Physikalisch-Technische Bundesanstalt
National Metrology Institute

2nd international DCC-Conference

01 - 03 March 2022

Proceedings

DOI: https://doi.org/10.7795/820.20220411

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12:45	DCC Implementation Strategies	45'	Implementation of Digital Calibration Certificate at NIMT	Pawat Phuaknoi, NIMT, Thailand
13:00			The Digital NIST Pilot Project	Robert J. Hanisch, NIST, USA
13:15			Towards DCC implementation in Finland	Sari Saxholm, National Metrology Institute VTT MIKES, Finland
13:30 – 13:45	Coffee Break	30'		
14:00	Industrial Applications, Requirements and Examples	90'	Need from industry on the DCC concerning harmonization and a regulating structure	Karlheinz Banholzer, LMG president CECIP, Germany
14:15			Digital Calibration Certificate - Proof of concept for Regulated Process Industry	Heiko Reitzer, Boehringer Ingelheim, Germany
14:30			Improving DCC-results by post-processing	Hans Koch, da+d, Germany
14:45			Digitalization of information and the impact of DCC on workflows	Jose Armando Lopez-Celis, CENAM, Mexico
15:00			Digital Quantities and Units for the MII	Mark Kuster, Independent Researcher and Consultant, USA
15:15				

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12:00	International Welcome PTB Welcome	Siegfried Hackel (Org)
12:15 – 12:30	DCC News	Héctor Laiz
12:45 – 13:15	DCC Implementation Strategies	Xiong Xingchuang
13:30 – 13:45	Coffee Break	
14:00 – 15:15	Industrial Applications, Requirements and Examples	Bob Hanisch

UTC	Wednesday (2022-03-02)			
12:00	DCC Applications	60'	The GEMIMEG Tool	Jan Loewe, PTB, Germany
12:15			Introducing PyDCC – a Python module for the DCC	Andreas Tobola, Siemens AG, Germany
12:30			Interconnecting Calibration Services at the Vacuum Metrology Group of PTB	Matthias Bernien, PTB, Germany
12:45			Modern data exchange platforms and the DCC	Antonio Matamala, BEAMEX Germany GmbH, Germany
13:00	DCC and Sensors	30'	Digital calibration system – Revolutionary sensor with digital calibrator mode	Pavel Proskurin, CBO ASPECT Company, USA
13:15			GEMIMEG-II – Status and progress report	Thomas Engel, Coordinator GEMIMEG-II Project, Germany
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14:00	Middleware 1	60'	Generation of digital calibration certificates using Python and Excel	Ian Smith, NPL, United Kingdom
14:15			A software solution for the practical creation of DCC files	Maik Stotz, STOTZ Software, Germany
14:30			From Excel to DCC and human readable calibration certificate – user-friendly middleware and digital signature at work	Caroline Stobe, Reference Institute for Bioanalytics, Germany
14:45			A no-code Excel tool for generating DCCs	Dirk Röske, PTB, Germany
15:00	DCC and Accreditation	30'	Digitizing the Scope of Accreditation / Digital Accreditation Information	Michael L. Schwartz, Cal Lab Solutions, USA
15:15			Embedding the Digital Calibration Certificate	Susanne Kuch, DAkkS, Germany

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12:15		
12:30		
12:45		
13:00	DCC and Sensors	Carlos Galvan
13:15		
13:30	Coffee Break	
13:45		
14:00	Middleware 1	Clifford Brown
14:15		
14:30		
14:45		
15:00	DCC and Accreditation	Mpho Phaloane
15:15		

UTC	Thursday (2022-03-03)			
12:00	DCC Syntax 4.0	45'	Digital SchemaX (DX)	Justin Jagieniak, PTB, Germany
12:15			Digital Calibration Request (DCR), Digital Calibration Answer (DCA), Digital Test Certificate (DTC) and the Digital Certificate for Reference Materials (DRM)	Siegfried Hackel, PTB, Germany
12:30			DCC Envelope	Gamze Söylev-Öktem, PTB, Germany
12:45	IT Security	45'	Metrological Digital Transformation and Cyber Security Protection of Documents in Saudi Arabia	Saad Ali Haj Bakri, King Saud University Talaat Al-Rahali, Advisor to the NMCC, Saudi Arabia
13:00			Security in DCC	Lisa Busser, TU Kaiserslautern, Germany
13:15			Technical security system for the signature, secure storage and export of Digital Calibration Certificates (DCC)	Matthias Kromphardt, D-TRUST, Germany
13:30	Coffee Break	30'		
13:45				
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14:15			Verifying DCCs	Hans Koch, da+d, Germany
14:30			Digital Calibration Certificates (DCC) using the Quality Information Framework (QIF)	Robert Brown, Mitutoyo America Corporation, USA
14:45			Using Schematron to Verify DCCs	Gamze Söylev-Öktem, PTB, Germany
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15:15	Final Discussion and Further Steps	15'	Final Discussion and Further Steps	Siegfried Hackel, PTB, Germany

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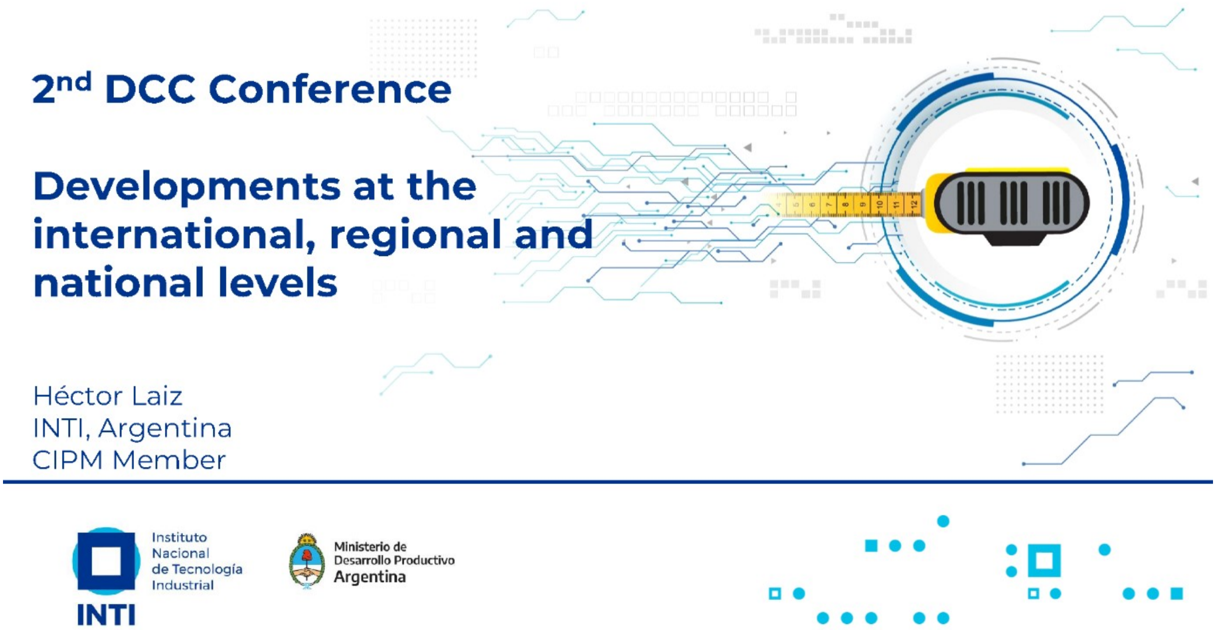
12:15		
12:30		
12:45	IT Security	Jochen Saßmannshausen
13:00		
13:15		
13:30	Coffee Break	
13:45		
14:00	Quality and Validation of the DCC	Jongseon Park
14:15		
14:30		
14:45		
15:00	DCC Helpdesk and DCC Summer School	Alexis Valqui
15:15	Final Discussion and Further Steps	Alexis Valqui

International Welcome

Héctor Laiz, CIPM WG Dig., Argentina

It is my pleasure to welcome you to this 2nd DCC Conference. I would like to thank the organizers for inviting me to open the event, but more importantly, for taking the effort to organize this series of conferences with focus in the development of the Digital Calibration Certificate. It's very important that our community come together and discuss how we will implement this tool that we will be crucial for the quality infrastructure in a digital environment, and not in the long term but tomorrow. This needs an international effort and coordination to achieve global acceptance as reflected by the participation inf this Conference and as I will present in my talk. So, many thanks to the Organizing Committee and especially to Dr. Siegfried Hackel for his efforts in developing the DCC and also for organizing this event.

Developments at the international, regional, and national levels



CIPM Task Grup on the Digital SI
Terms of reference

CIPM Digital SI

•To develop and establish a world-wide uniform, unambiguous and secure data exchange format for use in IoT networks based on the International System of Units (SI) described in the current SI Brochure.

•To coordinate this effort with all relevant stakeholders by exploring and/or establishing suitable liaisons.

•To propose suitable actions towards making the SI Brochure machine readable

CIPM Task Grup on the Digital SI
Members

CIPM Digital SI

Joachim Ullrich (chair)	PTB
Martin Milton	BIPM
Thomas Liew	A*STAR
James Olthoff	NIST
Alan Steele	NRC
Ismael Castelazo	CENAM
Yuning Duan	NIM
Héctor Laiz	INTI
Martyn Sené	NPL

CIPM Task Grup on the Digital SI
Summary of decisions & next steps – last meeting

CIPM Digital SI

Joint statement of Intent

- signature of the Joint Statement as soon as possible in a meeting between representatives of OIML, CODATA/ISC, IMEKO, and the CIPM as suggested by the TG.

Core Metrological Terms

- It was agreed that the definition of the CMTs should, on a long run, support highest levels of digitalization requirements.
- It was further agreed that efforts in this direction should not jeopardize the urgently needed short-time activities for proceeding with the actual metrology use-cases (SI-Brochure, CODATA fundamental constants, DCC, KCDB, CoCM).

Harmonization of unit formats

- The suggestion by the EG based on consultations with the use-cases teams and due within two months from now will be discussed in a meeting of the SCT end of March / beginning of April.

Forum D&M

- Collection of further input to the "mission statement" will be conducted.

Joint Statement of Intent
On the digital transformation in the international scientific and quality infrastructure

CIPM Digital SI

Recognising that

- governments, industry, academia, and civil society have been working toward comprehensive digital transformation for many years, and, in so doing, are increasingly
  - establishing systems to collect, aggregate, analyse and interpret digital data;
  - introducing networked sensor systems for diverse scientific and industrial applications;
  - sharing data at local, national, regional, and international scales;
- the scientific community has made significant progress in establishing reliable foundations for digital data interchange and management, including the FAIR principles for data management and stewardship;
- the organisations of the international quality infrastructure (metrology, accreditation, standardization, and conformity assessment) have a critical role working together to ensure sustainable economic development;
- the International System of Units (SI) plays a particular role in the international quality infrastructure providing confidence in the accuracy and global comparability of measurements needed for international trade, manufacturing, human health and safety, protection of the environment, global climate studies, and scientific research;
- maintaining this confidence in the accuracy and global comparability of measurements will require the creation and adoption of a full digital representation of the SI, including robust, unambiguous, and machine-actionable digital representations of units of measurement and of measurement results and uncertainties;

- progress on global challenges such as this requires the participation of, and critical thinking from, diverse communities;

- successfully effecting such a comprehensive digital transformation for metrology and ensuring its benefits are fully realised will require the active participation of a wide range of stakeholders; particularly other members of the International Quality System;

We the undersigned undertake to support in a way appropriate to each organisation the development, implementation, and promotion of the SI Digital Framework as part of a wider digital transformation of the international scientific and quality infrastructure.

27th CGPM - Draft Resolution B
On the global digital transformation and the International System of Units

Anticipating

- that maintaining and building confidence in accuracy and global comparability will require creation of a full digital representation of the SI, including robust, unambiguous, and machine-actionable digital representations of units of measurement and of measurement values and uncertainties;
- that successfully effecting such a comprehensive digital transformation will require engagement with a wide range of stakeholders including, but not limited to, ISO, IEC, OIML, ILAC, CODATA, and other scientific, regulatory, and quality infrastructure communities;

27th CGPM - Draft Resolution B

On the global digital transformation and the International System of Units

Encourages

- the CIPM to continue its outreach and engagement initiatives to ensure that the Metre Convention naturally extends its role as the globally accepted anchor of trust for metrology into the digital era;
- the CIPM to undertake the development and promotion of an **SI Digital Framework**, which includes:
  - a globally accepted digital representation of the SI, compatible with and useable within digital data exchange standards and protocols in addition to the ongoing use of existing non-digital solutions;
  - facilitating use of **digital certificates** in the existing robust infrastructure for the **world-wide recognition** and acceptance of national calibration and measurement capabilities;
  - adoption of the FAIR principles (Findable, Accessible, Interoperable, and Reusable) for digital metrological data and metadata, ensuring that other communities recognize the critical importance of metrological traceability for measurement data as an established requisite for building trust;

Participants

WG DCC

16 NMIs

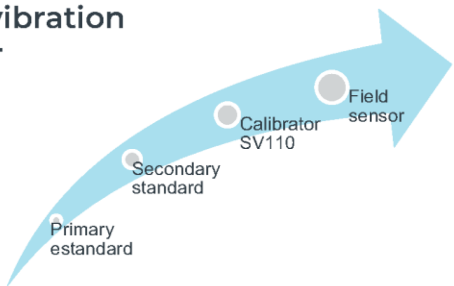
INTI (Argentina)	INMETRO (Brazil)	CENAM (México)
INACAL (Peru)	INDOCAL (Rep. Dom)	INTN (Paraguay)
LCM (Costa Rica)	CENAMEP (Panama)	CENAME (Guatemala)
IBMETRO (Bolivia)	TTBS (T&T)	SKNBS (SK&N)
CIM (El Salvador)	INM (Colombia)	BBS (Belice)
BNSI (Barbados)	BHN (Honduras)	NRC (Canada-Observer)

New metrological resources to ensure data quality in the context of industry 4.0

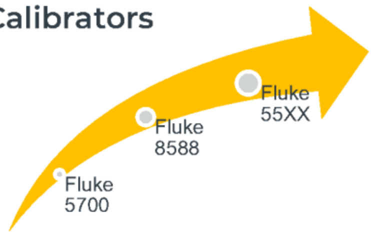
Application of the DCC in two treazability Chains

- INTI and Industry
- Duration 18 months
- Focus in remote calibrations and DCC
- Supported by the S+T+I Agency

Field vibration sensor



DMMs and Calibrators



Conclusions

- the Metre Convention will extend its role as the globally accepted anchor of trust for metrology into the digital era;
- the CIPM is making the steps towards the development of an SI Digital Framework, that facilitates the use of digital calibrations certificates
- We have projects and actions for the development of DCCs at regional and national levels
- International dialogue and cooperation is essential for a global acceptance

PTB Welcome

Frank Härtig, Vice-President PTB, Germany

Ladies and Gentlemen, dear colleagues,

On behalf of PTB, I cordially welcome you to the second international conference on the development of machine-readable and machine-understandable digital calibration certificates.

Since the foundation of the Metre Convention and since the establishment of the international system of units on May 20th, 1875 - almost 150 years ago – the field of metrology has undergone developments that have been more fundamental than in any other scientific field.

Digitalization has affected all communities within the field of metrology present in the over 100 countries that have joined the Metre Convention. These countries thus represent over 98% of the world's strongest economies.

Machine-readable and machine-understandable communication has become indispensable throughout the world – and establishing an infrastructure to support such technology has presented us with special challenges. We must succeed in developing solutions and setting standards that can unite all the domains within metrology. This includes defining a uniform data format for the exchange of metrological data – that is, at least one value with an associated specification of a unit.

Despite the many existing data formats, the Metre Convention is unmatched in its ability to develop a leading format here.

Yet in truth, making this vision a reality requires only the will of all of those involved in the creation of such standards.

With the necessary patience, we will then be able to guide it on its path from metrology institutes to calibration laboratories, then to industry and scientific institutions, and finally to the end users.

While this process may take many years, we can lay the foundation for it today. I am confident that we will succeed and that, in the long run, metrologists will set a standard that will be just as solid and unshakable as today's SI units. Let us not miss this opportunity.

The worldwide developments concerning machine-readable and machine-understandable calibration certificates have shown the way forward here and must be regarded as pioneering. Such developments show that we are on the right track and that we can succeed in creating a harmonized digital infrastructure for the dissemination of metrological information. Throughout the world, scientific institutions, industrial companies, and calibration service providers are now working on the development of digital certificates. One example is the German Calibration Service (DKD) with its 13 technical committees representing various domains, most of whom have agreed to develop the required data structures and guidelines for DCCs.

We must now follow this momentum. I have no doubt that Professor Hackel and his team – who have been a driving force behind machine-readable digital calibration certificates – will welcome everyone who wants to participate in these developments.

The biggest challenge in the coming months will be to harmonize the individual disciplines and domains, which – up to now – have communicated to only a small extent.

For example, specifying a temperature, humidity, or barometric pressure inside a DCC affects all domains, and it would therefore be beneficial to develop harmonized and coordinated solutions that can be used by everyone.

Many of the developments already started will be presented to you in the coming days. Personally, I would be very pleased if everyone contributed to these developments and if we jointly developed solutions that can set a standard for DCCs worldwide. Like the fathers of the Metre Convention, you too can help to shape digital metrology.

At this point, I wish you an interesting and successful event.

Vice-President

Dr.-Ing. Prof. h. c. Frank Härtig

Physikalisch-Technische Bundesanstalt Braunschweig und Berlin

Session “DCC-News”

Latest developments of the DCC

Presenting author Siegfried Hackel, PTB, Germany

siegfried.hackel@ptb.de

Additional authors Frank Härtig, Thorsten Schrader, Shanna Schönhals, Jan Loewe, Lutz Doering, Benjamin Gloger, Justin Jagieniak, Daniel Hutzschenreuter, Gamze Söylev-Öktem (all PTB, Germany)

dcc@ptb.de

Abstract

An overview of the latest developments since the first international DCC conference in October 2020 will be given. The roadmap of the DCC is presented and the connection to the conference programme is motivated. The connection between the new DCC scheme, the good practice approach as well as the 100 days programme of the PTB is shown.

The last conference showed that the middleware between the IT of the laboratory and the DCC as well as the middleware for generating the human-readable part of the DCC are important. Likewise, digitalisation in the environment of the DCC has progressed further. Developments in the area of DCC syntax are another focus.

The DCC is particularly important for use in industry. Great development potential is seen here. A look at the requirements from this area and the activities of the stakeholders are shown. The implementation of the DCC in these processes is discussed.

Calibrated sensors are playing an increasingly important role in production. Therefore, another focus is set here. Here, as in the other areas, the quality and validation of the DCC content is important.

Another focus will be the role of accreditation and IT security.

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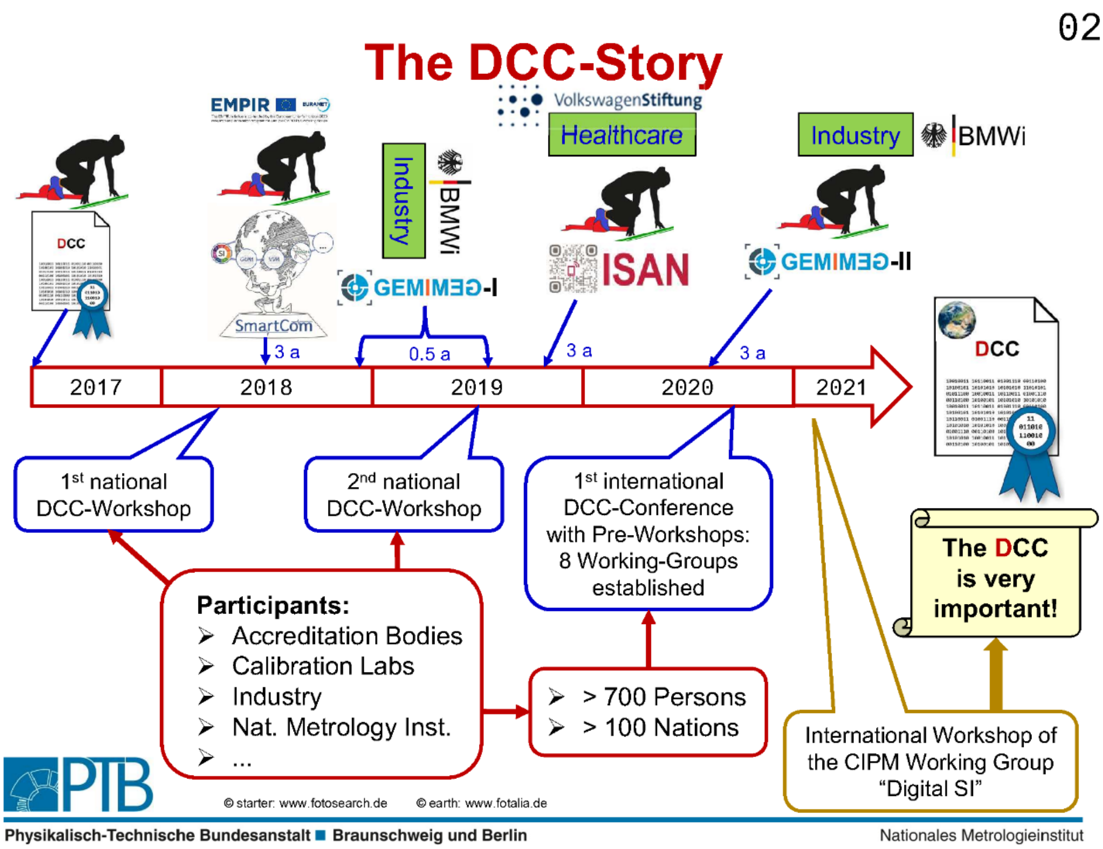
Latest developments of the DCC

Siegfried Hackel



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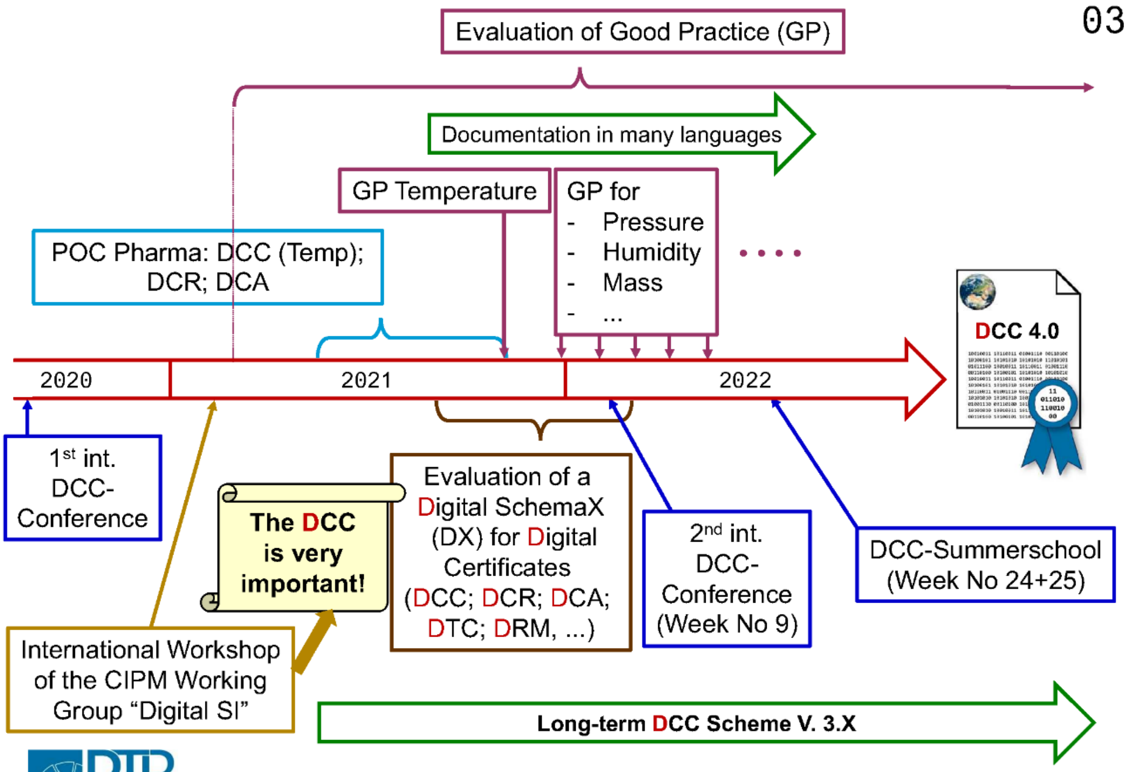

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04

Program

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06

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The PTB-DCC-Team

alphabetical sequence

Benjamin Gloger
Daniel Hutzschenreuter
Frank Härtig
Gamze Söylev-Öktem
Jan Loewe
Justin Jagieniak
Lutz Doering
Shanna Schönhals
Thorsten Schrader

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www.ptb.de/dcc

2022-03-01

DCC scheme version 3.0 and 3.1

Presenting author Benjamin Gloger, PTB, Germany

benjamin.gloger@ptb.de

Additional authors Siegfried Hackel, Frank Härtig, Thorsten Schrader, Shanna Schönhals, Jan Loewe, Lutz Doering, Justin Jagieniak, Daniel Hutzschenreuter, Gamze Söylev-Öktem (all PTB, Germany)

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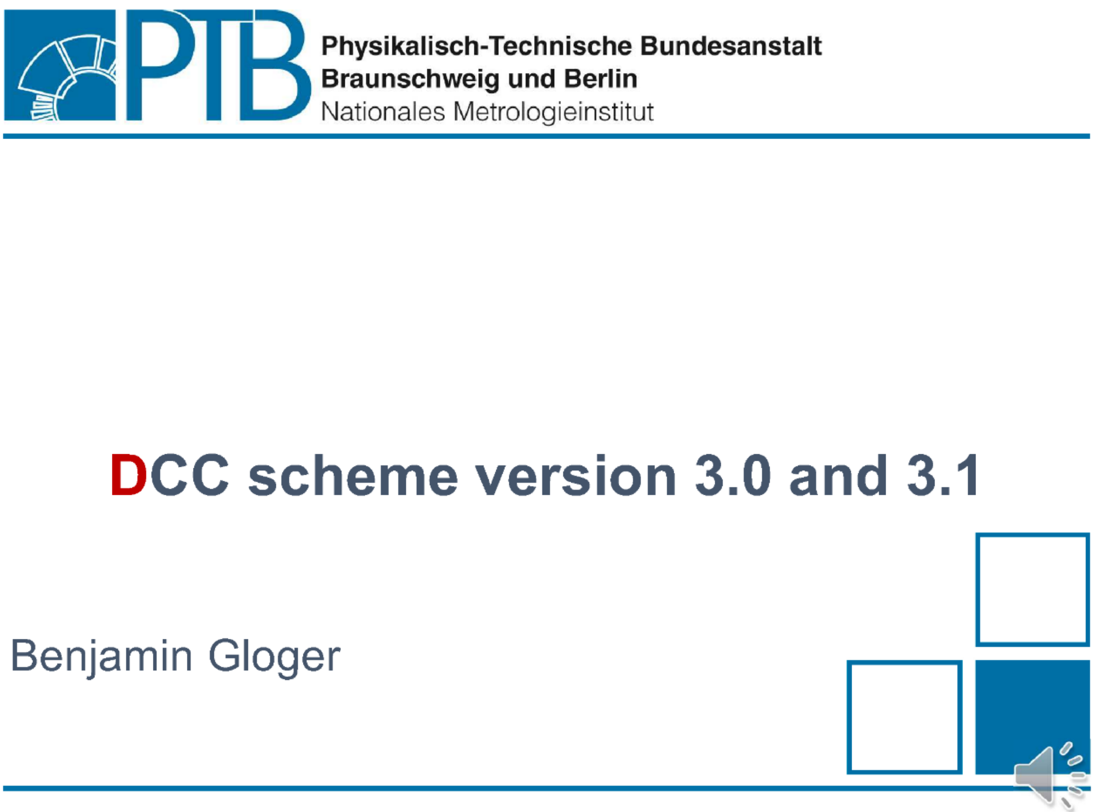
Abstract

The results and discussions in the working groups formed at the first international DCC conference have fed into the further development of the DCC scheme.

