dcc:content>
</dcc:name>
<si:realListXMLList>
<si:valueXMLList>1.0</si:valueXMLList>
<si:unitXMLList>\one</si:unitXMLList>
</si:realListXMLList>
</dcc:quantity>
<dcc:quantity refType="QoX_fuzzyMembershipUntimely">
<dcc:name>
<dcc:content>fuzzy_membership_untimely</dcc:content>
</dcc:name>
<si:realListXMLList>
<si:valueXMLList>1.50</si:valueXMLList>
<si:unitXMLList>\one</si:unitXMLList>
</si:realListXMLList>
</dcc:quantity>
</dcc:list>
Average data rate during calibration
$\frac{1}{n} \cdot \left(\sum_{i=1}^{n} t_i \right)$
Gaussian distribution
Standard score limit
$z = \frac{x - \mu}{\sigma}$
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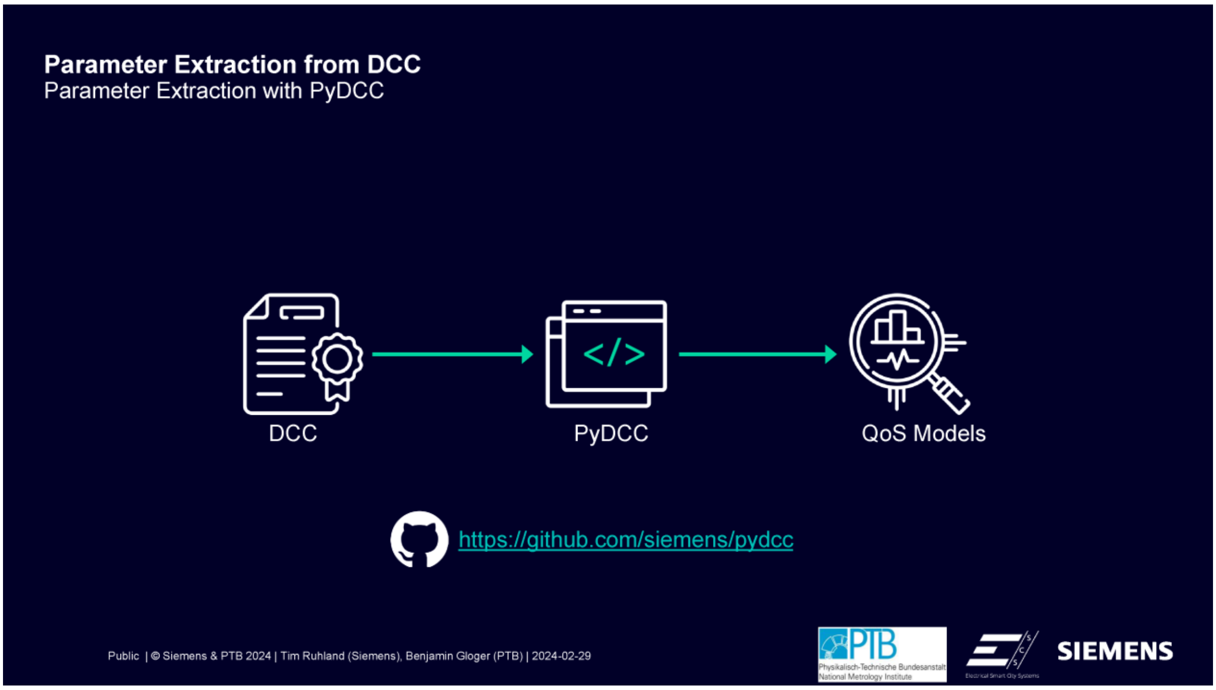
Parameter Extraction from DCC
Parameter Extraction with PyDCC
DCC
PyDCC
QoS Models
https://github.com/siemens/pydcc
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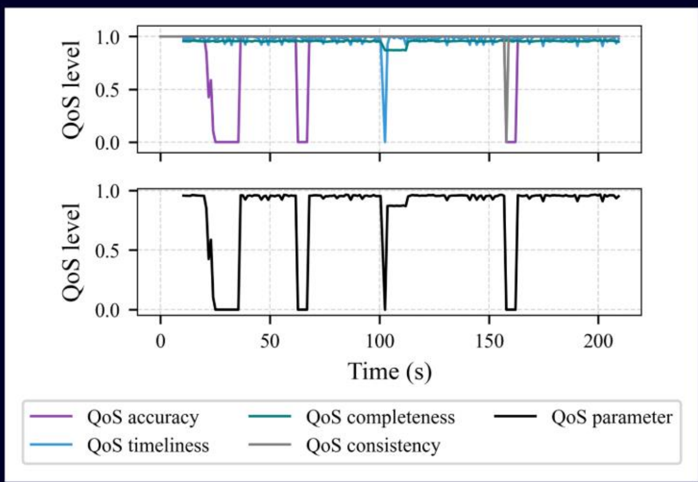
Parameter Extraction from DCC
Parameter Extraction with PyDCC

```
# Instantiate DCC class with XML file
dcco = DCC(xml_file_name)

# Verify DCC XML against online schema
dcco.verify_dcc_xml(online=True)

# Extract calibration metadata
metadata = dcco.get_calibration_metadata(type='xpath', refType='QoX_parameter')

# Get value and unit of "QoX_threshold"
QoX_threshold = dcco.get_quantity_value_and_unit("QoX_threshold")

# Instantiate TimelinessEvaluator with QoX threshold value and unit
TimelinessEvaluator(QoX_threshold, [...])
AccuracyEvaluator([...])
CompletenessEvaluator([...])
ConsistencyEvaluator([...])
```


Parameter Extraction from DCC
QoS Models with DCC Parameter



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Contact

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Tim Ruhland
PhD Student
T CED SSI-DE
Schuckertstr. 2
91058 Erlangen
Germany

Phone +49 9131 17-40555
Mobile +49 1734354053

E-Mail tim.ruhland@siemens.com

Benjamin Gloger
M. Eng.
Physikalisch-Technische Bundesanstalt
Bundesallee 100
38116 Braunschweig
Germany

Phone +49 531 592-1019

E-Mail benjamin.gloger@ptb.de

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43 Global Web platform for DCC at CENAM

Presenting author: Carlos Galvan Hernandez, CENAM; Mexico
E-mail address: cgalvan@cenam.mx
Additional authors: Lopez-Celis J.A. jolopez@cenam.mx, Dominguez-Mendoza I. idomingu@cenam.mx, García- Gonzalez A. algarcia@cenam.mx, Gasca-Aragon H. hgasca@cenam.mx

Abstract:

CENAM has designed and implemented a centralized scheme for DCC generation. It is a web tool that allows the management of digital calibration certificates. This platform making use of the existing customer and equipment records in the databases for the administrative data and allow upload the measurement result section.

In the platform, it is possible to retrieve administrative information related with the equipment under calibration (customer data and equipment data as serial number, Id, etc.), which are previously registered by clients. To complete the administrative data section, it is necessary select the real dates of calibration, the responsible and approval metrologist, with this the generation of the DCC starts.

In the next step, the responsible area of the calibration can load the XML file of the measurement results section. This file could be generated directly by specific software created for this task in more automated calibration process or by means of template spreadsheet where a sub-scheme of DCC schema is already loaded. The selection of the way to create the XML file is according to the degree of automation of each laboratory.

The use of the spreadsheet tool perhaps will be the most used tool for generate measurement results XML files at CENAM. Once the sub-scheme with lightly changes has been uploaded, so that can map the schema fields to link it, one by one with the existing cells in the measurement result sheets. It is necessary modify or update just once the usual tables contained in the spreadsheets so that they contain all the necessary fields of DDC schema of the measurement results section.

The platform integrates the measurement results section, validates against the schema, and join it with the administrative data section. Finally, the certificate signers are selected. Usually, two people sign the certificate. The platform makes use of digital signatures with PKI technology. The platform adds the hash of each signature in the corresponding layer of the DCC.

At the moment, the CENAM DCC team is working in the integration of the spreadsheets template in different services, in order to generate XML files corresponding to the measurement results section.

CENAM has shared the first DCCs with an automotive industry customer in Mexico, who already reads and uses the DCC data in its processes in a direct way.

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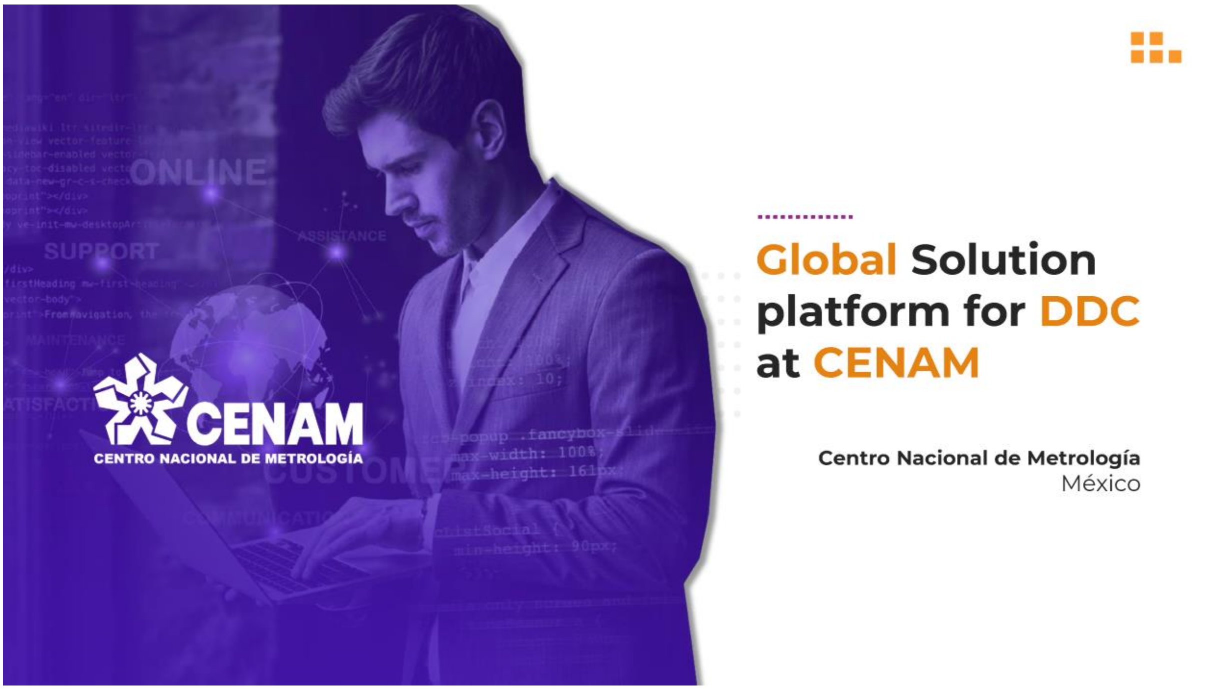
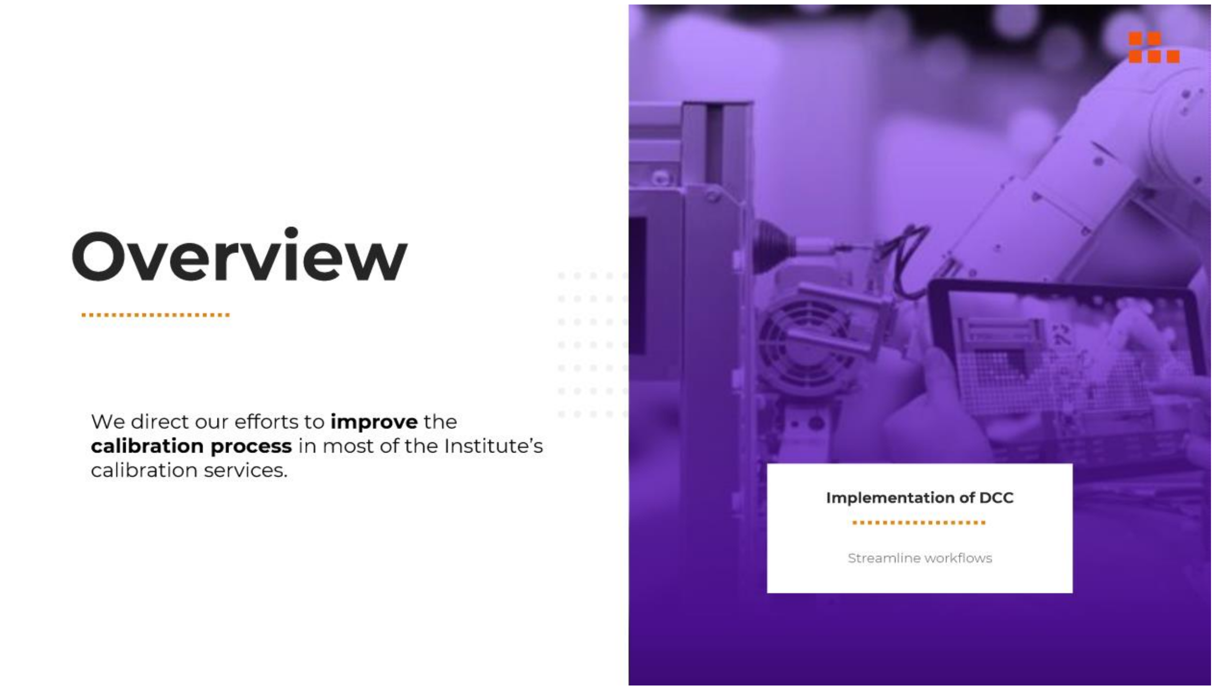
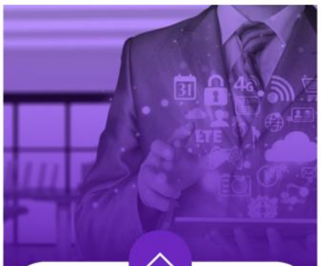
Presentation of Carlos Galvan Hernandez





Starting the change,



Digitalization of Information
XML in Worksheet

Process optimization
Web platform

Business opportunities
Digital services

Closing

Global solution

reducing errors, accelerating response times, and reducing costs

4 Pilots implemented:

- Gauge Blocks by Interferometry
- Step Gauge
- Platinum Thermometer Resistance
- Mass

Changes are good, and if they are for the benefit of all, even so more

Strengthen your value chain

Team Members

Jose Armando Lopez Celis
Metrologist
jolopez@cenam.mx

Carlos Galvan Hernandez
Metrologist
cgalvan@cenam.mx

Itzel Domínguez Mendoza
Developer
idomingu@cenam.mx

Oscar Ramos Monzalvo
Developer
proy-dim@cenam.mx

Aldo García Gonzalez
Metrologist
agarcia@cenam.mx

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Session “NMI Use Cases”
(Chair: Diego Coppa)

44 Reporting on the achievements of issuing digital calibration certificates at NMIJ, AIST

Presenting author: Domae Atsushi, NMIJ, Japan
E-mail address: domae-atsushi@aist.go.jp
Additional authors: TANABE Takehiko, TAKETOSHI Naoyuki n-taketoshi@aist.go.jp

Abstract

The NMIJ started trial issuing of digital calibration certificates (DCCs) for selected items in November 2022 [1]. Then, full issuance of DCC began in April 2023 (beginning of the fiscal year in Japan). NMIJ's DCCs are issued in PDF format to meet client requests and to ensure consistency with conventional certificates printed on paper [2]. NMIJ's DCCs are also machine-readable because electronic files containing calibration data, client's information, etc., are attached to the PDF file.

In recent years, NMIJ has issued approximately 700 paper calibration certificates per year. The number of DCCs issued from April to the end of November was 105, with DCCs accounting for 15% of the annual number of certificates issued. The breakdown of our DCCs shows that the number of certificates issued was high in some specific fields. This report provides details of our issuance achievements.

In addition, DCCs are often discussed in terms of how they are created. However, in order to actually issue DCCs to clients, it is necessary to reconsider a series of task associated with the issuance of certificates, including reception procedures for calibration, the verification of certificates at the calibration laboratories, and the safe delivery of DCCs to clients. In this report, associated tasks being reconsidered at NMIJ will also be reported.

[1] Kazuaki Yamazawa, “Development of PDF based Digital Calibration Certificates at NMIJ, AIST,” Abstracts of the 3rd International DCC Conference, page 17, March 2023.

[2] Kazuaki Yamazawa, “Activities related to DX in metrology at NMIJ,” APMP-DXFG Webinar: 28 November 2022.

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Presentation of Domae Atsushi

#044

Reporting on the achievements of issuing digital calibration certificates at NMIJ, AIST

4th International DCC Conference
27. - 29. February 2024
online/virtual

Presenting author: DOMAE Atsushi
National Metrology Institute of Japan, AIST (JAPAN)

Additional authors: TANABE Takehiko, TAKETOSHI Naoyuki

NMIJ Metrological Services

<Physics>

Recently about 700 Certificates issued / year.
NMIJ digital calibration certificate (DCC) issued from Nov. 2022.

Calibration Services

Testing Services (to determine reference values of measurement standards)

Certified Reference Materials and Reference Materials

<Chemistry>

Certified Reference Materials and Reference Materials

Calibration Services

<Legal Metrology>

[Domestic] For Measurements Instruments under the Law, *Measurement Act*

[International] Issuing OIML Certificates, Incl. OIML Testing, OIML Type Evaluation

(OIML: International Organization of Legal Metrology)

2

Before issuing a digital certificate at NMIJ

Discussed with stakeholders

- Organized meetings with stakeholders such as, relevant government ministry, industry associations, accreditation bodies, and clients to exchange opinions on DCCs.
- A study group was held within the NMIJ with members related to calibration services, and specifications for DCCs were discussed based on the results of the exchange of opinions with stakeholders.

Opinion from stakeholders	NMIJ DCC specifications
The appearance of the DCC should be the same as the paper certificate.	The XML format of the PTB and the PDF format of METAS were reviewed as prior examples. → **Adopt PDF format**
Machine-readable digital data should be attached to DCCs.	**Attach CSV files of calibration results and txt files containing client information, etc. to PDF files**

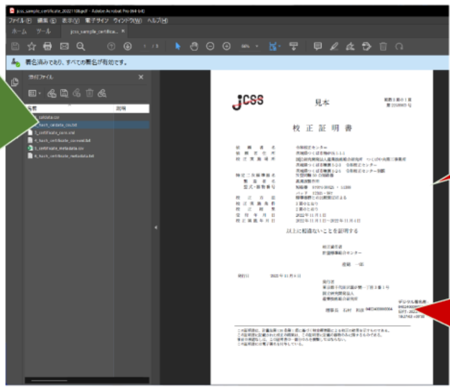
3

NMIJ digital calibration certificate

Machine-readable data (Reference information).

Following information is available:
- instruments,
- calibration sites,
- calibration data, and
- other supplemental technical information

in csv, txt or other formats



PDF format (Certificate section).
Same appearance as paper.

Electronic-Signature
- Guarantee of authenticity
  - Identification of the issuer

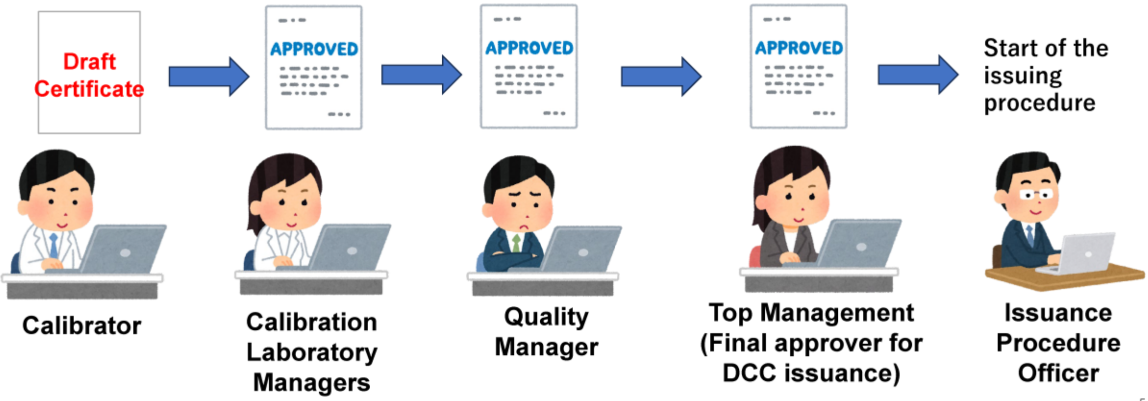
NMIJ digital calibration certificate

4

Verification work before issuing DCC

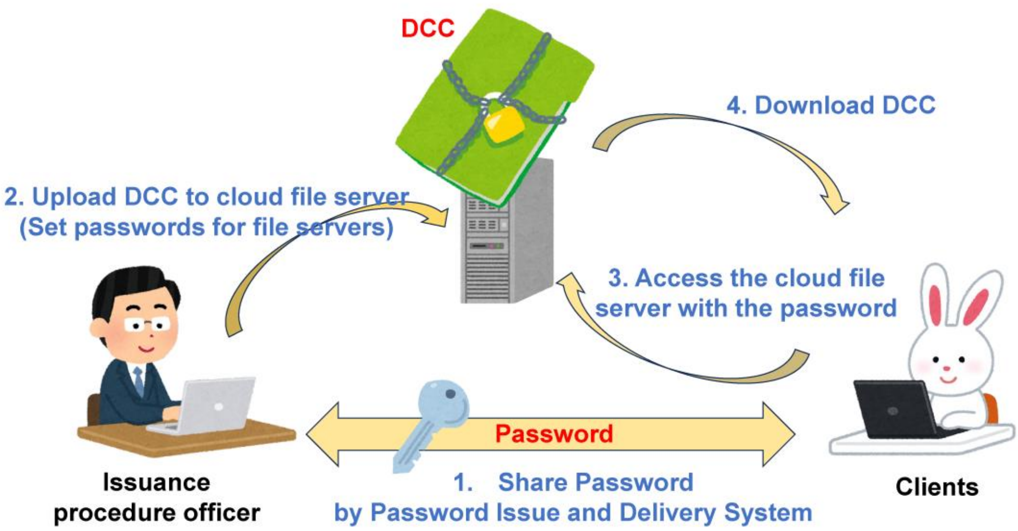
- Developed an electronic approval system to validate certificate drafts in the NMIJ.

- The draft certificate uploaded into the system will be reviewed in turn by the members of the figure below and if approved will proceed to the next step. If rejected, the process stops.



5

Delivery of DCC to clients



6

DCCs issued: FY2023

From 1 April, 2023 to 29 Feb, 2024

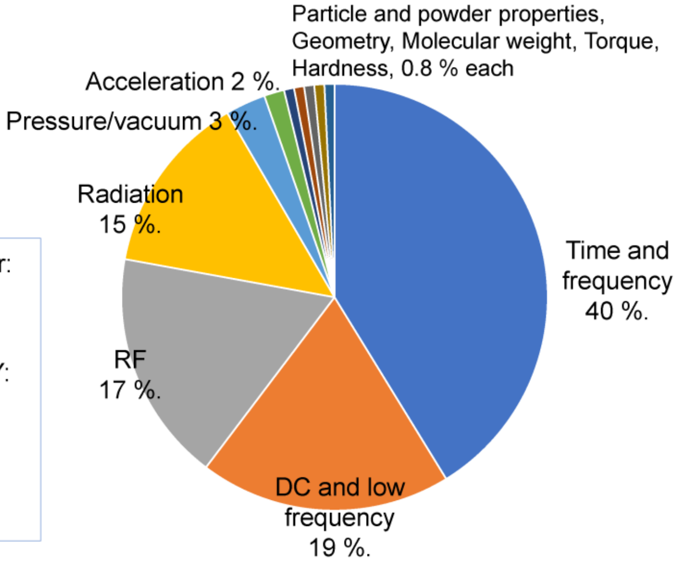
134 DCCs

(*Fiscal Year (FY) in Japan:
from 1 April to 31 March)

- Number of certificates issued per year:
  Approximately 700

- Number of issues at the end of the FY:
  Approximately 140(estimated)

→ Percentage of DCC:
20 % (estimated)



7

Trends in DCC Issuance Requests

Overall trend

For services with many calibration results listed on the calibration certificate, there tends to be more requests for DCCs to be issued.

→ The DCC was positively accepted, as it allowed for copying and pasting of calibration results.

Specific trends for Time-frequency Service

In the case of Time-frequency's remote calibration service, 12 certificates issued at one-month intervals and over the duration of a year.
Therefore, clients hope to shorten the time required to send certificates.

→ DCCs were positively accepted because DCCs take less time to deliver to clients compared to sending paper certificates by mail.

8

Summary

Reporting on the achievements of issuing digital calibration certificates at NMIJ.

- DCC Specification Determination Process
- Specifications for NMIJ's DCC
- Verification work before issuing DCC
- Delivery of DCC to clients
- DCC Issuance Achievements and its Trends

+ NMIJ's DCC adopted the PDF format based on stakeholder discussions. Depending on global and technological trends in DCCs, NMIJ will consider other formats such as XML.
+ NMIJ has just started issuing DCCs, and the current state is not the final version.
+ NMIJ will keep a close eye on client requests and global and technological trends, and aim to create a DCC that is better to use.