The presentation will discuss the changes from version 2.4 to the long-term available version 3.0 of the DCC scheme. Furthermore, it will be explained that the latest version 3.1.2 of the DCC scheme is backwards compatible with the DCC scheme 3.0.

Examples will be used to show the advantages of using the latest version in the creation and use of tables, both for the creator of DCCs and the user of DCCs. This will be discussed using good practice examples.

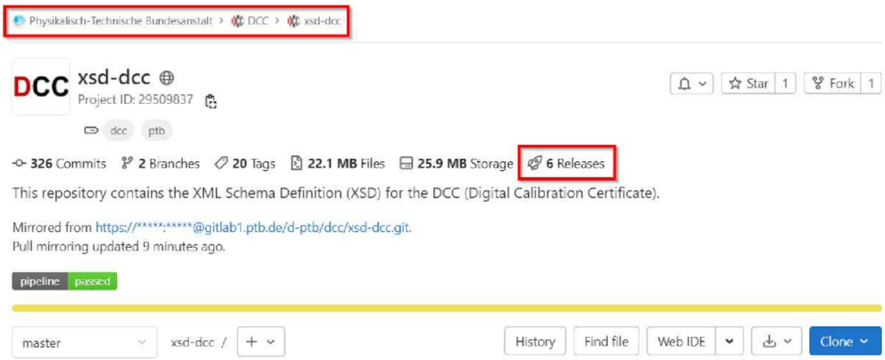


DCC V. 3.X

long-term available

DCC Release

- https://gitlab.com/ptb/dcc/xsd-dcc



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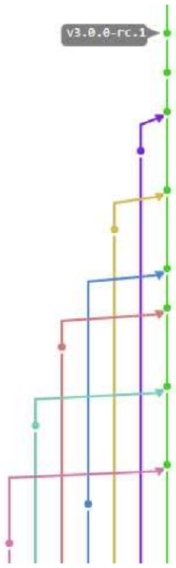
DCC 3.0



- Calibration location
  - <dcc:performanceLocation>
- Universal descriptions (Text, Formulas and Files)
  - new Type <dcc:richContentType>
- Conformity Statements
  - <dcc:conformity>
- refType, refId and Id on more elements

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DCC 3.0 Breaking Changes

- Upgrade to D-SI v2.0.0

- Consistent use of dcc:name and dcc:description
- Restructuring inside dcc:formula
- dcc:state has been renamed to dcc:status
- dcc:refId is now an attribute inside statementMetadataType

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DCC 3.1

- Upgrade to D-SI v2.1.0
  - XMLList
- Attribute Lists
- Implementation of relative Uncertainty
  - <dcc:relativeUncertainty>
- Extended softwareType
  - Type of software
  - Item <dcc:installedSoftwares>

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www.ptb.de/dcc

2022-03-01

DCC Good Practice

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Abstract

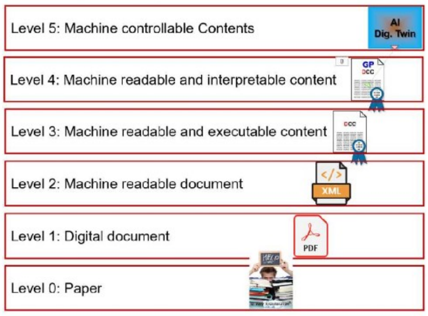
The basis for calibration reports for accredited calibration laboratories is the ISO / IEC 17025 standard. Section 7.8 specifies what the content of a calibration certificate is. Calibration certificates issued outside the accredited environment are also based on this standard.

The resulting self-similarity can be used to make DCCs not only machine-readable and executable, but also machine-interpretable. For this purpose, the utility model is discussed. Based on the utility model, the technical expertise of calibrators and users and the Pareto principle, good practice (GP) examples for temperature have been developed. These GP are described and the transfer (abstraction) to other measurands is shown.

01

DCC-Excursion:

DCC Good Practice



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02

Good Practice (GP)

- Calibration certificates have a degree of (self-) similarity
  - ✓ Text
  - ✓ Formulas
  - ✓ Tables
  - ✓ ...

High potential for optimization
and machine interpretable DCCs

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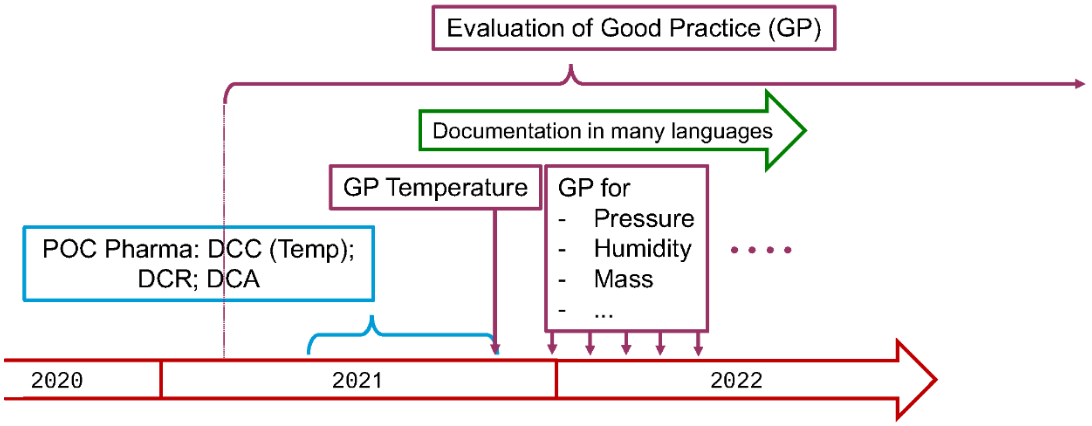
03

Good Practice (GP)



04

The Utility-Model

Level 5: Machine controllable Contents — AI Dig. Twin

Level 4: Machine readable and interpretable content — GP DCC

Level 3: Machine readable and executable content — DCC

Level 2: Machine readable document — XML

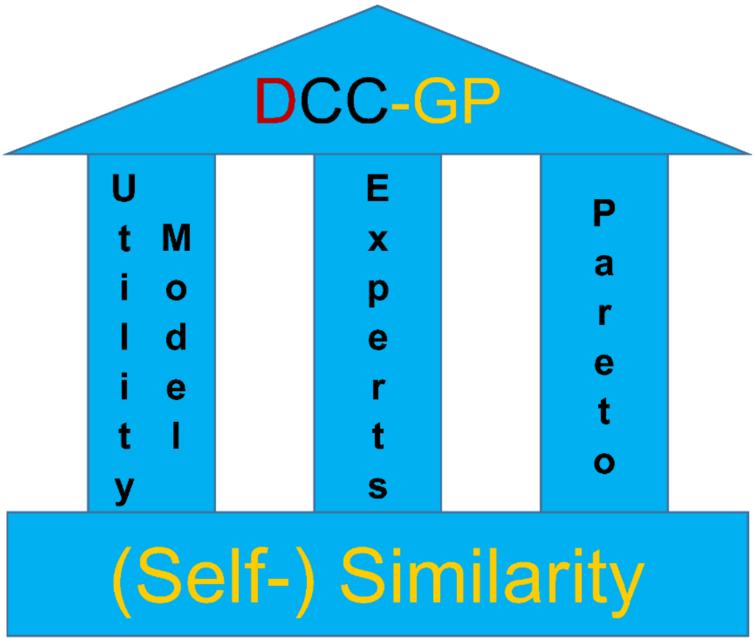
Level 1: Digital document — PDF

Level 0: Paper

From: „IDiS – Initiative Digitale Standards“. [Online]. see: https://www.dke.de/idis

05

The basic idea for DCC -GP



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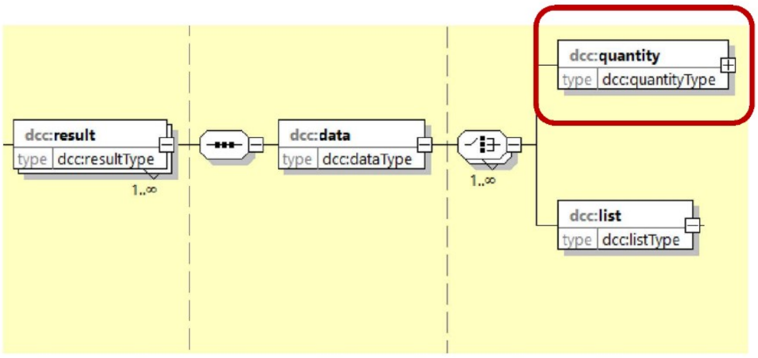
06

Pareto-Principle!!

Looking into the DCC -Scheme



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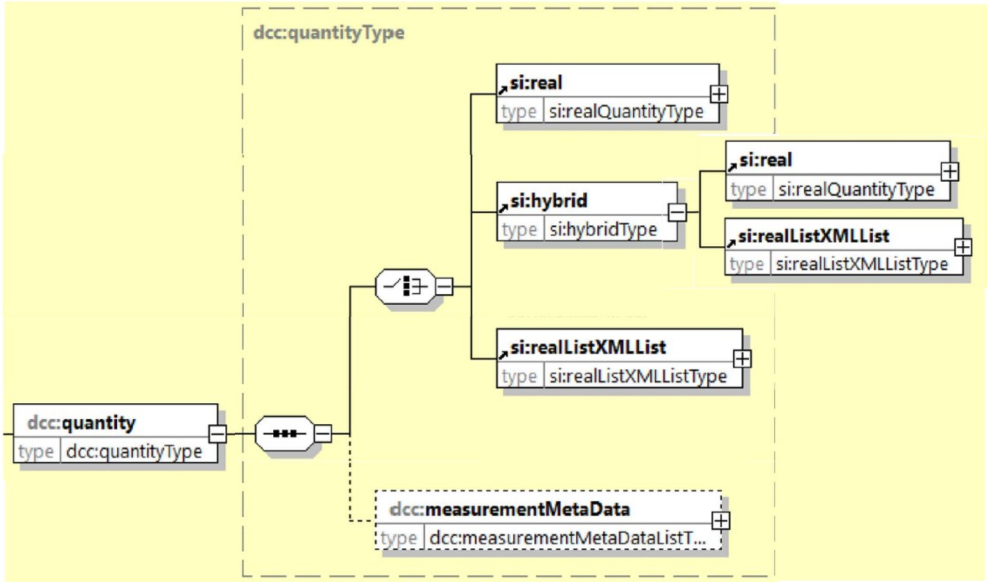
07

Pareto (!) - quantity



08a

DCC-GP Temperature: Simplified

refType_area1	basic_referenceValue
	Reference value / K
refType_area2	
refType_area3	
	306.248
	373.121
	448.253
	523.319
	593.154

Table continued ...

refType_area1	basic_measuredValue	basic_measurementError				
	Measured value/ K	Measurement error / K	U (Measurement error) / K			
refType_area2						
refType_area3						
	306.32	0.072	0.061	2	0.95	normal
	373.21	0.089	0.061	2	0.95	normal
	448.36	0.107	0.061	2	0.95	normal
	523.31	-0.009	0.061	2	0.95	normal
	593.07	-0.084	0.061	2	0.95	normal

VIM

Table continued ...

reftype_area1	basic_measurementError		
		Lower acceptance limit / K	Upper acceptance limit / K
refType_area2	basic_conformity		
refType_area3		basic_acceptanceLimitLower	basic_acceptanceLimitUpper
	pass	-0.23	0.23
	pass	-0.23	0.23
	pass	-0.23	0.23
	pass	-0.30	0.30
	pass	-0.30	0.30

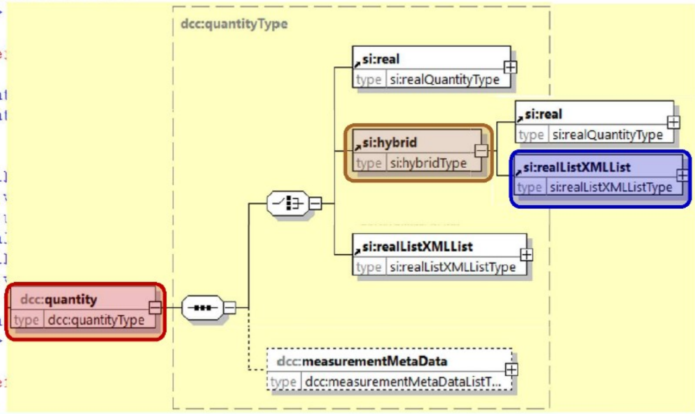
optional

Area	Used Elements / Attributes	simplified
result1	basic_referenceValue	
result1	basic_measuredValue	
result1	basic_measurementError	
result1	U (measurementError)	
result1	basic_conformity	
result1	basic_acceptanceLimitLower	
result1	basic_acceptanceLimitUpper	

08bI

DCC-GP Temperature: Simplified

```
<dcc:list refType="gp_table1">
    <dcc:quantity refType="basic_referenceValue">
        <dcc:name>
            <dcc:content lang="de">Bezugswert</dcc:content>
            <dcc:content lang="en">Reference value</dcc:content>
        </dcc:name>
        <si:hybrid>
            <si:realListXMLList>
                <si:valueXMLList>306.248 373.121 448.253 523.319 593.154</si:valueXMLList>
                <si:unitXMLList>\kelvin</si:unitXMLList>
            </si:realListXMLList>
            <si:realListXMLList>
                <si:valueXMLList>33.098 99.971 175.103 250.169 320.004</si:valueXMLList>
                <si:unitXMLList>\degreecelsius</si:unitXMLList>
            </si:realListXMLList>
        </si:hybrid>
    </dcc:quantity>
    <dcc:quantity re
        <dcc:name>
            <dcc:cont                                              ent>
            <dcc:cont
        </dcc:name>
        <si:hybrid>
            <si:reall
                <si:v
                <si:u
            </si:rea
            <si:reall
                <si:
                <si:
            </si:rea
        </si:hybrid>
    </dcc:quantity>
    <dcc:quantity re
```



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08bII

DCC-GP Temperature: Simplified

```
<dcc:list refType="gp_table1">
    <dcc:quantity refType="basic_referenceValue">
        <dcc:name>
            <dcc:content lang="de">Bezugswert</dcc:content>
            <dcc:content lang="en">Reference value</dcc:content>
        </dcc:name>
        <si:hybrid>
            <si:realListXMLList>
                <si:valueXMLList>306.248 373.121 448.253 523.319 593.154</si:valueXMLList>
                <si:unitXMLList>\kelvin</si:unitXMLList>
            </si:realListXMLList>
            <si:realListXMLList>
                <si:valueXMLList>33.098 99.971 175.103 250.169 320.004</si:valueXMLList>
                <si:unitXMLList>\degreecelsius</si:unitXMLList>
            </si:realListXMLList>
        </si:hybrid>
    </dcc:quantity>
    <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>306.32 373.21 448.36 523.31 593.07</si:valueXMLList>
                <si:unitXMLList>\kelvin</si:unitXMLList>
            </si:realListXMLList>
            <si:realListXMLList>
                <si:valueXMLList>33.17 100.06 175.21 250.16 319.92</si:valueXMLList>
                <si:unitXMLList>\degreecelsius</si:unitXMLList>
            </si:realListXMLList>
        </si:hybrid>
    </dcc:quantity>
    <dcc:quantity refType="basic_measurementError">
```

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08a

DCC-GP Temperature: Simplified

Area	Used Elements / Attributs	simplified
result1	basic_referenceValue	
result1	basic_measuredValue	
result1	basic_measurementError	
result1	U (measurementError)	
result1	basic_conformity	
result1	basic_acceptanceLimitLower	
result1	basic_acceptanceLimitUpper	

refType_area1	basic_referenceValue
	Reference value / K
refType_area2	
refType_area3	
	306.248
	373.121
	448.253
	523.319
	593.154

Table continued ...

refType_area1	basic_measuredValue	basic_measurementError				
	Measured value/ K	Measurement error / K	U (Measurement error) / K			
refType_area2						
refType_area3						
	306.32	0.072	0.061	2	0.95	normal
	373.21	0.089	0.061	2	0.95	normal
	448.36	0.107	0.061	2	0.95	normal
	523.31	-0.009	0.061	2	0.95	normal
	593.07	-0.084	0.061	2	0.95	normal

Table continued ...

reftype_area1	basic_measurementError		
		Lower acceptance limit / K	Upper acceptance limit / K
refType_area2	basic_conformity		
refType_area3		basic_ acceptanceLimitLower	basic_ acceptanceLimitUpper
	pass	-0.23	0.23
	pass	-0.23	0.23
	pass	-0.23	0.23
	pass	-0.30	0.30
	pass	-0.30	0.30

08c

DCC-GP Temperature: Simplified

```
<dcc:quantity refType="basic_measurementError">
    <dcc:name>
        <dcc:content lang="de">Messabweichung</dcc:content>
        <dcc:content lang="en">Measurement error</dcc:content>
    </dcc:name>
    <si:realListXMLList>
        <si:valueXMLList>0.072 0.089 0.107 -0.009 -0.084</si:valueXMLList>
        <si:unitXMLList>\kelvin</si:unitXMLList>
        <si:expandedUncXMLList>
            <si:uncertaintyXMLList>0.061</si:uncertaintyXMLList>
            <si:coverageFactorXMLList>2</si:coverageFactorXMLList>
            <si:coverageProbabilityXMLList>0.95</si:coverageProbabilityXMLList>
            <si:distributionXMLList>normal</si:distributionXMLList>
        </si:expandedUncXMLList>
    </si:realListXMLList>
    <dcc:measurementMetaData>
        <dcc:metaData refType="basic_conformity">
            <dcc:declaration>
```

08a

DCC-GP Temperature: Simplified

Area	Used Elements / Attributes	simplified
result1	basic_referenceValue	
result1	basic_measuredValue	
result1	basic_measurementError	
result1	U (measurementError)	
result1	basic_conformity	
result1	basic_acceptanceLimitLower	
result1	basic_acceptanceLimitUpper	

refType_area1	basic_referenceValue
	Reference value / K
refType_area2	
refType_area3	
	306.248
	373.121
	448.253
	523.319
	593.154

Table continued …

refType_area1	basic_measuredValue	basic_measurementError				
	Measured value/ K	Measurement error / K	U (Measurement error) / K			
refType_area2						
refType_area3						
	306.32	0.072	0.061	2	0.95	normal
	373.21	0.089	0.061	2	0.95	normal
	448.36	0.107	0.061	2	0.95	normal
	523.31	-0.009	0.061	2	0.95	normal
	593.07	-0.084	0.061	2	0.95	normal

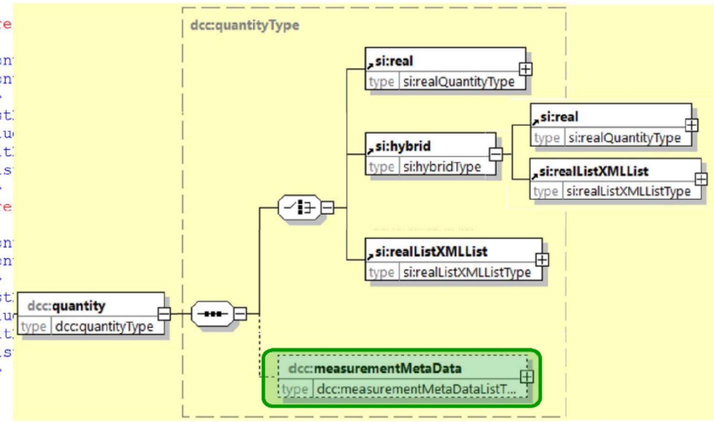
Table continued …

reftype_area1	basic_measurementError		
		Lower acceptance limit / K	Upper acceptance limit / K
refType_area2	basic_conformity		
refType_area3		basic_acceptanceLimitLower	basic_acceptanceLimitUpper
	pass	-0.23	0.23
	pass	-0.23	0.23
	pass	-0.23	0.23
	pass	-0.30	0.30
	pass	-0.30	0.30

08d

DCC-GP Temperature: Simplified

```
        <si:coverageProbabilityXMLList>0.95</si:coverageProbabilityXMLList>
        <si:distributionXMLList>normal</si:distributionXMLList>
    </si:expandedUncXMLList>
</si:realListXMLList>
<dcc:measurementMetaData>
    <dcc:metaData refType="basic_conformity">
        <dcc:declaration>
            <dcc:name>
                <dcc:content lang="de">Konformität</dcc:content>
                <dcc:content lang="en">Conformity</dcc:content>
            </dcc:name>
        </dcc:declaration>
        <dcc:conformityXMLList>pass</dcc:conformityXMLList>
        <dcc:data>
            <dcc:quantity re
                <dcc:name>
                    <dcc:con
                    <dcc:con
                </dcc:name>
                <si:realList
                    <si:valu
                    <si:unit
                </si:realLis
            </dcc:quantity>
            <dcc:quantity re
                <dcc:name>
                    <dcc:con
                    <dcc:con
                </dcc:name>
                <si:realList
                    <si:valu
                    <si:unit
                </si:realLis
            </dcc:quantity>
        </dcc:data>
    </dcc:metaData>
</dcc:measurementMetaData>
</dcc:quantity>
```



09a

DCC-GP Temperature: Typical

refType_area1	basic_referenceValue	
	Reference value / K	Calibration value / K
refType_area2		basic_calibrationValue
refType_area3		
	306.248	306
	373.121	373
	448.253	448
	523.319	523
	593.154	593

Area	Used Elements / Attributs	simplified	typical
result1	basic_referenceValue		
result1	basic_calibrationValue		
result1	basic_measuredValue		
result1	basic_measurementError		
result1	U (measurementError)		
result1	basic_conformity		
result1	basic_acceptanceLimitLower		
result1	basic_acceptanceLimitUpper		

Table continued …

refType_area1	basic_measuredValue	basic_measurementError				
	Measured value/ K	Measurement error / K	U (Measurement error) / K			
refType_area2						
refType_area3						
	306.32	0.072	0.061	2	0.95	normal
	373.21	0.089	0.061	2	0.95	normal
	448.36	0.107	0.061	2	0.95	normal
	523.31	-0.009	0.061	2	0.95	normal
	593.07	-0.084	0.061	2	0.95	normal

Table continued …

reftype_area1	basic_measurementError		
		Lower acceptance limit / K	Upper acceptance limit / K
refType_area2	basic_conformity		
refType_area3		basic_ acceptanceLimitLower	basic_ acceptanceLimitUpper
	pass	-0.23	0.23
	pass	-0.23	0.23
	pass	-0.23	0.23
	pass	-0.30	0.30
	pass	-0.30	0.30

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09b

DCC-GP Temperature: Typical

```
<dcc:quantity refType="basic_referenceValue">
    <dcc:name>
        <dcc:content lang="de">Bezugswert</dcc:content>
        <dcc:content lang="en">Reference value</dcc:content>
    </dcc:name>
    <si:hybrid>
        <si:realListXMLList>
            <si:valueXMLList>306.248 373.121 448.253 523.319 593.154</si:valueXMLList>
            <si:unitXMLList>\kelvin</si:unitXMLList>
        </si:realListXMLList>
        <si:realListXMLList>
            <si:valueXMLList>33.098 99.971 175.103 250.169 320.004</si:valueXMLList>
            <si:unitXMLList>\degreecelsius</si:unitXMLList>
        </si:realListXMLList>
    </si:hybrid>
    <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>
</dcc:quantity>
```

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10

DCC-GP Temperature: Typical / Adjustment

refType_area1	basic_referenceValue	
	Reference value / K	Calibration value / K
refType_area2		basic_calibrationValue
refType_area3		
	306.245	306
	373.127	373
	448.249	448
	523.321	523
	593.151	593

Table continued ...

refType_area1	basic_measuredValue	basic_measurementError				
	Measured value/ K	Measurement error / K	U (Measurement error) / K			
refType_area2						
refType_area3						
	306.35	0.105	0.89	2	0.95	normal
	373.45	0.323	0.89	2	0.95	normal
	448.05	-0.199	0.89	2	0.95	normal
	523.05	-0.271	0.89	2	0.95	normal
	593.35	0.199	0.89	2	0.95	normal

Table continued ...

reftype_area1	basic_measurementError		
		Lower acceptance limit / K	Upper acceptance limit / K
refType_area2	basic_conformity		
refType_area3		basic_ acceptanceLimitLower	basic_ acceptanceLimitUpper
	pass	-0.75	0.75
	pass	-0.75	0.75
	pass	-0.75	0.75
	pass	-0.90	0.90
	pass	-0.90	0.90

refType_area1	basic_referenceValue	
	Reference value / K	Calibration value / K
refType_area2		basic_calibrationValue
refType_area3		
	306.248	306
	373.121	373
	448.253	448
	523.319	523
	593.154	593

Table continued ...

refType_area1	basic_measuredValue	basic_measurementError				
	Measured value/ K	Measurement error / K	U (Measurement error) / K			
refType_area2						
refType_area3						
	306.32	0.072	0.061	2	0.95	normal
	373.21	0.089	0.061	2	0.95	normal
	448.36	0.107	0.061	2	0.95	normal
	523.31	-0.009	0.061	2	0.95	normal
	593.07	-0.084	0.061	2	0.95	normal

Table continued ...

reftype_area1	basic_measurementError		
		Lower acceptance limit / K	Upper acceptance limit / K
refType_area2	basic_conformity		
refType_area3		basic_ acceptanceLimitLower	basic_ acceptanceLimitUpper
	pass	-0.23	0.23
	pass	-0.23	0.23
	pass	-0.23	0.23
	pass	-0.30	0.30
	pass	-0.30	0.30

Area	Used Elements / Attributs	simplified	typical	typical_ Adjustment
Adjustment	basic_referenceValue			
Adjustment	basic_calibrationValue			
Adjustment	basic_measuredValue			
Adjustment	basic_measurementError			
Adjustment	U (measurementError)			
Adjustment	basic_conformity			
Adjustment	basic_acceptanceLimitLower			
Adjustment	basic_acceptanceLimitUpper			
result1	basic_referenceValue			
result1	basic_calibrationValue			
result1	basic_measuredValue			
result1	basic_measurementError			
result1	U (measurementError)			
result1	basic_conformity			
result1	basic_acceptanceLimitLower			
result1	basic_acceptanceLimitUpper			

As found / As left

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11

DCC-GP Temperature: Resistance (Ω)

Area	Used Elements / Attributs	minimal	typical	typical_ Adjustment	resistance
result1	basic_referenceValue				
result1	basic_calibrationValue				
result1	basic_measuredValue				
result1	basic_measurementError				
result1	U (measurementError)				
result1	basic_conformity				
result1	basic_acceptanceLimitLower				
result1	basic_acceptanceLimitUpper				
result2	gp_coefficients				
result2	basic_conformity				
result2	R0				
result2	A				
result2	B				

refType_area1	basic_referenceValue		basic_measuredValue
	Reference value / K	Measured value/ Ω	Measured value/ Ω
refType_area2		basic_calibrationValue	
refType_area3			
	273.149	273.15	100.0220
	283.151	283.15	103.9329
	293.151	293.15	107.8300
	303.149	303.15	111.7130
	313.149	313.15	115.5841
	323.149	323.15	119.4422
	333.150	333.15	123.2880
	303.151	303.15	111.7131
	273.151	273.15	100.0224

Coefficients according to Callendar van Dusen

$R_0 / \frac{\text{kg m}^2}{\text{s}^3 \cdot \text{A}^2}$	A / K^{-1}	B / K^{-2}
100.0225	0.0039155	-6.469E-07

measurementMetaData **metaData** **refType="basic_conformity"**

The conformity statement is made for class A Pt100 resistance sensors ...

Determination by „Kunde GmbH"

PASS

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12

DCC-GP Temperature: Extensive

Area	Used Elements / Attributs	simplified	typical	typical_ Adjustment	resistance	extensive
Adjustment	<dcc:dateTime>					
Adjustment	basic_referenceValue					
Adjustment	<si:dateTime>					
Adjustment	gp_uM*					
Adjustment	gp_uS*					
Adjustment	gp_mE*					
Adjustment	basic_normalUsed					
Adjustment	basic_calibrationValue					
Adjustment	basic_measuredValue					
Adjustment	<si:dateTime>					
Adjustment	basic_measurementError					
Adjustment	U (measurementError)					
Adjustment	gp_uMTotalSampleTime					
Adjustment	gp_uMNumberOfSamples					
Adjustment	basic_conformity					
Adjustment	basic_toleranceLimitLower					
Adjustment	basic_acceptanceLimitLower					
Adjustment	basic_acceptanceLimitUpper					
Adjustment	basic_toleranceLimitUpper					
result1	<dcc:dateTime>					
result1	basic_referenceValue					
result1	<si:dateTime>					
result1	gp_uM*					
result1	gp_uS*					
result1	gp_mE*					
result1	basic_normalUsed					
result1	basic_calibrationValue					
result1	basic_measuredValue					
result1	<si:dateTime>					
result1	basic_measurementError					
result1	U (measurementError)					
result1	gp_uMTotalSampleTime					
result1	gp_uMNumberOfSamples					
result1	basic_conformity					
result1	basic_toleranceLimitLower					
result1	basic_acceptanceLimitLower					
result1	basic_acceptanceLimitUpper					
result1	basic_toleranceLimitUpper					
result2	gp_coefficients					
result2	basic_conformity					
result2	R0					
result2	A					
result2	B					
End	basic_note1					

	refType_area1	basic_referenceValue					
Start time		Method No.	Software No.	Equipment No.	Reference value / K	Measuring time	Calibration value / K
	refType_area2	gp_uM*	gp_uS*	gp_mE*			basic_calibrationValue
	refType_area3						
1957-08-13T13:00Z		1	1	1	306.248	1957-08-13T13:15Z	306
1957-08-13T14:00Z		1	1	2	373.121	1957-08-13T14:15Z	373
1957-08-13T15:00Z		1	2	2	448.253	1957-08-13T15:15Z	448
1957-08-13T16:00Z		2	2	3	523.319	1957-08-13T16:15Z	523
1957-08-13T17:00Z		2	2	3	593.154	1957-08-13T17:15Z	593

Table continued ...

refType_area1	basic_measuredValue		basic_measurementError						
	Measured value/ K	Measuring time	Measurement error / K	U (Measurement error) / K				Total measurement time / s	Number of measurements
refType_area2									
refType_area3									
	306.32	1957-08-13T13:25Z	0.072	0.061	2	0.95	normal	1261.23	60
	373.21	1957-08-13T14:25Z	0.089	0.061	2	0.95	normal	1259.44	60
	448.36	1957-08-13T15:25Z	0.107	0.061	2	0.95	normal	1257.27	60
	523.31	1957-08-13T16:25Z	-0.009	0.061	2	0.95	normal	1260.87	60
	593.07	1957-08-13T17:25Z	-0.084	0.061	2	0.95	normal	1264.59	60

Table continued ...

refType_area1	basic_measurementError				
		Lower tolerance limit / K	Lower acceptance limit / K	Upper acceptance limit / K	Upper tolerance limit / K
refType_area2	basic_conformity				
refType_area3		basic_toleranceLimitLower	basic_ acceptanceLimitLower	basic_ acceptanceLimitUpper	basic_toleranceLimitUpper
	pass	-0.58	-0.23	0.23	0.58
	pass	-0.58	-0.23	0.23	0.58
	pass	-0.58	-0.23	0.23	0.58
	pass	-0.78	-0.30	0.30	0.78
	pass	-0.78	-0.30	0.30	0.78

Timestamps | Measurement details | Tolerance

Notes:

[1]: This is a typical procedure in the case of calibrating a temperature-sensor.

13

Let's talk about Text...

- Texts are also a fundamental part of the DCC!
  - Look to the GP examples.
- It is possible to make important components of texts searchable.
  - For example, standards can be referred to directly.
- Many standardisation bodies have therefore also transformed their standards into XML.

The PTB-DCC-Team

alphabetical sequence

Benjamin Gloger
Daniel Hutzschenreuter
Frank Härtig
Gamze Söylev-Öktem
Jan Loewe
Justin Jagieniak
Lutz Doering
Shanna Schönhals
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www.ptb.de/dcc

2022-03-01

PTB's 100 Days Programme

Presenting author Shanna Schönhals, PTB, Germany

shanna.schoenhals@ptb.de

Additional author Frank Härtig, Siegfried Hackel, Thorsten Schrader, Jan Loewe, Lutz Doering, Benjamin Gloger, Justin Jagieniak, Gamze Söylev-Öktem (all PTB, Germany)

dcc@ptb.de

Abstract

PTB will start its 100-day programme to support the DCC directly after the conference. During this time, various work packages are to be completed. A central goal is to develop further good practice DCCs for other measurands and to present them to the committees for discussion.

Further tools for the middleware from the laboratory IT to the DCC, the creation of a human-readable output and the establishment of an internal helpdesk will also be on the to-do list during this time.

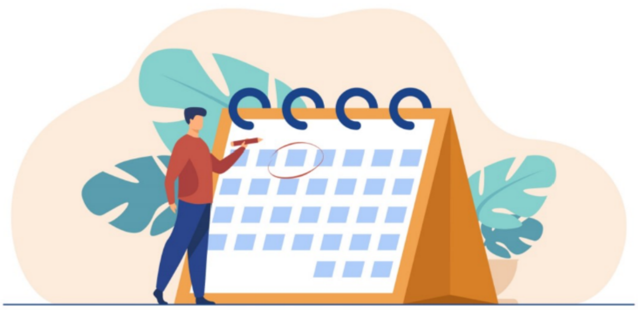
Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

PTB's 100 Days Programme for the DCC

Shanna Schönhals

Why a 100 days programme

- Formulation of SMART goals (**S**pecific, **M**easurable, **A**chievable, **R**ealistic, and **T**imely)
- Focus efforts on what matters most to enable the roll-out of the DCC
- Motivation to achieve the goals
- Starting directly after the DCC conference



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Our agenda for the next 100 days

Good Practice Examples

- Temperature
- Air pressure
- Humidity

today

Functionality

- XML
- XSD

today

- Human readable output in HTML and PDF
- GEMIMEG-Tool for non-commercial use

Wednesday

- Publication series on fundamental DCC topics

PTB Service

- Internal helpdesk

Thursday

- Issuing DCCs for first measurands (Temperature)

Physikalisch-Technische Bundesanstalt ■ Braunschweig und Berlin

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www.ptb.de/dcc

2022-03-01

Session “DCC Implementation Strategies”

Implementation of Digital Calibration Certificate at NIMT

Presenting author Pawat Phuaknoi, NIMT, Thailand

Additional authors Kittisun Mongkolsuttirat, Narin Chantawong, Wasin Limthunyalak, Jariya Buajarern (all NIMT, Thailand)

Abstract

Calibration certificates are essential for assuring accuracy of the measuring instrument which is necessary to control quality of products and services. The calibration certificates are mostly used in legal metrology for quality audits, accreditation, and examination processes and also in the operational metrology to adjust measurement results according to error of an instrument. Hard copy calibration certificates are successfully used for decades.

With the advance in digital technology, approaches for digital calibration certificates (DCCs) were proposed. DCCs based on a PDF/A-3 solution is one of a stepping-stone towards the digitalization of metrological services. DCCs is expected to fulfil the emergence of new technologies and applications that require automated creation, processing, and updates of the calibration certificates.

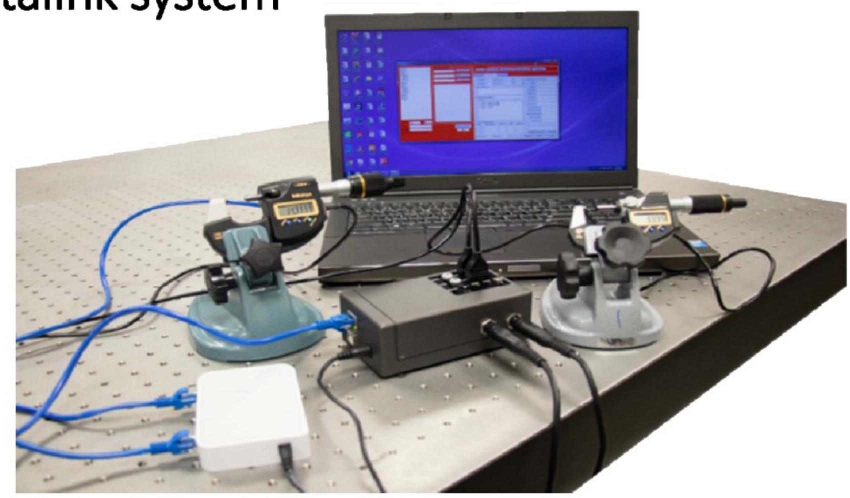
We present here an application of this approach at NIMT by implementing DCC with Data-link system developed by NIMT using Visual Studio. DCC will be imported to the Data-link software. The nominal value and correction value from DCC will be used in measurement value correction. During measurement, software will collect measured value from the instrument and look up for the corresponding correction value and report corrected measured value which can be recorded for further analysis.

Implementation of Digital Calibration Certificate at NIMT

Mr. Pawat Phuaknoi

National Institute of Metrology (Thailand)

Datalink system

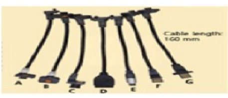


Datalink system

Specification

- This device can connect dimensional measuring instruments such as micrometer, caliper, dial indicator, height gauge, micrometer head etc. and also all other digital instruments.
- Data can be sent from the measuring instrument or by using a foot switch.
- This device can connect to a computer.

Hardware

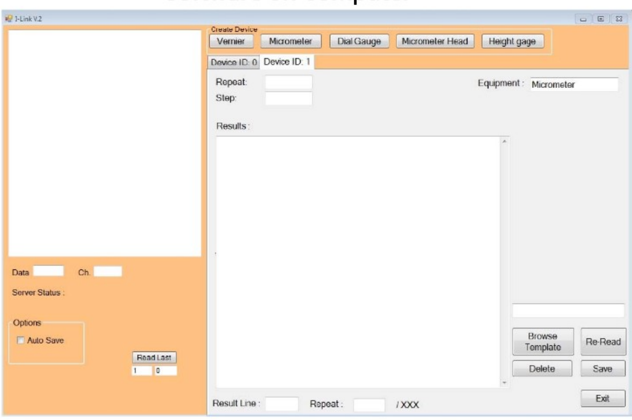


Cable

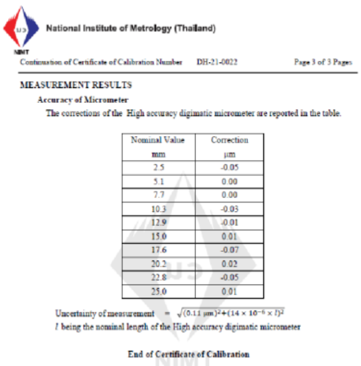
Foot switch

Instruments

Software on Computer



PDF/A-3 DCC



National Institute of Metrology (Thailand)

Continuation of Certificate of Calibration Number DH-21-0022 Page 3 of 3 Pages

MEASUREMENT RESULTS

Accuracy of Micrometer

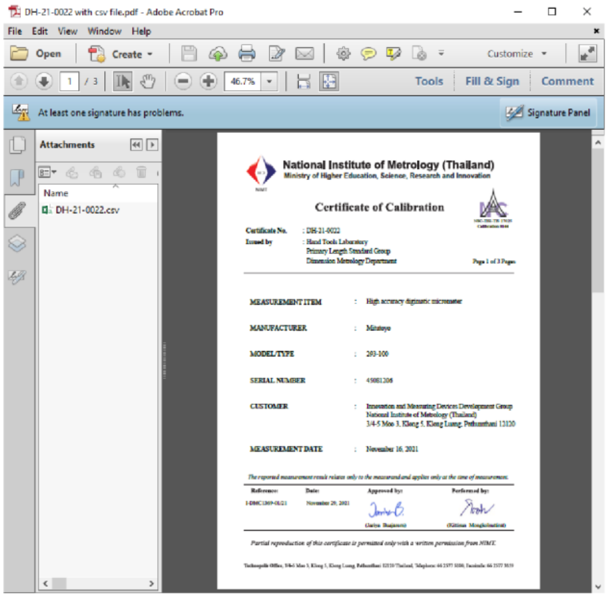
The corrections of the High accuracy digimatic micrometer are reported in the table.

Nominal Value mm	Correction µm
2.5	-0.05
5.1	0.00
7.7	0.00
10.3	-0.03
12.9	-0.01
15.0	0.01
17.6	-0.07
20.2	0.02
22.8	-0.05
25.0	0.01

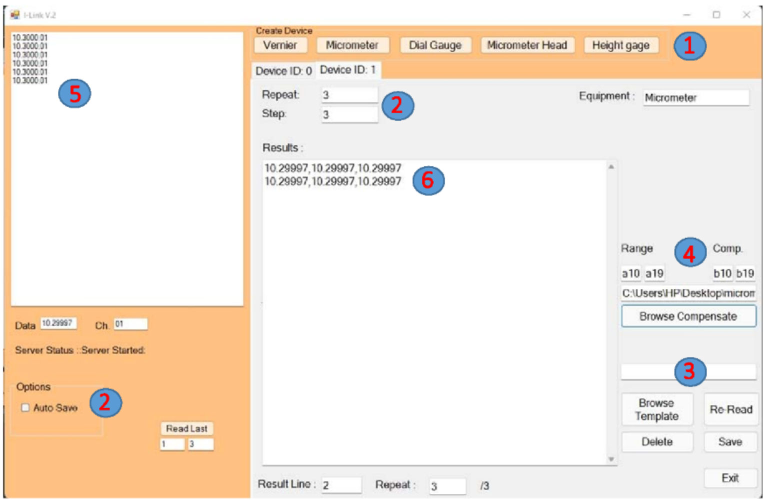
Uncertainty of measurement $= \sqrt{(0.11\ \mu m)^2 + (14 \times 10^{-6} \times l)^2}$

l being the nominal length of the High accuracy digimatic micrometer

End of Certificate of Calibration

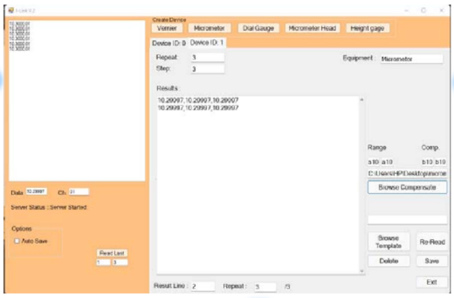


Implementation of Digital Calibration Certificate at NIMT



1. The program can create device such as micrometer, caliper, dial indicator, height gauge, micrometer head etc.
2. The program can set no. of repeat and measurement steps in case of wanting to save measurement results automatically.
3. The program can choose the record template as needed.
4. Able to enter data values of error of measuring instruments from Certificate
5. Data obtained from measuring instruments
6. Data obtained after being corrected

Implementation of Digital Calibration Certificate at NIMT



National Institute of Metrology (Thailand)

Continuation of Certificate of Calibration Number DH-21-0022 Page 3 of 3 Pages

MEASUREMENT RESULTS

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Uncertainty of measurement $= \sqrt{(0.11\ \mu m)^2 + (14 \times 10^{-6} \times l)^2}$

l being the nominal length of the High accuracy digimatic micrometer

End of Certificate of Calibration

Digitization + DCC

Thank you

pawat@nimt.or.th

The Digital NIST Pilot Project

Presenting author Robert J. Hanisch, NIST, USA

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Additional authors J. Fedchak, S. Choquette, K. Rimmer, B. Long, R. Plante, K. Lippa, D. Camara (all NIST, USA)

Abstract

NIST recently began planning for the modernization and digitalization of its measurement services:

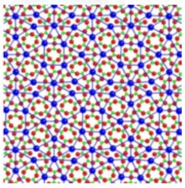
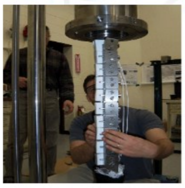
calibrations, reference materials, reference instruments, and standard reference data.

This will be a significant effort going forward, touching on all aspects of data acquisition, analysis, management, and dissemination, with the goal of making these services fully FAIR.

At this time, we are pursuing a pilot study focused on digital certificates. We are evaluating the feasibility of mapping our calibration reports and certificates of analysis into the PTB DCC schema.

We are hopeful that most of our essential information can be supported, but if not, we will cooperate with PTB and other NMIs to either update the schema or deploy extensions that preserve maximum compatibility and interoperability.

In our presentation we will describe the aspirations and expectations for our long-term measurement services program and the anticipated outcomes of our pilot study.


The Digital NIST

Robert Hanisch (Office of Data and Informatics)

Steve Choquette (Office of Reference Materials)
Jim Fedchak (Physical Measurement Laboratory)
Kate Rimmer (Chemical Sciences Division)
Ben Long (Information Technology Laboratory)

History and Motivation

- 2017, PTB and NPL discuss/plan "digitalization" efforts at NMI Directors Meeting, BIPM
- Fall 2019, CIPM established the Digital SI Task Group; Jim Olthoff NIST Associate Director for Laboratory Programs) represents NIST. Joachim Ullrich (PTB) chair.
- November 2019, Task Group appoints Expert Group; Jim Olthoff asked Bob Hanisch to represent NIST. Daniel Hutzschenreuter (PTB), chair.
- Expert Group developed "grand vision" for the Digital SI and organized workshop, hosted by BIPM, in February 2021.
    - "The International System of Units (SI) and FAIR Digital Data"
    - ~1200 participants from NMIs, standards organizations, industry, academia
    - Broad consensus that metrology needs to move to fully digital, fully FAIR data
    - Statement of cooperation
- March 2021, NIST Measurement Services Council spun off Digital Transformation Working Group.
- March 2021, senior NIST management asked Bob Hanisch, Steve Choquette, and Jim Fedchak to develop strategy document for the Digital NIST.

History and Motivation

- Fall 2021, developed proposal for Digital NIST Pilot
- January 2022, Associate Director for Laboratory Programs approved proposal
- Funds allocated and project teams formed
  - Certificates of analysis for reference materials
  - Calibration reports
  - Pilots to run to the end of September 2022
  - Stakeholder workshop, September or October 2022

NIST MATERIAL MEASUREMENT LABORATORY

Digital NIST Vision

- *Commerce in the 21st Century is dependent on the digital exchange of information, however NIST still delivers the data from its metrology products and services through paper-based modalities.*
- *The development of a "Digital NIST" includes digital certificates for standard reference materials (SRM) and calibrations, and a cloud-based system for sharing of interoperable metrology data, calculations, legal metrology documents, and other digital tools.*
- *The Digital NIST requires substantial investment in data and computing infrastructure such that there is digital traceability for all of the data that support measurement services.*
- *The Digital NIST will help U.S. industry compete in global markets by meeting international standards requirements for accreditation, conformity, quality, and product safety, with an estimated financial benefit of $Bs/year.*
- *The Digital NIST is a multi-year effort, estimated at $25M/year for five years.*

NIST MATERIAL MEASUREMENT LABORATORY

DCC evaluation

- Using NIST's Configurable Data Curation System (CDCS), which supports ingest of XML schemas
  - PTB DCC V3.1.0 uploaded and validated
- Will test against a representative sample of certificates of analysis (CoAs)
- Likely that we will need a different schema for CoAs, NIST calibration reports, and Standard Reference Data
  - A suite of Digital Certificates (DCs)
  - Use common elements where possible for maximum interoperability

NIST MATERIAL MEASUREMENT LABORATORY

DCC in CDCS

NIST

Sample certificate of analysis

NIST National Institute of Standards and Technology U.S. Department of Commerce

Date of Issue: 10 December 2020

Standard Reference Material® 2454a
Hydrogen in Titanium Alloy
(Nominal Mass Fraction 215 mg/kg H)
(pin form)

CERTIFICATE OF ANALYSIS

Purpose: This Standard Reference Material (SRM) is a titanium, 6 % aluminum, 4 % vanadium alloy intended primarily for use in evaluating chemical and instrumental methods for determination of hydrogen in titanium and its alloys. It can be used to validate value assignment of in-house reference materials.

Description: A unit of SRM 2454a consists of one bottle containing 10 g of pins having an approximate mass per pin of 0.10 g and approximate dimensions of 2.5 mm diameter and 4.5 mm length per pin.

Certified Value: The certified value is the estimated mean mass fraction of the element hydrogen in titanium for all bottles of SRM 2454a. A certified value is the present best estimate of the true value [1]. The certified value is metrologically traceable to the SI derived unit of mass fraction, expressed as milligrams per kilogram. The expanded uncertainty is an interval calculated for nominal 95 % coverage using a Bayesian multilevel consensus model [2] in a manner consistent with the ISO/JCGM Guide [3-4], and it expresses contributions from all recognized sources of uncertainty.