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45 Interlaboratory comparison in ionizing radiation metrology: challenges to fair principles and 4.0 technology absorption

Presenting author: Eric Matos Macedo – IRD/CNEN and Labprosaud/IFBA; Brazil
E-mail address: ematosmacedo@gmail.com
Additional authors: Igor Fernando Modesto Garcia lem.labprosaud@ifba.edu.br, Matheus Rebello do Nascimento, Jeovana Santos Ferreira, José Guilherme Pereira Peixoto, Marcus Vinicius Teixeira Navarro.

Abstract

Proficiency Testing activities, especially interlaboratory comparisons in ionizing radiation, are an essential tool for continuously monitoring the performance of laboratories in their processes and maintaining the reliability of participants and other interested parties. However, those events bring operational challenges, mainly logistics. Our work used technologies from the fourth industrial revolution and metrology 4.0 to mitigate these difficulties. We developed a technical framework for comparisons in terms of air kerma between digital twin laboratories.

But how do we manage those data since we have challenges incorporating the FAIR principles into existing comparison processes? How can we pave the way to absorb new technologies?

The pilot project of the digital twin calibration lab will be presented, as well as its challenges, generated data, used quality infrastructure (QI), and perspectives for the future. Additionally, a short review of tools can be used as a north of one (or more) solution(s).

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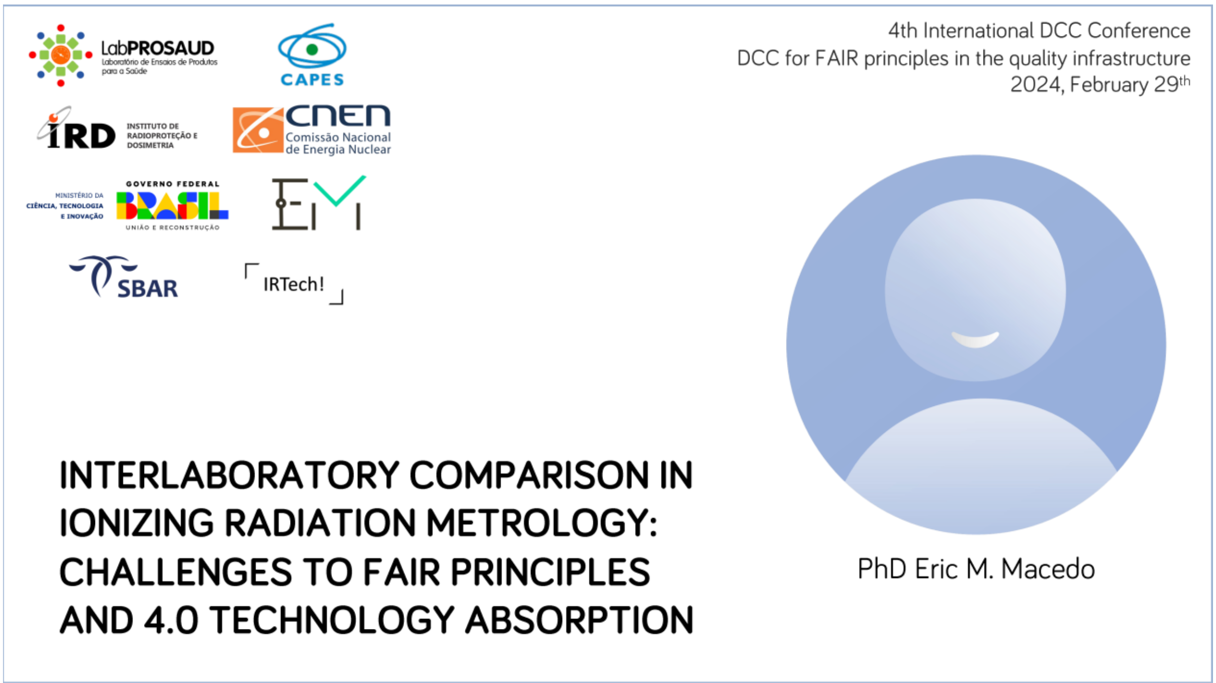
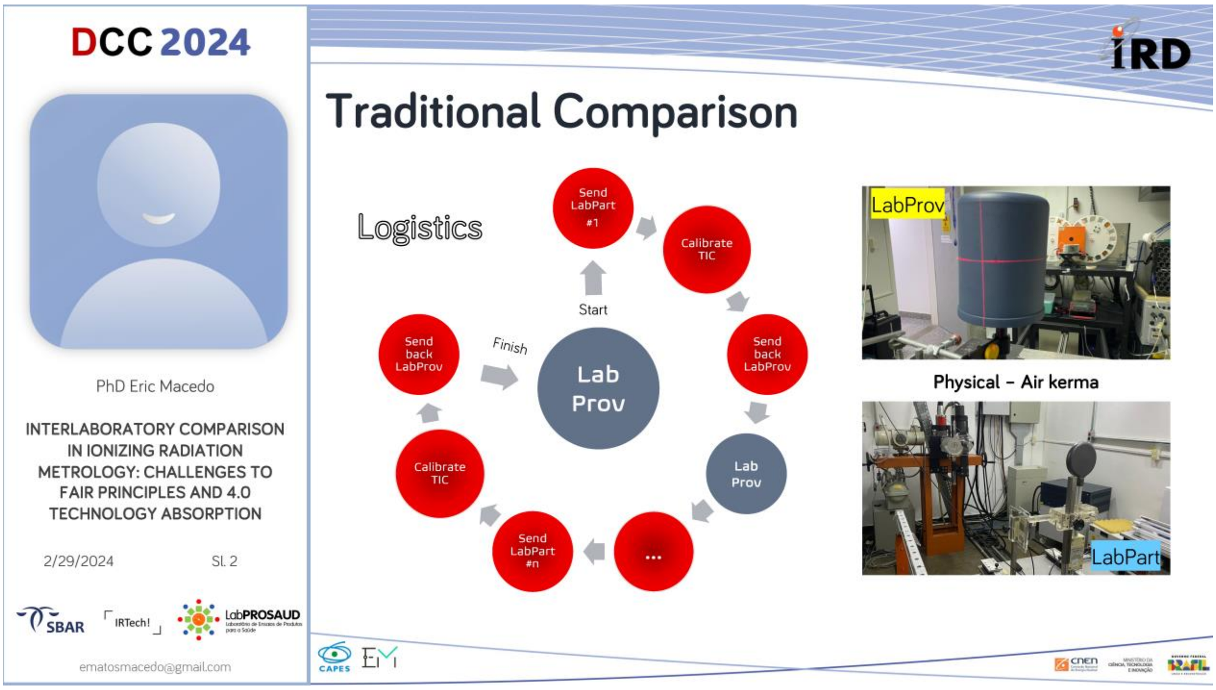
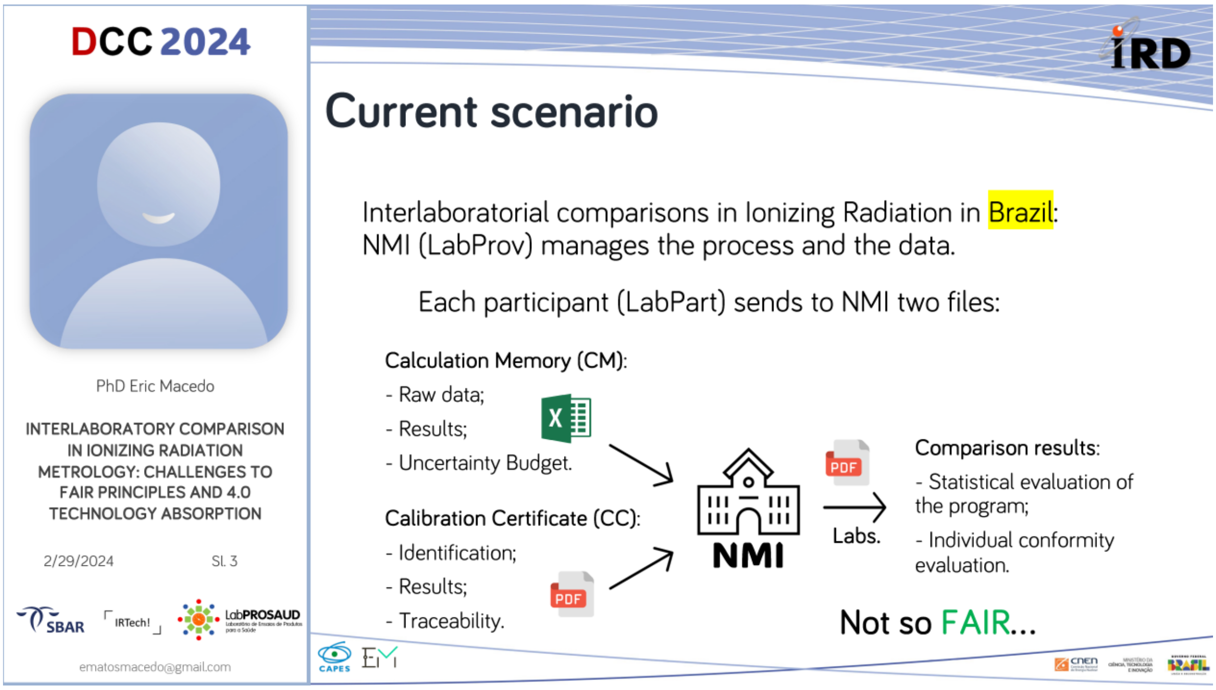
Presentation of Eric Matos Macedo




DCC 2024
PhD Eric Macedo
INTERLABORATORY COMPARISON IN IONIZING RADIATION METROLOGY: CHALLENGES TO FAIR PRINCIPLES AND 4.0 TECHNOLOGY ABSORPTION
2/29/2024
SL 2
SBAR
IRTech!
LabPROSAUD
ematosmacedo@gmail.com
iRD
Traditional Comparison
Logistics
Send LabPart #1
Calibrate TIC
Send back LabProv
Lab Prov
...
Send LabPart #n
Calibrate TIC
Send back LabProv
Start
Finish
Lab Prov
LabProv
Physical – Air kerma
LabPart
CAPES
cnen


DCC 2024
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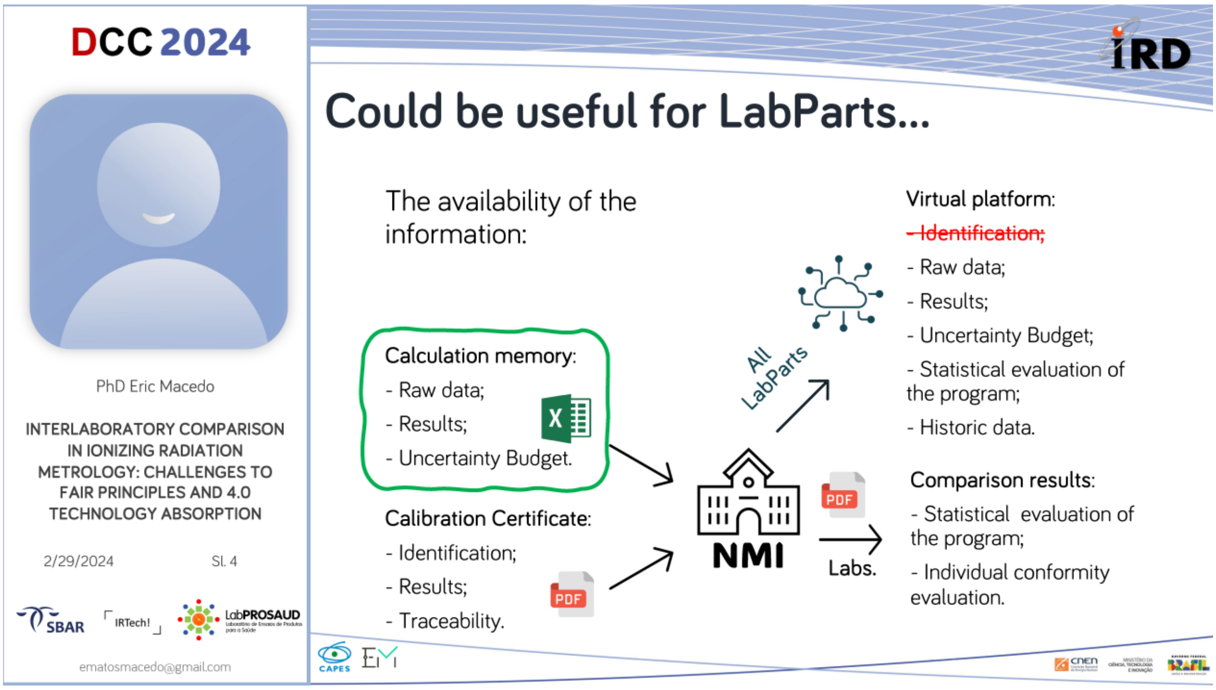
2/29/2024
SL 3
SBAR
IRTech!
LabPROSAUD
ematosmacedo@gmail.com
iRD
Current scenario
Interlaboratorial comparisons in Ionizing Radiation in Brazil:
NMI (LabProv) manages the process and the data.
Each participant (LabPart) sends to NMI two files:
Calculation Memory (CM):
- Raw data;
- Results;
- Uncertainty Budget.
Calibration Certificate (CC):
- Identification;
- Results;
- Traceability.
NMI
PDF
Labs.
Comparison results:
- Statistical evaluation of the program;
- Individual conformity evaluation.
Not so FAIR...
CAPES
cnen


DCC 2024
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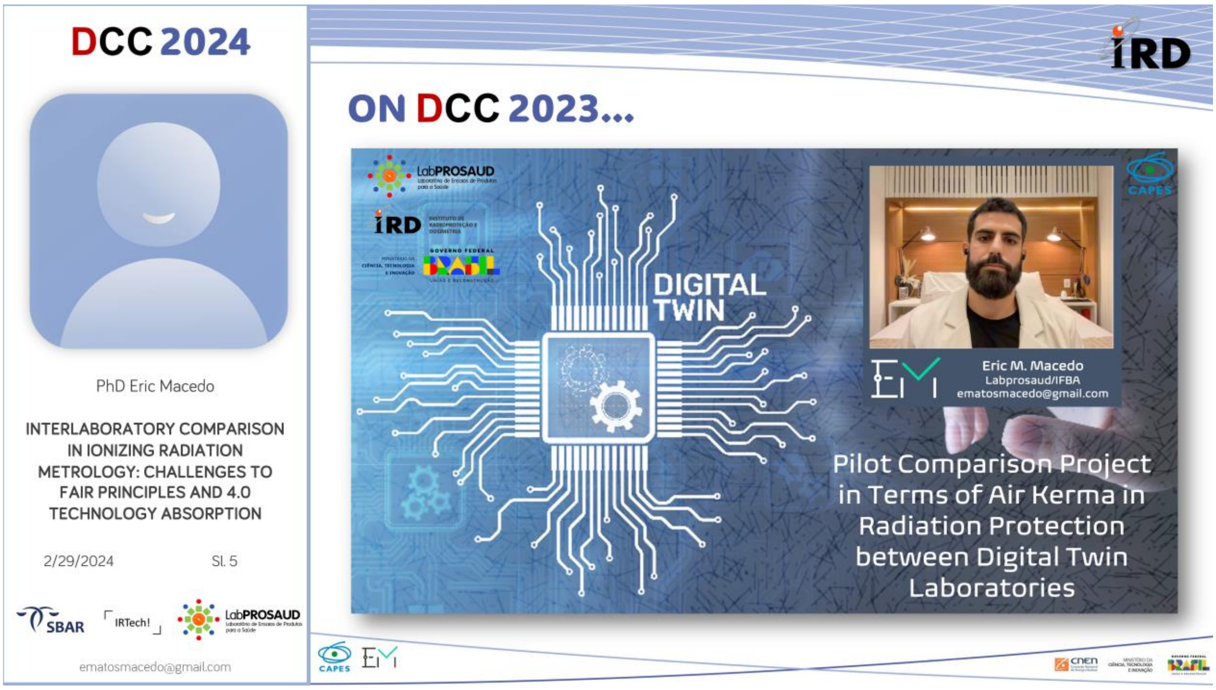
IRTech!
LabPROSAUD
ematosmacedo@gmail.com
IRD
Could be useful for LabParts...
The availability of the information:
Calculation memory:
- Raw data;
- Results;
- Uncertainty Budget.
Calibration Certificate:
- Identification;
- Results;
- Traceability.
PDF
PDF
All LabParts
NMI
Labs.
Virtual platform:
~~-Identification;~~
- Raw data;
- Results;
- Uncertainty Budget;
- Statistical evaluation of the program;
- Historic data.
Comparison results:
- Statistical evaluation of the program;
- Individual conformity evaluation.
CAPES


DCC 2024
PhD Eric Macedo
INTERLABORATORY COMPARISON IN IONIZING RADIATION METROLOGY: CHALLENGES TO FAIR PRINCIPLES AND 4.0 TECHNOLOGY ABSORPTION
2/29/2024
Sl. 5
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IRTech!
LabPROSAUD
ematosmacedo@gmail.com
IRD
ON DCC 2023...
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IRD
DIGITAL TWIN
Eric M. Macedo
Labprosaud/IFBA
ematosmacedo@gmail.com
Pilot Comparison Project in Terms of Air Kerma in Radiation Protection between Digital Twin Laboratories
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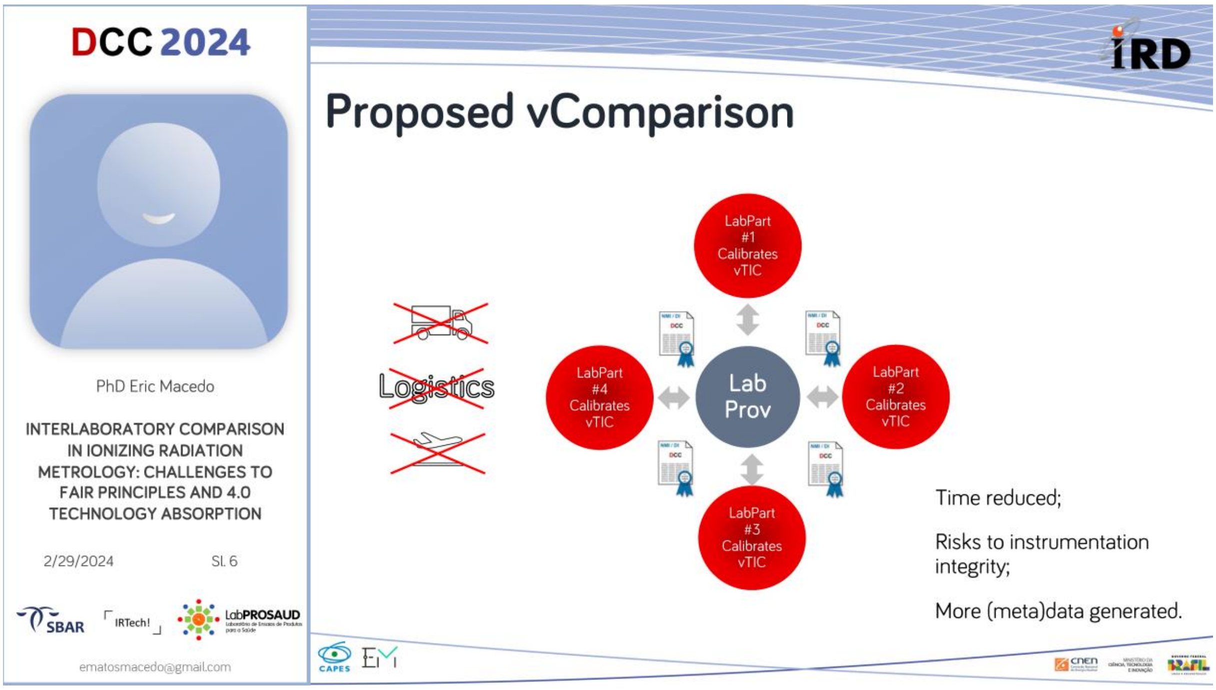
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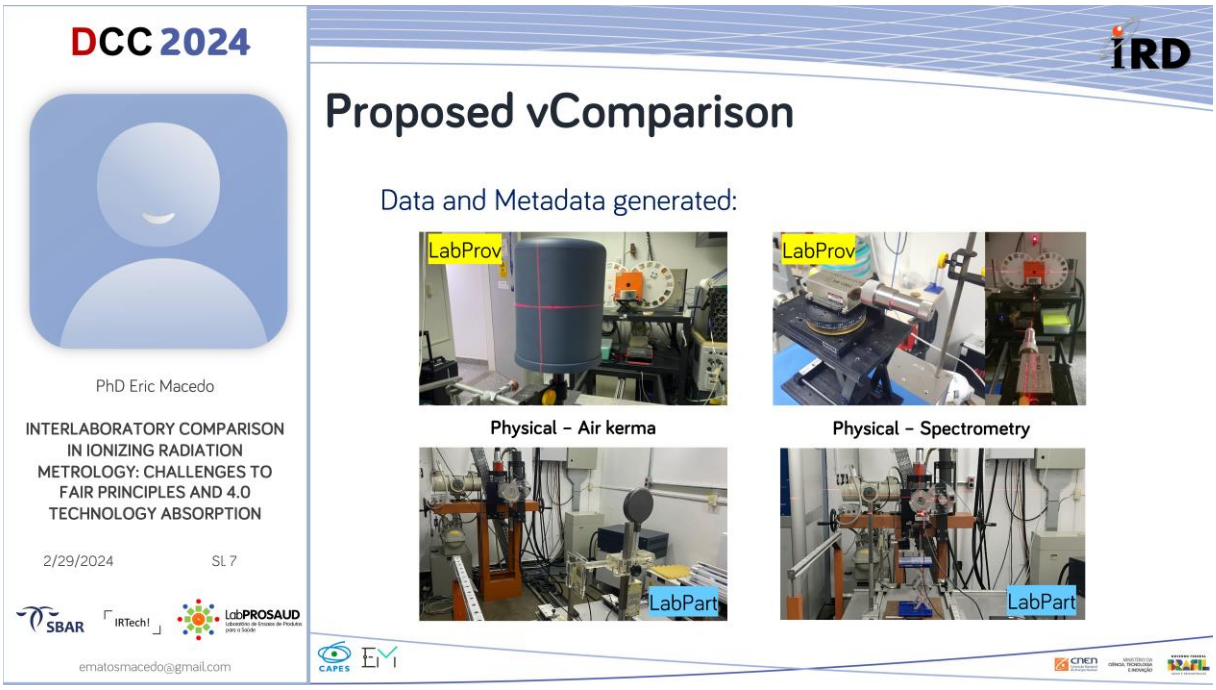
Proposed vComparison
Logistics
LabPart #1 Calibrates vTIC
LabPart #2 Calibrates vTIC
LabPart #3 Calibrates vTIC
LabPart #4 Calibrates vTIC
Lab Prov
Time reduced;
Risks to instrumentation integrity;
More (meta)data generated.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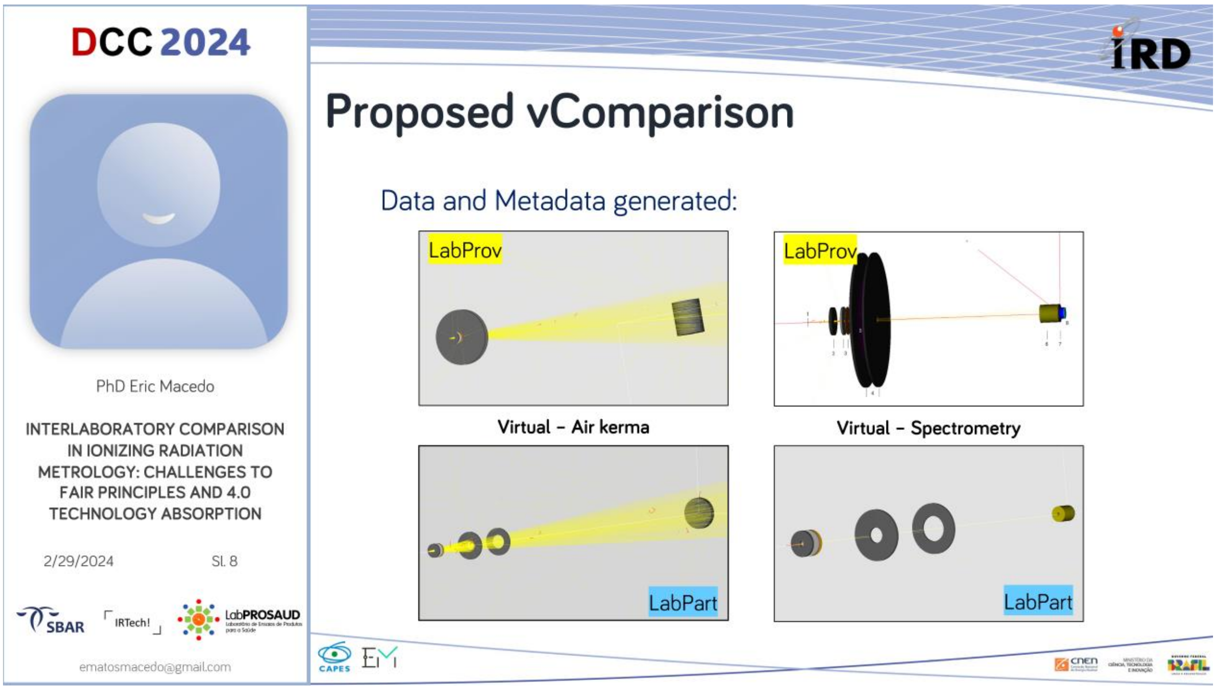
Proposed vComparison
Data and Metadata generated:
LabProv
LabProv
Physical – Air kerma
Physical – Spectrometry
LabPart
LabPart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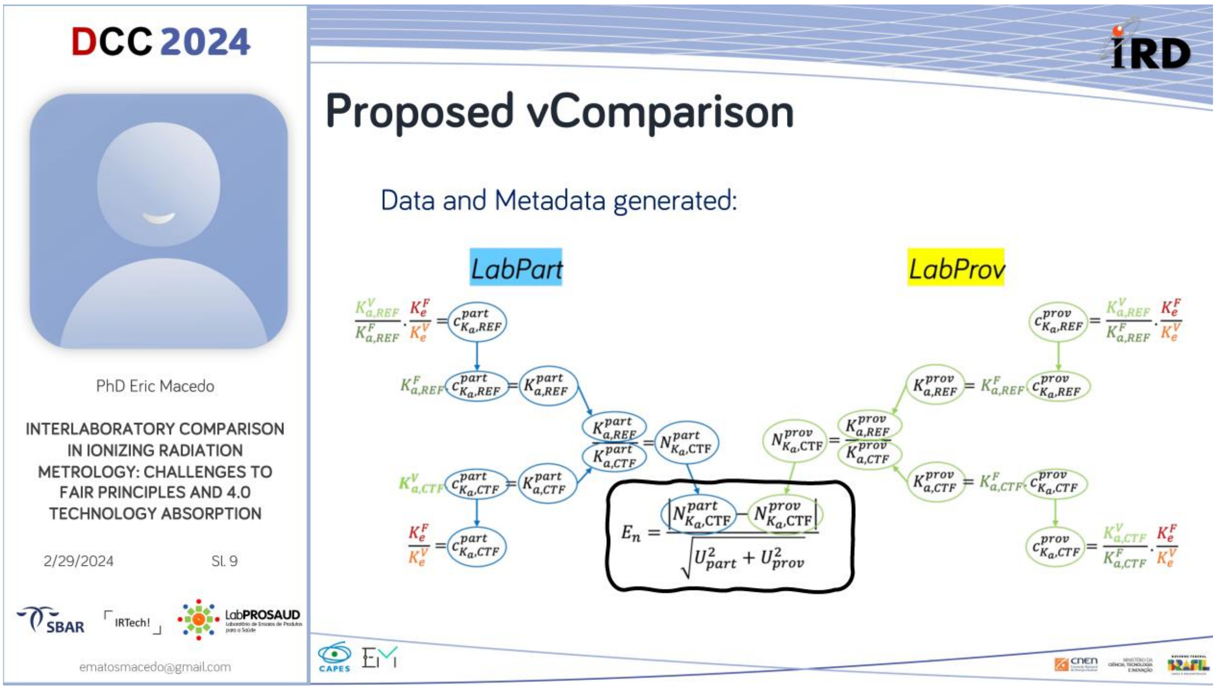
Proposed vComparison
Data and Metadata generated:
LabProv
LabProv
Virtual – Air kerma
Virtual – Spectrometry
LabPart
LabPart
CAPES
cnen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PhD Eric Macedo
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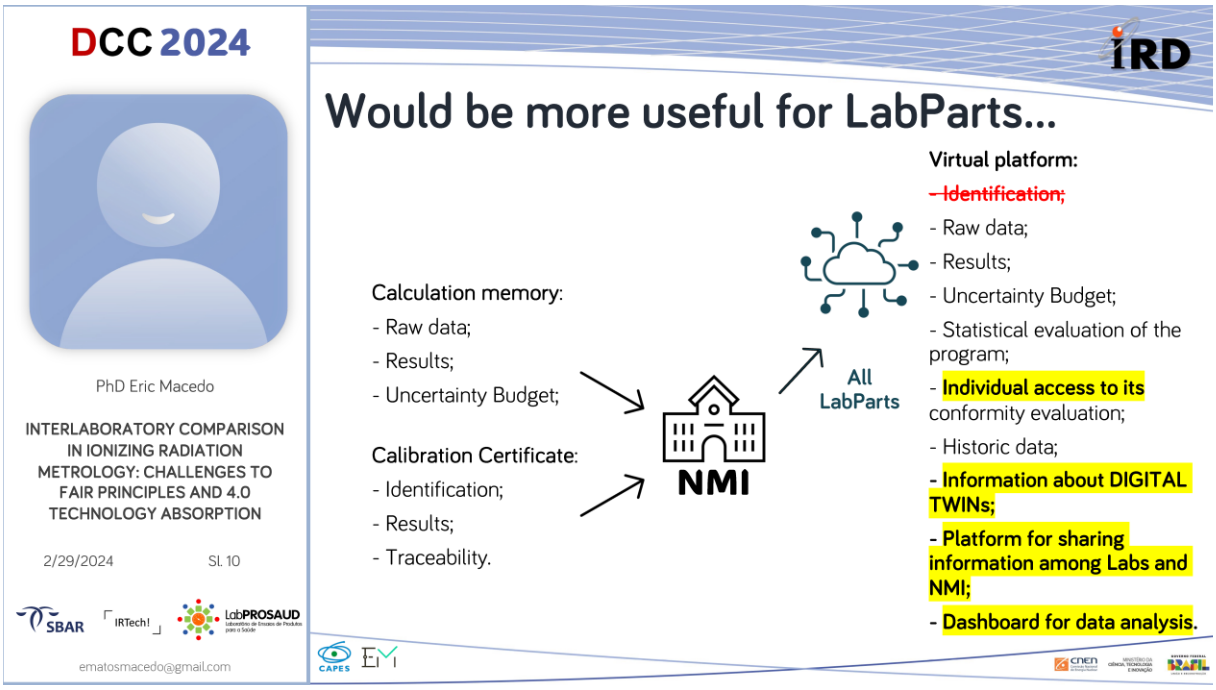
Proposed vComparison
Data and Metadata generated:
LabPart
LabProv
$E_n = \frac{|N^{part}_{K_a,CTF} - N^{prov}_{K_a,CTF}|}{\sqrt{U^2_{part} + U^2_{prov}}}$
CAPES
cnen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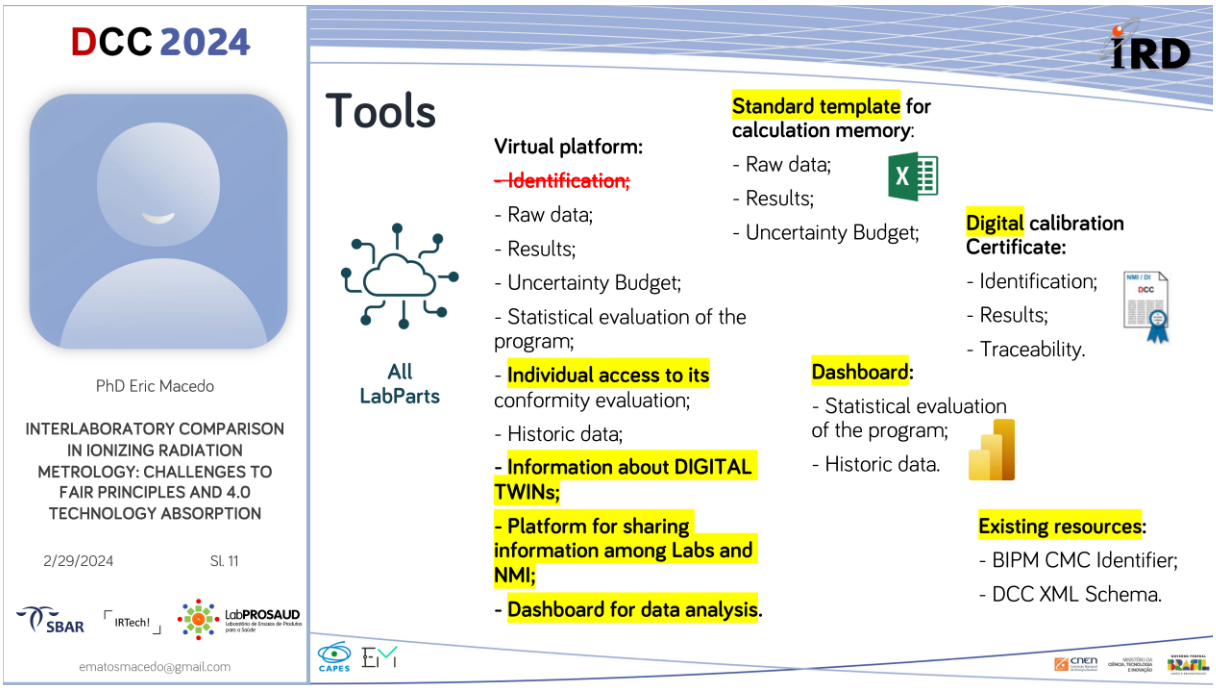
Would be more useful for LabParts...
Calculation memory:
- Raw data;
- Results;
- Uncertainty Budget;
Calibration Certificate:
- Identification;
- Results;
- Traceability.
NMI
All LabParts
Virtual platform:
- ~~Identification;~~
- Raw data;
- Results;
- Uncertainty Budget;
- Statistical evaluation of the program;
- Individual access to its conformity evaluation;
- Historic data;
- Information about DIGITAL TWINs;
- Platform for sharing information among Labs and NMI;
- Dashboard for data analysis.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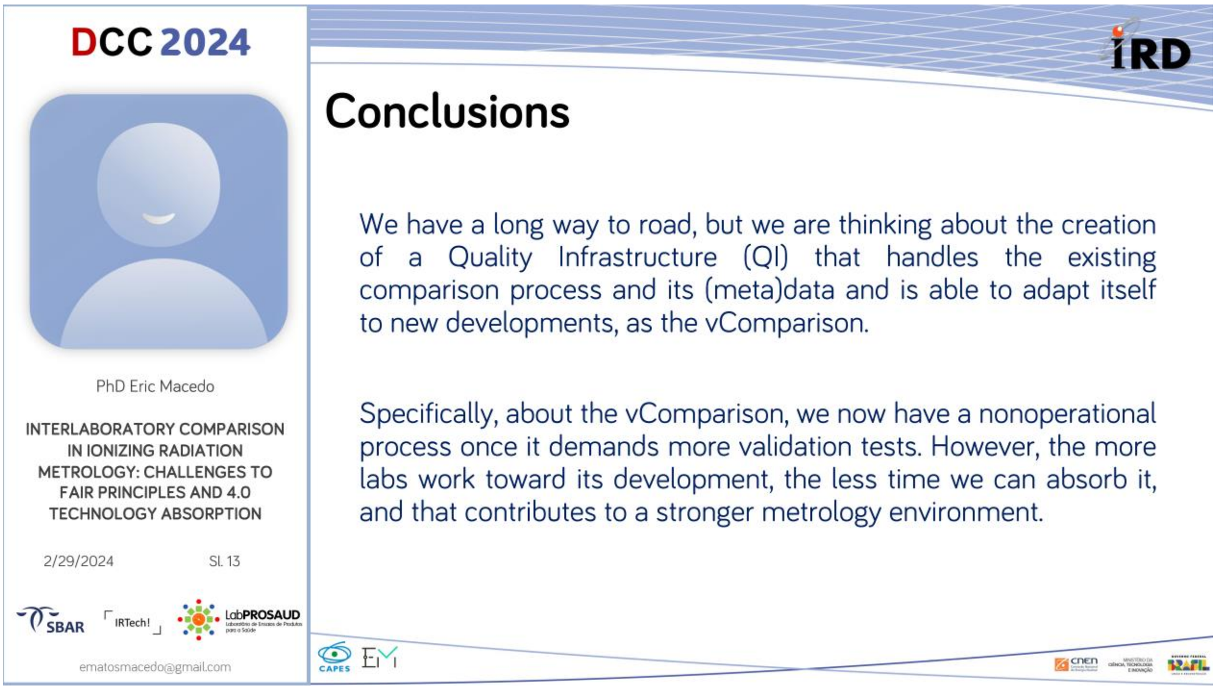
Tools
All LabParts
Virtual platform:
- ~~Identification;~~
- Raw data;
- Results;
- Uncertainty Budget;
- Statistical evaluation of the program;
- Individual access to its conformity evaluation;
- Historic data;
- Information about DIGITAL TWINs;
- Platform for sharing information among Labs and NMI;
- Dashboard for data analysis.
Standard template for calculation memory:
- Raw data;
- Results;
- Uncertainty Budget;
Digital calibration Certificate:
- Identification;
- Results;
- Traceability.
Dashboard:
- Statistical evaluation of the program;
- Historic data.
Existing resources:
- BIPM CMC Identifier;
- DCC XML Schema.


DCC 2024
Conclusions
We have a long way to road, but we are thinking about the creation of a Quality Infrastructure (QI) that handles the existing comparison process and its (meta)data and is able to adapt itself to new developments, as the vComparison.
Specifically, about the vComparison, we now have a nonoperational process once it demands more validation tests. However, the more labs work toward its development, the less time we can absorb it, and that contributes to a stronger metrology environment.
PhD Eric Macedo
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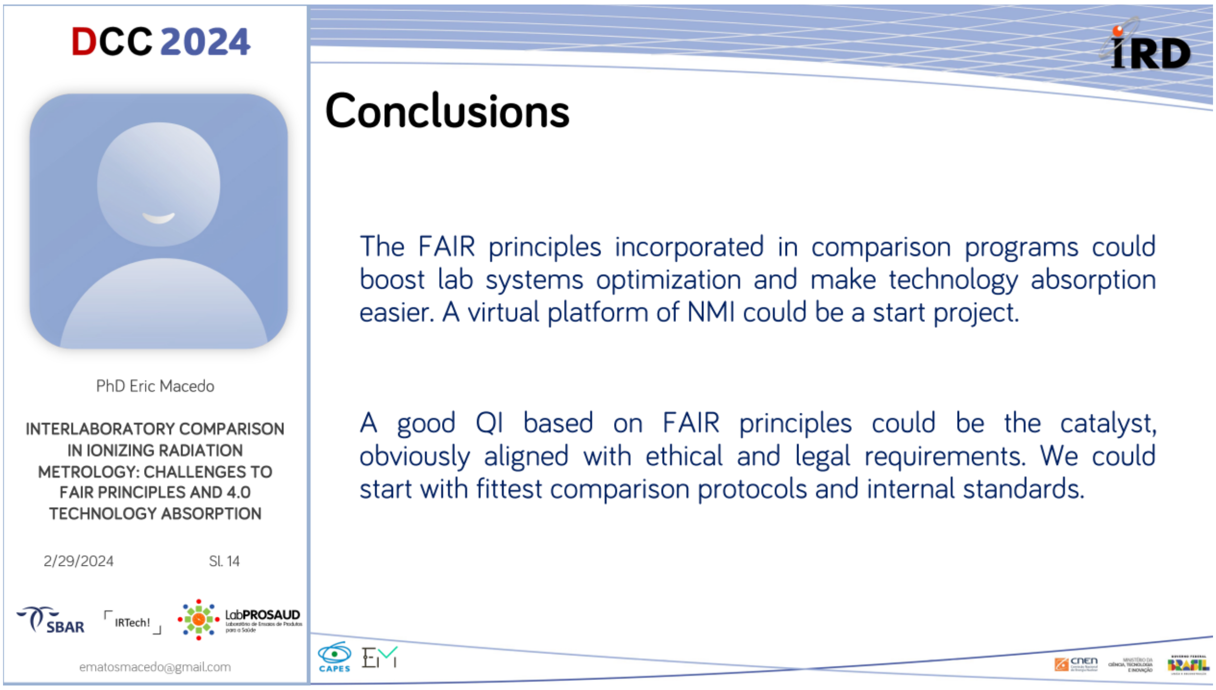
DCC 2024
Conclusions
The FAIR principles incorporated in comparison programs could boost lab systems optimization and make technology absorption easier. A virtual platform of NMI could be a start project.
A good QI based on FAIR principles could be the catalyst, obviously aligned with ethical and legal requirements. We could start with fittest comparison protocols and internal standards.
PhD Eric Macedo
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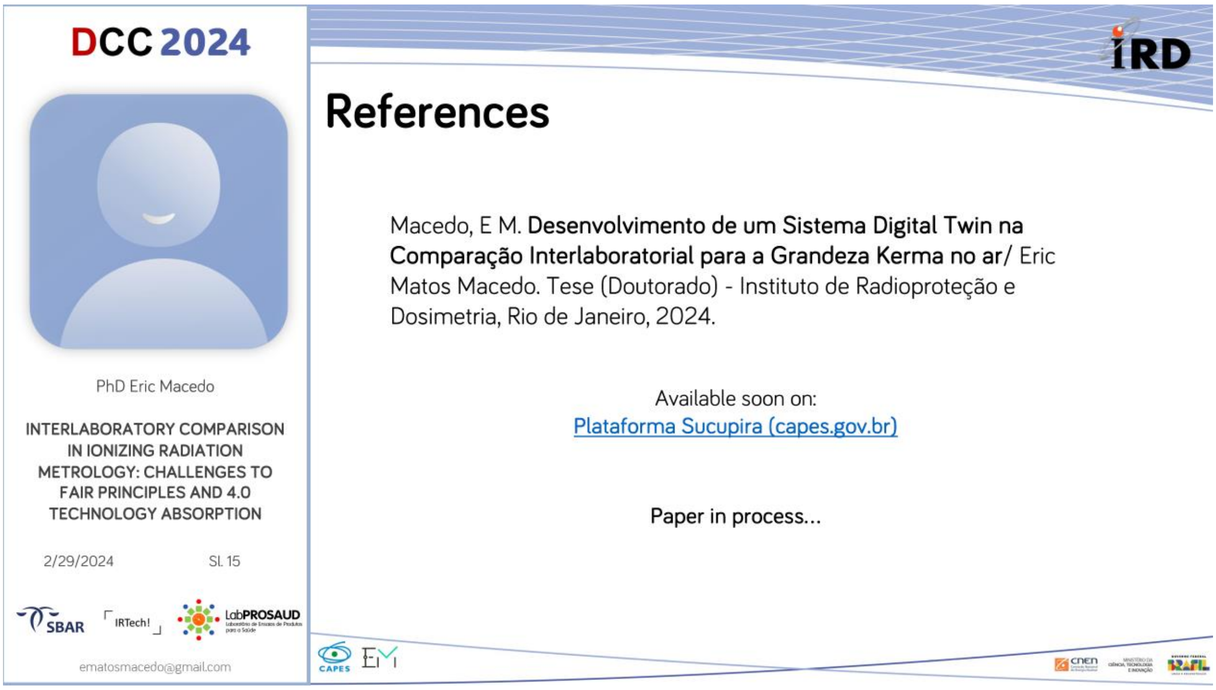
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Available soon on:
Plataforma Sucupira (capes.gov.br)
Paper in process...


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JONES, D et al. Characterising the Digital Twin: A systematic literature review. CIRP Journal of Manufacturing Science and Technology, v. 29, p. 36–52, 2020. DOI: 10.1016/j.cirpj.2020.02.002.
Garcia, I F M. Desenvolvimento de modelo conceitual com software de aplicação para gestão da qualidade e calibração 4.0/ Igor Fernando Modesto Garcia. Tese (Doutorado) - Instituto de Radioproteção e Dosimetria, Rio de Janeiro, 2024.
GOFAIR. https://www.go-fair.org/how-to-go-fair/
Digital Calibration Certificate (DCC) - Wiki. https://dccwiki.ptb.de
The Digital Transformation. https://www.bipm.org/en/digital-transformation

Acknowledgement

LabPROSAUD Laboratório de Ensaios de Produtos para a Saúde

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IRD INSTITUTO DE RADIOPROTEÇÃO E DOSIMETRIA

CNEN Comissão Nacional de Energia Nuclear

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MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO

GOVERNO FEDERAL BRASIL UNIÃO E RECONSTRUÇÃO

PhD Eric M. Macedo

PhD Eric M. Macedo

ematosmacedo@gmail.com

http://lattes.cnpq.br/1864113474457250

@ematosmacedo

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46 TUBITAK UME Digital Metrology Pilot Project and Dissemination to Turkiye

Presenting author: Erkan Danacı, TUBITAK UME, TURKIYE
E-mail address: erkan.danaci@tubitak.gov.tr
Additional authors: Bulent Aydemir bulent.aydemir@tubitak.gov.tr TUBITAK UME, TURKIYE

Abstract

In September 2023, the TÜBİTAK UME Digital Working Group (DWG) was formed from metrology experts working in different groups within TÜBİTAK UME. This group has determined the road map for metrological digital transformation in Türkiye with the pilot project.

The objectives of the TÜBİTAK UME digitalization pilot project are as follows:

- Transferring Metrological Scientific Outputs to Digital Media
- Creating the Digital Calibration Certificate (DCC) and digital Test Reports (DTR)
- Creating smart Calibration Systems with Digital Measurement Device Twins

Sub-work packages and tasks have been defined by DWG to realize these objectives.

With the completion of the digitalization pilot project,

- The duties and responsibilities of metrology players in transferring metrological outputs to the digital platform will be explained.
- DCC-creating activities will be started in TUBITAK UME and Türkiye.
- A road map will be determined to transfer the process that would start at DCC to the DTR.
- The road map for the smart calibration system, the digital twin creation, and metrological applications on the clouds will be completed for Turkish quality system players.

In this study, the duties of TÜBİTAK UME DWG and its work plans and projections will be given in detail for the next five years.

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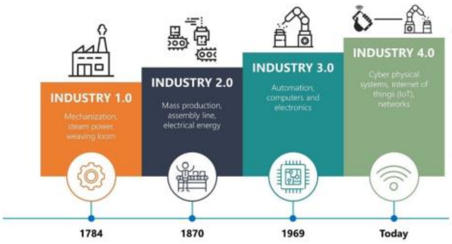
Presentation of Erkan Danacı

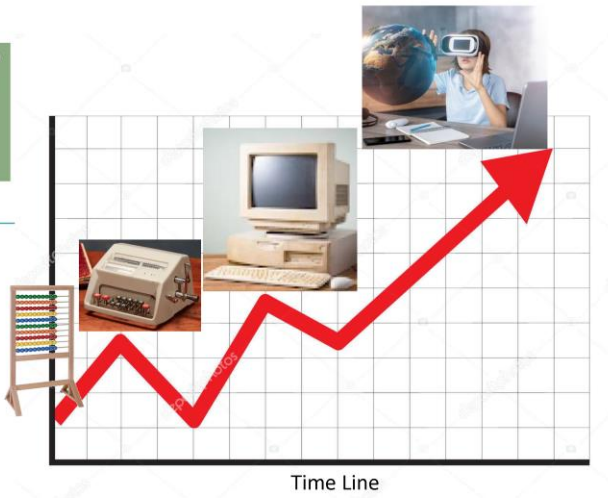
Content

- Digitalization activities in TUBITAK UME
- Digital Metrology Pilot Project
  - Objectives
  - Actions
- Conclusion & Future Works

TÜBİTAK UME

Metrology in the Digital Age





TÜBİTAK UME

Digitalization activities in TUBITAK UME

- Digital Working Group's (DWG) was created in 2023.
- Objectives, strategies, and the anticipated impact of the Digital Metrology Pilot Project over the next 5 years were determined by DWG in Turkiye.

Contact:
ume.dcg@tubitak.gov.tr

Digitalization | Pilot Project | Objective1 | Objective2 | Objective3 | Outputs | Conclusion

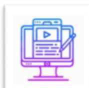
Objectives of Digital Metrology Pilot Project

The TÜBİTAK UME **Digital Metrology Pilot Project** marks a transformative step towards enhancing the efficiency and precision of metrology practices in Turkiye.

With the increase in global digital applications, metrological processes are also directed towards digitalization

The objectives of the TÜBİTAK UME digitalization pilot project :

- **Obj1.** Transferring Metrological Scientific Outputs to Digital Media
- **Obj2.** Creating the Digital Calibration Certificate (DCC) and Digital Test Reports (DTR) and Sharing them an a digital platform
- **Obj3.** Creating smart Calibration Systems with Digital Measurement Device Twins



Digitalization | Pilot Project | Objective1 | Objective2 | Objective3 | Outputs | Conclusion

5

Obj1. Transferring Metrological Outputs to Digital Media

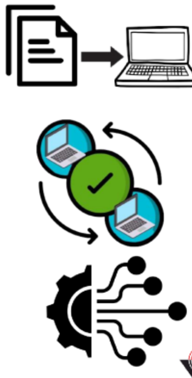
DIGITAL science

The sub-task steps planned within the scope of the Transferring Metrological Scientific Outputs to Digital Media objective are determined as follows.