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

Period of Validity: The certification of **SRM 2454a** is valid, within the measurement uncertainty specified, until **30 June 2039**, provided the SRM is handled and stored in accordance with the instructions given in this certificate. The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

Maintenance of Certified Values: NIST will monitor this SRM to the end of the period of validity. If substantive technical changes occur that affect the certification before the expiration of this certificate, NIST will notify the purchaser. Registration (see attached sheet or register online) will facilitate notification.

NIST ... MENT LABORATORY

Sample certificate of analysis

Storage: The material should be stored in its original, tightly capped bottle in a cool, dry location. Keep a new bottle sealed in the aluminized polyester pouch until time of use. Use a clean, dry tool to handle the pins, and do not touch the pins with any material likely to contaminate the surface with moisture or hydrocarbon compounds.

Use: To relate analytical determinations to the assigned value on this Certificate of Analysis, a minimum sample quantity of 0.1 g (1 pin) is recommended. The material does not require preparation prior to weighing. To use the uncertainty interval given in this certificate in comparisons and calculations, it is recommended to use an approximation to the combined standard uncertainty, u_c, equal to one fourth of the width of the 95 % coverage interval given in Table 1.

Source and Preparation: The material for SRM 2454a was obtained in the form of pins prepared by White Horse Technical Services (Temple City, CA), using a proprietary procedure based on a process developed by NIST for development of SRMs 2452, 2453, and 2454 [5]. The material was bottled at NIST and sealed into aluminized polyester pouches. Homogeneity testing was performed at White Horse Technical Services using inert gas fusion with thermal conductivity detection following ASTM International E1447-09(2016) [6]. Material heterogeneity was low and fit for the purpose of value assignment with the standard deviation of a single determination of hydrogen equal to 0.8 mg/kg based on samples consisting of two pins each.

Quantitative analyses of the material for SRM 2454a were performed at NIST and at White Horse Technical Services. At NIST, prompt gamma-ray activation analysis (PGAA) was performed with each sample consisting of a single 0.10 g pin. At White Horse, inert gas fusion with thermal conductivity detection and standard additions calibration with pure H_2 gas was performed with each sample consisting of a single 0.10 g pin.

NOTICE TO USERS

NIST strives to maintain the SRM inventory supply, but NIST cannot guarantee the continued or continuous supply of any specific SRM. Accordingly, NIST encourages the use of this SRM as a primary benchmark for the quality and accuracy of the user's in-house reference materials and working standards. As such, the SRM should be used to validate the more routinely used reference materials in a laboratory. Comparisons between the SRM and in-house reference materials or working standards should take place at intervals appropriate to the conservation of the SRM and the stability of relevant in-house materials. For further guidance on how this approach can be implemented, contact NIST by email at srms@nistgov.

NIST MATERIAL MEASUREMENT LABORATORY

Sample certificate of analysis

REFERENCES

[1] Beauchamp, C.R.; Camara, J.E.; Carney, J.; Choquette, S.J.; Cole, K.D.; DeRose, P.C.; Duewer, D.L.; Epstein, M.S.; Kline, M.C.; Lippa, K.A.; Lucon, E.; Phinney, K.W.; Polakoski, M.; Possolo, A.; Sharpless, K.E.; Sieber, J.R.; Toman, B.; Winchester, M.R.; Windover, D.; *Metrological Tools for the Reference Materials and Reference Instruments of the NIST Material Measurement Laboratory*; NIST Special Publication 260-136; U.S. Government Printing Office: Washington, DC (2020); available at https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.260-136-2020.pdf (accessed Dec 2020).

[2] Gelman, A.; Carlin, J.B.; Stern, H.S.; Dunson, D.B.; Vehtari, A.; Rubin, D.B.; *Bayesian Data Analysis*; 3rd ed., CRC Press (2014).

[3] JCGM 100:2008; *Evaluation of Measurement Data — Guide to the Expression of Uncertainty in Measurement* (GUM 1995 with Minor Corrections); Joint Committee for Guides in Metrology (2008); available at https://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Sep 2020); see also Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297; U.S. Government Printing Office: Washington, DC (1994); available at https://www.nist.gov/pml/nist-technical-note-1297 (accessed Dec 2020).

[4] JCGM 101:2008; *Evaluation of Measurement Data— Supplement 1 to the Guide to the Expression of Uncertainty in Measurement — Propagation of Distributions Using a Monte Carlo Method*; Joint Committee for Guides in Metrology (JCGM) (2008); available at https://www.bipm.org/utils/common/documents/jcgm/JCGM_101_2008_E.pdf (accessed Dec 2020).

[5] Paul, R.L.; Lindstrom, R.M.; *Preparation and Certification of Hydrogen in Titanium Alloy Standard Reference Materials*; Metall. Mater. Trans. A, Vol. 43A, pp. 4888–4895 (2012).

[6] ASTM E1447-09(2016); *Standard Test Method for Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity/Infrared Detection Method*; Annu. Book ASTM Stand., Vol. 3.05, West Conshohocken, PA (2019).

Certain commercial organizations, services, equipment, or materials may be identified in this Certificate of Analysis to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the organizations, services, materials, or equipment identified are necessarily the best available for the purpose.

Users of this SRM should ensure that the Certificate of Analysis in their possession is current. This can be accomplished by contacting the Office of Reference Materials 100 Bureau Drive, Stop 2300, Gaithersburg, Maryland 20899-2300; telephone (301) 975-2200; e-mail srminfo@nist.gov; or the Internet at https://www.nist.gov/srm.

* * * * * * * * * * * * End of Certificate * * * * * * * * * * * *

NIST — MATERIAL MEASUREMENT LABORATORY

Digital NIST Plans

- Phase 1: DCC evaluation, schema extension development
  - Start of CY'22, joint effort of ORM, ODI, ITL
  - Nine months
  - Includes consultation with PTB, NPL
- Phase 2:
  - Work with staff to create appropriate templates for calibration reports and SRM certificates of analysis; SRM supporting data will be stored in the NIST Public Data Repository (joint effort of ORM and ODI)
  - Develop and implement appropriate DC schemas for NIST
  - Work with staff to develop appropriate data format for DC implementation
- Phase 3:
  - Transfer Digital NIST to US standards organizations and US manufacturing, support Industry 4.0
  - Develop secure repositories for DCs and supporting data, "metrology cloud" of integrated data and services

NIST — MATERIAL MEASUREMENT LABORATORY

Resource Estimates

- Phase 1: DCC evaluation, schema extension development
  - Relies on currently available staff
  - ~12 staff-month effort
  - October 1, 2021 start
- Phases 2 and 3:
  - 12-15 FTEs
  - FY’23 + 4 years
  - Integrated Project Team (IPT) drawn from ODI, ORM, PML, ITL, OISM
  - Steering Group
- Plus distributed effort in retooling data acquisition and management such that all data supporting measurement services are FAIR
- Initiative in preparation, “Measurement Services Delivery Modernization and Upgrades”

NIST MATERIAL MEASUREMENT LABORATORY

Summary

The Digital NIST represents a profound renovation of our measurement services and their foundational data that is essential to support NIST stakeholders and Industry 4.0

Contact: Robert Hanisch, robert.hanisch@nist.gov

NIST MATERIAL MEASUREMENT LABORATORY

Towards DCC implementation in Finland

Presenting author Sari Saxholm, National Metrology Institute VTT MIKES, Finland

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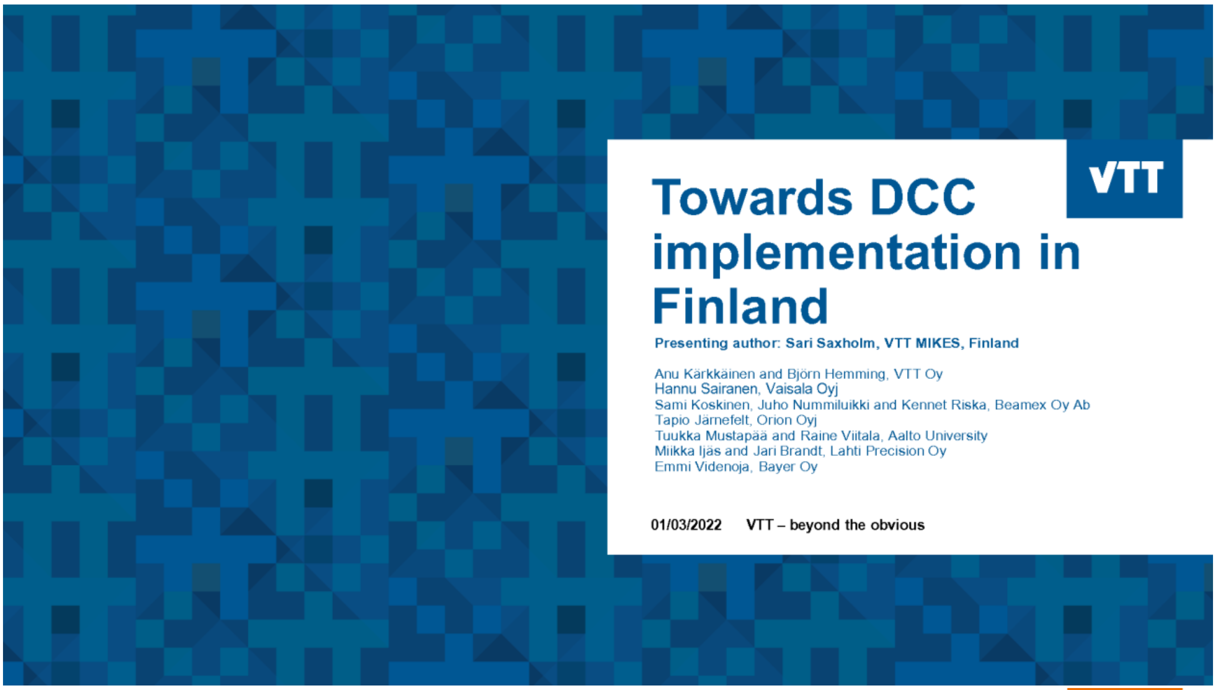
Miikka Ijäs and Jari Brandt, Lahti Precision Oy, Finland

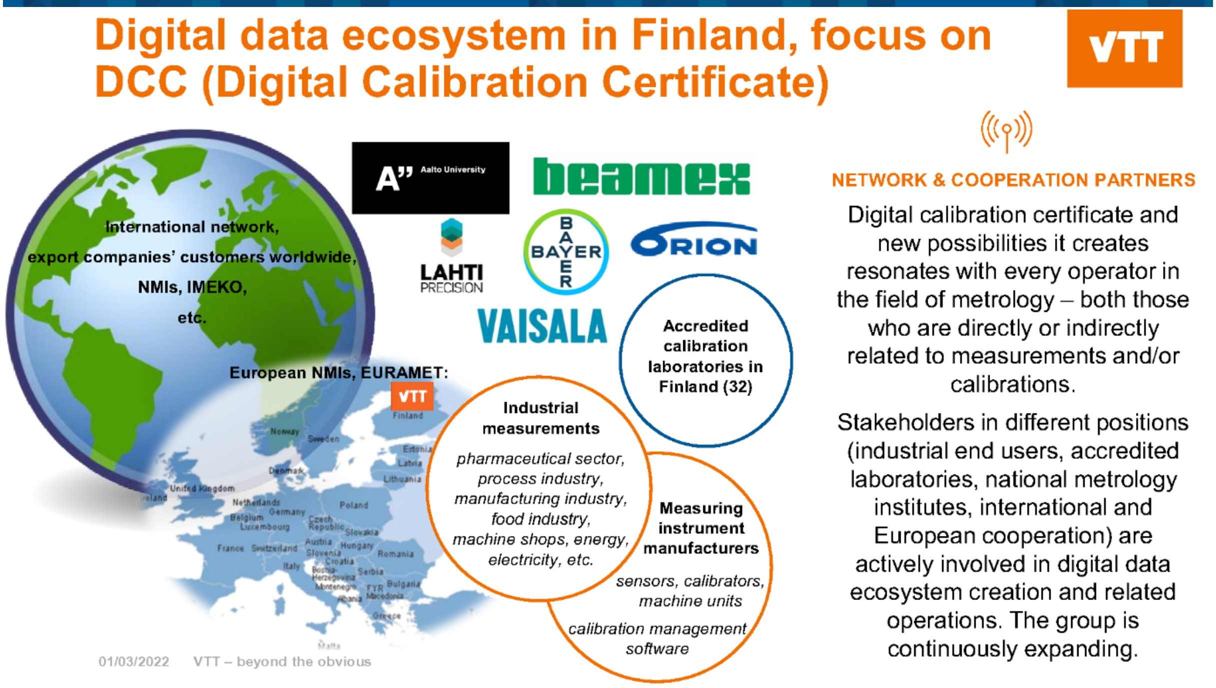
Mikko Haapalainen, Valmet Automation Oy, Finland

Emmi Videnoja, Bayer Oy, Finland

Abstract

A group of active research institutes and forerunner companies, including instrument manufacturers, calibration laboratories and end users, have established an ecosystem in Finland for more efficient and extensive digital utilization of measurement data. Key topics at the moment are digital calibration and automated data validation of measurement data, as well as digital calibration certificate (DCC). These include, e.g., traceability of the results in the digital format, reliable data transfer and operability between different user interfaces. The ecosystem has created a Proof of Concept (PoC) for humidity sensor calibration including DCC for relative humidity and temperature calibration sequence. A digital authentication replacing a traditional human signature was also demonstrated. In addition, a Python module was tested to modify xml code that enables reliable transfer of measurement results instead of making changes directly to the xml. The aim was to understand the benefits of DCC and implementation realities in the end-user processes. Related to DCC xml, the main findings were, e.g., that there are various ways to insert measurement data challenging achieving machine readability in the end. The other practical challenge was the lack of support for measurement resolution, which caused issues in uncertainty calculations in the receiving system. At the moment, several project preparations are ongoing both in national and international level. At the same time activities are taken to strengthen and widen the current digital data ecosystem. Next steps are to be towards digital infrastructure, which enables DCC but is not limited to that. New opportunities and ways of working are sought towards fully digital calibration processes and automated data validation processes. Results, ideas, and future plans will be shown in the presentation.


Towards DCC implementation in Finland
VTT
Presenting author: Sari Saxholm, VTT MIKES, Finland
Anu Kärkkäinen and Björn Hemming, VTT Oy
Hannu Sairanen, Vaisala Oyj
Sami Koskinen, Juho Nummiluikki and Kennet Riska, Beamex Oy Ab
Tapio Järnefelt, Orion Oyj
Tuukka Mustapää and Raine Viitala, Aalto University
Miikka Ijäs and Jari Brandt, Lahti Precision Oy
Emmi Videnoja, Bayer Oy
01/03/2022 VTT – beyond the obvious


Digital data ecosystem in Finland, focus on DCC (Digital Calibration Certificate)
VTT
International network,
export companies' customers worldwide,
NMIs, IMEKO,
etc.
European NMIs, EURAMET:
VTT
Finland
Norway
Sweden
Estonia
Latvia
Lithuania
Denmark
United Kingdom
Netherlands
Poland
Germany
Belgium
Luxembourg
Czech Republic
Slovakia
France
Switzerland
Austria
Hungary
Slovenia
Croatia
Romania
Italy
Serbia
Bulgaria
Greece
Malta
Aalto University
beamex
LAHTI PRECISION
BAYER
ORION
VAISALA
Accredited calibration laboratories in Finland (32)
Industrial measurements
pharmaceutical sector, process industry, manufacturing industry, food industry, machine shops, energy, electricity, etc.
Measuring instrument manufacturers
sensors, calibrators, machine units
calibration management software
NETWORK & COOPERATION PARTNERS
Digital calibration certificate and new possibilities it creates resonates with every operator in the field of metrology – both those who are directly or indirectly related to measurements and/or calibrations.
Stakeholders in different positions (industrial end users, accredited laboratories, national metrology institutes, international and European cooperation) are actively involved in digital data ecosystem creation and related operations. The group is continuously expanding.
01/03/2022 VTT – beyond the obvious

Key topics

VTT

- Digital calibration process development,
- automated validation of measurement data, and
- experimenting digital calibration certificate (DCC).
- Traceability of the results in the digital format, reliable data transfer and operability between different user interfaces
- Testing through complete metrological traceability chain

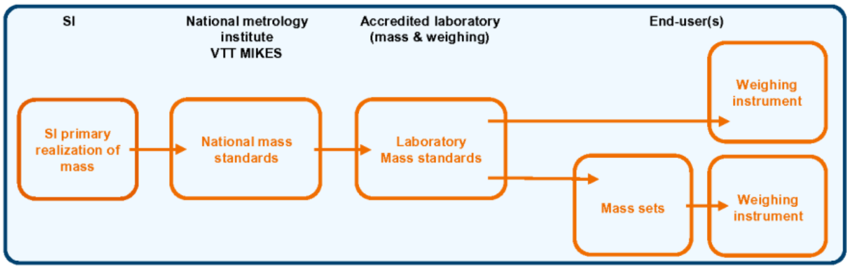


Figure 1. Next demonstration will be performed in mass & weighing instrument industrial end-user case.

Findings and notes

VTT

- Some challenges related to DCC xml
  - Possibility to insert measurement data in various ways
    - ➢ Challenging to achieve machine readability in the end
  - Lack of support for measurement resolution
    - ➢ Uncertainty calculations in the receiving system don't work correctly
- Python module was tested to modify xml code
    - ➢ Enables reliable transfer of measurement results
    - ➢ Making changes directly to the xml is risky

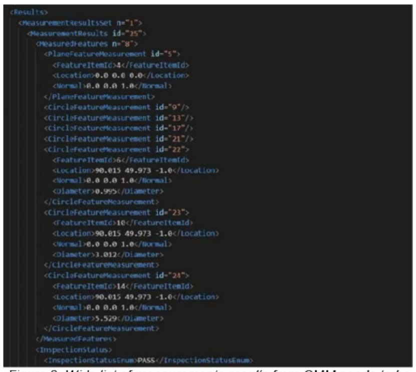
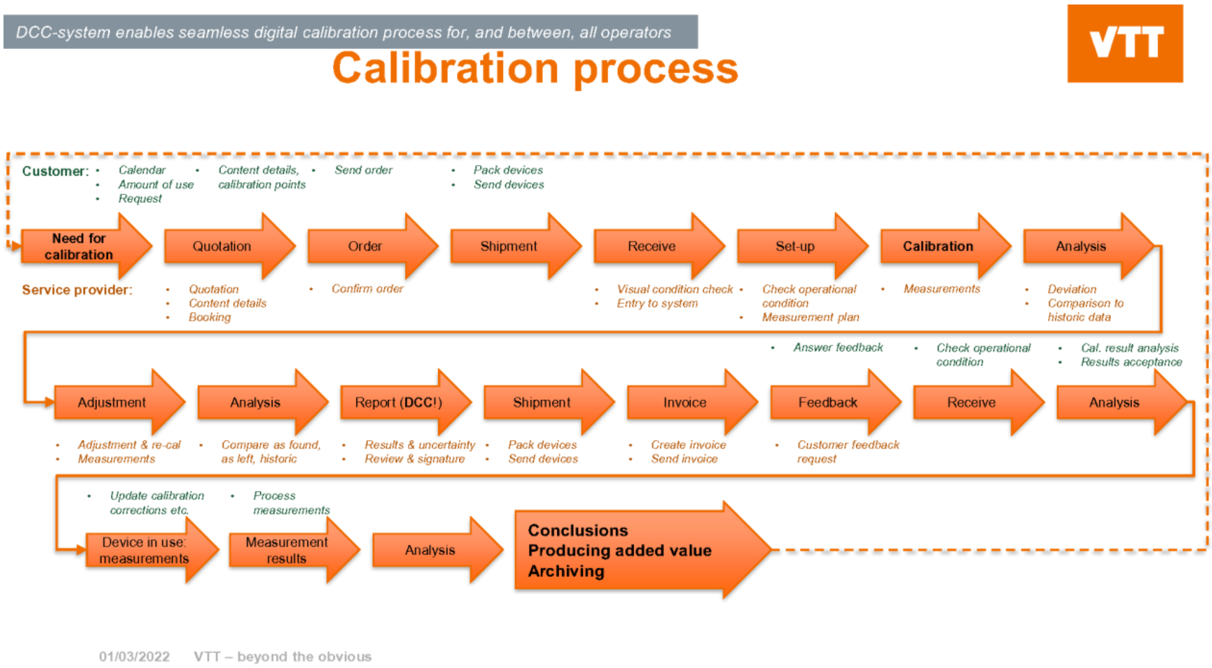
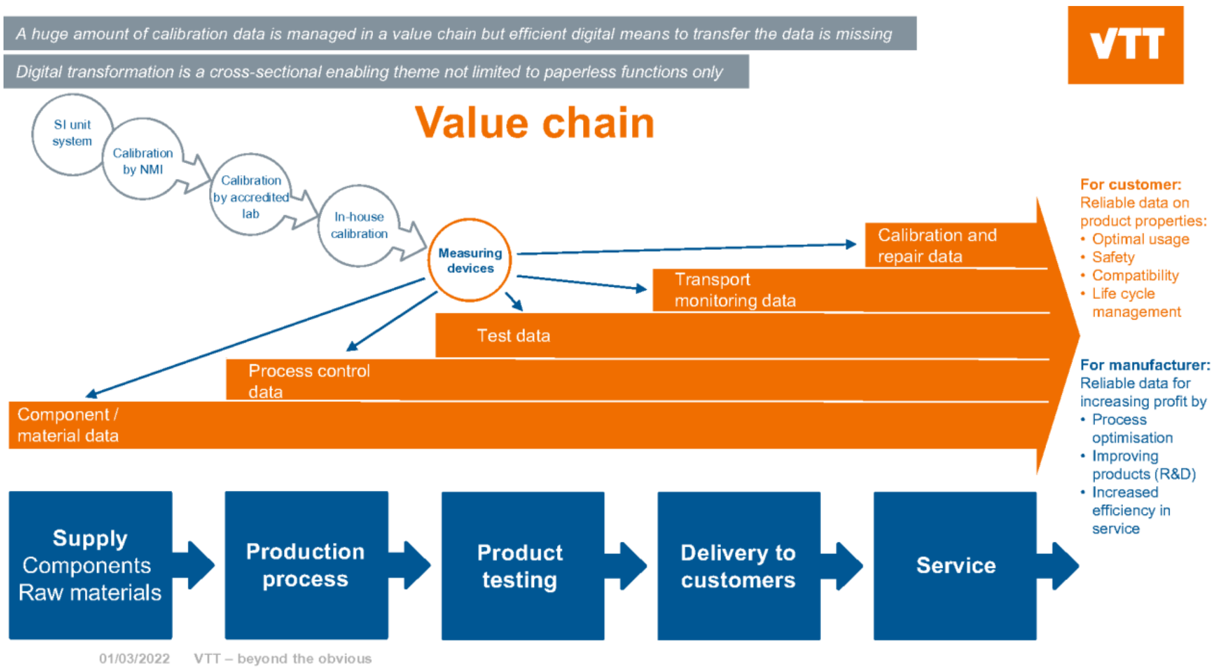


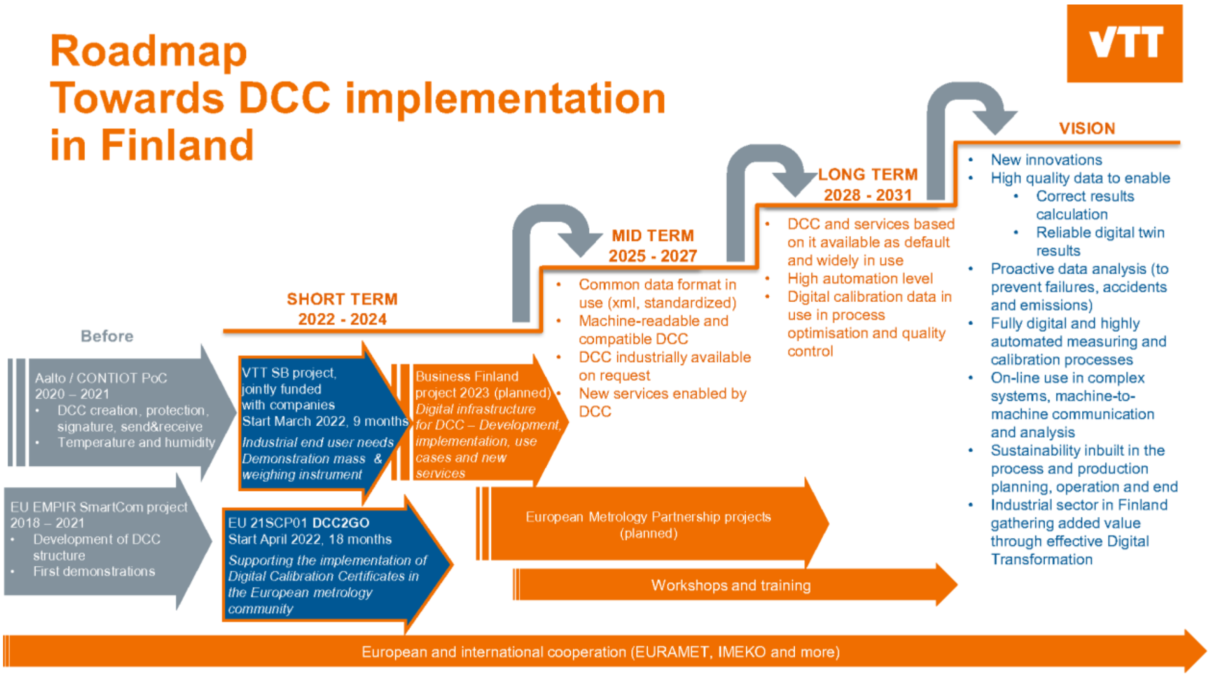
Figure 2. Wide list of measurements results from CMM needs to be added to the calibration certificate in xml.

```
# add measured results to list of measured results
measResultsList = QIFDocument.ResultsType()
measResultsSet = QIFDocument.MeasurementResultsSetType()
measResultsSet.n = 1
measResultsSet.MeasurementResults.append(measResults)
measResultsList.MeasurementResultsSet = measResultsSet
self.qifdata.Results = measResultsList
```

Figure 3. List of measurements results (Figure 1) was added to the calibration certificate using Python module.