1.1. **Transferring the publications** produced by institutions and organizations interested in Scientific and Industrial Metrology and for the benefit of institutions and organizations carrying out metrological activities in our country **into digital media**. (2025)

1.2. **Making the demand and offer systems** of calibration and experiment services offered by TÜBİTAK UME, which is interested in Scientific Metrology in our country, **accessible digitally**. (2026)

1.3. **Establishing a mechanism** to share the digital forms of **Calibration Certificates (DCC)** and **Test Reports (DTR)** with the relevant parties (2027)



Digitalization › Pilot Project › Objective1 › Objective2 › Objective3 › Outputs › Conclusion

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TÜBİTAK UME

Obj2. Creating the DCC and DTR

The sub-task steps planned within the scope of the Creating the Digital Calibration Certificate (DCC) and digital Test Reports (DTR) objective are determined as follows.

2.1. **Creating and publishing the taxonomies** of the quantities measured **in our country** according to the international measurement system (2025)

2.2. **Creation of machine-readable format** of Calibration Certificate and Test reports (DCC / DTR) (2027)

2.3. **Dissemination of digital formats of Calibration Certificates and Test Reports** within the country (2028)

Digitalization › Pilot Project › Objective1 › Objective2 › Objective3 › Outputs › Conclusion

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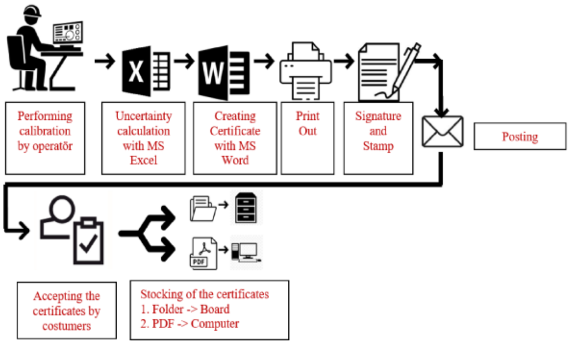
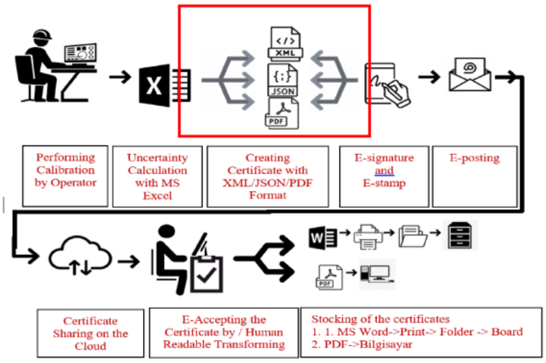
TÜBİTAK UME

Digital Calibration Certificate (DCC)

- Current workflow in calibration certificate creation



- Workflow in digital calibration certificate creation



Digitalization | Pilot Project | Objective1 | Objective2 | Objective3 | Outputs | Conclusion

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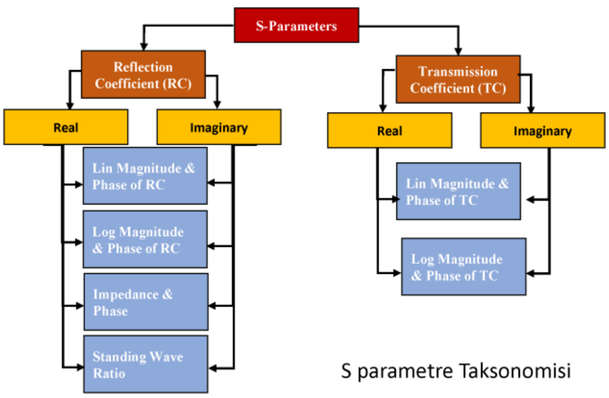
First DCC example based XML format

- Calibration certificate for S parameter measurement

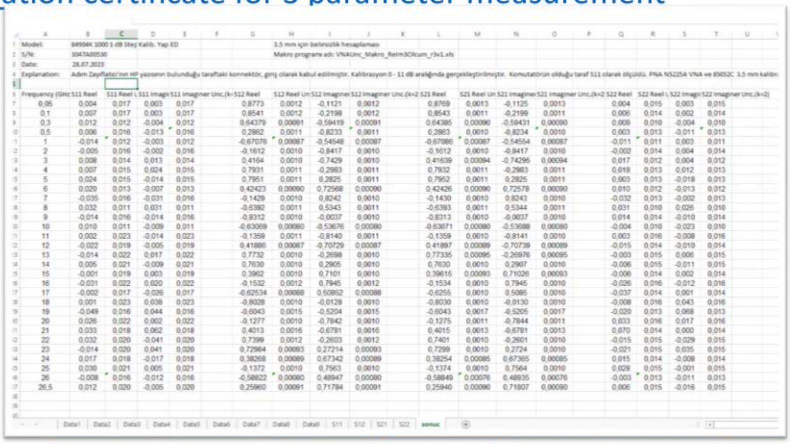


S parametre Taksonomisi

Digitalization | Pilot Project | Objective1 | Objective2 | Objective3 | Outputs | Conclusion

First DCC example based XML format

- Calibration certificate for S parameter measurement



Model: 84904K 1000 1 dB Steç Kalib. Yap ED — 3.5 mm için belirsizlik hesaplaması
S/N: 3047A00530 — Makro programı adı: VNAUnc_Makro_Reim3Olcum_r3v1.xls
Date: 28.07.2023
Explanation: Adım Zayıflatıcı'nın HP yazısının bulunduğu taraftaki konnektör, giriş olarak kabul edilmiştir. Kalibrasyon 0 - 11 dB aralığında gerçekleştirilmiştir. Komutatörün olduğu taraf S11 olarak ölçüldü. PNA N5225A VNA ve 85052C 3.5 mm kalibr

Frequency (GHz	S11 Reel	S11 Reel U	S11 Imagi	S11 Imaginer Unc.(k=	S12 Reel	S12 Reel Un	S12 Imaginer	S12 Imaginer Unc.(k=2	S21 Reel	S21 Reel Un	S21 Imaginer	S21 Imaginer Unc.(k=2	S22 Reel	S22 Reel U	S22 Imagi	S22 Imaginer Unc.(k=2)
0,05	0,004	0,017	0,003	0,017	0,8773	0,0012	-0,1121	0,0012	0,8769	0,0013	-0,1125	0,0013	0,004	0,015	0,003	0,015
0,1	0,007	0,017	0,003	0,017	0,8541	0,0012	-0,2198	0,0012	0,8543	0,0011	-0,2199	0,0011	0,006	0,014	0,002	0,014
0,3	0,012	0,012	-0,004	0,012	0,64379	0,00091	-0,59419	0,00091	0,64385	0,00090	-0,59431	0,00090	0,009	0,010	-0,004	0,010
0,5	0,006	0,016	-0,013	0,016	0,2862	0,0011	-0,8233	0,0011	0,2863	0,0010	-0,8234	0,0010	0,003	0,013	-0,011	0,013
1	-0,014	0,012	-0,003	0,012	-0,67076	0,00087	-0,54548	0,00087	-0,67086	0,00087	-0,54554	0,00087	-0,011	0,011	0,003	0,011
2	-0,005	0,016	-0,002	0,016	-0,1612	0,0010	-0,8417	0,0010	-0,1612	0,0010	-0,8417	0,0010	-0,002	0,014	0,004	0,014
3	0,008	0,014	0,013	0,014	0,4164	0,0010	-0,7429	0,0010	0,41639	0,00094	-0,74295	0,00094	0,017	0,012	0,004	0,012
4	0,007	0,015	0,024	0,015	0,7931	0,0011	-0,2983	0,0011	0,7932	0,0011	-0,2983	0,0011	0,018	0,013	0,012	0,013
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6	0,020	0,013	-0,007	0,013	0,42423	0,00090	0,72568	0,00090	0,42426	0,00090	0,72578	0,00090	0,010	0,012	-0,013	0,012
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20	0,026	0,022	0,002	0,022	-0,1277	0,0010	-0,7842	0,0010	-0,1275	0,0011	-0,7844	0,0011	0,033	0,016	0,017	0,016
21	0,033	0,018	0,062	0,018	0,4013	0,0016	-0,6781	0,0016	0,4015	0,0013	-0,6781	0,0013	0,070	0,014	0,000	0,014
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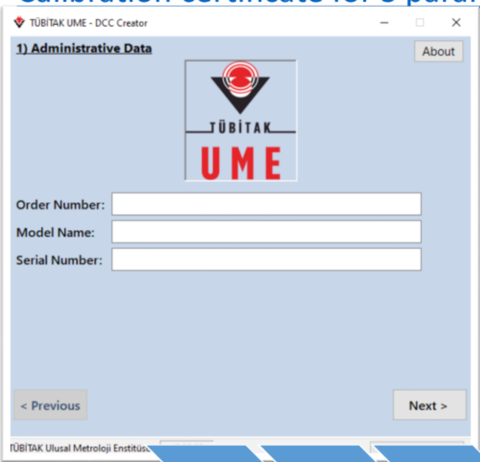
23	-0,014	0,020	0,041	0,020	0,72984	0,00093	0,27214	0,00093	0,7299	0,0010	0,2724	0,0010	-0,021	0,015	0,035	0,015
24	0,017	0,018	-0,017	0,018	0,38268	0,00089	0,67342	0,00089	0,38254	0,00085	0,67365	0,00085	0,015	0,014	-0,008	0,014
25	0,030	0,021	0,005	0,021	-0,1372	0,0010	0,7563	0,0010	-0,1374	0,0010	0,7564	0,0010	0,029	0,015	-0,001	0,015
26	-0,008	0,016	-0,012	0,016	-0,58822	0,00080	0,48947	0,00080	-0,58849	0,00076	0,48935	0,00076	-0,003	0,013	-0,011	0,013
26,5	0,012	0,020	-0,005	0,020	0,25960	0,00091	0,71784	0,00091	0,25940	0,00090	0,71807	0,00090	0,006	0,015	-0,016	0,015

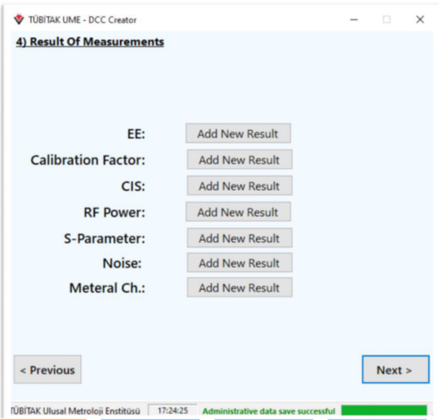
Data1 Data2 Data3 Data4 Data5 Data6 Data7 Data8 Data9 S11 S12 S21 S22 sonuc

Digitalization | Pilot Project | Objective1 | Objective2 | Objective3 | Outputs | Conclusion

First DCC example based XML format

- Calibration certificate for S parameter measurement

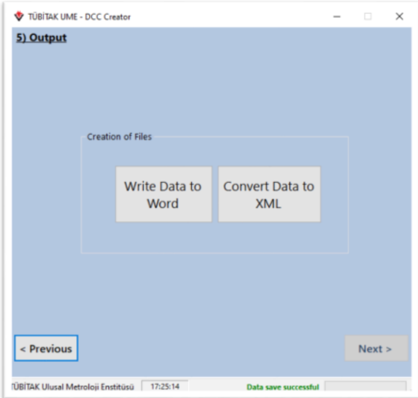




Digitalization | Pilot Project | Objective1 | Objective2 | Objective3 | Outputs | Conclusion

First DCC example based XML format

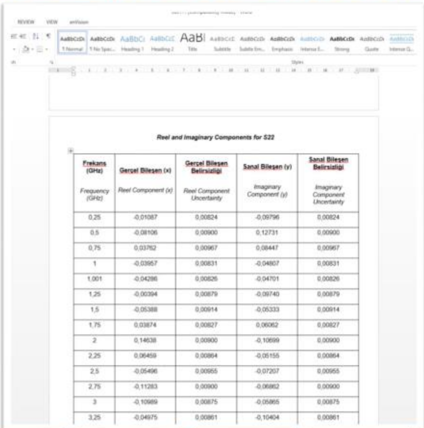
- Calibration certificate for S parameter measurement



Digitalization | Pilot Project | Objective1 | Objective2 | Objective3 | Outputs | Conclusion

First DCC example based XML format

- Calibration certificate for S parameter measurement



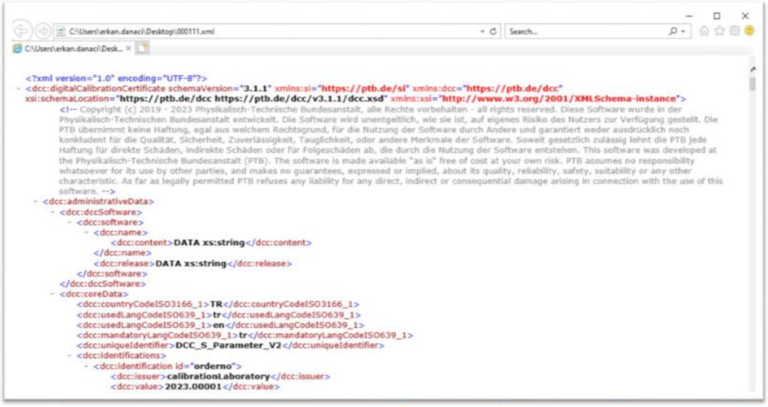
Reel and Imaginary Components for S22

Frekans (GHz) *Frequency (GHz)*	Gerçel Bileşen (x) *Reel Component (x)*	Gerçel Bileşen Belirsizliği *Reel Component Uncertainty*	Sanal Bileşen (y) *Imaginary Component (y)*	Sanal Bileşen Belirsizliği *Imaginary Component Uncertainty*
0,25	-0,01087	0,00824	-0,09796	0,00824
0,5	-0,08106	0,00900	0,12731	0,00900
0,75	0,03762	0,00967	0,08447	0,00967
1	-0,03957	0,00831	-0,04807	0,00831
1,001	-0,04286	0,00826	-0,04701	0,00826
1,25	-0,00394	0,00879	-0,09740	0,00879
1,5	-0,05388	0,00914	-0,05333	0,00914
1,75	0,03874	0,00827	0,06062	0,00827
2	0,14638	0,00900	-0,10699	0,00900
2,25	0,06459	0,00864	-0,05155	0,00864
2,5	-0,05496	0,00955	-0,07207	0,00955
2,75	-0,11283	0,00900	-0,06862	0,00900
3	-0,10989	0,00875	-0,05865	0,00875
3,25	-0,04975	0,00861	-0,10404	0,00861

Digitalization | Pilot Project | Objective1 | Objective2 | Objective3 | Outputs | Conclusion

First DCC example based XML format

- Calibration certificate for S parameter measurement




```xml
<?xml version="1.0" encoding="UTF-8"?>
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    <!-- Copyright (c) 2019 - 2023 Physikalisch-Technische Bundesanstalt, alle Rechte vorbehalten - all rights reserved. Diese Software wurde in der Physikalisch-Technischen Bundesanstalt entwickelt. Die Software wird unentgeltlich, wie sie ist, auf eigenes Risiko des Nutzers zur Verfügung gestellt. Die PTB übernimmt keine Haftung, egal aus welchem Rechtsgrund, für die Nutzung der Software durch Andere und garantiert weder ausdrücklich noch konkludent für die Qualität, Sicherheit, Zuverlässigkeit, Tauglichkeit, oder andere Merkmale der Software. Soweit gesetzlich zulässig lehnt die PTB jede Haftung für direkte Schäden, indirekte Schäden oder für Folgeschäden ab, die durch die Nutzung der Software entstehen. This software was developed at the Physikalisch-Technische Bundesanstalt (PTB). The software is made available "as is" free of cost at your own risk. PTB assumes no responsibility whatsoever for its use by other parties, and makes no guarantees, expressed or implied, about its quality, reliability, safety, suitability or any other characteristic. As far as legally permitted PTB refuses any liability for any direct, indirect or consequential damage arising in connection with the use of this software. -->
  - <dcc:administrativeData>
    - <dcc:dccSoftware>
      - <dcc:software>
        - <dcc:name>
            <dcc:content>DATA xs:string</dcc:content>
          </dcc:name>
          <dcc:release>DATA xs:string</dcc:release>
        </dcc:software>
      </dcc:dccSoftware>
    - <dcc:coreData>
        <dcc:countryCodeISO3166_1>TR</dcc:countryCodeISO3166_1>
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        <dcc:mandatoryLangCodeISO639_1>tr</dcc:mandatoryLangCodeISO639_1>
        <dcc:uniqueIdentifier>DCC_S_Parameter_V2</dcc:uniqueIdentifier>
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            <dcc:issuer>calibrationLaboratory</dcc:issuer>
            <dcc:value>2023.00001</dcc:value>
```


Digitalization | Pilot Project | Objective1 | Objective2 | Objective3 | Outputs | Conclusion

TÜBİTAK UME

Obj3. Creating Smart Calibration Systems with Digital Measurement Device Twins

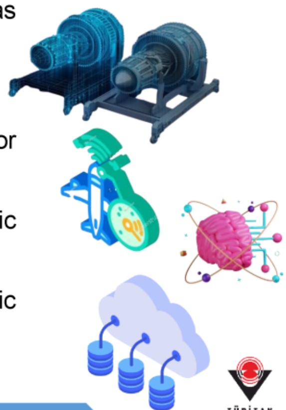
The sub-task steps planned within the scope of the Creating smart Calibration Systems with Digital Measurement Device Twins objective are determined as follows.

3.1. **Creating digital twins of devices** (2028)

3.2. **Establishing Remote and Automatic Calibration Systems** for Basic Measurement Quantities (2028)

3.3. **Application of machine and deep learning methods** to automatic calibration and experiment systems (2028)

3.4. **Developing open-source software** and device drivers for automatic **calibration and uncertainty calculations** (2028)



Digitalization | Pilot Project | Objective1 | Objective2 | Objective3 | Outputs | Conclusion

15

TÜBİTAK UME

Outputs of Digital Metrology Pilot Project

2024
- -Business Development
- -Networking

2025
- -Digital Transformation of Current Documentations
- -Taxonomy studies

2026
- -Interactive Service Management System

2027
- -DCC creating
- -DCC sharing Platform

2028
- -Knowledge Sharing on DCC in Turkiye
- -Automatic Calibration Systems
- -Machine Learning, Deep Learning application on metrology
- -Cloud Computing

Digitalization › Pilot Project › Objective1 › Objective2 › Objective3 › **Outputs** › Conclusion

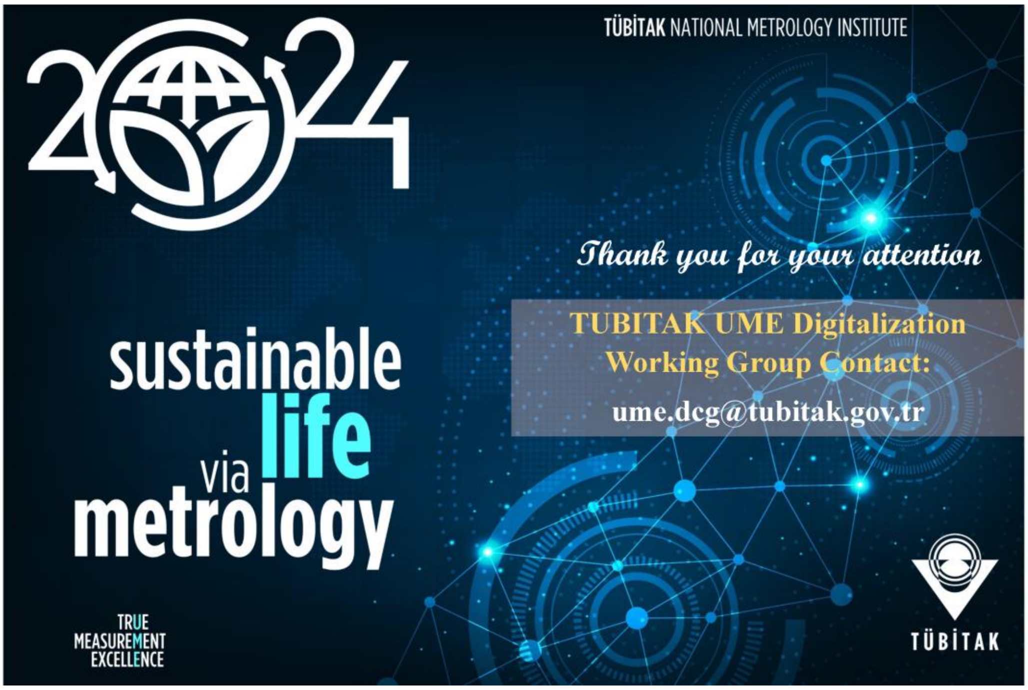
Conclusion and Future Works

With the completion of the digitalization pilot project in Turkiye,

- The duties and responsibilities of metrology players in transferring metrological outputs to the digital platform will be carried out.
- DCC-creating will be started at TUBITAK UME and commercial laboratories in Türkiye.
- A road map will be determined to transfer the process that would start at DCC to the DTR.
- The road map for the smart calibration system, the digital twin creation, and metrological applications on the clouds will be completed for Turkish quality system players.

- In conclusion, the TÜBİTAK UME Digital Metrology Pilot Project signifies a crucial step towards modernizing metrology practices in Turkiye. With a roadmaps, well-defined objectives, and the collaborative efforts of the Digital Working Group, the project is ready to bring about a positive transformation in the precision and efficiency of metrological areas.

Digitalization › Pilot Project › Objective1 › Objective2 › Objective3 › Outputs › **Conclusion**



TÜBİTAK UME

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47 An Integrated Digital Calibration System for Frequency Source Calibration at SNSU-BSN

Presenting author: Marizsa Rahima Indra, SNSU-BSN, Indonesia
E-mail address: marizsa.rahima@bsn.go.id
Additional authors: Reggi Aryunadi, A.M. Boynawan, Ratnaningsih, Yulita Ika Pawestri, Brillyana Githanadi (All SNSU-BSN)

Abstract

Digital transformation is an essential element in measurement systems, aiming not only to minimize errors but also to improve efficiency and effectiveness. An integrated system is required in the calibration process, starting from data acquisition to generating the certificates.

The Time and Frequency Laboratory of National Measurement Standard - National Standardization Agency of Indonesia (SNSU-BSN) has developed software to integrate frequency source calibration systems using Python. The system uses a frequency counter, which is controlled by the software in setting and data acquisition. Additionally, the software automatically saves the calibration data into a spreadsheet for the calculation of error values and measurement uncertainties. A calibration report is generated using the same spreadsheet based on these calculations. Subsequently, the calibration report is sent to the existing system for review and approval by supervisors, digitally signed, and then dispatch to the calibration customers.

This system has the capability to reduce manual intervention and enhance precision and consistency in calibration. In order to expedite the fulfillment of frequency source calibration service needs in healthcare and disaster management, especially below 1 Hz, this development contributes to a decrease in time and effort in calibration activities.

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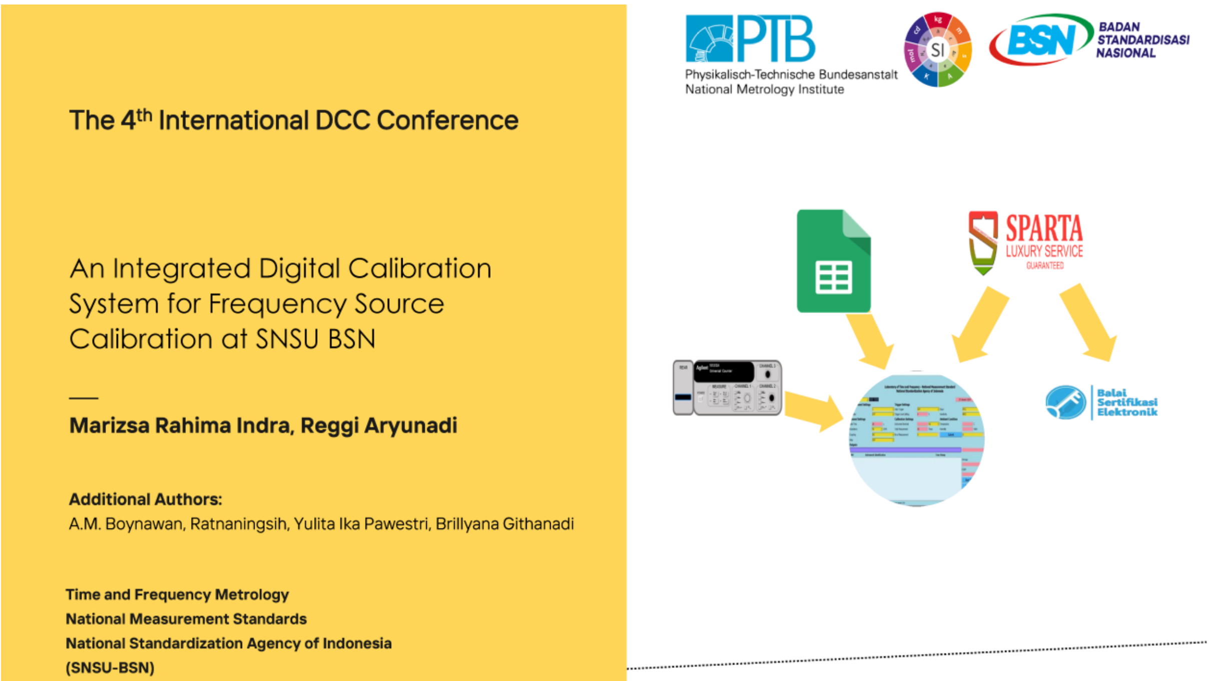
Presentation of Marizsa Rahima Indra



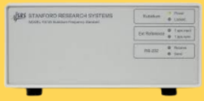
INTRODUCTION

- Measurement using a frequency counter spans a **broad spectrum**
  - lower frequency ranges: meteorology, acoustic vibration, and healthcare
  - higher frequencies : telecommunications.