DCC-system enables seamless digital calibration process for, and between, all operators
Calibration process
VTT
Customer:
Calendar
Amount of use
Request
Content details, calibration points
Send order
Pack devices
Send devices
Need for calibration
Quotation
Order
Shipment
Receive
Set-up
Calibration
Analysis
Service provider:
Quotation
Content details
Booking
Confirm order
Visual condition check
Entry to system
Check operational condition
Measurement plan
Measurements
Deviation
Comparison to historic data
Answer feedback
Check operational condition
Cal. result analysis
Results acceptance
Adjustment
Analysis
Report (DCC!)
Shipment
Invoice
Feedback
Receive
Analysis
Adjustment & re-cal
Measurements
Compare as found, as left, historic
Results & uncertainty
Review & signature
Pack devices
Send devices
Create invoice
Send invoice
Customer feedback request
Update calibration corrections etc.
Process measurements
Device in use: measurements
Measurement results
Analysis
Conclusions
Producing added value
Archiving
01/03/2022 VTT – beyond the obvious


A huge amount of calibration data is managed in a value chain but efficient digital means to transfer the data is missing
Digital transformation is a cross-sectional enabling theme not limited to paperless functions only
VTT
Value chain
SI unit system
Calibration by NMI
Calibration by accredited lab
In-house calibration
Measuring devices
Calibration and repair data
Transport monitoring data
Test data
Process control data
Component / material data
For customer:
Reliable data on product properties:
Optimal usage
Safety
Compatibility
Life cycle management
For manufacturer:
Reliable data for increasing profit by
Process optimisation
Improving products (R&D)
Increased efficiency in service
Supply Components Raw materials
Production process
Product testing
Delivery to customers
Service
01/03/2022 VTT – beyond the obvious


Roadmap
Towards DCC implementation
in Finland
VTT
VISION
New innovations
High quality data to enable
Correct results calculation
Reliable digital twin results
Proactive data analysis (to prevent failures, accidents and emissions)
Fully digital and highly automated measuring and calibration processes
On-line use in complex systems, machine-to-machine communication and analysis
Sustainability inbuilt in the process and production planning, operation and end
Industrial sector in Finland gathering added value through effective Digital Transformation
LONG TERM
2028 - 2031
DCC and services based on it available as default and widely in use
High automation level
Digital calibration data in use in process optimisation and quality control
MID TERM
2025 - 2027
Common data format in use (xml, standardized)
Machine-readable and compatible DCC
DCC industrially available on request
New services enabled by DCC
SHORT TERM
2022 - 2024
Before
Aalto / CONTIOT PoC
2020 – 2021
DCC creation, protection, signature, send&receive
Temperature and humidity
VTT SB project, jointly funded with companies
Start March 2022, 9 months
Industrial end user needs
Demonstration mass & weighing instrument
Business Finland project 2023 (planned)
Digital infrastructure for DCC – Development, implementation, use cases and new services
EU EMPIR SmartCom project
2018 – 2021
Development of DCC structure
First demonstrations
EU 21SCP01 DCC2GO
Start April 2022, 18 months
Supporting the implementation of Digital Calibration Certificates in the European metrology community
European Metrology Partnership projects (planned)
Workshops and training
European and international cooperation (EURAMET, IMEKO and more)


VTT
beyond
the obvious
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Session “Industrial Applications, Requirements and Examples”

Need from industry on the DCC concerning harmonization and a regulating structure

Presenting author Karlheinz Banholzer, LMG president CECIP (European Weighing Industry Association), Germany

Additional authors Christian Müller-Schöll, CECIP, Switzerland Julian Haller, CECIP, Germany

Abstract

From an industrial view, the XML Scheme Definition (XSD) for a DCC developed by the PTB is a powerful and flexible tool that has the potential to become a success story in the digitalization of metrology in general and calibration activities in particular and thus opens up completely new ways with regard to the use of calibration data.

However, its flexibility is curse and blessing at the same time – while it allows to use the scheme for presumably every measurand and every type of calibration, it also bears the risk of parallel incompatible developments. From industry’s perspective it is of utmost importance that DCCs issued by different laboratories are compatible with each other in the sense that a potential customer can change from one laboratory to another without having to adopt his software tools or infrastructure. Otherwise, unnecessary hurdles for a free choice of provider would be the consequence for customers and a threat to free competition.

Therefore, CECIP as a representative of an important part of the measurement instrument industry is underlining the need for harmonized best practice examples for DCCs in order to avoid heterogeneity of DCCs and is going to suggest some kind of regulating structure as a central controlling body for such best practice examples.

Such an international “controlling body” should be flexible, fast, and not overregulating in order to not delay the developments and progress of digitalization. If this is guaranteed, CECIP is convinced that such a “controlling body” can be an important guarantee for the success of the DCC.

Agenda

CECIP European Weighing Industry

- Introduction CECIP
- CECIP's general perception of the DCC
- Risk of the DCC
- Requirements on the DCC
- DCC infrastructure

Introduction CECIP

CECIP European Weighing Industry

- CECIP is the European association for national trade organisations representing the European manufacturers of weighing instruments.
- Founded in 1958, CECIP has today 14 members:
  - 11 national member associations: Austria, Czech Republic, France, Germany, Italy, Netherlands, Poland, Slovakia, Spain, Switzerland and United Kingdom
  - 3 company members from Portugal, Sweden and Turkey.
- CECIP is striving for common and harmonised standards to be adopted at European and International levels in order to provide safety and quality to both consumers and users of weighing instruments.
- CECIP aims to provide valuable contributions to improve the quality of legislation and standards.

CECIP's general perception of the DCC

CECIP European Weighing Industry

- powerful and flexible tool
- potential to become a success story in the digitalization of metrology in general and calibration activities in particular
- opens up completely new ways with regard to the use of calibration data
- might become a role model for the digitalization of further processes (declaration of conformity, verifications,……)

CECIP 01 March 2022 Page 4 2nd International DCC Conference

Risk of the DCC

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- The high flexibility of the DCC scheme bears the risk of parallel developments and thus incompatible implementations
- (Most) humans are intelligent and can process information context-sensitively
- Machines can't (or can only with a lot of effort)

Temperatura media (Average ambient temperature)	Pressione media (Average atmospheric pressure)	Umidità Relativa media (Average ambient moisture)
(17,8 ± 1,0) °C	(959,5 ± 3,0) hPa	(49,0 ± 4,0) % U.R.

	Tlak zraka Air pressure hPa	Temperatura zraka Air temperature °C	Relativna vlažnost zraka Relative humidity of air %RH
Početak umjeravanja	1005,7	20,90	51,3
Kraj umjeravanja	19	21,00	51,2

	von from	bis to	Unsicherheit uncertainty $k = 2$
Temperatur / °C temperature	21,57	21,57	0,20
rel. Luftfeuchte / % relative humidity	45,3	45,6	2,0
Luftdruck / mbar air pressure	994,90	995,50	0,20

Temperatura otoczenia: (19,8 ÷ 21,9) °C
Wilgotność: (30,9 ÷ 36,7) %

Lämpötila alussa 24,0 °C lopussa 24,0 °C
Ilmanpaine 1011 mbar Kosteus 56 %
Ilman tiheys 1,178 kg/m³

Temperatur Temperature	[illegible]
Relative Feuchte der Luft Relative humidity of air	[illegible]
Luftdruck Air pressure	[illegible]

		from von	up to bis	Measurement uncertainty U(k=2)	
Temperatur	temperature	21,64	22,66	0,10	°C
Rel. Luftfeuchtigkeit	rel. humidity	44,0	46,1	1,5	%
Luftdruck	Air pressure	986,7	990,6	0,2	mbar

	inicial	final
Temperatura [°C]	20,5	20,6
Humedad relativa [%hr]	53,0	55,1
Presión atmosférica [hPa]	951,1	951,6

Zum Zeitpunkt der Kalibrierung betrug die mittlere Luftdichte ρl = 1,17 kg m⁻³. Sie wurde mit einer erweiterten Messunsicherheit von 0,03 kg m⁻³ berechnet.

gewicht in lucht van 1,2 kg/m³ in evenwicht is. De omgevings-temperatuur tijdens de kalibratie bedroeg (20 ± 5) °C.

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Risk of the DCC

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- Different ways where/how to represent e.g. the temperature are possible with the DCC as well:

General notation of Max and Min:

Temperatura otoczenia: (19,8 ÷ 21,9) ºC

```
dcc:measurementResults
    dcc:measurementResult
        dcc:influenceConditions
            dcc:influenceCondition
            <dcc:list id="temperatur">
                <dcc:name><dcc:content lang="en">temperature</dcc:content></dcc:name>
                <dcc:quantity><dcc:name><dcc:content lang="en">from</dcc:content></dcc:name>
                <si:real><si:value>19.8</si:value><si:unit>\degreeCelsius</si:unit</si:real>
                </dcc:quantity>
                <dcc:quantity>
                <dcc:name><dcc:content lang="en">to</dcc:content></dcc:name>
                <si:real><si:value>21.9</si:value><si:unit>\degreeCelsius</si:unit></si:real>
                </dcc:quantity>
        dcc:results
            dcc:result
```

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Risk of the DCC

CECIP European Weighing Industry

- Different ways where/how to represent e.g. the temperature are possible with the DCC as well:

General notation of initial and final value:

	inicial	final
Temperatura [ºC]	20,5	20,6

```
dcc:measurementResults
    dcc:measurementResult
        dcc:influenceConditions
            dcc:influenceCondition
            <dcc:list id="temperatur">
                <dcc:name><dcc:content lang="en">temperature</dcc:content></dcc:name>
                <dcc:quantity><dcc:name><dcc:content lang="en">initial</dcc:content></dcc:name>
                <si:real><si:value>20.5</si:value><si:unit>\degreeCelsius</si:unit</si:real>
                </dcc:quantity>
                <dcc:quantity>
                <dcc:name><dcc:content lang="en">final</dcc:content></dcc:name>
                <si:real><si:value>20.6</si:value><si:unit>\degreeCelsius</si:unit></si:real>
                </dcc:quantity>
        dcc:results
            dcc:result
```

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Risk of the DCC

CECIP European Weighing Industry

- Different ways where/how to represent e.g. the temperature are possible with the DCC as well:

General notation of mean and „span“ as uncertainty:

```
dcc:measurementResults
    dcc:measurementResult
        dcc:influenceConditions
            dcc:influenceCondition
            <dcc:name><dcc:content lang="en">temperature</dcc:content></dcc:name>
            <dcc:quantity<si:real><si:value>17.8</si:value><si:unit>\degreeCelsius</si:unit</si:real>
            <si:uncertainty>1.0</si:uncertainty><si:coverageFactor>2</si:coverageFactor>
            <si:coverageProbability>0.95</si:coverageProbability>
            </dcc:quantity>
        dcc:results
            dcc:result
```

Temperatura media ***(Average ambient temperature)***
(17,8 ± 1,0) °C

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Risk of the DCC

CECIP European Weighing Industry

- Different ways where/how to represent e.g. the temperature are possible with the DCC as well:

Notation per result, „row-wise“:

```
dcc:measurementResults
    dcc:measurementResult
        dcc:results
            dcc:result
            dcc:influenceConditions
            <dcc:influenceCondition id="temperature">
                <dcc:name><dcc:content lang="en">temperature</dcc:content></dcc:name>
                <si:real><si:value>20.5</si:value><si:unit>\degreeCelsius</si:unit</si:real>
                </dcc:quantity>
            … (measurement result 1 here)…..
            dcc:result
            dcc:influenceConditions
            <dcc:influenceCondition id="temperature">
                <dcc:name><dcc:content lang="en">temperature</dcc:content></dcc:name>
                <si:real><si:value>20.6</si:value><si:unit>\degreeCelsius</si:unit</si:real>
                </dcc:quantity>
            … (measurement result 2 here)…..
```

Nominal value /a.u.	Meas. result /a.u.	Temperature /°C
1	1.001	20.5
2	1.999	20.6
…	…	…

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Risk of the DCC

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- Different ways where/how to represent e.g. the temperature are possible with the DCC as well:

Notation per result, „column-wise“:

```
dcc:measurementResults
    dcc:measurementResult
        dcc:influenceConditions
        <dcc:influenceCondition refType="basic_temperature">
        <dcc:name><dcc:content lang="en">temperature</dcc:content></dcc:name>
        <si:realListXMLList>
        <si:valueXMLList>20.5 20.6 …</si:valueXMLList><si:unitXMLList>\degreeCelsius</si:unitXMLList>
        </si:realListXMLList>
        dcc:results
            <dcc:name><dcc:content lang="en">Meas. results</dcc:content></dcc:name>
            <si:realListXMLList>
            <si:valueXMLList>1.001 1.999 …</si:valueXMLList><si:unitXMLList>\arbitraryUnits</si:unitXMLList>
            </si:realListXMLList>
            …
```

Nominal value /a.u.	1	2	…
Meas. result /a.u.	1.001	1.999	…
Temperature /°C	20.5	20.6	…
…	…	…	

Requirements on the DCC

CECIP European Weighing Industry

- DCCs for the same measurands/types of measuring instruments from different labs **MUST** be processable with the same import module
- DCCs for different measurands/types of measuring instruments **SHOULD** be processable with the same import module

- **General rules needed for all measurands/types of measuring instruments**
  - Denoting accredited/non-accredited results
  - Terminology/namespace
  - Preferred structures for measurand classes/types of measuring instruments

- **Detailed “Best Practice Guides” for particular measurands/calibration procedures are needed**

DCC infrastructure

CECIP European Weighing Industry

- To avoid parallel (contradicting) developments, a „DCC instance“ could officially assign the definition of a Best Practice Guide to a particular stakeholder group (see „companion specifications“ at OPC-UA)
- Such an international “controlling body” should be flexible, fast and not overregulating in order to not delay the developments and progress of digitalization.
- If this is guaranteed, CECIP is convinced that such a “controlling body” can be an important guarantee for the success of the DCC.

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CECIP European Weighing Industry

Thank you

Digital Calibration Certificate - Proof of concept for Regulated Process Industry

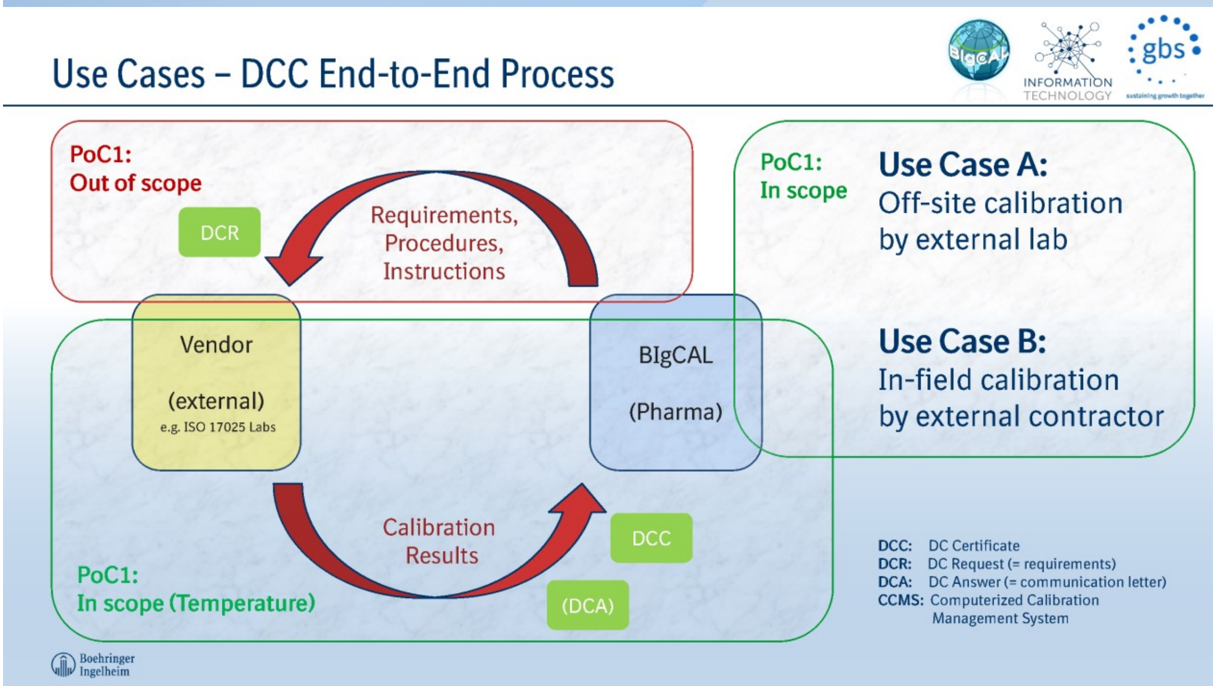
Presenting authors Heiko Reitzer, Boehringer Ingelheim GmbH, Germany Eric Kuenz, Boehringer Ingelheim GmbH, Germany

Juho Nummiluikki, Beamex Oy Ab, Finland

Abstract

The digital calibration certificate (DCC) has seen significant development as a format recently. There have not yet been many tests in the actual industrial environments to test the applicability of the DCC for industrial end users. To test the industrial applicability of the DCC, a Proof-of-concept project was initiated and executed to test the usage of the DCC in Pharmaceutical environment. The Proof-of-concept 1 (PoC 1) concentrated on testing the process of creating, securing, transferring, and receiving a DCC for a temperature sensor. The project consortium consisted of five partners: Industrial end user (Boehringer Ingelheim), German Metrology Institute and DCC specialist (PTB), calibration service provider (Testo), calibration solution provider (Beamex) and IT infrastructure provider (Aalto University of Finland). The calibration service provider was responsible for generating the DCC from their calibration management system according to the format provided be the PTB. The DCC was then secured with an electronic signature and transferred to the end user with a transfer platform. The end user imported the DCC to their calibration management system, checked against the predefined procedure and approved the calibration result. As a result of the PoC 1, first part of fully digitalized end-to-end calibration process from calibration provider to instrument owner was tested and demonstrated. The successful execution of the PoC 1 provides one approach of the middleware for DCC processing, data extraction and human readable output. The PoC 1 presents an example of DCC implementation in a highly regulated environment of pharmaceutical industry and a good practice example for temperature calibration. According to PoC 1 results achieved additional PoC's have to be executed, to fully test and demonstrate target end to end process including Digital Calibration Request (DCR) for process industries specific calibration procedures transfer.


Dig. Calib. Certificate
Image: PTB
Digital Calibration Certificate -
Proof of concept for Regulated Process Industry
2nd DCC Conference, March 2022
Heiko Reitzer / Eric Kuenz
Boehringer Ingelheim GmbH
Boehringer Ingelheim


Use Cases – DCC End-to-End Process
INFORMATION TECHNOLOGY
gbs
PoC1:
Out of scope
DCR
Requirements, Procedures, Instructions
Vendor
(external)
e.g. ISO 17025 Labs
BIgCAL
(Pharma)
Calibration Results
DCC
(DCA)
PoC1:
In scope (Temperature)
PoC1:
In scope
Use Case A:
Off-site calibration by external lab
Use Case B:
In-field calibration by external contractor
DCC: DC Certificate
DCR: DC Request (= requirements)
DCA: DC Answer (= communication letter)
CCMS: Computerized Calibration Management System
Boehringer Ingelheim

Scope of PoC1

- Quality of certificate: Non-/unaccredited (field calibration) + accredited (lab) certificate
- Measurement quantity **<temperature>**
- Create DCC files based on DCC standard XML schema (V. 3.0)
- Develop secure DCC data transmission / sharing platform for E2E system integration / interoperability
- Import DCC - XML data into Beamex CMX database (CCMS)
- Approval by Customer (to complete internal calibration process)

executed
Dec. 2020 -> Jun. 2021

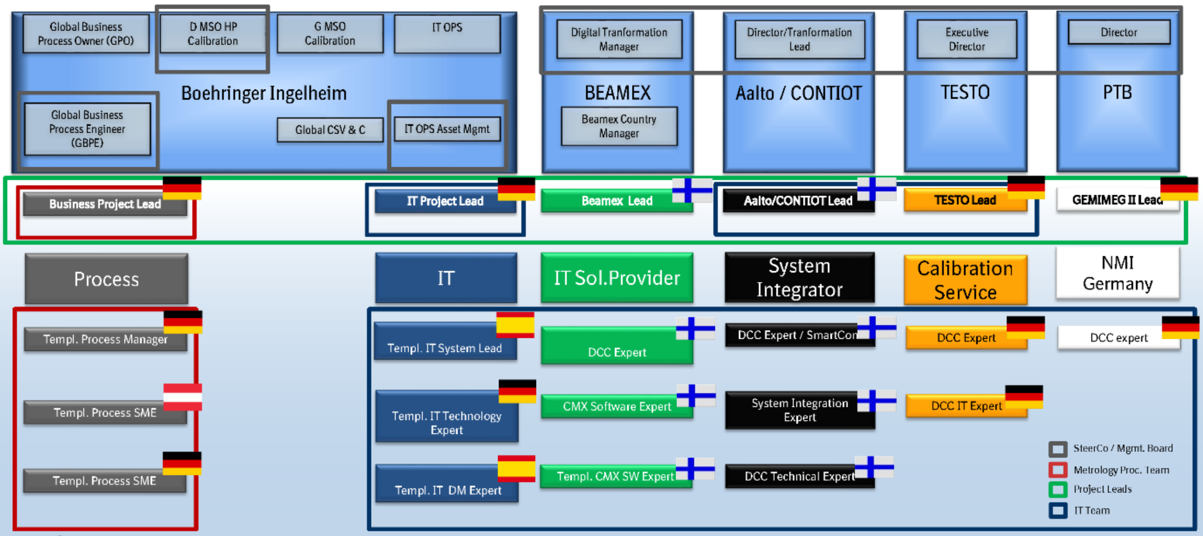
Important positive site effect:

- Establishing of first DCC "**Good Practice Example**" for temperature

Boehringer Ingelheim

BI DCC (PoC)

Project Organization



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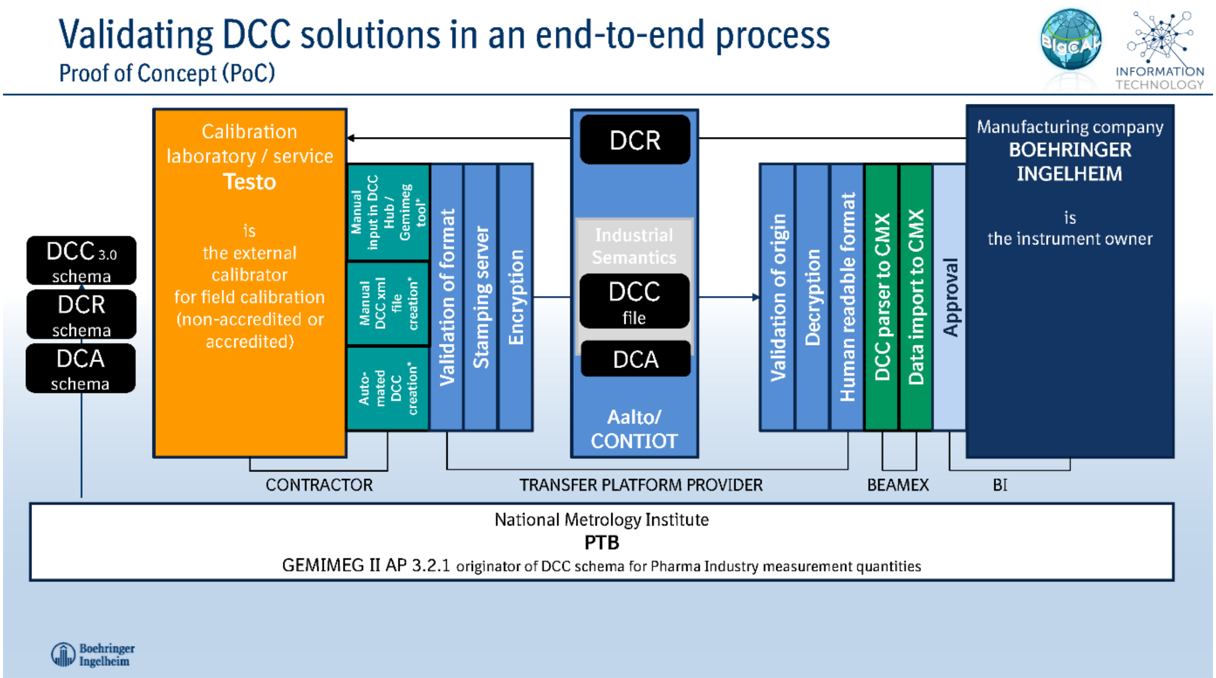
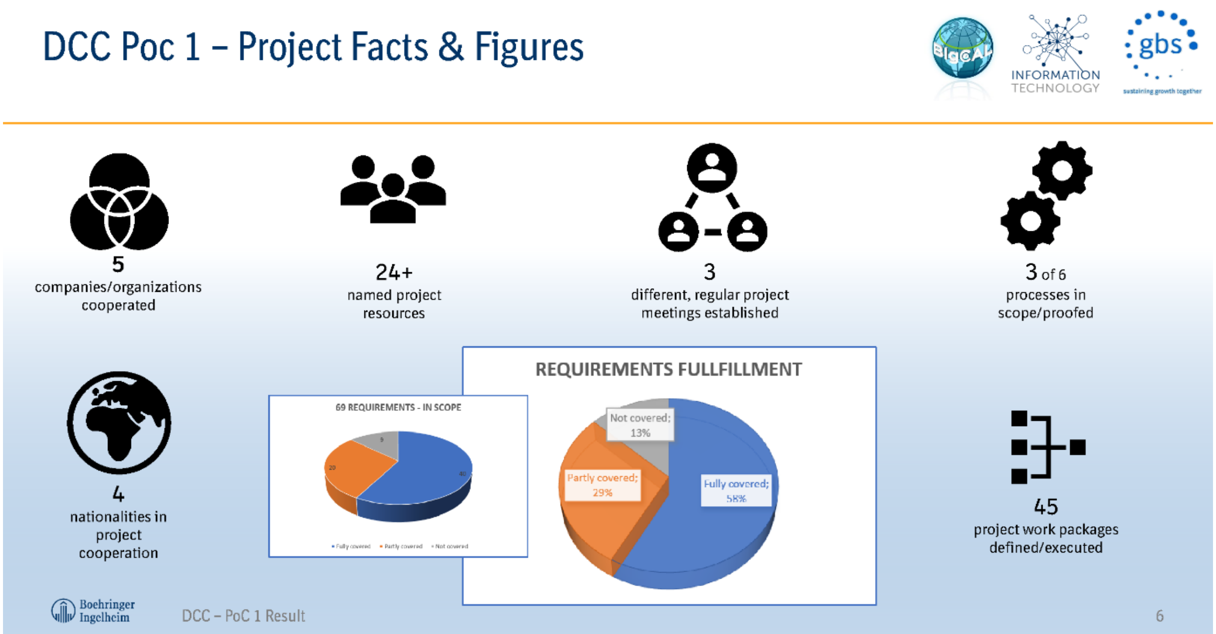

Validating DCC solutions in an end-to-end process
Proof of Concept (PoC)
INFORMATION TECHNOLOGY
Calibration laboratory / service
Testo
is
the external calibrator
for field calibration
(non-accredited or accredited)
DCC 3.0 schema
DCR schema
DCA schema
Manual input in DCC Hub / Gemimeg tool*
Manual DCC xml file creation*
Auto-mated DCC creation*
Validation of format
Stamping server
Encryption
DCR
Industrial Semantics
DCC file
DCA
Aalto/ CONTIOT
Validation of origin
Decryption
Human readable format
DCC parser to CMX
Data import to CMX
Approval
Manufacturing company
BOEHRINGER INGELHEIM
is
the instrument owner
CONTRACTOR
TRANSFER PLATFORM PROVIDER
BEAMEX
BI
National Metrology Institute
PTB
GEMIMEG II AP 3.2.1 originator of DCC schema for Pharma Industry measurement quantities
Boehringer Ingelheim


DCC Poc 1 – Project Facts & Figures
INFORMATION TECHNOLOGY
gbs
5
companies/organizations cooperated
24+
named project resources
3
different, regular project meetings established
3 of 6
processes in scope/proofed
4
nationalities in project cooperation
69 REQUIREMENTS - IN SCOPE
REQUIREMENTS FULLFILLMENT
Not covered; 13%
Partly covered; 29%
Fully covered; 58%
45
project work packages defined/executed
Boehringer Ingelheim
DCC – PoC 1 Result
6

DCC Innovation Framework

interdependencies / restrictions

Interdependencies

- German NMI to drive global DCC standard and providing further DCC schemes / stencils (ie. humidity; pressure; flow; mass)
- Acceptance of the DCC by the relevant authorities (EMA, FDA, ...)
- Support by strategic calibration service provider for future DCC development
- BEAMEX to drive DCC capability to be part of commercial of the shelf calibration solution (CMX / LOGiCAL)

Restrictions

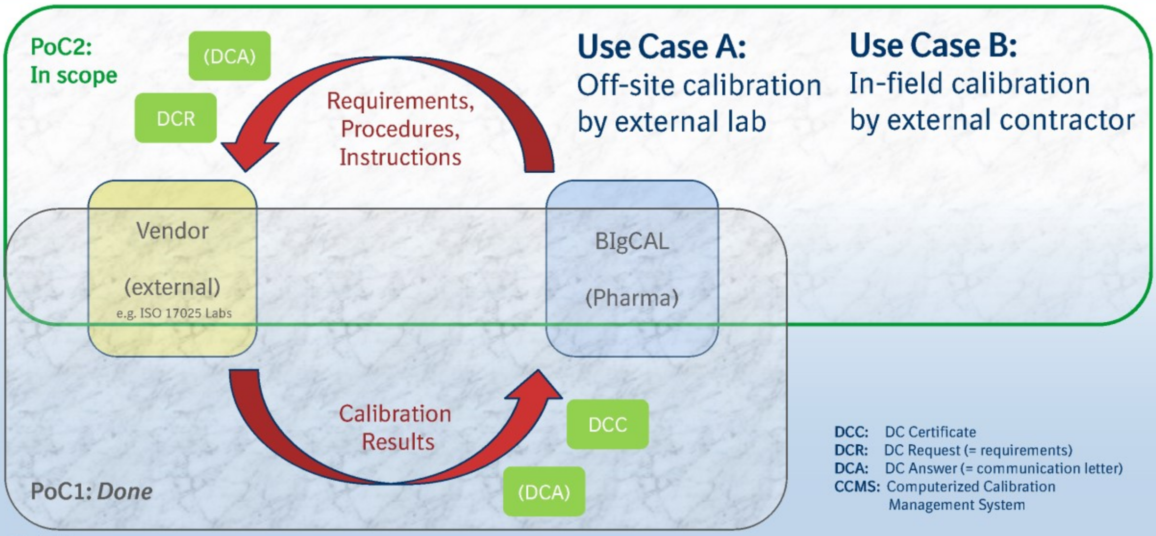
- BI Resources & Budget
- Active support from Beamex Pharma Group cooperation partners
- Fulfillment of legal requirements for onboarding of new innovation driving partners/vendors (**N**on **D**isclosure **A**greement NDA)
- Data security requirements to be met

But ...

- BI DCC team will continue to take care of it and drive the further development for the implementation of DCC into our BIgCAL process

Boehringer Ingelheim

Conclusion: DCR in Scope of PoC 2



DCC: DC Certificate
DCR: DC Request (= requirements)
DCA: DC Answer (= communication letter)
CCMS: Computerized Calibration Management System

Boehringer Ingelheim

DCC PoC Framework / Approach

Outlook, what's required?

Establish close collaboration and commitment

Reliable partners and technologies

- NMI (PTB) -> already worked well ✓
- DCC **"Sharing Hub"** platform provider -> to be established X
- Service provider for DCC XML-Schema development and maintenance -> to be established X
- Calibration Service provider -> already worked well ✓
- Calibration Management solution provider -> already worked well ✓

Boehringer Ingelheim

Boehringer Ingelheim

10

Improving DCC-results by post-processing

Presenting author Hans Koch, da+d, Germany

Abstract

The machine readability of DCC reduces the hurdle for post-processing immanent with conventional calibration certificates.

It will be shown by a case study from the NIST/SEMATEC Handbook (https://ogy.de/e9kl), how to gain added value:

• more reliable means and uncertainties than those given in the DCC

• a calibration curve with an associated uncertainty function

• reduction of uncertainties by exploiting correlations (up to a factor of 3 in the case study mentioned above!).

The calculations presented in the NIST Handbook may be substantially simplified by utilizing the Python-package "uncertainties" (https://ogy.de/h23f).

Improving DCC-results by post-processing

Hans Koch

www.da-plus-d.de

The data analysis presented here is

- not new and may be found in chapter 2.3.6.5.1. of https://www.itl.nist.gov/div898/handbook/ .
- However, the program code has been simplified considerably thanks to the Python package "uncertainties" (https://ogy.de/h23f).

Main message:

With conventional calibration certificates the input values for these calculations have to be extracted in a very eleborate manner, whereas

with a DCC it is done in a flash!

One line of code reads the whole list from the <si:valueXMLList>-element:

```
root.find(".//dcc:metaData[@refType='basic_setValue']/dcc:data/dcc:quantity/
                                                si:realListXMLList/si:valueXMLList", ns)
```

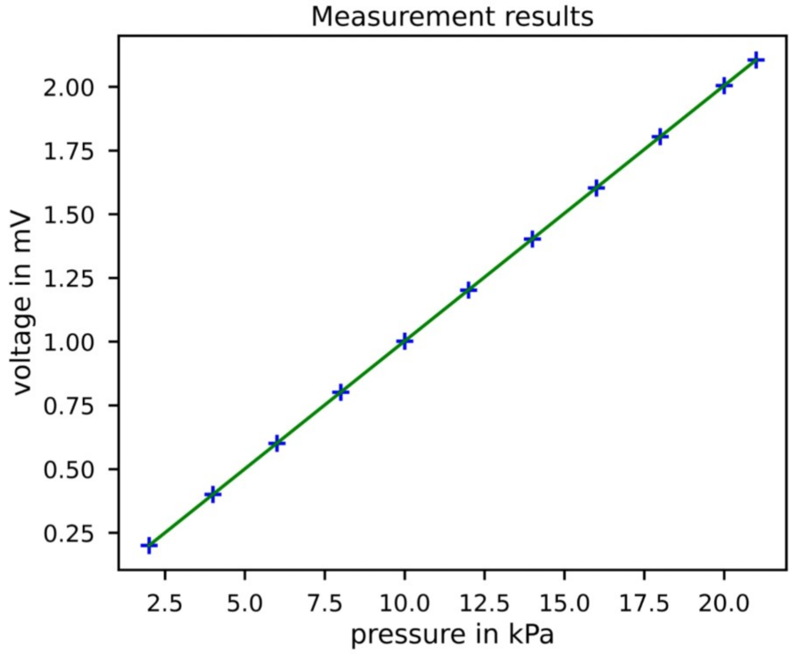
DCC cutout:

```
- <dcc:measurementMetaData>
   - <dcc:metaData refType="basic_setValue">
      - <dcc:declaration>
            <dcc:content lang="de">Kalibrierpunkt</dcc:content>
            <dcc:content lang="en">Calibration value</dcc:content>
        </dcc:declaration>
        <dcc:data>
          <dcc:quantity>
            <si:realListXMLList>
              <si:labelXMLList>kPa</si:labelXMLList>
              <si:valueXMLList>2.0 2.0 2.0 4.0 4.0 4.0 6.0 6.0 6.0 8.0
                 8.0 8.0 10.0 10.0 10.0 12.0 12.0 12.0 14.0 14.0 14.0
                 16.0 16.0 16.0 18.0 18.0 18.0 20.0 20.0 20.0 21.0
                 21.0 21.0</si:valueXMLList>
              <si:unitXMLList>\kilo\kilogram\metre\tothe{-1}
                 \second\tothe{-2}</si:unitXMLList>
```

Plotting the data and adding a linear fit:

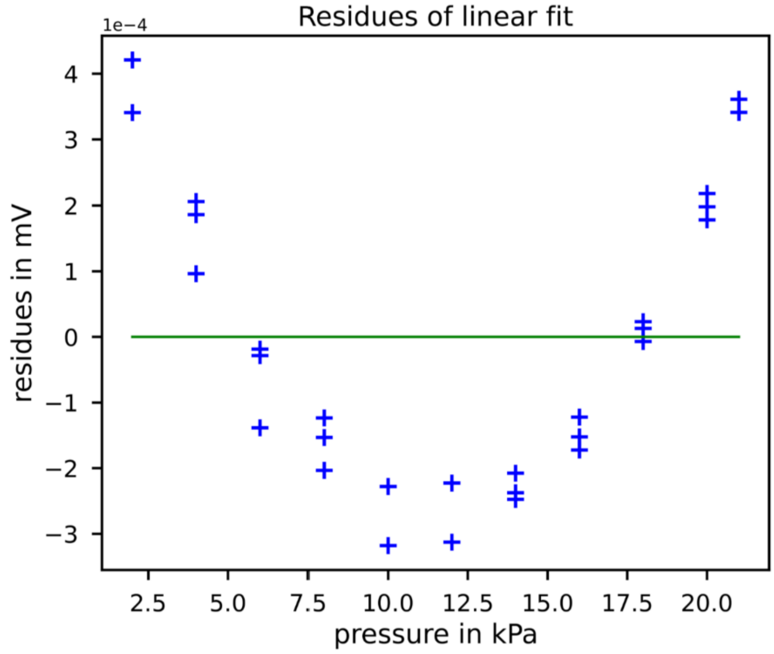
```
root, ns = getRoot()

setData = root.find(".//dcc:metaData[@refType='basic_setValue']/dcc:d
x = np.array(setData.text.split(), dtype=float)

measData = root.find(".//dcc:quantity[@refType='basic_measuredValue']
y = np.array(measData.text.split(), dtype=float)

xl, yl, results = linFit(x,y)

# plotting:
ax = ff.fig_frame("""Measurement results""", r'pressure in kPa',r'vol
ax.plot(x,y,'b+',ms=10, mew=2)
ax.plot(xl,yl,'g-',lw=2)
```

Plotting the data (+) and adding a linear fit (__):

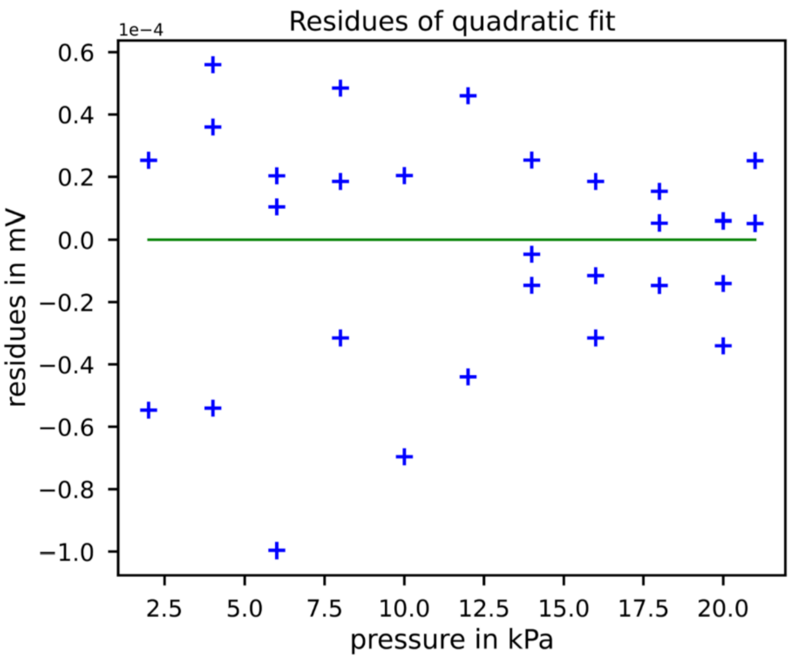


Plotting residues to a linear fit:

```
xl, yl, results = linFit(x,y)
rsd = results.resid
```

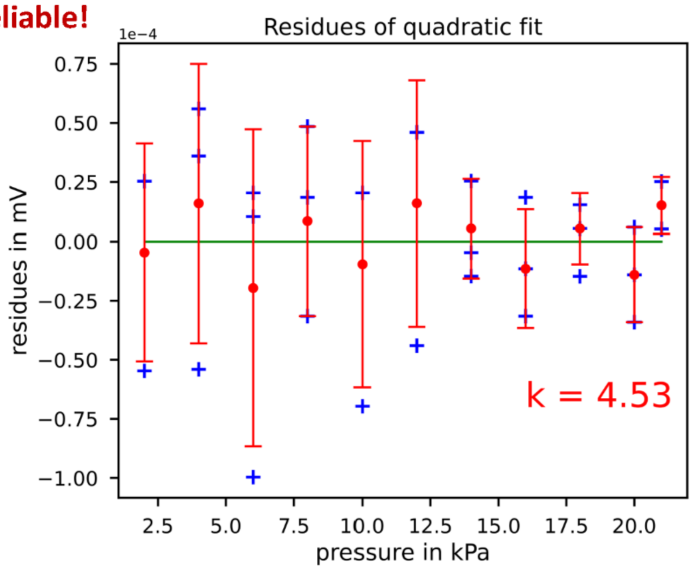


Plotting residues to a quadratic fit (now "under statistical control"):



Information given by the calibration certificate:
1) **mean**
2) **expanded uncertainty**

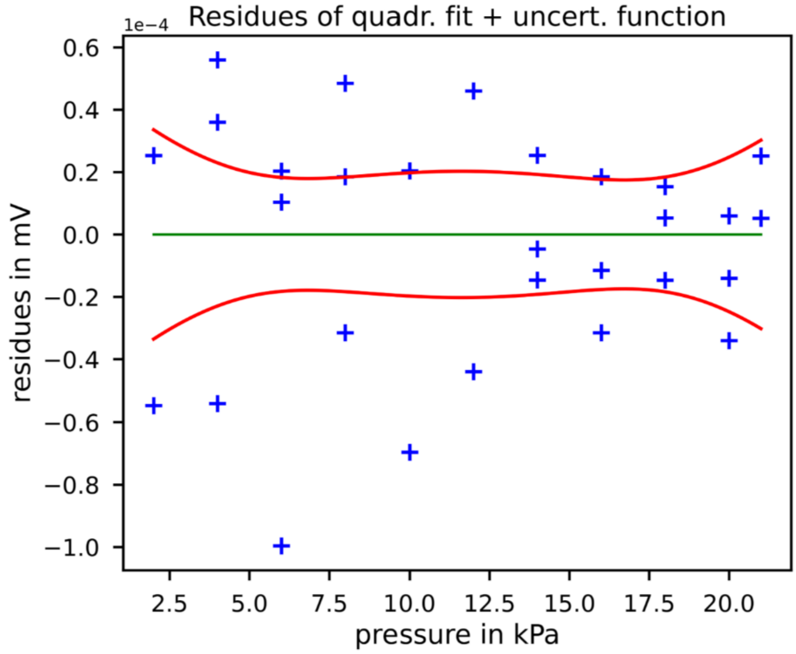
for only 3 data points
for each pressure set value.
This is statistically quite unreliable!



Calculating an uncertainty function
considering correlations of the fit parameters
Utilizing the "uncertainty"-package of Python

```
xl, yl, results = quadFit(x,y)
rsd = results.resid

a,b,c = results.params
cov = results.cov_params()

from uncertainties import correlated_values, unumpy
(a1,b1,c1) = correlated_values([a, b, c], cov)

xr = unumpy.uarray(np.linspace(x[0],x[-1],100), 0.0)
y = a1 + b1*xr + c1*xr*xr

# plotting:
ax = ff.fig_frame("""Residues of quadr. fit + uncert. function""", r'pr
ax.plot(x, rsd,'b+',ms=10, mew=2)
ax.plot([x[0],x[-1]], [0,0],'g',lw=1.5)

ax.plot(unumpy.nominal_values(xr), unumpy.std_devs(y)*2.0, 'r', lw=2)
ax.plot(unumpy.nominal_values(xr), -unumpy.std_devs(y)*2.0, 'r', lw=2)
```

Calculated uncertainty function



Outcome:

- **Since the fit function and the uncertainty function are based on 30 DOF (degrees of freedom) as opposed to 2 DOF before, these results are statistically far more reliable.**
- **Both functions span over the whole device range and are valid for intermediate values as well.**
- **The uncertainty values are smaller than those tabulated in the DCC.**

Hint: in the NIST/SEMATECH handbook the calculation consider the inverse of the calibration curve as well. This was omitted here for clarity reasons.

Digitalization of information and the impact of DCC on workflows

Presenting author Jose Armando Lopez-Celis, CENAM, Mexico

Additional authors Itzel Dominguez-Mendoza, Carlos Galvan-Hernandez, Aldo Garcia-Gonzalez, Hugo Gasca Aragon, Oscar Ramos-Monsalvo (all CENAM, Mexico)

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Abstract

The covid-19 pandemic has impacted the world by accelerating technological changes that were thought to be unnecessary, but in recent years it has come to rethink strategies, providing the opportunity to carry out a digital transformation, and metrology is no exception.

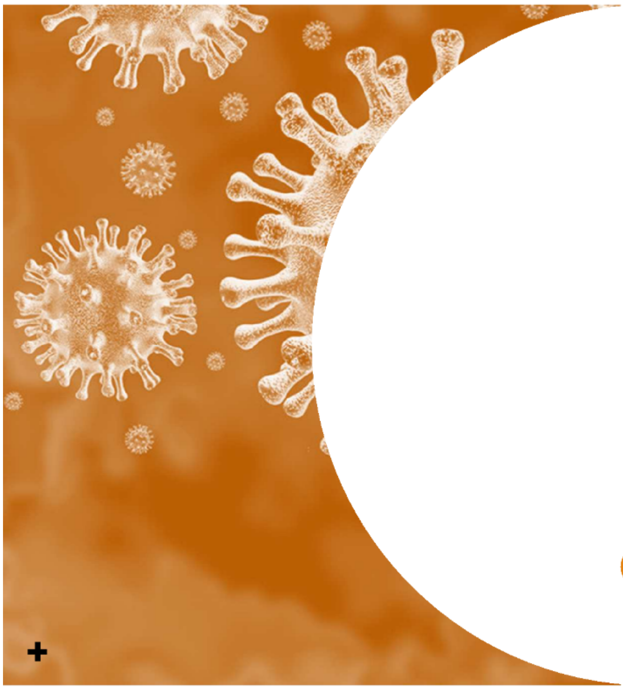
Industrial and IT technologies currently play an important role in the acceleration of processes and workflows, which brings competitive advantages in terms of time reduction and process efficiency.

It is important to consider the need to digitize data and processes within metrology laboratories, as well as the impact of the calibration certificate (DCC) on workflows in the value chain, optimizing communication between the different elements that compose it.

By ensuring that machines are capable of interpreting and processing information, data and status exchange is achieved throughout the process, minimizing errors and time in production processes.

Finally, progress is shown in the proposals of the National Metrology Centre of Mexico (CENAM) on the way to developing the DCC.


Digitalization
of information and
the impact of DCC
on workflows.
Centro Nacional de Metrología
CENAM
CENTRO NACIONAL DE METROLOGÍA



COVID 19,

Evidenced the **shortcomings and lags** in the areas of **information sciences** and **technology**

Resistance to change

Need of **innovation** in the workflows

New Needs and future services

These gaps direct our efforts to **improve** the **calibration process**.

Starting the change,

Digital maturity

Strategic allies

Business opportunities

Constant innovation,

As part of the organizational culture

AGILE Methodologies

Technology adoption

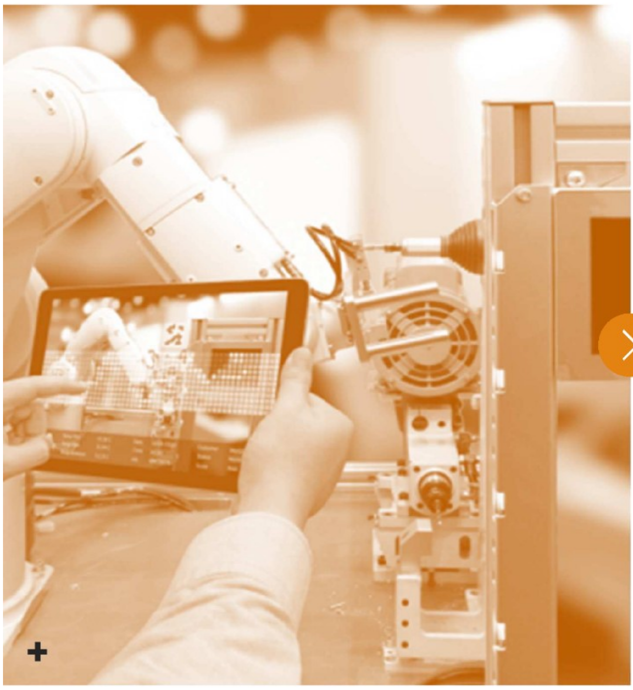
Adopting technologies that serve to speed up the process

Digitalization of information

Digitalization of information for data exchange

Process optimization

More efficient processes for better results



Closing

Global solution

reducing errors, accelerating response times, and reducing costs

Changes are good, and if they are for the benefit of all, even so more

Strengthen your value chain

CENAM
CENTRO NACIONAL DE METROLOGÍA

Certificado de Calibración Digital
Centro Nacional de Metrología

Certificado de Calibración Digital
Centro Nacional de Metrología

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Digital Quantities and Units for the MII

Presenting author Mark Kuster, Independent Researcher and Consultant, USA

mjk@ieee.org

Abstract

NCSLI members have worked on a measurement information infrastructure (MII), a digital transformation for metrology, since 2013. The effort soon concluded that machine-readable measurement data would require uniquely identifying the measurand quantity and that relying only on representing measurement units would not suffice. The NCSLI 141 MII & Automation Committee has a test bed that contains a basic database of quantities and units for reference in developing digital metrology document structures. Having neared the point of publishing a digital accreditation-statement document format, the committee would like to replace this development database with a registry of unique identifiers for quantities and units. Such a registry would facilitate wide-scale interoperability of digital certificates and other metrology data.

This presentation will explore efforts toward that goal.