- The accuracy of frequency measurement via a frequency counter is contingent upon **the gate time**
  - Lower frequencies: **longer** measuring time; not effective
  - Higher frequencies: **shorten** measuring time; human error

- The use of Python programming in **digitizing the calibration process** has been extensively developed



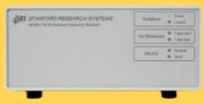


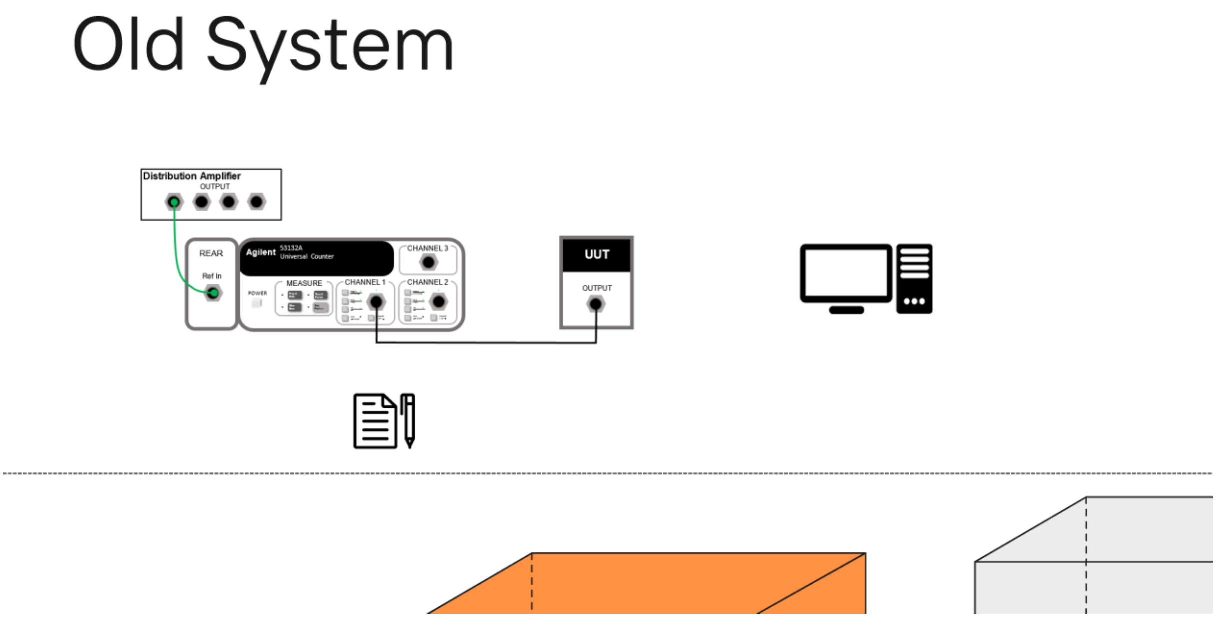
INTRODUCTION

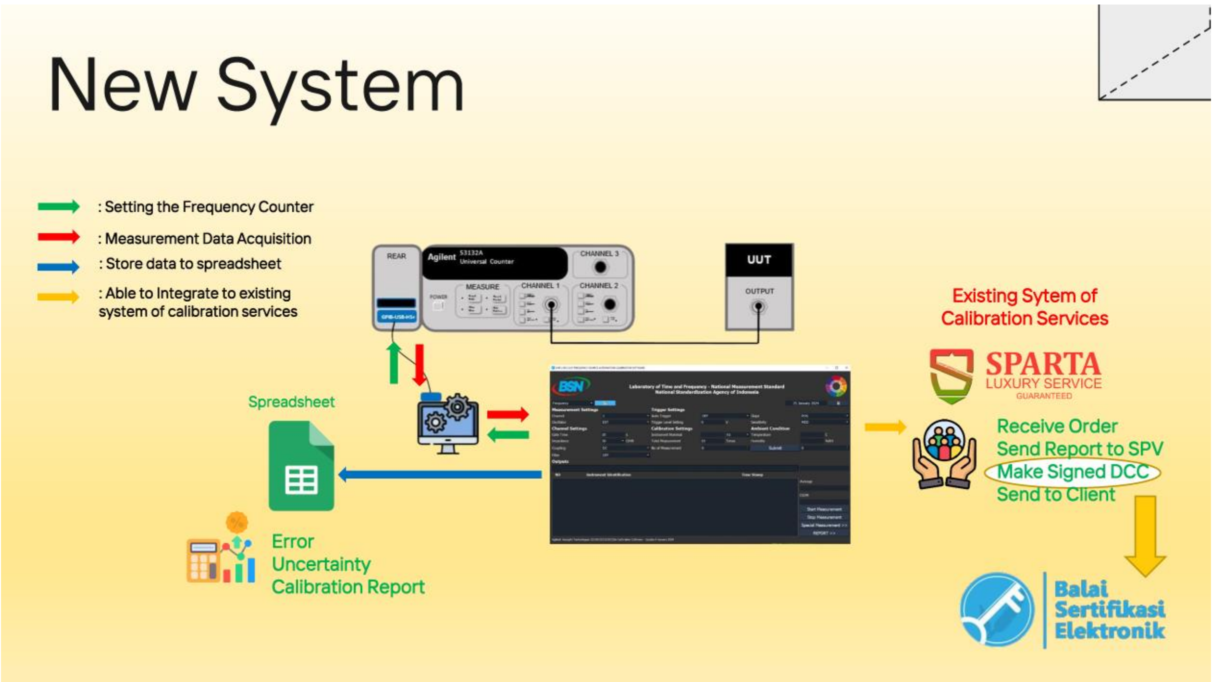
Aim:

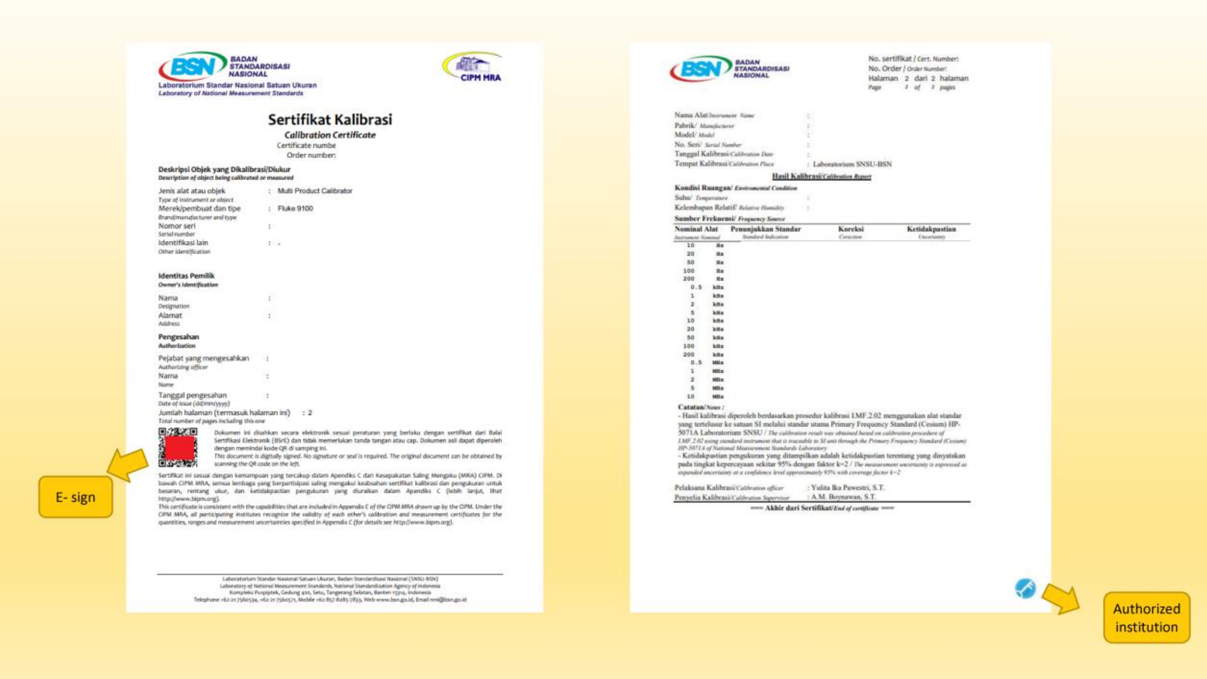
- ✓ Reduce manual intervention
- ✓ Efficient process
- ✓ Enhance precision and consistency in each measurements






Old System
Distribution Amplifier
OUTPUT
REAR
Ref In
Agilent 53132A Universal Counter
CHANNEL 3
MEASURE
CHANNEL 1
CHANNEL 2
POWER
UUT
OUTPUT


New System
: Setting the Frequency Counter
: Measurement Data Acquisition
: Store data to spreadsheet
: Able to Integrate to existing system of calibration services
REAR
Agilent 53132A Universal Counter
CHANNEL 3
MEASURE
CHANNEL 1
CHANNEL 2
POWER
UUT
OUTPUT
Spreadsheet
Error
Uncertainty
Calibration Report
Existing Sytem of Calibration Services
SPARTA
LUXURY SERVICE
GUARANTEED
Receive Order
Send Report to SPV
Make Signed DCC
Send to Client
Balai Sertifikasi Elektronik



Validation

To validate this integrated system:

Comparison between manual and automatic data acquisition in frequency source calibration

Linear regression: Y=1.0X+ -0.0
Determination Coefficient = 1

Nominal Frequency	Manual (Hz)	Automatic (Hz)
0,01 Hz	0,010 000 051	0,009 999 928
0,02 Hz	0,019 999 914	0,020 016 111
0,05 Hz	0,050 000 015	0,049 999 970
0,1 Hz	0,099 999 107	0,099 999 063
0,2 Hz	0,199 999 666	0,199 999 706
0,5 Hz	0,500 000 146	0,499 998 949
1 Hz	1,000 000 123	1,000 003 137
2 Hz	1,999 995 303	1,999 989 524
5 Hz	5,000 000 352	4,999 994 972
10 Hz	9,999 985 600	9,999 985 275

Conclusion

- It has already been implemented at Time and Frequency Laboratory of SNSU BSN
- This integrated system has actively and efficiently improved the calibration process,especially for frequency source calibrations

THANK YOU!

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48 Recent advances regarding machine-actionable information and data in the quality infrastructure of BSTI Bangladesh

Presenting author: Abdullah Al Mamun, Deputy director, Bangladesh (BSTI)
E-mail address: mamun.bsti@yahoo.com
Additional authors:

Abstract

Data

Data is information that has been translated into a form that is efficient for movement or processing.

Machine actionable data and information

In the sense of computer language data is information converted into binary digital form. Data represents values attributed to parameters, and knowledge signifies understanding of real things or abstract concepts.

The machine actionable data is a structured in a consistent way so that machines, or computers, can be programmed against the structure.

Quality infrastructure

Quality infrastructure (QI) is the system put in place to ensure products and services are safe and of high quality. It covers everything from standardization and conformity assessment (testing, inspection and certification) to accreditation, metrology and market surveillance.

FAIR principles

The FAIR principles (Findable, Accessible, Interoperable, Reusable) describe how data should be organized to be more easily accessible, understood, exchangeable and reusable.

Digital Calibration Certificate

Digital calibration certificate (DCC) is intended to become a globally standardized format for calibration data defined in the form of an XML (Extensible Markup Language) schema. The DCC contains all relevant calibration data, the method, uncertainty, and results of the calibration.

DCC for FAIR Principle in QI

The main benefits of the DCC are increased reliability, transparency, efficiency, and traceability in the calibration process, as well as reduced costs and time. FAIR principles aim is to facilitate, encourage and guide researchers towards making their data easily findable and accessible Within QI system, experts and QI institutions work together to protect people, health and the environment. QI in metrology works and following FAIR concept DCC aim to do the jobs for globally standardized way by using data and information by software for more reliable the calibration and traceability.

DCC of BSTI, Bangladesh

Bangladesh Standards and Testing Institution (BSTI) committed to comply with DCC in metrology. BSTI already update the service by e-application process and machine readable Quick Response (QR) code certificate. It is easy for service provider and taker with more reliable way. But the service is not globally standard format or XML Schema. Before developing the software by the third party not aware the global standard format. Presently by dint of digitalization of metrology focus group activity BSTI takes the initiative to comply in the XML format applying python software for globally standardized format.

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Presentation of Abdullah Al Mamun

4th International DCC Conference

welcome

from

BSTI, Dhaka

PAPER TITLE

Recent advances regarding machine-actionable information and data in the quality infrastructure of BSTI Bangladesh

Engr. Md. Abdullah Al Mamun

Deputy Director (Metrology)

Bangladesh Standards and Testing Institution (BSTI)

Dhaka, Bangladesh

Information & Data

- Information is any entity or form that resolves uncertainty or provides the answer to a question of some kind.
- Information is a collection of data that gives everyone an advantage since it helps in decision-making for the individuals involved.
- Raw information is called data.
- Data is the term used to describe information entered into and saved on a computer.
- Data is information that has been translated into a form that is efficient for movement or processing.

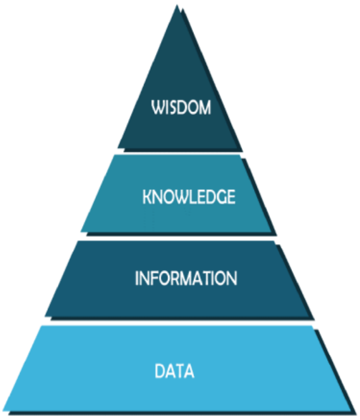
Information & Data

Knowledge

Information that has been processed, examined, and interpreted and may be utilized to lead decisions is known as knowledge. The idea of knowledge encompasses both the information and the capacity to access it.

Wisdom

Information, knowledge, and experience are combined to create wisdom, which is the ability to apply knowledge to actual situations.



Machine-Actionability

The information that is consistently structured so that machines can be programmed against such a structure. It is emphasized lately in the domain of data management plans and metadata, as tools need to process and evaluate them effectively.

Structured Data: Meticulously organized library, where each book has an assigned and predefined location. It is commonly referred to as a database or Relational Database Management System (RDBMS).

DMP: **A data management plan documents the lifecycle of your data.** The plan provides details on data collection for storage, access, sharing, and reproducibility of your results.

Meta data: Meta data is defined as **the information that describes and explains data**. It provides context with details such as the **source, type, owner, and relationships to other data sets**. So, it can help you understand the relevance of a particular data set and guide you on how to use it. In a nutshell: Metadata is a cornerstone of a modern enterprise data stack.

Machine actionable data and information

In the sense of computer language data is information converted into binary digital form.

Quality

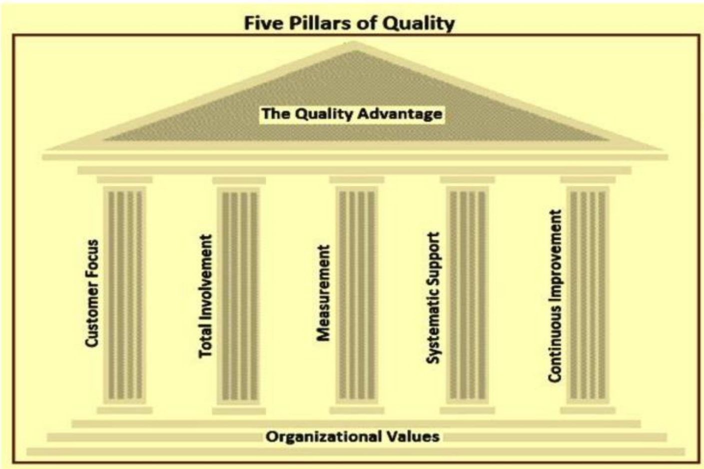
Quality is the degree to which an object or entity (e.g., process, product, or service) satisfies a specified set of attributes or requirements. The quality of something can be determined by comparing a set of inherent characteristics with a set of requirements.

Pillar of Quality

Five pillars of quality are:

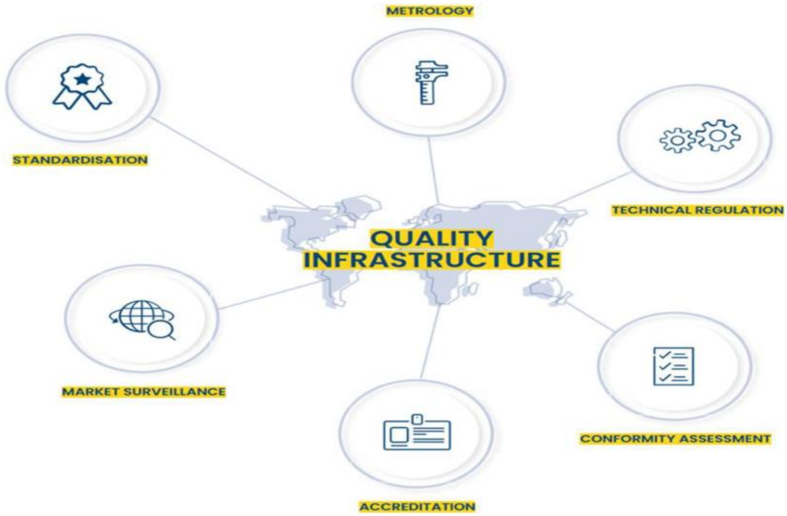
- Customer focus
- Total involvement of employees
- Measurement
- Systematic support, and
- Continuous improvement.

These five pillars provide the organization with the quality advantage.



Quality Infrastructure

Quality infrastructure (QI) is the system put in place to ensure products and services are safe and of high quality



QI

Three Elements of QI

❖Standards

❖Metrology &

❖Accreditation

✓Standardization – Benefiting business and society. ...

✓Conformity assessment – Ensuring reliability. ...

✓Accreditation – Generating trust. ...

✓Metrology – To measure is to know. ...

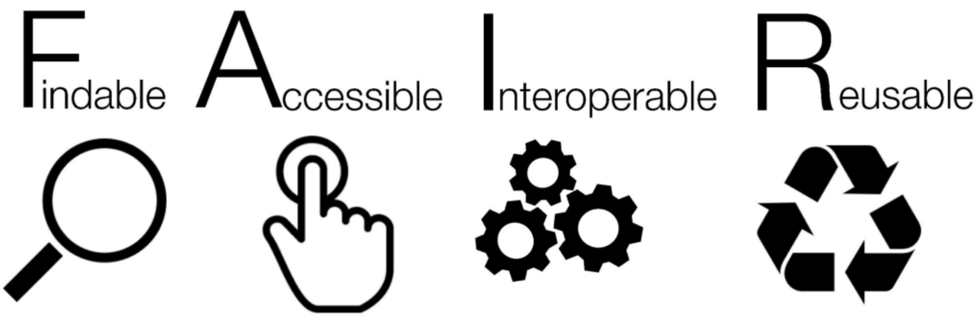
✓Market surveillance and product safety – ensuring fair competition and safety.

FAIR principles

Describe how data should be organized to be more easily

- accessible
- understood
- exchangeable and
- reusable.

FAIR



Digital Calibration Certificate (DCC)

DCC is intended to become a globally standardized format for calibration data defined in the form of an XML (Extensible Markup Language) schema.

In computer programming, a schema (pronounced SKEE-mah) is the organization or structure for a database, while in artificial intelligence (AI) a schema is a formal expression of an inference rule.

DCC for FAIR Principle in QI

The main benefits of the DCC are

- Increased reliability,
- Transparency,
- Efficiency, and
- traceability in the calibration process, as well as reduced costs and time.

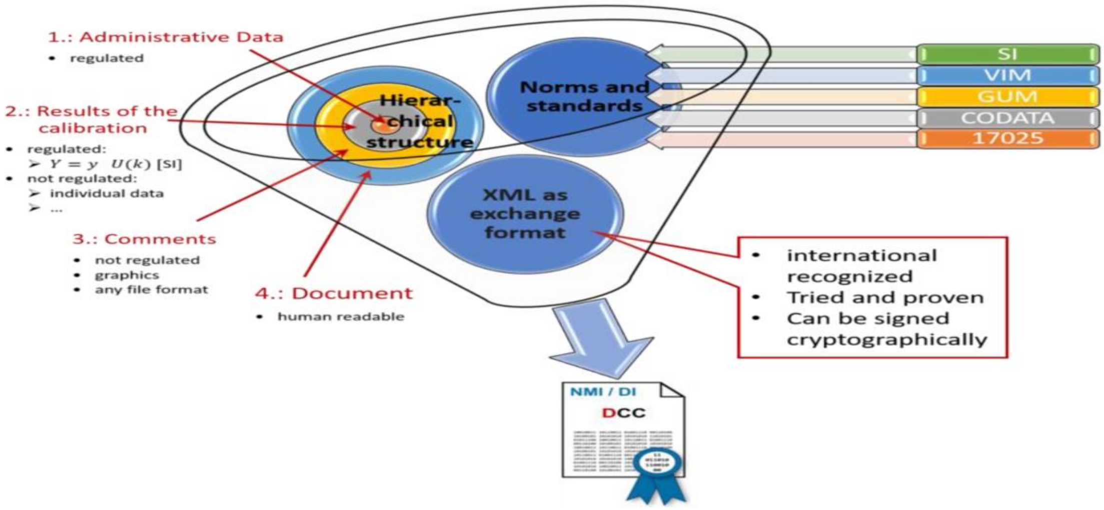
DCC aim to do the jobs for globally standardized way by using data and information by software for more reliable the calibration and traceability.

FAIR principles aim is to facilitate, encourage and guide researchers towards making their data easily findable and accessible.

Within QI system, experts and QI institutions work together to protect people, health and the environment.

QI in metrology works and following FAIR concept.

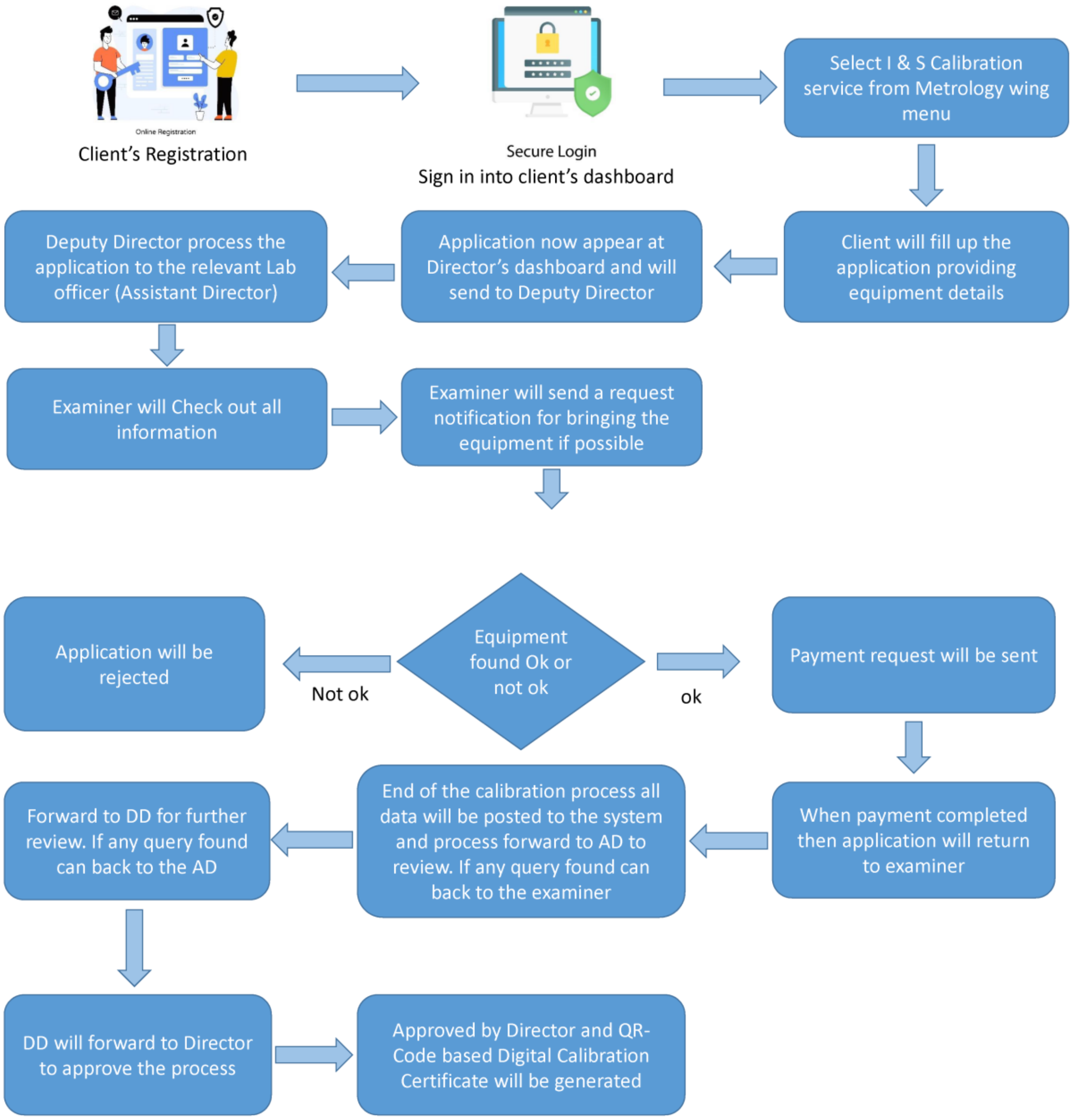
DCC (PTB)

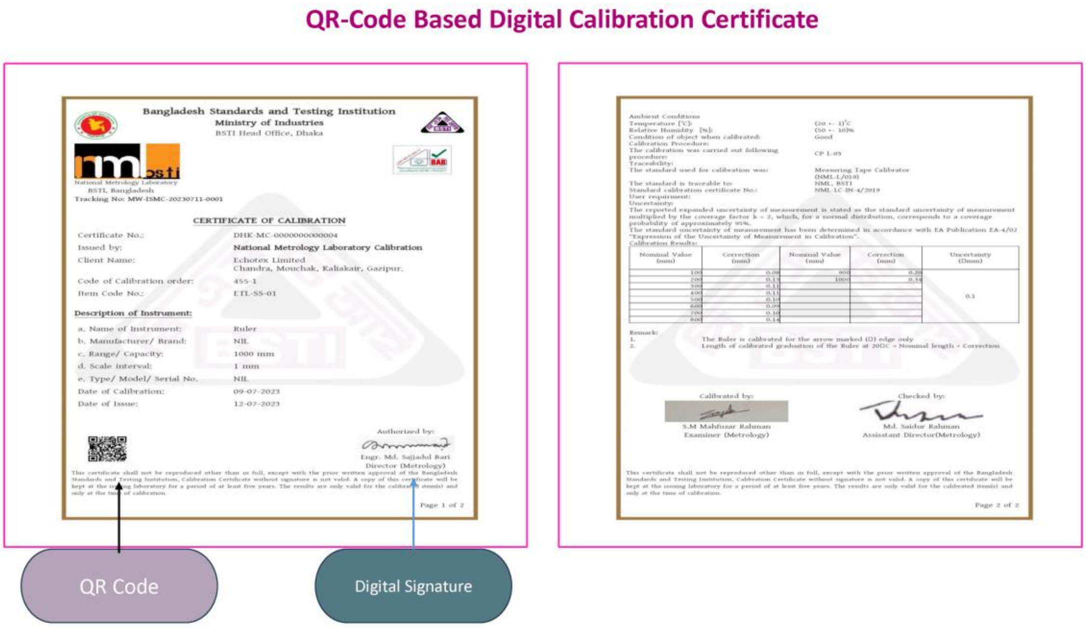


Extensible Markup Language (XML)

- Define and store data in a shareable manner.
- Supports information exchange between computer systems such as websites, databases, and third-party applications.
- Predefined rules make it easy to transmit data as XML files over any network because the recipient can use those rules to read the data accurately and efficiently.