Digital Quantities and Units for the MII

Mark Kuster, `mjk@ieee.org`, USA

NCSLI Measure Editor, Independent Researcher, Consultant

Second International DCC Conference

NCSLI 141 (MII) | DCC Conference 2022 | March 1-3 | 1 / 16

Section 1

Introduction

Today's Topics

1. Introduction
2. Digital Transformation (DX) and Successful Adoption
3. The NCSLI (MII) Approach to Quantities and Units
4. Conclusion

Acronyms

Definition

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

- IQI—international quality infrastructure
- DX—digital transformation
- NCSLI—NCSL International
- SoA—scope of accreditation
- M-Layer—information layer to support metrological data and application types

Section 2

Digital Transformation (DX) and Successful Adoption

An IQI Foundation

The IQI remains key to world-wide commerce—product acceptance and interoperability.

A more challenging future environment presents problems though:

- An agile, automated world demanding inexpensive, fast service
- Sheer numbers of measuring instruments: e.g., IoT devices
- Intolerance to lost value in manual processes

Digital Transformation

Metrology's DX has begun but lags other industries:

- science, manufacturing, travel, banking, entertainment, . . .

The MII initiative envisions a DX solution with opportunities:

- Higher quality and reduced costs via automation
- New value from digitalized measurement information
- New products, services, business

A digitally transformed IQI might ensure continued viability.

Barriers to Success

DX will solve the problem and foster innovation if

- fit-for-purpose and championed for adoption.

Simple digitization will not suffice. That only ...

- changes the package, the wrapper,
- prolongs existing manual processes and weaknesses,
- retains ambiguity that foils machine consumption,
- leaves us with manual processing in a different form.

Critical Success Factors

True fit-for-purpose DX requires rethinking our processes to leverage digital technology.

For true DX we should:

- Rethink our processes from the ground up.
- Replace our manual shortcuts.
- Discard pragmatic practices for extensible replacements.
- Champion adoption within top-level authorities.

Value-creating innovation and production drive demand, not consumers.
No one ever asked for a streaming music service to replace their phonograph.
"Build it and they will come."

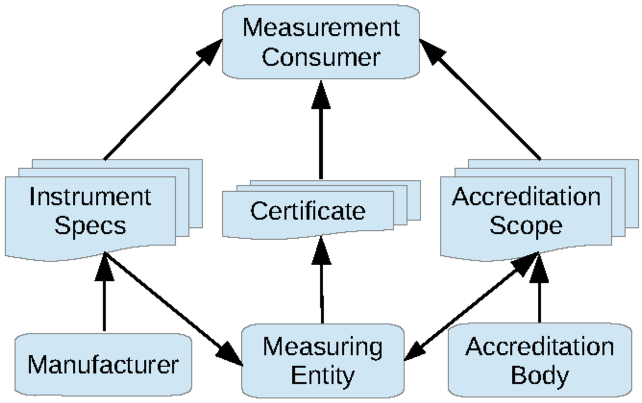
Section 3

The NCSLI (MII) Approach to Quantities and Units

NCSL International and the MII

- NCSL International
  - Established 1960, now at https://ncsli.org/
  - Volunteer-driven, measurement-science professional organization
  - Annual conference, standards & practice publications, tutorials, webinars
  - *Metrologist* magazine, *Measure* journal
- NCSLI 141 MII & Automation Committee
  - Reformulated at the 2015 annual conference
  - Chartered to develop MII digital documents and facilitate related products
  - Updates in *Metrologist* and *Cal Lab*
  - See http://miiknowledge.wikidot.com/

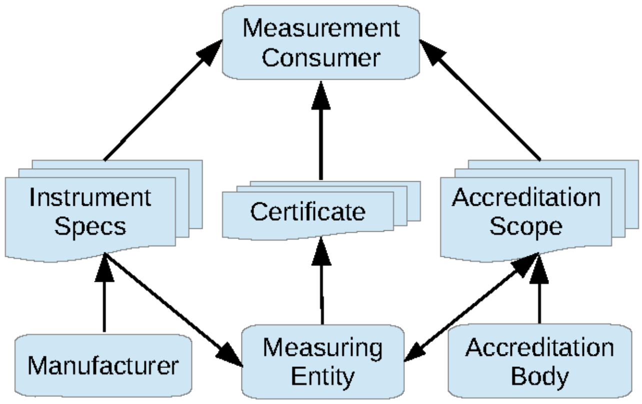
MII Digital Documents in the Measurement Economy



All three documents revolve around measurement information and so share a common data structure.

The NCSLI (MII) Approach to Quantities and Units

MII Digital Documents in the Measurement Economy



All three documents revolve around measurement information and so share a common data structure.

Where to start?

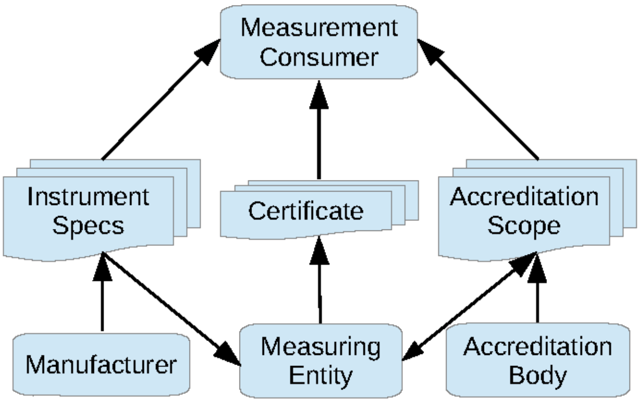
Calibration certificates: billions
Instrument specifications: millions
Accreditation scopes: thousands

Emphasis on commercial products:

- Practicable, yet extensible
- Minimum viable product: SoA
- Leverage the SoA structure to inform instrument specifications, certificates

NCSLI 141 (MII) DCC Conference 2022 March 1-3 12 / 16

MII Digital Documents in the Measurement Economy

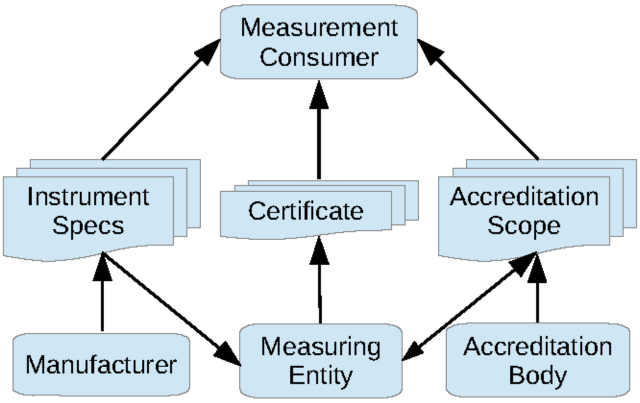


All three documents revolve around measurement information and so share a common data structure.

MII Design Requirements

- Standardization (norms)
- Interoperability (unambiguous)
- Data Completeness (full data retention)
- Identity (reusable data)
- Extensibility (compatible versioning)
- Authentication and Authorization (ownership)
- Revocation (withdrawal)

MII Digital Documents in the Measurement Economy



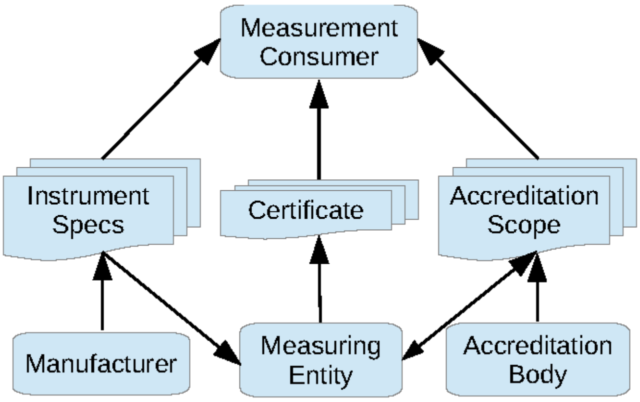
All three documents revolve around measurement information and so share a common data structure.

Rethinking measurands . . .

Current representations work for humans but remain inoperable for machines.

- Free-text quantity descriptions
- Multiple quantities per unit
- Endless dimensionless quantities
- Implicit scale-type traps
- Exceptional cases (e.g., kg)
- Objections fill the literature.

MII Digital Documents in the Measurement Economy



All three documents revolve around measurement information and so share a common data structure.

Machines require metadata to process documents correctly.

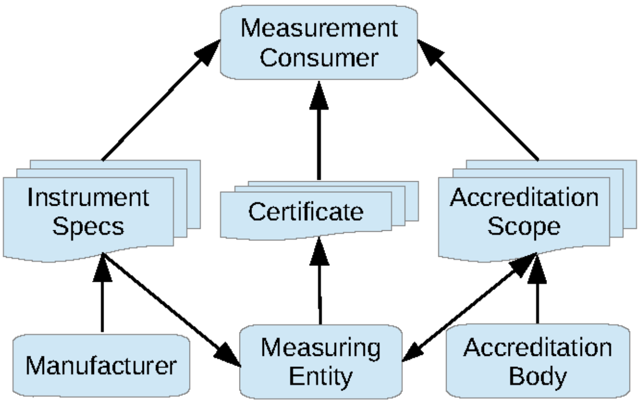
Measurement metadata = measurand descriptions = MII taxons

∴ The MII uses a standard measurand taxonomy drawn from a test-bed quantity database.

SoA	`Measure.Voltage.DC`
Spec	`Source.Voltage.DC`
Cert	`Source.Voltage.DC`

The NCSLI (MII) Approach to Quantities and Units

MII Digital Documents in the Measurement Economy



All three documents revolve around measurement information and so share a common data structure.

However, the MII test-bed lacks

- Global interoperability
- Scale & operator definitions
- Quantity relations

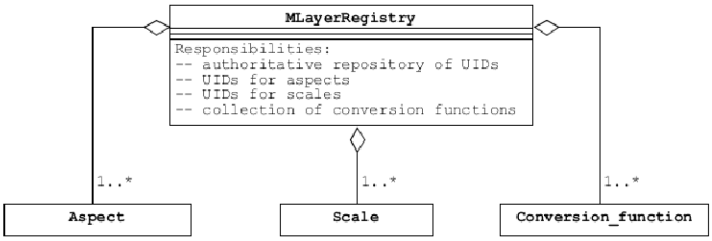
∴ We want a more general metrology information basis (the M-Layer).

$\langle q \rangle$	aspect—generalized "quantity"
q	numeric (usually) value
$[Q]$	unit or other scale reference

The M-Layer

Principles

- Support diverse metrological data and fully exploit DX.
- Capture scale types, relations and meaningful operations.
- Render familiar (e.g. SI) representations in documents.



The M-layer would comprise an authoritative register of unique identifiers for aspects, scales (units), and conversion functions. (Blair Hall (MSL) and M. Kuster)

Not only ratio scales, but interval, cyclic, logarithmic, ordinal and nominal scales

Section 4

Conclusion

Next Steps

We recommend that all digital documents incorporate M-layer principles.

At present, we plan to ...

- Continue modeling M-Layer data.
- Solidify and populate the M-Layer for testing.
  - Quantities, scales, units definitions and interrelations
  - Measurand taxonomy
- Involve stakeholders to refine the documents: Labs, ABs, manufacturers, ...
- Replace the MII quantity-unit development DB with the M-Layer.
- Incorporate into applications (commercial, internal, open-source).

Acknowledgments

Many thanks go to the

- DCC Conference 2022 Committee
- PTB Leadership for its DX emphasis
- NCSL International for its MII support
- NCSL International 141 MII and Automation Committee participants for their development work

And Thank You for your time!

We would like to collaborate with your DX effort.

- NCSL International Workshop & Symposium, August 20 to 24, 2022
- Call for papers: https://ncsli.org/page/WS22CP

Session “DCC Applications”

01

Program

UTC	Wednesday (2022-03-02)
12:00	DCC Applications
12:15	
12:30	
12:45	
13:00	DCC and Sensors
13:15	
13:30	Coffee Break
13:45	
14:00	Middleware 1
14:15	
14:30	
14:45	
15:00	DCC and Accreditation
15:15	

Tasks from the 1st international DCC-Conference

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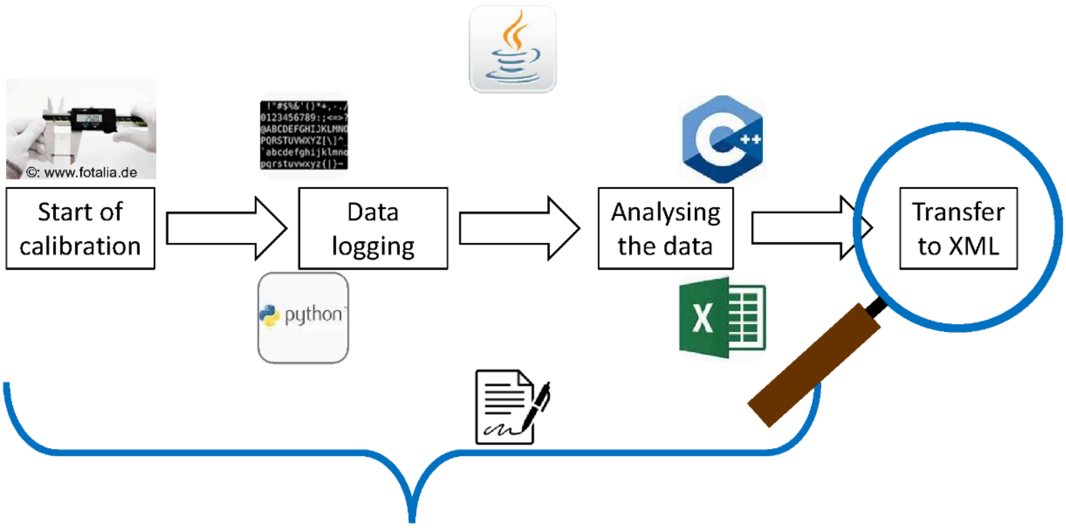
02

Workflow



Proceed as previously done

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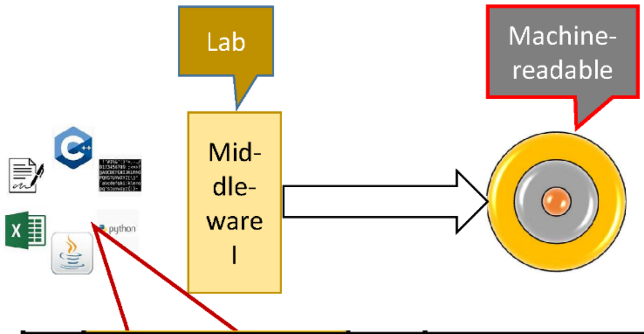
03

Transfer to XML



14:00	Middleware 1	60'	Generation of digital calibration certificates using Python and Excel
14:15			A software solution for the practical creation of DCC files
14:30			From Excel to DCC and human readable calibration certificate – user-friendly middleware and digital signature at work
14:45			A no-code Excel tool for generating DCCs

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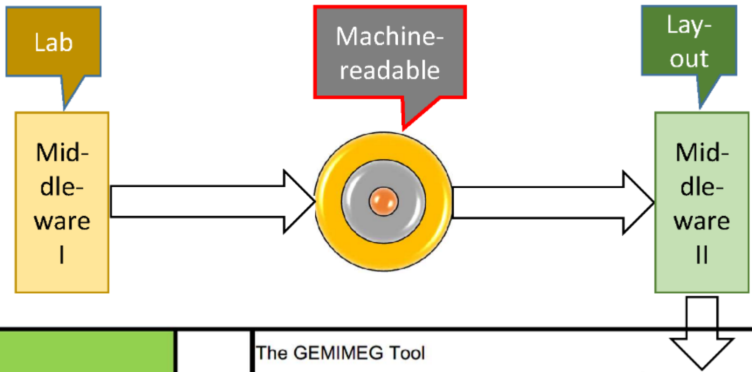
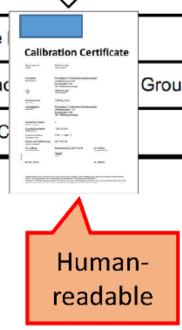
04a

Human Readable



12:00	DCC Applications	60'	The GEMIMEG Tool
12:15			Introducing PyDCC – a Python module for the
12:30			Interconnecting Calibration Services at the Vac … Group of PTB
12:45			Modern data exchange platforms and the DCC



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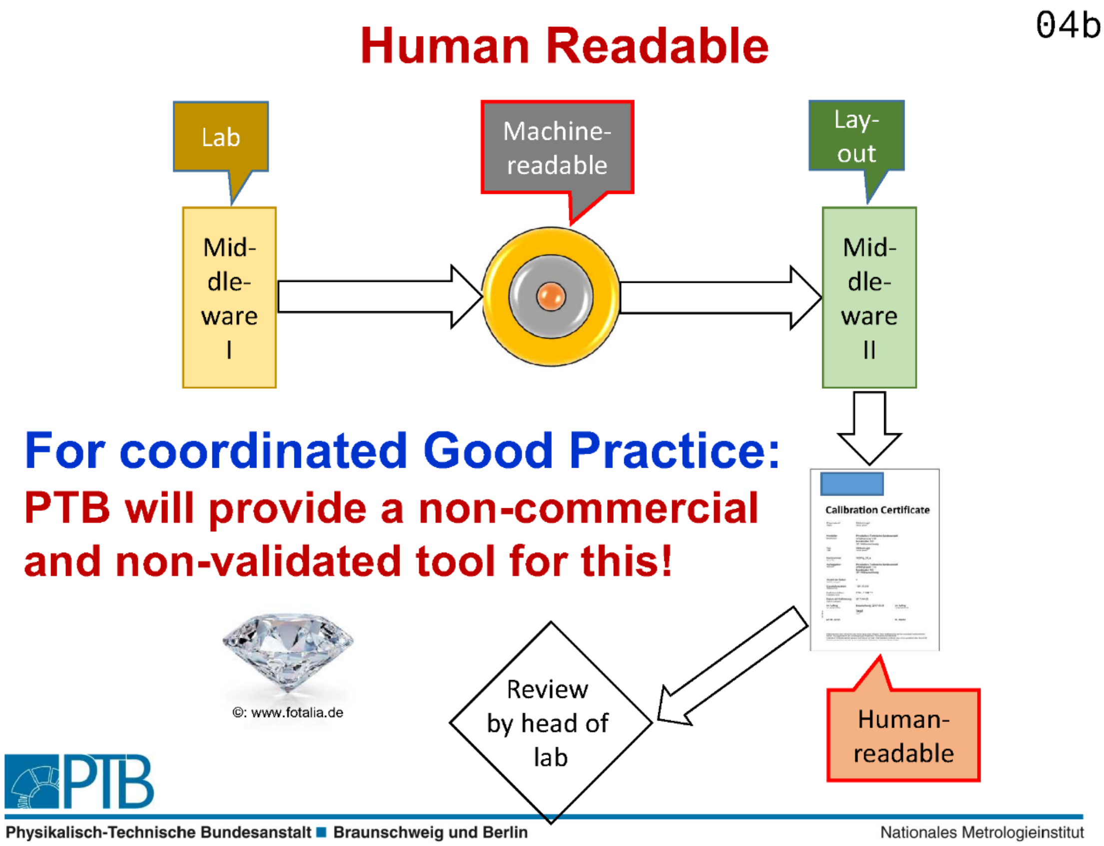
04b
Human Readable
Lab
Machine-readable
Lay-out
Mid-dle-ware I
Mid-dle-ware II
For coordinated Good Practice:
PTB will provide a non-commercial and non-validated tool for this!
Calibration Certificate
©: www.fotalia.de
Review by head of lab
Human-readable
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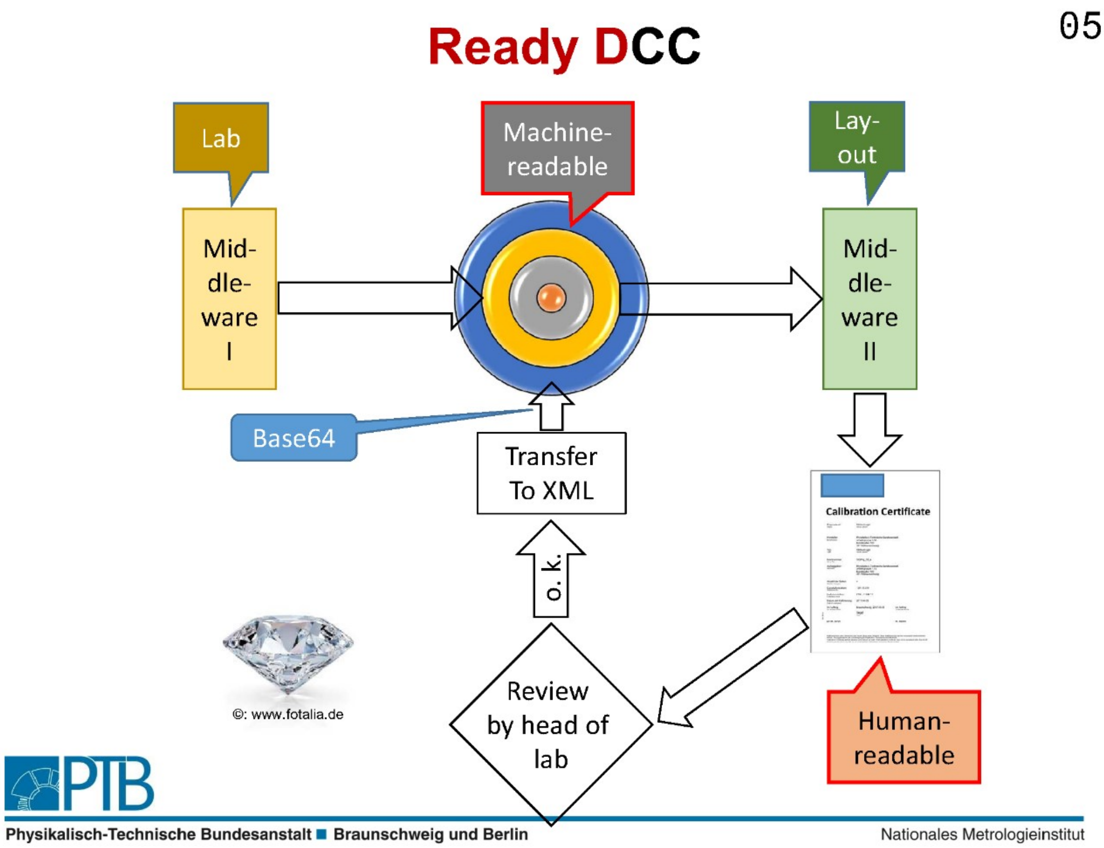
05
Ready DCC
Lab
Machine-readable
Lay-out
Mid-dle-ware I
Mid-dle-ware II
Base64
Transfer To XML
o.k.
Calibration Certificate
©: www.fotalia.de
Review by head of lab
Human-readable
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Nationales Metrologieinstitut

The GEMIMEG tool

Presenting author Jan Loewe, PTB, Germany

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Additional author Frank Härtig, Siegfried Hackel, Benjamin Gloger, Justin Jagieniak, Gamze Söylev-Öktem (all PTB, Germany)

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Abstract

At the last DCC conference, a DCC of a silicon sphere was used to demonstrate how the GEMIMEG tool works.

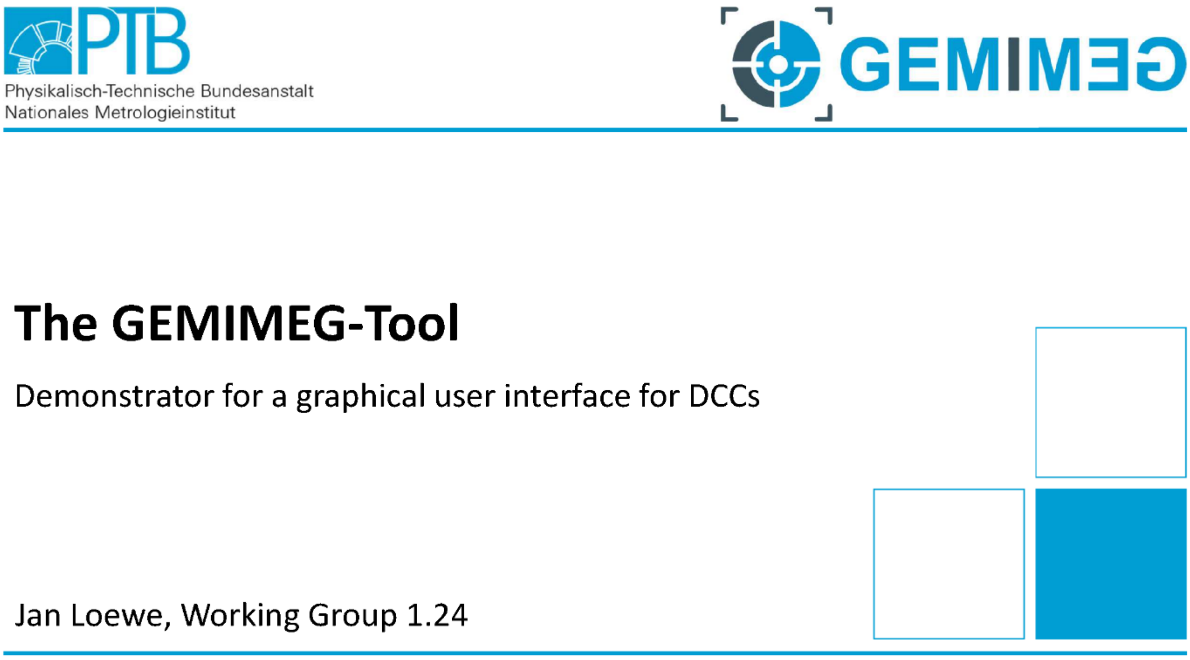
This presentation will show how the GEMIMEG tool works in the field of temperature calibration based on the GP-DCC. Exemplarily, the following steps for creating a DCC with the tool will be demonstrated:

1. Reading in a template,

2. Input of the calibration data via a web GUI as well as

3. the output of a DCC including the human-readable part.