QR-Code based Digital Calibration Certificate using e-Application Management System





Bangladesh Standards and Testing Institution
Ministry of Industries
BSTI Head Office, Dhaka

National Metrology Laboratory
BSTI, Bangladesh
Tracking No: MW-ISMC-20230711-0001

CERTIFICATE OF CALIBRATION

Certificate No.: DHK-MC-0000000000004
Issued by: **National Metrology Laboratory Calibration**
Client Name: Echotex Limited
Chandra, Mouchak, Kaliakair, Gazipur.
Code of Calibration order: 455-1
Item Code No.: ETL-SS-01

Description of Instrument:

a. Name of Instrument: Ruler
b. Manufacturer/ Brand: NIL
c. Range/ Capacity: 1000 mm
d. Scale interval: 1 mm
e. Type/ Model/ Serial No. NIL
Date of Calibration: 09-07-2023
Date of Issue: 12-07-2023

Authorized by:
Engr. Md. Sajjadul Bari
Director (Metrology)

This certificate shall not be reproduced other than in full, except with the prior written approval of the Bangladesh Standards and Testing Institution, Calibration Certificate without signature is not valid. A copy of this certificate will be kept at the issuing laboratory for a period of at least five years. The results are only valid for the calibrated item(s) and only at the time of calibration.

Page 1 of 2

Ambient Conditions
Temperature [°C]: (20 +- 1)°C
Relative Humidity [%]: (50 +- 10)%
Condition of object when calibrated: Good
Calibration Procedure:
The calibration was carried out following procedure: CP L-03
Traceability:
The standard used for calibration was: Measuring Tape Calibrator (NML-L/010)
The standard is traceable to: NML, BSTI
Standard calibration certificate No.: NML-LC-IN-4/2019
User requirement:
Uncertainty:
The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which, for a normal distribution, corresponds to a coverage probability of approximately 95%.
The standard uncertainty of measurement has been determined in accordance with EA Publication EA-4/02 "Expression of the Uncertainty of Measurement in Calibration".
Calibration Results:

Nominal Value (mm)	Correction (mm)	Nominal Value (mm)	Correction (mm)	Uncertainty (mm)
100	0.08	900	0.20	0.1
200	0.13	1000	0.34	
300	0.11			
400	0.11			
500	0.10			
600	0.09			
700	0.10			
800	0.14			

Remark:
1. The Ruler is calibrated for the arrow marked (D) edge only
2. Length of calibrated graduation of the Ruler at 20°C = Nominal length + Correction

Calibrated by:
S.M Mahfuzar Rahman
Examiner (Metrology)

Checked by:
Md. Saidur Rahman
Assistant Director(Metrology)

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Session “Quality Infrastructure II” (Chair: Jariya Buajarem)

50 Use Case “ eAttestation ”: Roll-out of digital accreditation symbol for German accredited CABs and enabling DCC for accredited CABs as fully machine readable

Presenting author: Florian Witt, Head of Technical Unit 1.1, DAkkS; Germany
E-mail address: florian.witt@dakks.de

Abstract

As national accreditation body, DAkkS developed a temper-proof digital version of the accreditation symbol that is also machine readable.

In this contribution, DAkkS will shortly present the results of the pilot phase of the digital accreditation symbol on DCCs by three accredited calibration laboratories.

From 30th March 2024 onwards, all accredited CABs in Germany can apply for the digital accreditation symbol, since the symbol can be applied to all digital attestations and on different file formats, such as PDF or XML. By using machine readable formats for attestations, the combination allows the integration of digital test reports in fully automated processes. It further creates the possibility for an easy international roll-out for every national accreditation body and can contribute to a paperless system of attestations for international trade.

This contribution will further address the necessary requirements for CABs regarding accreditation procedures as well as the necessity of general guidelines from experts regarding the correct implementation of normative requirements for a certain measurand in the DCC XML scheme.

The project is integrated within a broader initiative of the central players in German quality infrastructure (QI) - DIN, DKE, DAkkS, PTB, and BAM. The joint initiative “QI-Digital” develops digital and interlinked processes and solutions for a modern quality infrastructure that serves the analogue as well as the digital product world.

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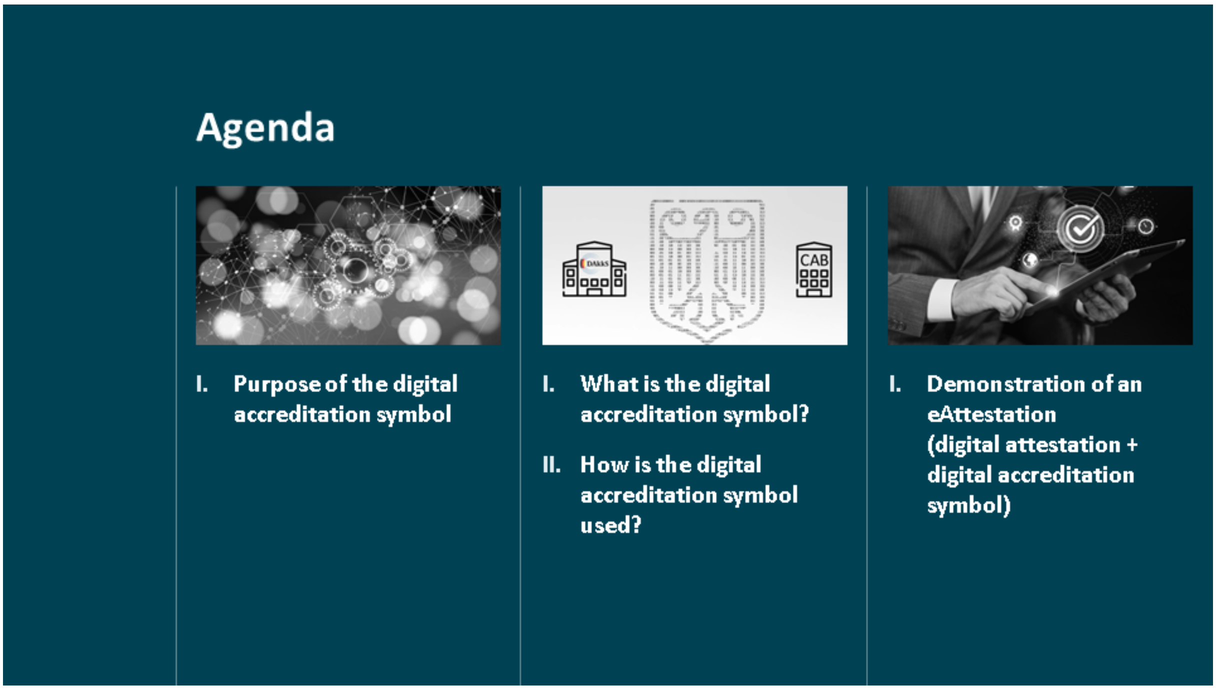
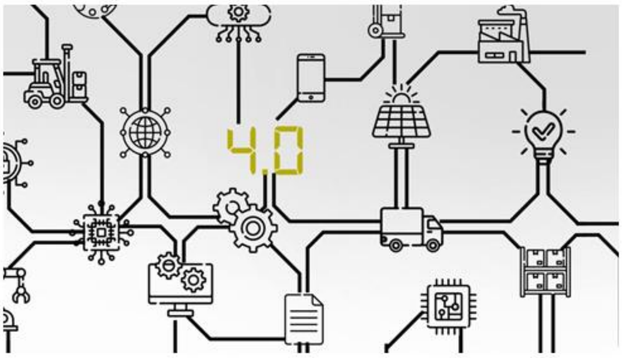
Presentation of Florian Witt



Purpose of the digital accreditation symbol

QI-DIGITAL INITIATIVE GERMANY

Supporting the digital transformation of the economy and enabling a paperless digital trade regime



Purpose of Digital Accreditation Symbol

- Trustworthy digital issuance of attestations by accredited CABs
- Automatized verification of accreditation status in real-time
- Considering machine-readable data-formats:
  - Protection against fraud
  - automatized proof of traceability
  - Conformity with normative requirements (protection, reference to accreditation)

DAkkS

Functionality and usage of the digital accreditation symbol

DAkkS

Digital Identities and machine-readable information are the basis for the digital accreditation symbol

- **Electronic seal as „digital company stamp" / „digital finger print"**

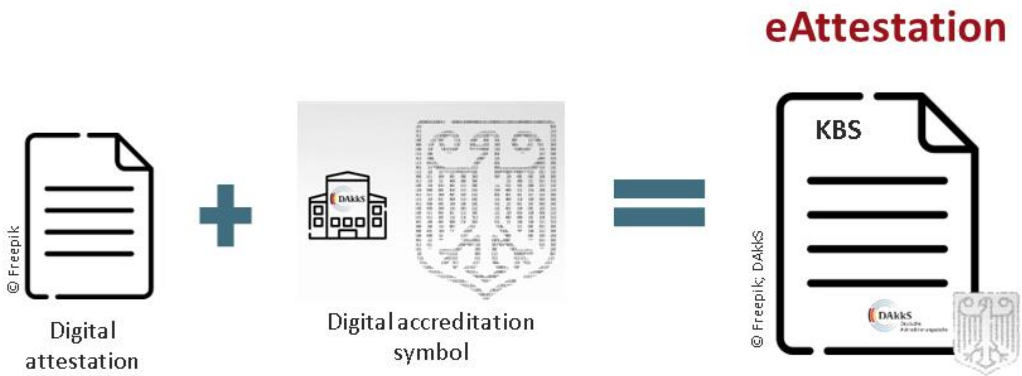
Icons: © Freepik at https://www.flaticon.com & Carave Video

- **Entailed information in digital accreditation symbol**:
  - **Name** of the **legal entity** of a CAB
  - Unique **accreditation number** with reference to accreditation body and country
    - E.g. **DAkkS**00-**DE**-K-19125-01-00
  - **Restriction** to the application on attestations only

→ Enables **technically secure issuance of attestations** and **machine-verifiable proof of accreditation** in real-time

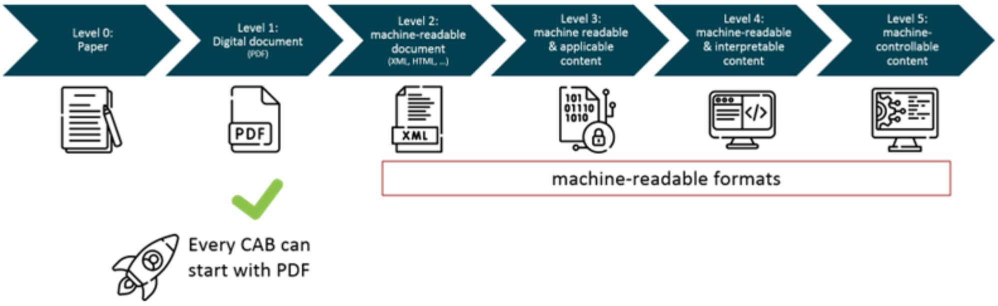
DAkkS

Digital accreditation symbol in practice – eAttestation



DAkkS

eAttestation is applicable in all phases of digitalization



Original source IDiS, *IDiS Webinar I: Digitale Transformation der Normung – Ausgangssituation und Vision*, letzter Aufruf: 28.02.22, www.dke.de/idis

RESULTS OF PILOT PHASE

Application of the Digital Accreditation Symbol

- Usage was tested in a joint pilot phase with CABs and PTB
- Aimed at the technical aspects of issuance and usage between CABs and their customers and effects on accreditation processes
- Usage for PDF and DCC was successfully demonstrated
- Lessons learned:
  - No changes in accreditation processes
  - In assessments the compliance of „eAttestations" with normative requirements needs to be audited (as today)
  - Detailed technical specifications for allowing machines to „understand" the content of a DCC are a pre-requisite (e.g. DKD-Guidelines)

Advantages for CABs & economy

- Digital accreditation symbol (AS) technically protected in digital space
  → increase of trust in issued eAttestations
- Advantages for customers of a CAB:
  - **Integration of QI information** into automated processes through machine readability of the accreditation symbol **without media disruption**
  - **Verifiability of the identity, authenticity and integrity** of the eAttestation in real time and worldwide

  → **increases efficiency, reduces costs**

DAkkS

Demonstration of an eAttestation as applied result of the digital accreditation symbol

DAkkS

eAttestation: PDF example

- **Demonstration for Humans**:
  - Calibration certificate by an accredited calibration laboratory issued as PDF
- The **digital accreditation symbol was attached without visible sign** on the document
- Digital accreditation symbol is applied to serve the **purpose of a secure technical issuance and machine-verifiable proof of accreditation** in the digital world

DAkkS

Contact

Susanne Kuch
Digital policy officer for quality infrastructure
Accreditation Governance, Research and Innovation

susanne.kuch@dakks.de
+49 30 67 05 91- 272

DAkkS

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51 Real or fake? - Trust is good, proof is better…

Presenting author: Robert Hilgers, Bundesdruckerei; Germany
E-mail address: Robert.Hilgers@bdr.de
Additional authors:

Abstract

Our presentation will explain how digital information sources are electronically secured.

Qualified electronic seals help to create value in the form of trust in modern information societies but also in business contexts. In order to illustrate this, we will look at the high quality camera Leica M11-P, the world's first camera to use content credentials to create a seamless chain of authenticity from capture to publication. Furthermore, we will describe how non-standard digital document formats, such as XMLs, are easily and securely electronically sealed.

A TÜV-approved eIDAS qualified electronic seal from the Bundesdruckerei | D- Trust is easy to integrate into existing laboratory software architectures to deal with digital calibration certificates (DCC). Implementation works quick and easy.

Technical contact:
Peter Schrameyer, Product Management Fiskalisierung, DTR M PB
D-Trust GmbH | Ein Unternehmen der Bundesdruckerei
Kommandantenstr. 15, 10969 Berlin
Tel + 49 (0) 170 – 301 85 77, Peter.Schrameyer@d-trust.net, www.d-trust.net

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Presentation of Robert Hilgers

First a Bit of History . . .

d-trust.

From dripping wax to secure PKI

- We all recognize the velum pages full of wax blobs and ribbons from our history lessons. Princes, kings and bishops used coloured wax, heated it and then stamped their coat of arms into it. This seal was used to confirm the authenticity of a document. A contract, a passport or an escort bill with a wax seal was recognized as genuine.
- In legal transactions, this kind of document sealing has been out of fashion for a very long time.
  - The last traces of it can still be found on registered letters that you receive through the German postal service or in the rubber stamps of the tax office on annual income tax assessment notices.
- The EU's eIDAS (electronic IDentification, Authentication and trust Services) regulation has brought government and corporate seals back into focus.

29.02.2024

Teil der Bundesdruckerei-Gruppe

Electronic Seals

d-trust.

Electronic Seals

The digital stamp for legal entities

- ✗ Substitute for a personal statement of will
- ✓ Confirmation of origin
- ✓ Confirmation of integrity
- ✓ Security against forgery
- ✓ Can be verified in the long term

Customers and institutions receiving laboratory reports with eIDAS qualified electronic seals can digitally authenticate these documents and confidently forward them to further recipients.

Are There Use Cases for Laboratories?

d-trust.

The Smart Solution?

- It makes sense to look for application scenarios for digital seals in the laboratory sector
- An individual signature costs time and therefore money. A digital seal happens in an instant.
- Digital seals are suitable for mass use, where a large number of documents need to be processed in a short time.

29.02.2024

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Fake or real –
Trust is good, proof is better.

(Approval by German Trust Center)

Teil der Bundesdruckerei-Gruppe

The Problem

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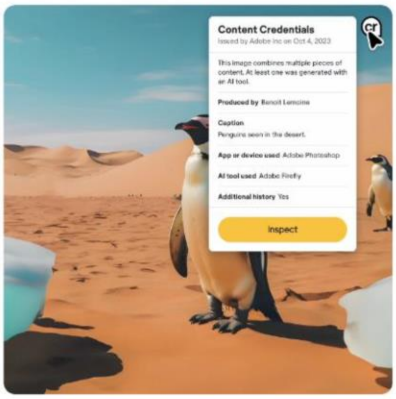
Wait, where did this image come from?

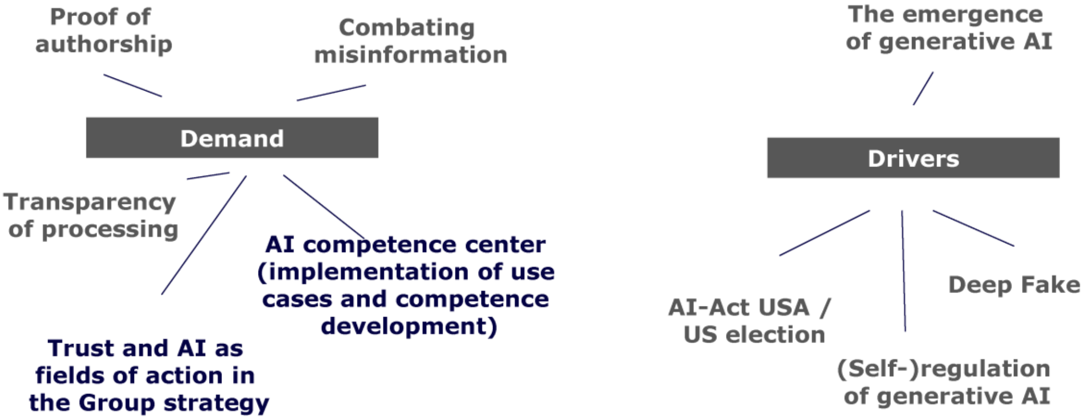
Deepfakes. Voice cloning. Synthetic media. It's hard to tell what's accurate and authentic these days.



29.02.2024 Teil der Bundesdruckerei-Gruppe 6

The market: needs and drivers

d-trust.



Generative AI is driving demand

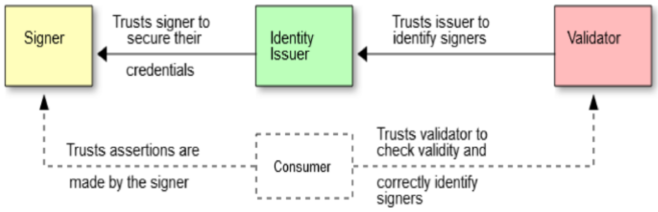
29.02.2024 Teil der Bundesdruckerei-Gruppe 7

Solution: System sketch - Role TSP

d-trust.

Role of TSPs according to C2PA Trust Model

- Issues Signer's certificate so that the claims can be cryptographically signed
- TSP should be stored on the validators' **trusted list**
- Manages a list of all issued certificates that are used to sign C2PA manifests



Governance model of the list requested from C2PA

Quelle: https://c2pa.org/specifications/specifications/1.3/specs/C2PA_Specification.html#_trust_model

29.02.2024 Teil der Bundesdruckerei-Gruppe 8

Market exploration: Reference "Leica"

d-trust.

Reference "Leica" - First manufacturer worldwide with certificate

Leica

PRESSEINFORMATION

Neu: Leica M11-P

Die weltweit erste Kamera, die mit Content Credentials von der Aufnahme bis zur Veröffentlichung eine lückenlose Authentizitätskette schafft

- DTR operates a sub-PKI for Leica and provides certificates (special form of the device ID "device signature")
- Implementation meets the technical standard
- First photo "Coffee cup"

Quelle: https://zeitheute.news/die-neue-leica-m11-p-digitale-signatur-schutzt-die-authentizitat-der-fotos/

29.02.2024 Teil der Bundesdruckerei-Gruppe 9 d-trust.

Our Solution – The Remote Seal Service „seal-me"

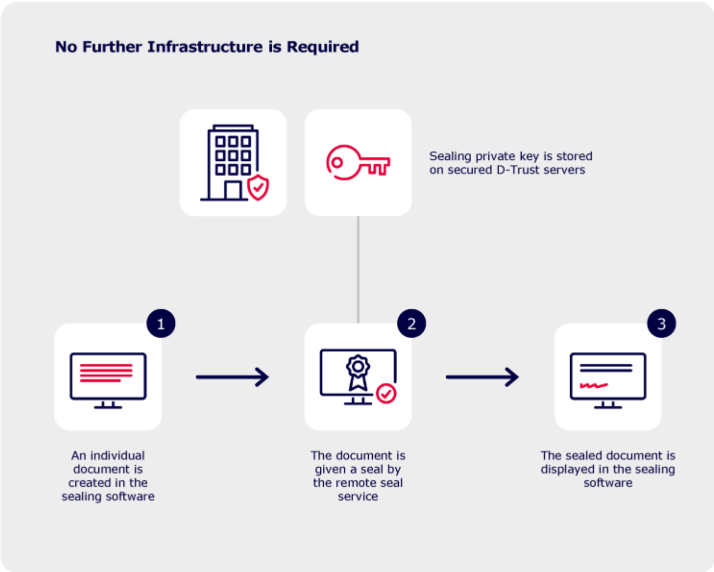
Teil der Bundesdruckerei-Gruppe

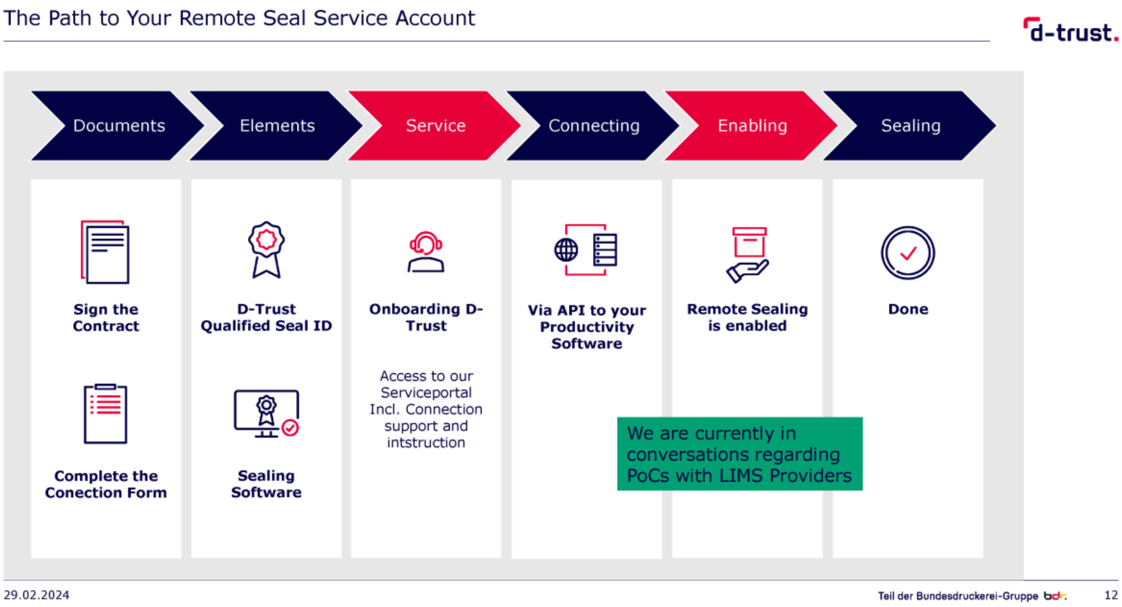
Remote Seal Service

d-trust.

Seal-me – Seal as-a-service

With the remote sealing service, the digital service for your secure electronic seal, you handle your sealing processes end-to-end electronically. Simple and straightforward.





d-trust.

Thank you.

Robert Hilgers

D-Trust GmbH
Senior Sales Manager DTR SC
E-Mail: robert.hilgers@d-trust.net
Telefon: +49 160 2238632

Andrew Freund

D-Trust GmbH
Senior Product Manager DTR M PB
E-Mail: andrew.freund@d-trust.net
Telefon: +49 171 5329642

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52 A new Era for Measurements: The DCC makes Tolerances superfluous

Presenting author: Christian Müller-Schöll, Mettler-Toledo Int. Inc., Greifensee, Switzerland
E-mail address: christian.mueller-schoell@mt.com

Abstract:

For decades measuring instruments have been classified and rated by tolerances and tolerance classes. Even for calibrated instruments, the corrections are not applied, but adherence to tolerance used instead. Why is this so? – The author claims this is pure laziness! – It is owed to the fact that calculating a correction used to be complicated and error prone in the "paper, pencil and slide rule" times.

However, with the DCC and modern computerized LIMS or manufacturing systems, calculations are done for free and with no risk of calculation errors. Furthermore, the use of tolerances for establishing traceability is sometimes questioned (ref. Klauenberg) and ignoring known systematic errors clearly contradicts the rules of the GUM.

The advantages of using the DCC to perform computerized corrections to the measured values are:

- More accurate measurements, smaller uncertainties
- Longer calibration periods
- No need for adjusting instruments any longer

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Presentation of Christian Müller-Schöll

Topics Covered

METTLER TOLEDO | 2

Why do we use tolerances?

METTLER TOLEDO | 3

Examples for tolerances:

- Percentages (and according accuracy classes)
- OIML Weight accuracy classes
- Pt100 classes
- Manufacturer tolerances
- …

OIML R 111-1: 2004 (E)

Table 1 Maximum permissible errors for weights (± δm in mg)

Nominal value*	Class E_1	Class E_2	Class F_1	Class F_2	Class M_1	Class M_{1-2}	Class M_2	Class M_{2-3}	Class M_3

- But why???

Hypothesis

METTLER TOLEDO | 4

Hypothesis:

- Tolerances have been in use for many decades.
- They were practical in the "paper-and-pencil" and in the "slide rule" era
- They eased the use of measuring instruments by human operators
- They help avoiding mistakes in transferring values
- They help avoding calculation errors

Example: Material Measure (Weight Piece)

METTLER TOLEDO | 5

E2 weight piece of 1 kg, error 0.5 mg, MPE = 1.6 mg

- The difference is in the uncertainty!
- Assumed calibration uncertainty associated with the result: U = 0.3 mg

1. Weight piece "used by corrected value":
   - 1.0000005 kg
   - How many zeroes??

1. Uncertainty in use: 0.3 mg + drift component

2. The same "used by tolerance":
   - 1 kg.

2. Uncertainty in use: 1.3 mg + drift component

Calculation according to EMUE "Good practice in evaluating measurement uncertainty Compendium of examples", van der Veen, Cox et al., 2021, E2.5.

Continuous Instruments

METTLER TOLEDO 6

1. Instrument "used by corrected value"
- Correction function is e.g. a 2-order polynomial
- Value = 0.003 kg + I * 0.9998 = 7.80144 kg

2. The same "used by tolerance"
- Value = 7.8 kg.

- Uncertainties will be larger for case 2.

The Digital Era

METTLER TOLEDO 7

- Use the DCC in an integrated process with the instrument connected to a digital system:
- No need for complicated manual calculations during the measurement process
- No risk of wrong manual transfer of long numbers
- The LIMS / Computer system
  - transfers data directly,
  - does all calculations,
  - and makes no typo mistakes.

Further Advantages

METTLER TOLEDO | 8

The DCC enables automated, integrated and error free calculation of corrected values.

No tolerances are used.

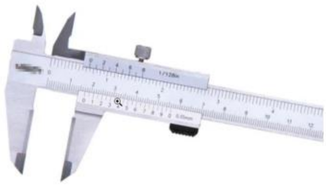
- No more need to re-adjust instruments
- Less discarding of worn material measures
- Smaller uncertainty == Better quality, when using corrected values
- No longer "decisions" to be taken
- No more "false" decisions
- No "probabilities or risks of false acceptance"
- No discussions "how to use a conformity statement to express metrological traceability"

Conclusion

METTLER TOLEDO | 9

Conclusion

- If we use the DCC data in integrated systems and integrated processes,
- Tolerances and associated issues and discussions are no longer justified for many types of instruments
- (Well, some exceptions…)



Questions, Discussion

METTLER TOLEDO 10

Do you now have a question?

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53 Importance of open exchange of data in DCC-based calibration processes

Presenting author: Tuukka Mustapää, Beamex Oy Ab, Finland
E-mail address: tuukka.mustapaa@beamex.com

Abstract:

Harmonized data formats and frameworks such as the digital calibration certificate (DCC) are in a key role in enabling digitalization of processes where metrological data is used or transferred. As a result, a lot of effort has been put into standardization and harmonization initiatives. The diversity of the actors within the metrology infrastructure means that also the systems used can be very different due to different requirements. Introducing new formats for representing data will require significant changes to existing systems or new solutions altogether.

Ensuring the interoperability of the data and systems will require a paradigm shift and revising of system design philosophies, as openness of the data exchange between systems will be essential in taking the DCC fully into use and exploiting all the potential benefits. In this presentation, we will discuss what challenges we have observed in the uptake of the DCC from a system provider's point of view. We also present how the DCC could eventually be taken into use in the calibration management on the industry level and what kind of changes would need to be introduced in the existing solutions by using the Beamex calibration ecosystem as an example.

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Presentation of Tuukka Mustapää

4th International DCC Conference

INTRODUCTION

- Beamex in short
- Challenges for system providers in current calibration processes
- How does the DCC change these?
- Our vision for DCC implementation
- Accomplishing the vision


beamex

4th International DCC Conference

CHALLENGES FOR SYSTEM PROVIDERS

- Diversity of the actors involved in the metrology infrastructure
  - Plenty of industry or region specific regulations, different sizes of organizations, ...
  - Different requirements for calibration systems
- Systems used in the industry have been mostly closed
  - This has been the easiest way to provide value for customers
- Without harmonised data formats, communication between different systems is laborious to establish and maintain
  - System integrations have been possible, but in many cases problematic

4th International DCC Conference

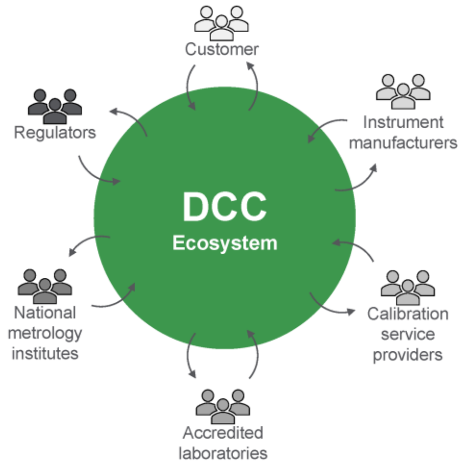
HOW DOES THE DCC CHANGE THINGS?

- DCC revolutionizes calibration processes
  - With the introduction of the DCC, blockages for system integrations are dimished
  - Automating processes becomes easier
- A common format for calibration data makes the data available for new purposes
  - Harmonised calibration data can provide significant value, e.g., in process optimisation
- A paradigm shift in the fundamentals of system development
  - Enabling open exchange of data is the key to improving efficiency

4th International DCC Conference

OUR VISION FOR DCC IMPLEMENTATION

- Fully digital flow of calibration data
  - Uncompromized integrity of data
- Platform-based calibration ecosystem(s)
  - Number of integrations needed is reduced to minimum
  - Collaboration between multiple organisations becomes easier
  - New value from calibration data
  - Improved transparency



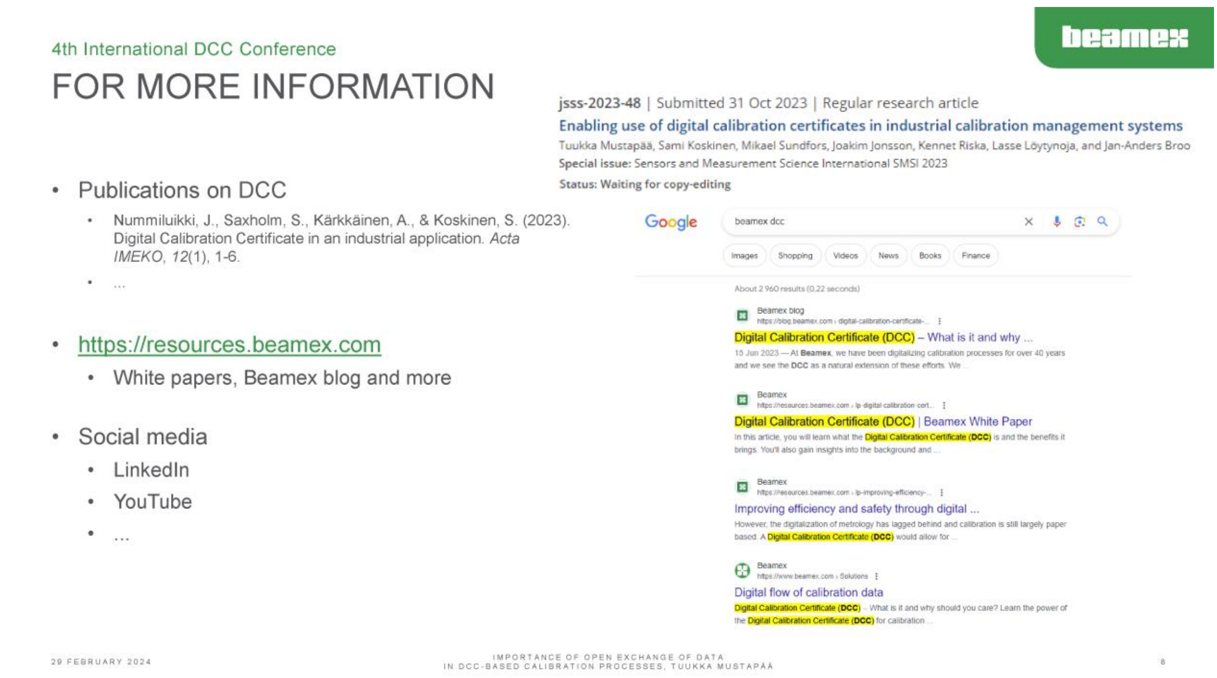
29 FEBRUARY 2024 IMPORTANCE OF OPEN EXCHANGE OF DATA IN DCC-BASED CALIBRATION PROCESSES, TUUKKA MUSTAPÄÄ 6

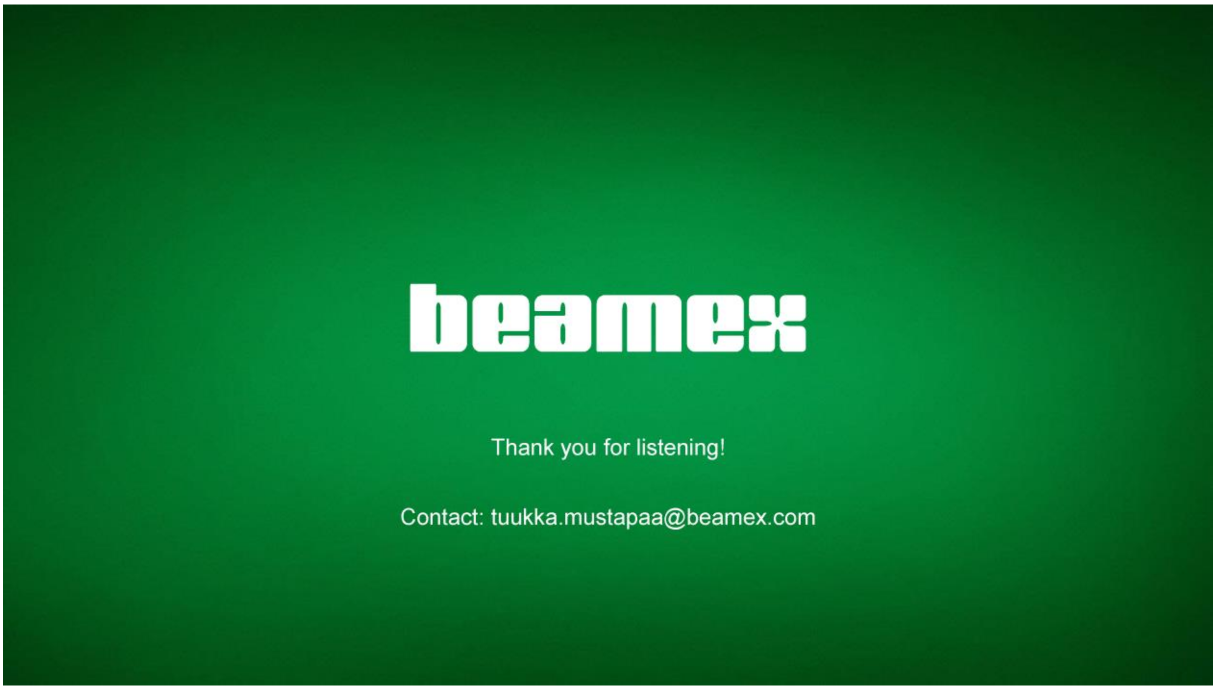
4th International DCC Conference

ACCOMPLISHING THE VISION

- Aligning internal data formats to be compatible with the DCC
  - E.g., defining refTypes for industry specific data
- Developing interfaces and functionalities required for DCC-based data exchange
  - Enabling communication between Beamex systems and third-party systems for different scenarios
- **Collaboration**
  - **Providing concrete proofs for the industry that there is a strong business case for the DCC**

29 FEBRUARY 2024 IMPORTANCE OF OPEN EXCHANGE OF DATA IN DCC-BASED CALIBRATION PROCESSES, TUUKKA MUSTAPÄÄ 7





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54 Making QI data available for research

Presenting author: Ulrich Harmes-Liedtke, Mesopartner and TU Berlin, Germany
E-mail address: uhl@mesopartner.com
Additional author: Ann-Sara Ramkissoon ar@mesopartner.com

Abstract:

The national, regional and international quality infrastructure organisations regularly generate a large amount of data. Examples include the BIPM key comparison database (KCDB), the ISO Survey of Management System Certification and the IAF Cert Search Database.

This data is necessary for analysing the development and general trends of national QI systems. Reliable data is particularly important for scientific research into the impact of QI on the economy and sustainable development. Panel data should be made available to construct panel datasets over an extended period (time series). These datasets must also be comparable across the various QI components and be sufficiently granular in geographic and sectoral terms.

The Global Quality Infrastructure Index (GQII) compiles an international QI ranking based on available data. The GQII uses only publicly available data from the official organisations for metrology, standardization and accreditation. The database comprises around 60,000 data points from 185 countries and economies. This index is supported by German development cooperation and the PTB.

The article provides an overview of the current availability and quality of QI data and explains how digitalisation can improve the databases for economic analysis and QI foresight. Centralised and decentralised models of data provision are compared. It also addresses the question of which indicators are best suited to measure the level of development and performance of national QI systems.

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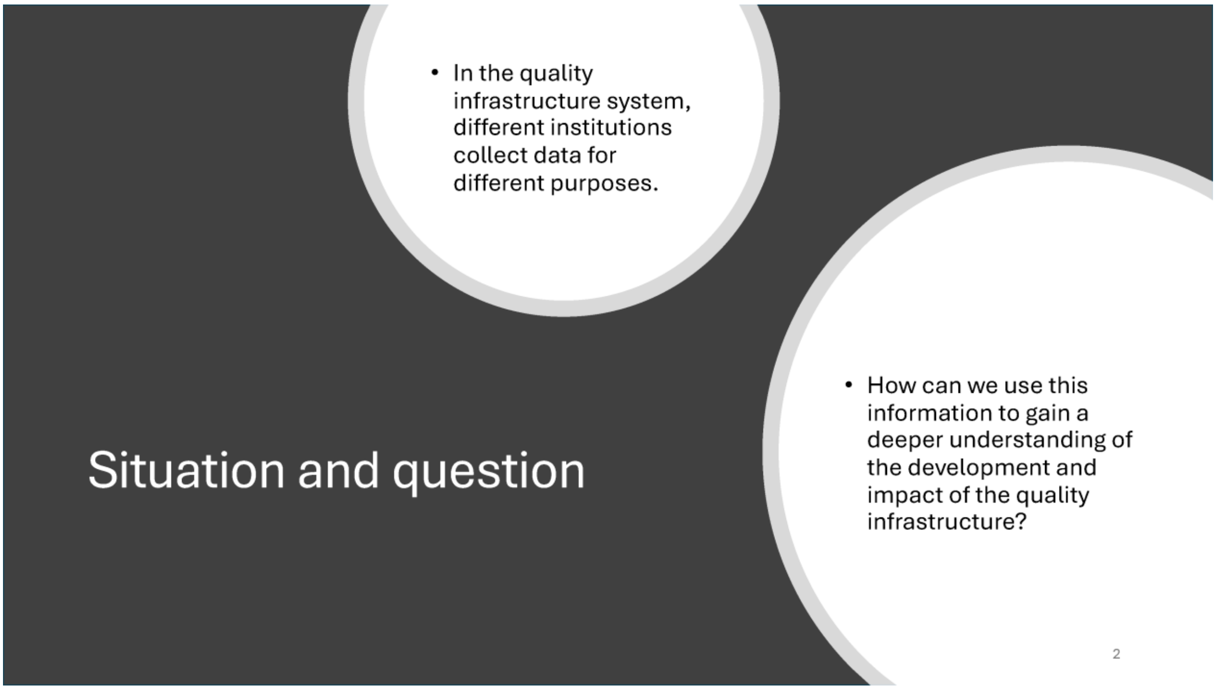
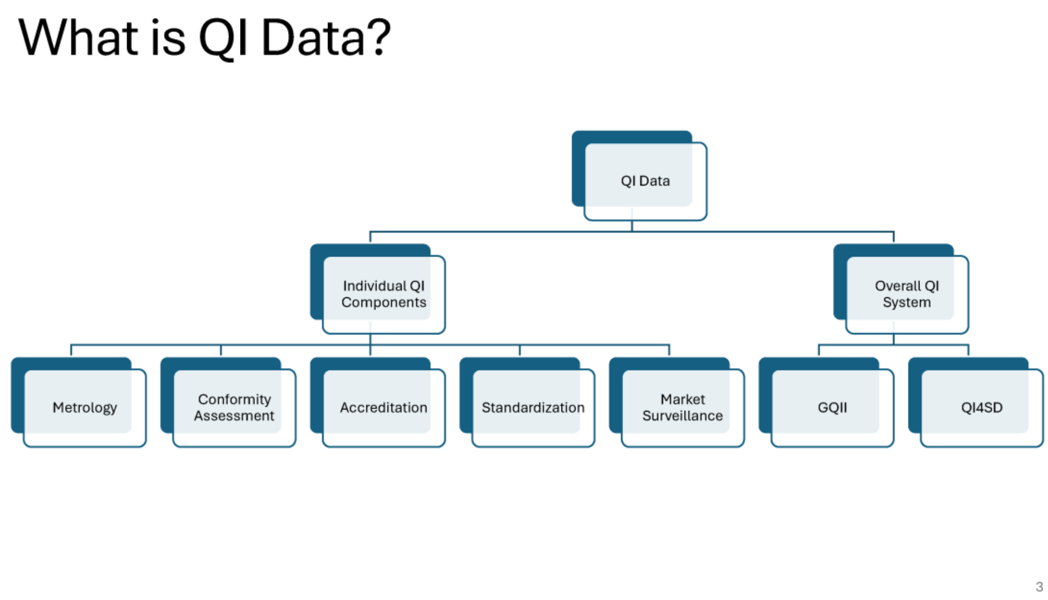
Presentation of Ulrich Harmes-Liedtke


Situation and question
• In the quality infrastructure system, different institutions collect data for different purposes.
• How can we use this information to gain a deeper understanding of the development and impact of the quality infrastructure?
2


What is QI Data?
QI Data
Individual QI Components
Overall QI System
Metrology
Conformity Assessment
Accreditation
Standardization
Market Surveillance
GQII
QI4SD
3

Sources of quantitative QI Data by Component

Types of data

- Membership in regional and international Cooperation
- Participation in Technical Committees
- Number of accredited or certified bodies

Owners and sources of data

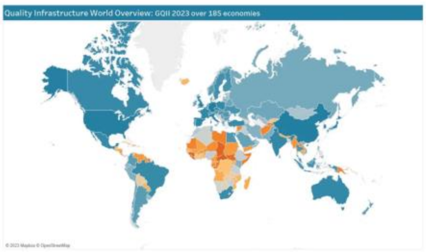
- Metrology
  - BIPM: CIPM Key Comparison Data Base (KCDB)
  - OIML
- Standardisation
  - ISO - ISO Survey
  - IEC
  - ITU
- Accreditation
  - ILAC
  - IAF – IAF Cert Search

4

Global QI rankings

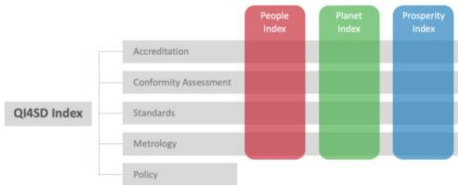
Global Quality Infrastructure Index (GQII)

GQII 2023

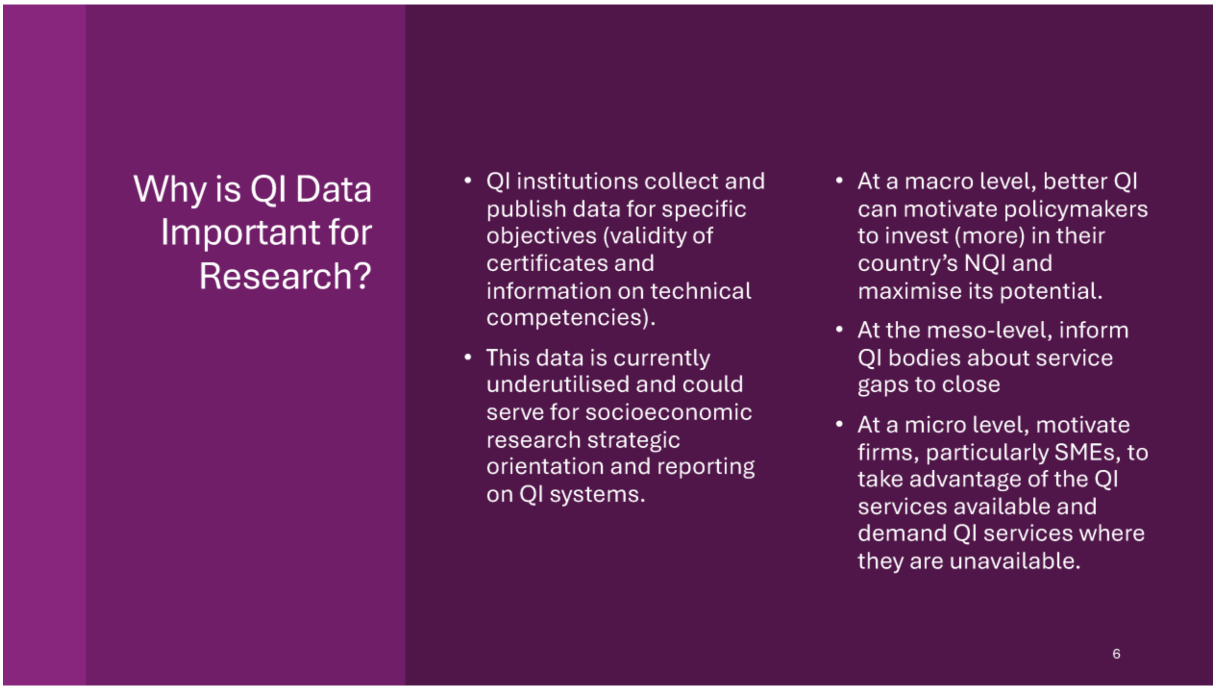


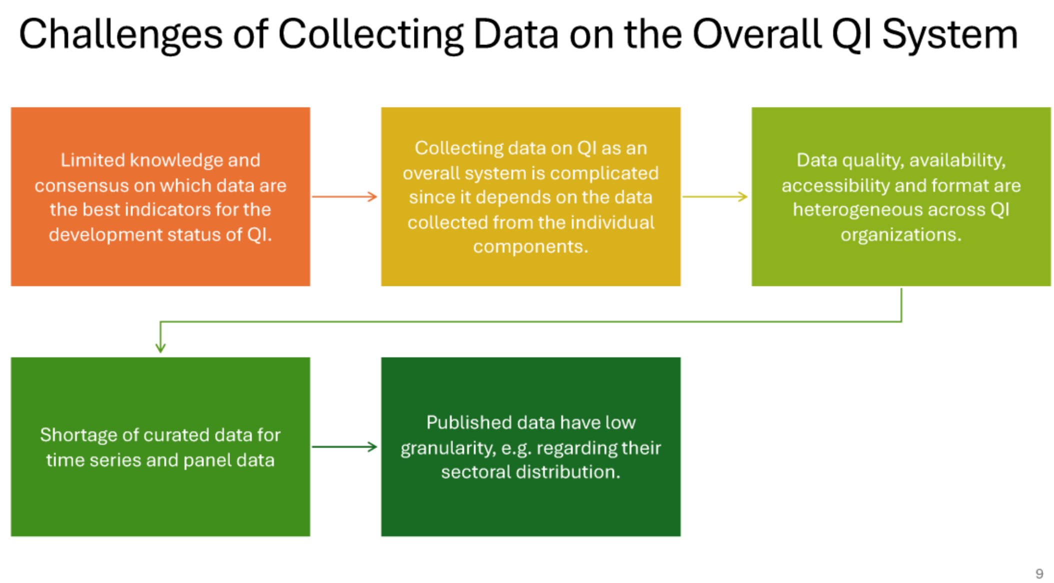
The GQII 2023 ranks 185 countries according to the relative development of their QI. A formula calculates a score for each country based on its position in the sub-rankings for metrology, standards and accreditation.

Quality Infrastructure for Sustainable Development (QI4SD)



5


Why is QI Data Important for Research?
• QI institutions collect and publish data for specific objectives (validity of certificates and information on technical competencies).
• This data is currently underutilised and could serve for socioeconomic research strategic orientation and reporting on QI systems.
• At a macro level, better QI can motivate policymakers to invest (more) in their country's NQI and maximise its potential.
• At the meso-level, inform QI bodies about service gaps to close
• At a micro level, motivate firms, particularly SMEs, to take advantage of the QI services available and demand QI services where they are unavailable.
6


Challenges of Collecting Data on the Overall QI System
Limited knowledge and consensus on which data are the best indicators for the development status of QI.
Collecting data on QI as an overall system is complicated since it depends on the data collected from the individual components.
Data quality, availability, accessibility and format are heterogeneous across QI organizations.
Shortage of curated data for time series and panel data
Published data have low granularity, e.g. regarding their sectoral distribution.
9

Outlook on improving Data Availability, Quality and Transparency using Digitalisation

- Significant coordination is needed to standardize QI data collection and make this data available across QI bodies, countries and sectors.
- Datasets need to become compatible and interoperable.
- Dematerializing metrology, standardization, and conformity assessment efforts increase data availability and transparency.
- Open QI data helps to connect with other socio-economic research fields and increases QI visibility.

10

Thank you for your attention

More information at:

- https://gqii.org
- https://qi4d.org
- https://www.mesopartner.com/research/quality-infrastructure

Contact:

Ann Ramkissoon, ar@mesopartner.com

Ulrich Harmes-Liedtke, uhl@mesopartner.com

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55 Realising the benefits of digital calibration data: a dialog between disciplines

Presenting author: Vashti Galpin, University of Edinburgh Research Institute/University; United Kingdom of Great Britain and Northern Ireland
E-mail address: Vashti.Galpin@ed.ac.uk

Abstract:

In its analog form, a calibration certificate provides information about a single calibration of one instrument. It would take significant manual and programming effort to develop an understanding of calibration over that one instrument's life time, or more generally over instruments that do the same measurement from analog calibration certificates.

The introduction of digital calibration certificates (DCCs) opens up new possibilities for understanding measurements across instruments. Our earlier work [1] show how temporal databases can be used to track changes in DCCs. This approach supports versioning of DCCs but allows much more than this. Examples of using temporal database features include:

- storing data from all calibrations for an instrument, and using "snapshot" queries (queries that provide the data at a specific time instance) to define the data that goes into a particular DCC,
- comparison of calibration data across calibration events for a single instrument (or collection of instruments) to understand changes in calibration with a possible goal of providing a drift function that can then be used between calibrations, decreasing the frequency of calibrations, and
- comparing the data from two DCCs for a single instrument, and providing an explanation for the changes between them as a form of quality assurance by assessing the consistency of the changes. For example, a change of unit without a change of measurement values would be unusual and could be flagged for further investigation.

Since the standards and processes for creating and managing DCCs are currently still in development, ongoing interaction between metrologists and database researchers presents an opportunity early in this process to match up the needs of metrology and the technology that is often inaccessible in database and related computer science research papers. This research landscape has important pieces of the puzzle regarding technical solutions for data storage and provenance. However, without input from metrologists, it is difficult to determine which problems are more important and which solutions will have the most impact, if done well, on the success of standards. Dialog in both directions is called for.

The goal of this presentation is to describe some use cases of temporal database features including those listed above, to stimulate dialog around the future requirements for digital data in metrology, and to contribute to ensuring that the developing standards actually do enable important needs. The alternative is not addressing these needs at all, or the development of ad hoc future work-arounds to address them. After the presentation, an online survey that will be available to record information and feedback from conference attendees.

[1] V. Galpin, I. Smith, J.-L. Hippolyte, Tracking and viewing modifications in digital calibration certificates, Acta IMEKO 12(1), 2023, https://doi.org/10.21014/ actaimeko.v12i1.1407

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Presentation of Vashti Galpin

Realising the benefits of digital calibration data: a dialog between disciplines

Vashti Galpin
University of Edinburgh

4th International DCC Conference: DCC for FAIR principles in the quality infrastructure

School of informatics

lfcs | Laboratory for Foundations of Computer Science

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Motivation

- I'm a computer scientist focussing on programming languages and databases.
- I'm funded by the Royal Society to work with NPL on DCCs and data change.
- I'm learning more about metrology and calibration every day.
- I'm seeking a dialog between our two disciplines.
  - What are the needs of metrologists with respect to digital calibration data (and data, more generally)?
  - How can computer scientists match research knowledge with these needs?
- This talk is an attempt, as part of an ongoing interaction, to encourage dialog.

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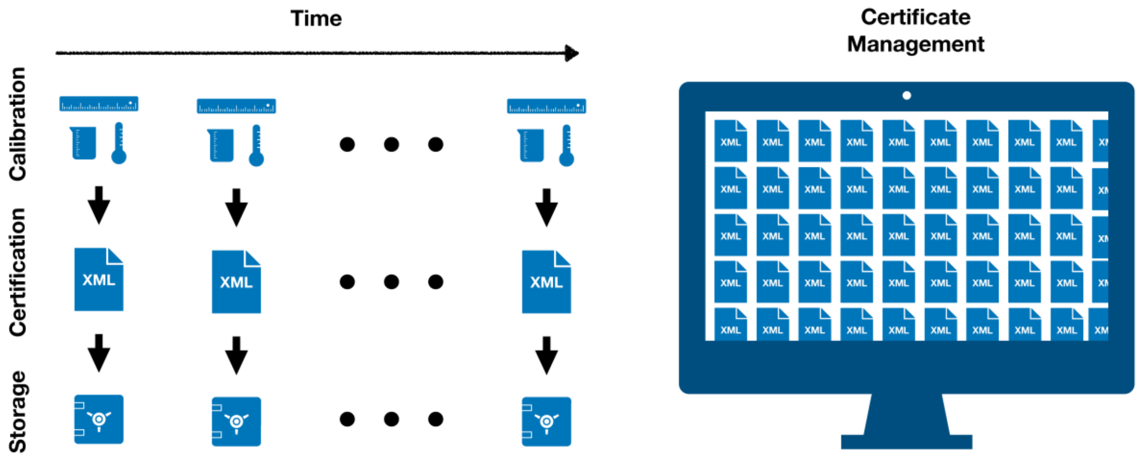
Workflow: *single artefact*



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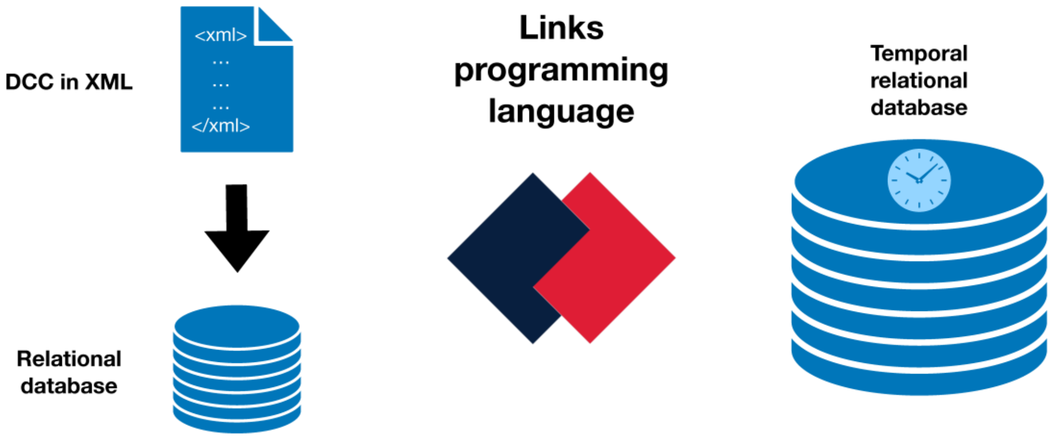
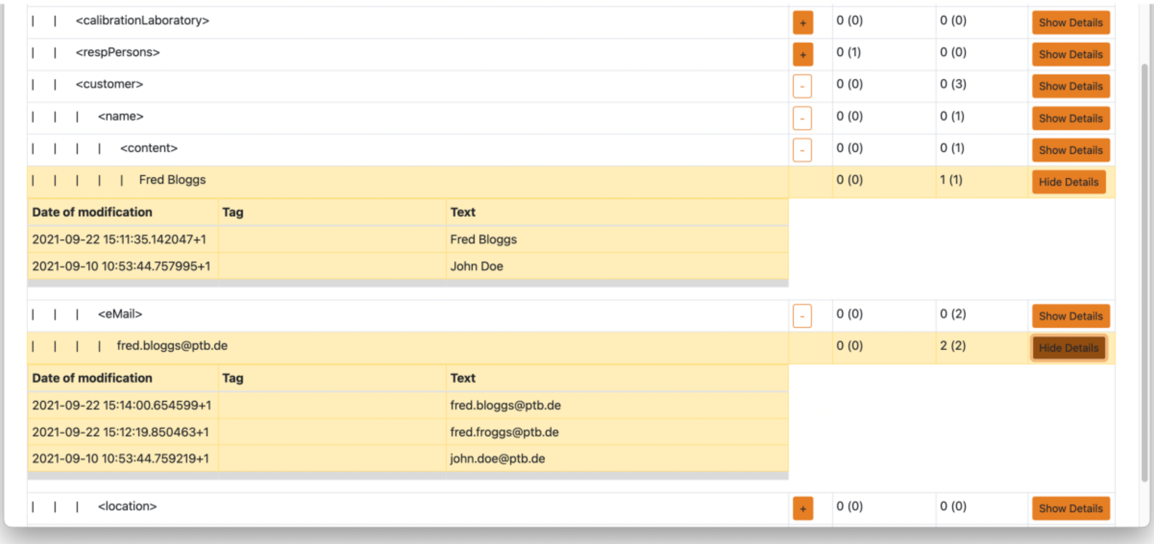
A potential solution



Certificate comparison — details of changes



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2021-09-10 10:53:44.757995+1		John Doe

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2021-09-10 10:53:44.759219+1		john.doe@ptb.de

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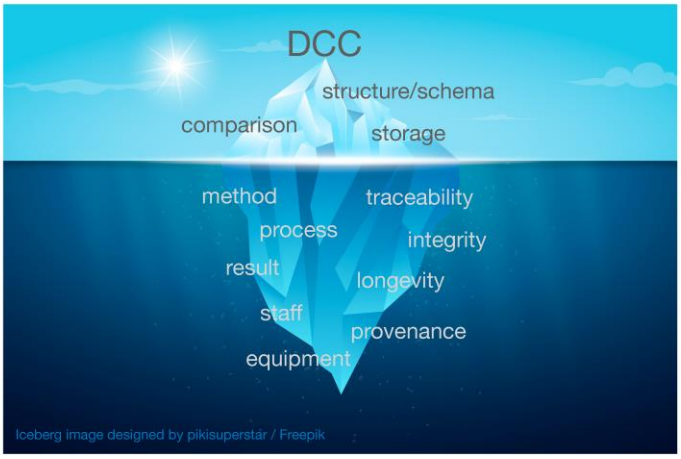
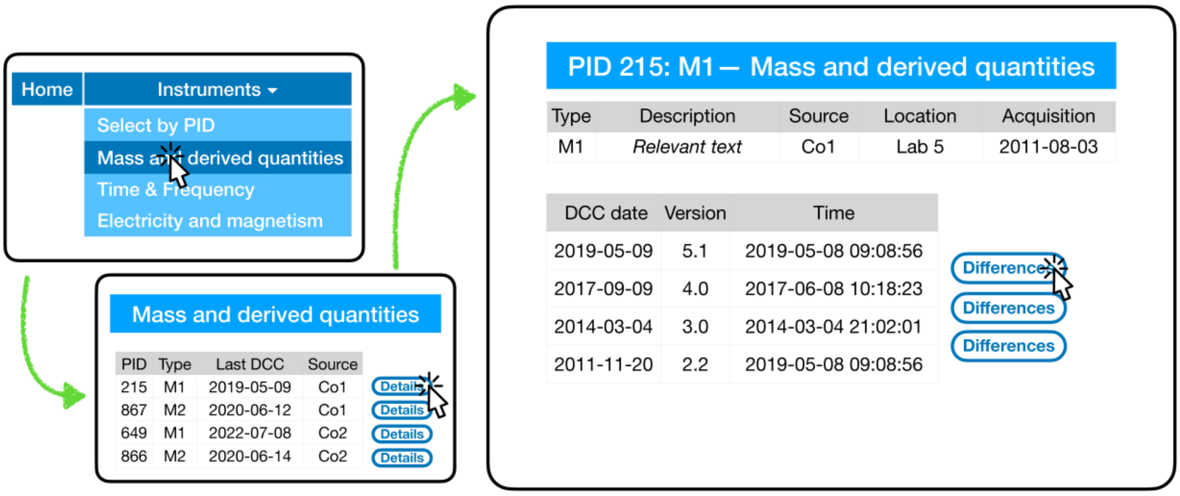
Digital Calibration Certificates are the tip of the iceberg



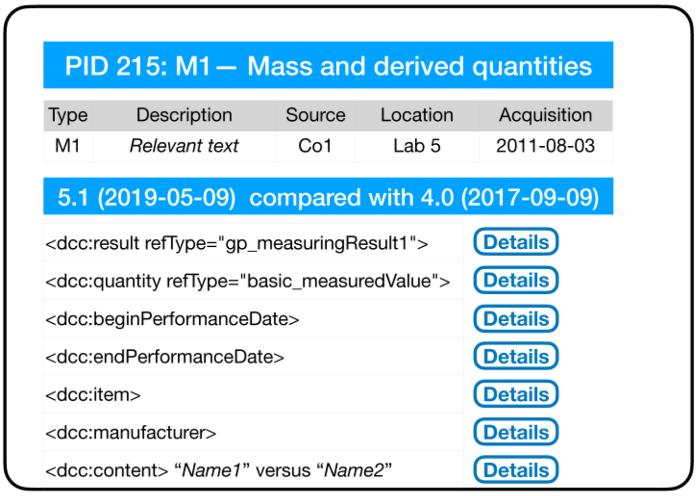
software support is needed for the full lifecycle of machine-readable calibration data

Vashti.Galpin@ed.ac.uk

Versioning for digital calibration certificates



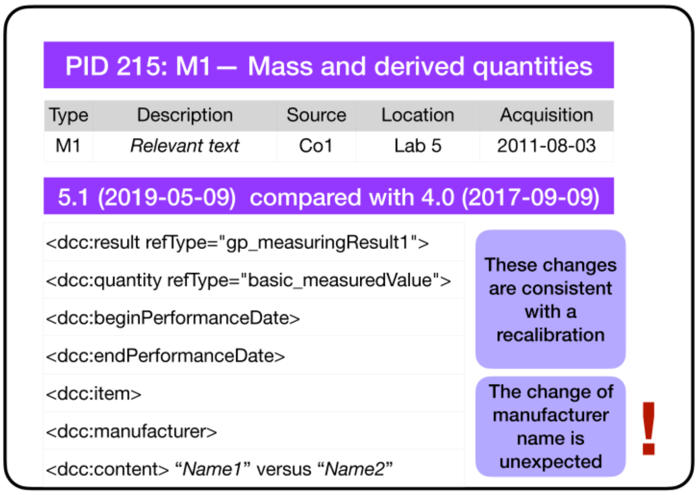
Presentation of differences between DCCs



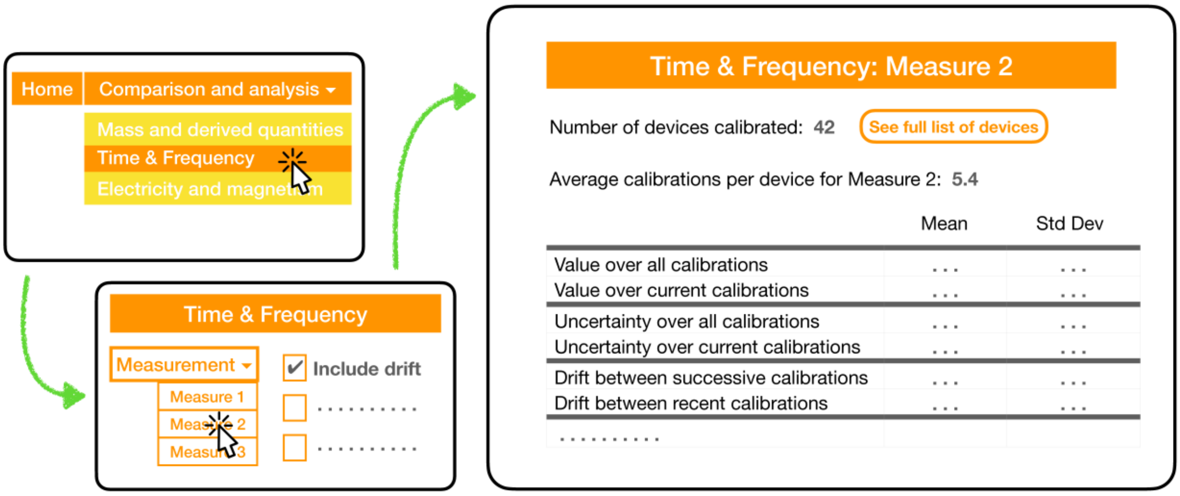
- Two textual differences may refer to the same change in values.
- A challenge is to identify meaningful differences between the two versions of the XML document.
- This approach compares the document in terms of strings but does not explain the differences semantically

Semantic explanation of differences in DCCs

- The idea is to use an ontology with an appropriate logic to classify changes by looking at the consistency of changes across the two versions.
- Changes can then be flagged as reasonable or problematic.
- A DCC ontology is being developed (see Moritz Jordan's presentation).



Comparison and analysis of calibrations



Visualisation of traceability

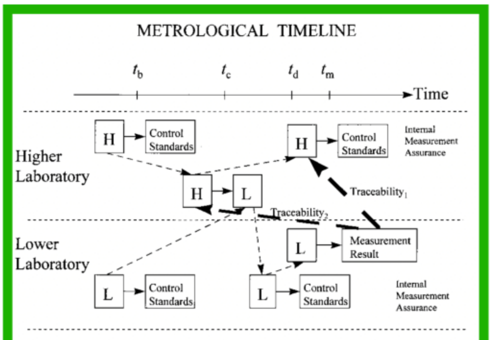


Fig. 6. Metrological timeline demonstrating two possible traceability paths for a measurement result obtained in a laboratory lower in a traceability hierarchy to a standard maintained in a laboratory higher in the traceability hierarchy.

Metrological Timelines in Traceability
Ehrlich and Rasberry, J. Res. Natl. Inst. Stand. Technol. 103, 1998
https://doi.org/10.6028/jres.103.005

- Calibrations are repeated over time leading to a complex chain of measurement comparisons.
- The idea is to provide graphs of traceability together with information about uncertainty at each level.
- Anonymised sharing of data that is viewed as commercially sensitive could be supported by the Gaia-X system (see presentation by Tomasz Sołtysiński).

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Please rate my proposals!

https://forms.office.com/e/ujRyk3CwjW

Proposals for temporal aspects of digital calibration data

Contact me at

Vashti.Galpin@ed.ac.uk

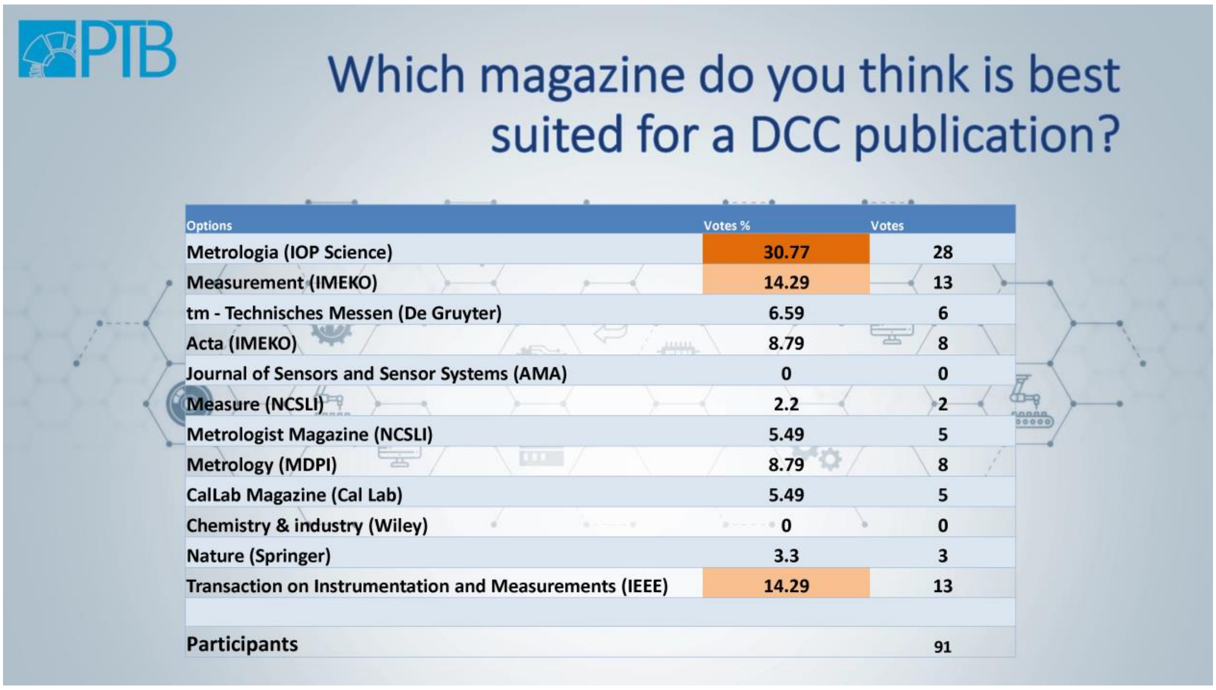
homepages.inf.ed.ac.uk/vgalpin1

Thank you for your attention
Any questions, comments or feedback?

Closing Session
(Chair: Carlos Galvan)

Presenting author: Carlos Galvan Hernandez, CENAM; Mexico
E-mail address: cgalvan@cenam.mx

Presentation of Carlos Galvan Hernandez



Options	Votes %	Votes
Metrologia (IOP Science)	30.77	28
Measurement (IMEKO)	14.29	13
tm - Technisches Messen (De Gruyter)	6.59	6
Acta (IMEKO)	8.79	8
Journal of Sensors and Sensor Systems (AMA)	0	0
Measure (NCSLI)	2.2	2
Metrologist Magazine (NCSLI)	5.49	5
Metrology (MDPI)	8.79	8
CalLab Magazine (Cal Lab)	5.49	5
Chemistry & industry (Wiley)	0	0
Nature (Springer)	3.3	3
Transaction on Instrumentation and Measurements (IEEE)	14.29	13
Participants		91

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Key Takeaways

- **1058 Participants on 4th DCC**
- **Harmonization**
- **Industry applications is growing**
- **Impact of the DCC in D-QI**
- **More Labs, NMI's, AB are prepared for DCC**

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