The advantages of outputting in HTML5 format are explained. Furthermore, the generation of a pdf file and the integration into the fourth ring of the DCC is demonstrated.



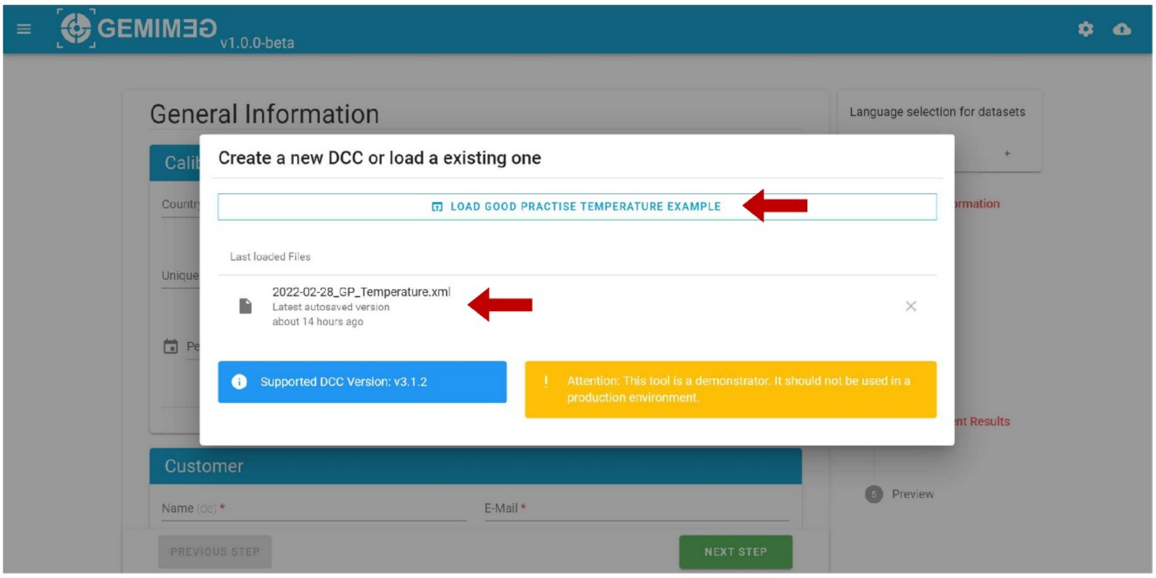
Scope

- Demonstrator for a graphical user interface
- Works with the Good Practice Example for the Temperature
- Support localization of the tool

Features

- Web Application
  - Static HTML, no real backend needed
  - Everything is done on the Client-Side using JavaScript
  - Written in modern JavaScript / TypeScript
  - Vue.js is used as a framework
- Supports latest DCC Schema (v3.1.2)
- Edited DCCs are never sent to a Server (Stored in your Browser)
- Every part of the Temperature Example can be edited
- Generate a preview using XSL

Layout of the Tool



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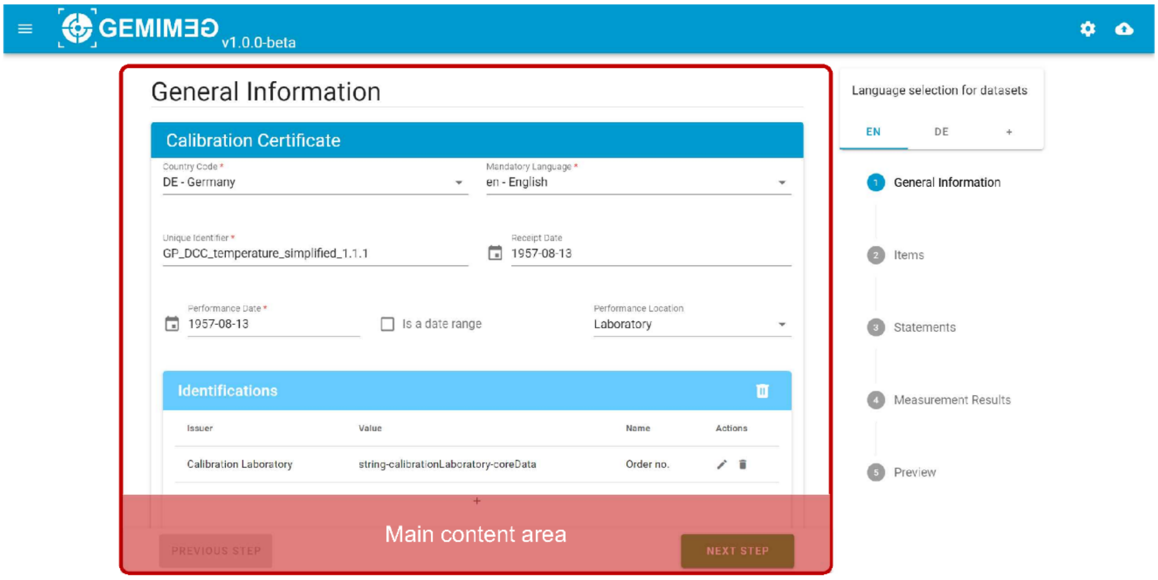
Layout of the Tool



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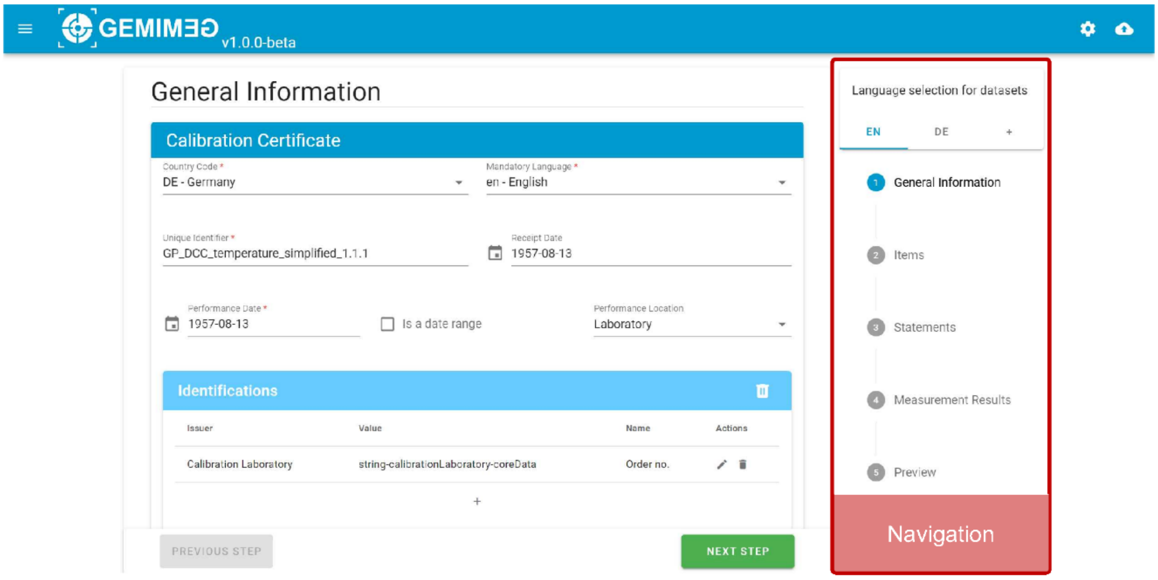
Layout of the Tool



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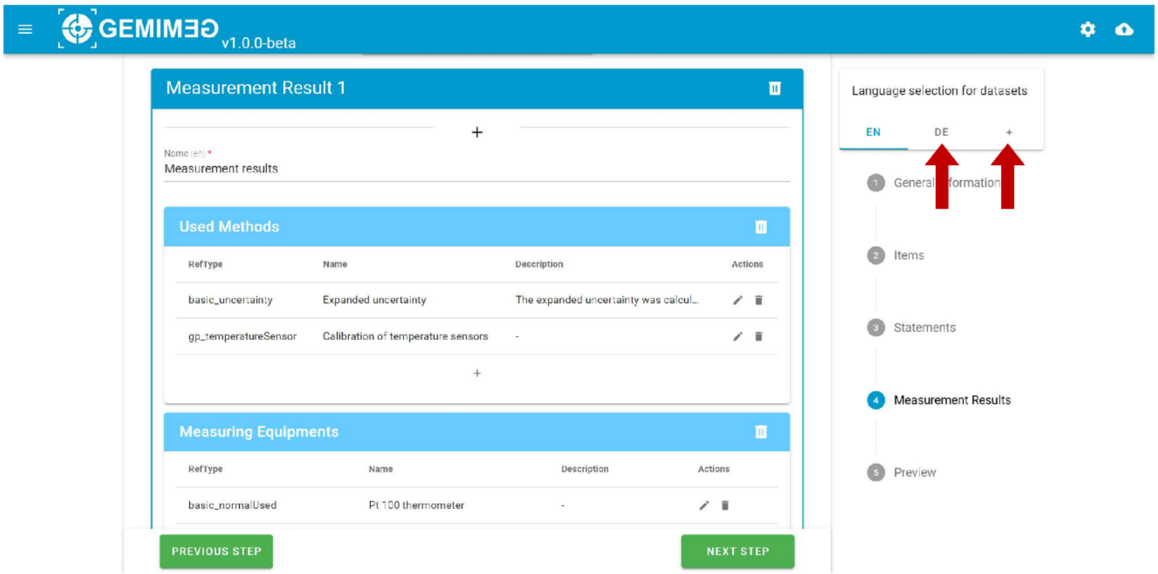
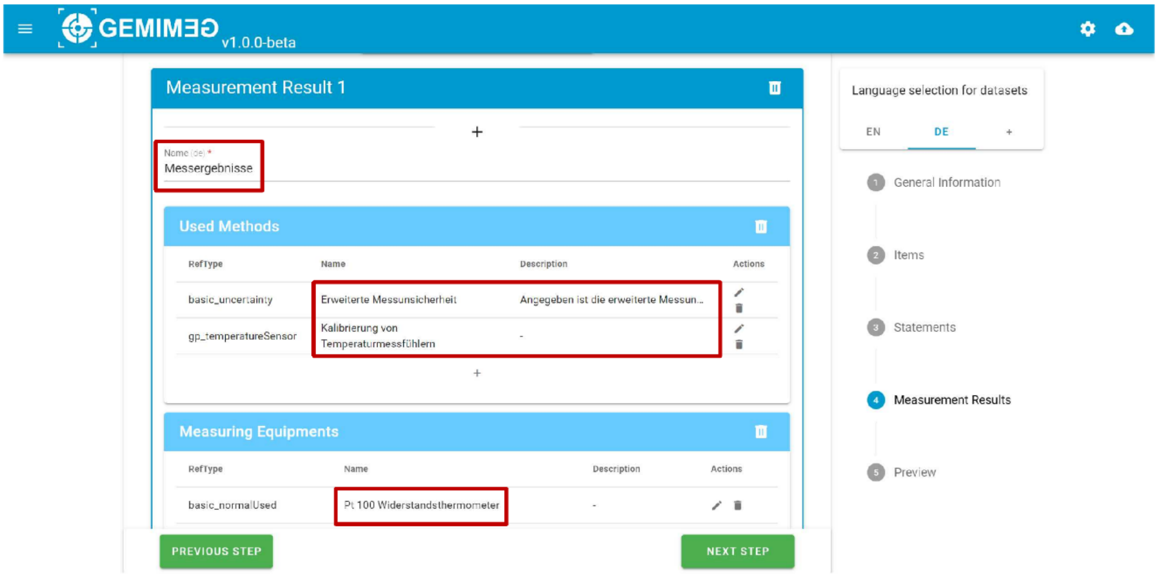
DCCs with multiple languages



2022-04-03 8 Jan Loewe

DCCs with multiple languages



Try it yourself!

Source Code of the Tool:
https://gitlab.com/ptb/dcc/gemimeg-tool

Try it yourself here:
https://ptb.gitlab.io/dcc/gemimeg-tool

Future of the tool

- Flexible and expandable core
  - Loading and storing DCCs using APIs / the filesystem
  - Further validation of DCCs (e. g. using TraCIM)
  - Generate previews using other technologies (e. g. LaTeX)

Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

Thank you for your attention!

Do you have any questions or comments?

Jan Loewe, Working Group 1.24

Introducing PyDCC – a Python module for the DCC

Presenting author Andreas Tobola, Siemens AG, Germany

Abstract

For the programming language Python there are numerous support libraries for almost every data structure and interface. This variety of libraries enables creating new applications rapidly. Why not having a library for the handling DCCs? This is exactly what PyDCC is intended for. Within the project GEMIMEG-II the software component PyDCC has been developed together with the participating project partners. The advantage of the software is an accelerated development of new applications around the DCC. This talk introduces PyDCC and its usage. PyDCC was licensed under the open-source license MIT.

PyDCC

Introducing PyDCC – a Python Module for the DCC

Andreas Tobola

2nd International DCC-Conference

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PyDCC*

Software module for enabling faster handling of Digital Calibration Certificates on Edge and Cloud

*Python Module for Digital Calibration Certificates

Page 2

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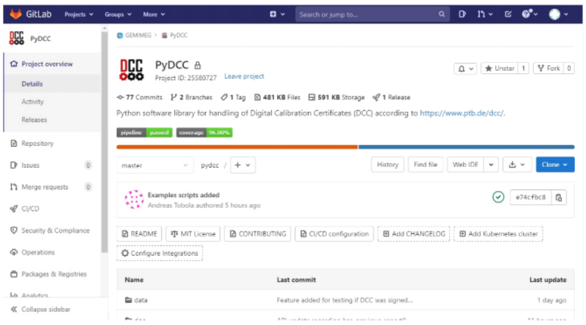
PyDCC
Administrative information

1. Has been developed within the research project GEMIMEG-II
2. Joint development with project members of GEMIMEG-II
3. Software license: MIT
4. Official release planed to the end of GEMIMEG-II



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http://gemimeg.de

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Digital Calibration Certificate (DCC)
Content of the DCC

1) Administrative Data
- DCC ID
- Item ID(s)
- Calibration laboratory
- Calibration date
- Previous documents
- …

2) Results of the Calibration
- Calibration conditions
- Calibration parameters
- Adjustment parameters
- Uncertainty

DCC

3) Comments

Non formal section containing user data

4) Document
- Human readable document
- Printout conform with DIN 17025

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https://www.ptb.de/dcc

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PyDCC
The Motivation for this Software Module

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

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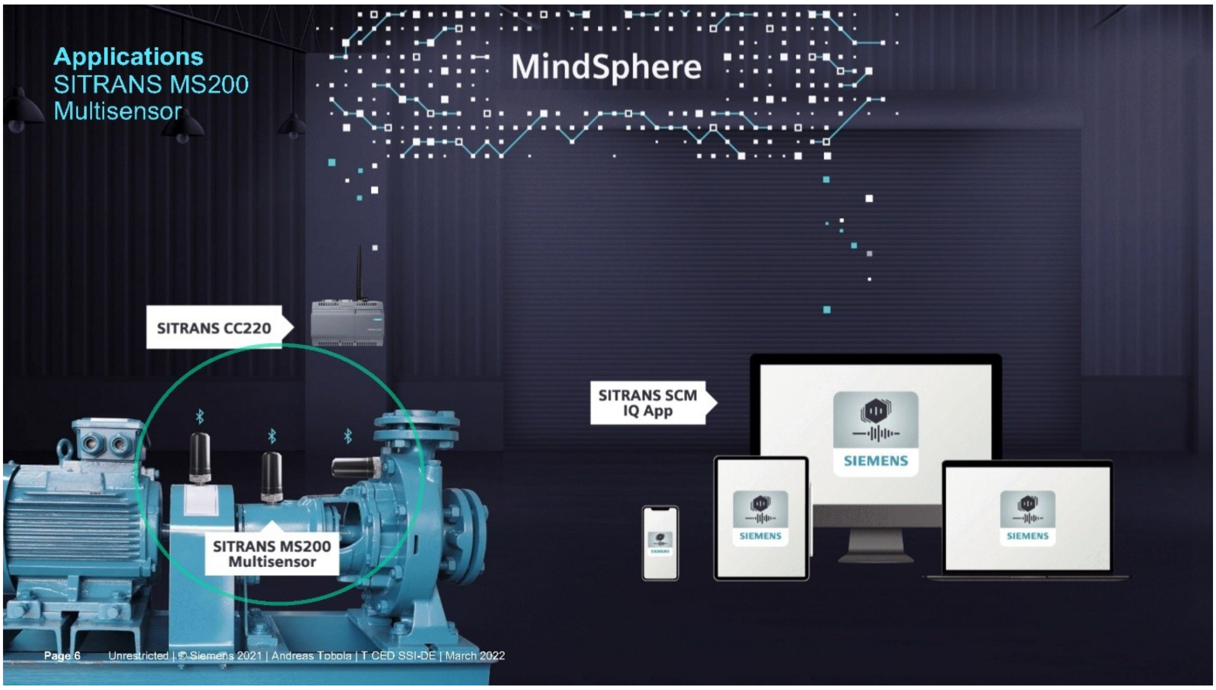

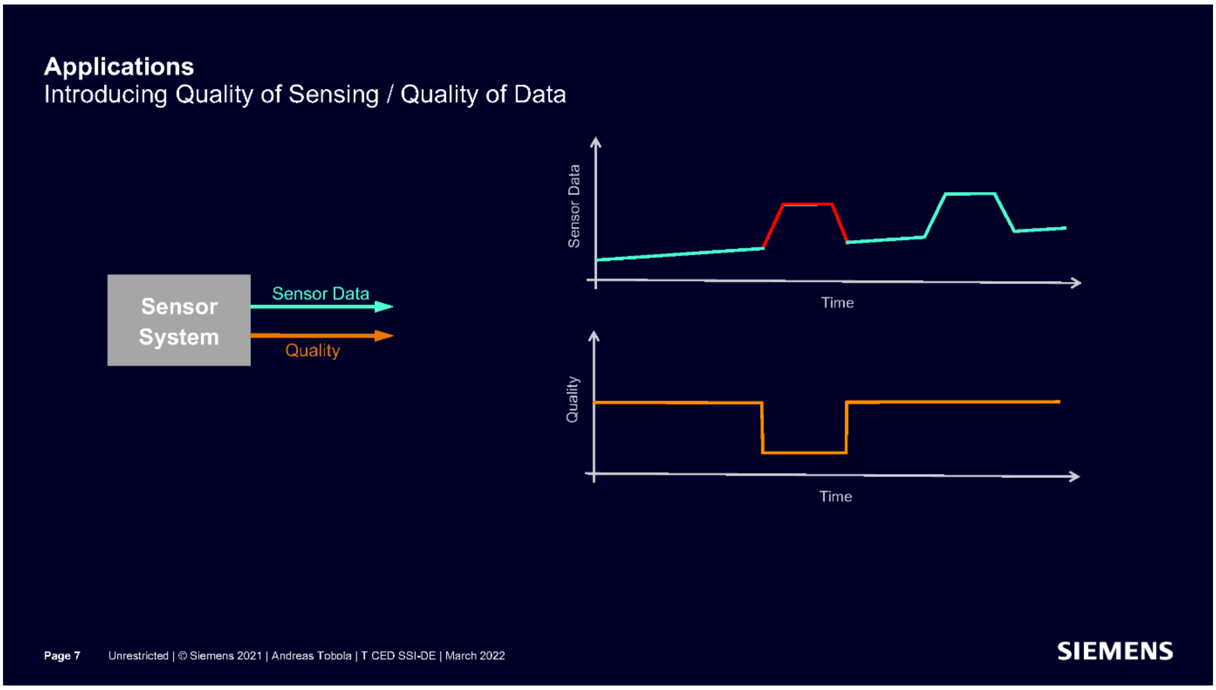

Applications
Calibration Example

Generate a
Digital Calibration Certificate
with signature
and sensor UID

Upload to DCC repository

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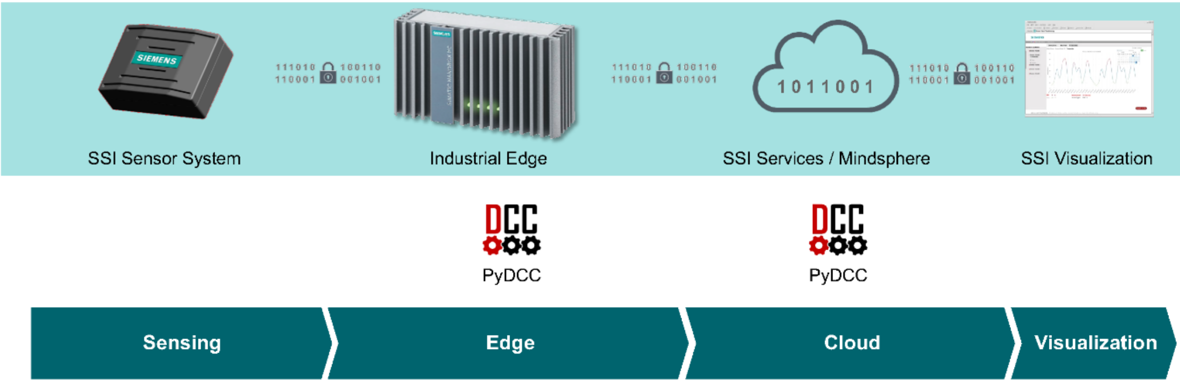
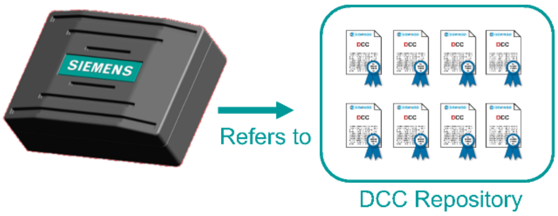
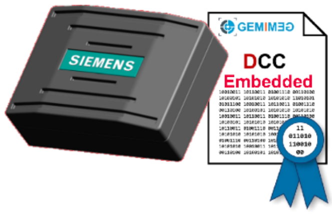
Application Example
Usage of PyDCC



DCC Use Cases
DCC Repository and Embedded DCC

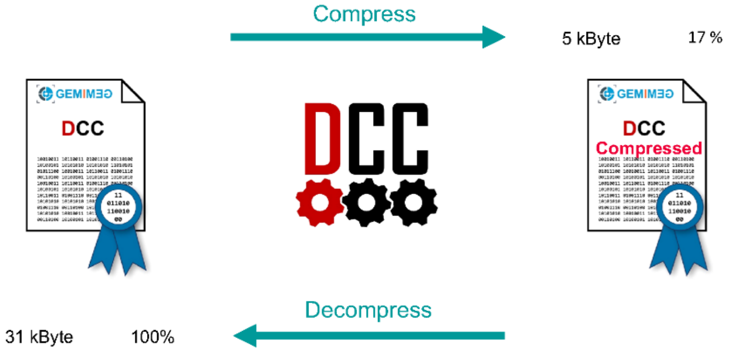




Variant 1: Calibrated Sensor System with a Link to a DCC Repository

Variant 2: Calibrated Sensor System with an Embedded DCC

DCC Use Cases
Compressed DCC



PyDCC
Software Management

Feature Implementation

Implemented

- Read DCC from file
- DCC version
- Get DCC from Repository
- Read DCC from stream
- Calibration date
- Get Previous DCC
- Read DCC compressed
- Days since last calibration
- Calibration Lab
- Compress DCC
- Read basic uncertainty list

Ongoing

- Verify DCC schema
- Read variants of measurement results
- Verify signature
- Item IDs

Housekeeping

- Unit tests
- 3rd Party Lic. Clearing
- Continuous Test
- Developer Team Building
- Open Source License
- Contributing Guide
- Test Coverage Measurement
- External Repository
- Py Module Packaging
- API Documented

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

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Interconnecting Calibration Services at the Vacuum Metrology Group of PTB

Presenting author Matthias Bernien, PTB, Germany

matthias.bernien@ptb.de

Additional authors Thomas Bock, Rolf Niepraschk, Karl Jousten (all PTB, Germany)

Abstract

In the Vacuum Metrology Group, about 170 customer calibrations are performed annually. Most of the calibration processes are automated. This includes the generation of digital calibration certificates (DCCs) using the Python library Jinja as a template system for XML as well as the preparation of customer correspondence and calibration certificates based on LaTeX. By now, 155 DCCs have been issued and provided to our customers for testing purposes in addition to the official printed calibration certificates. Two DCCs have been received from another laboratory and have been used for the correction of measurement values.

The cornerstone of the calibration workflow is the NoSQL-database CouchDB. It is used to make data available on every computer in the lab. Furthermore, it provides redundancy and backup. The schema free structure of the data sets can be adapted without migrating the database facilitating continuous development. Communication with the database is carried out via the HTTP protocol. Where possible, functionality is implemented as web services that can be accessed via RESTful interfaces using the HTTP protocol. In this way a loose coupling is realized such that individual services can be modified without the need to amend the other functions. User interfaces are implemented using HTML and JavaScript running on every browser.

To foster the benefits of a digital calibration workflow, interconnection with external services is desirable. We implemented a RESTful application interface in cooperation with the “Embedded Systems” working group at PTB, that loosely couples our calibration workflow with their metrological service platform (AnGeWaNt) [1], which will provide a user portal for calibrations among many other services.

[1] A. Oppermann et al.: “Digital Transformation in Metrology: Building a Metrological Service Ecosystem”, International Conference on Industry 4.0 and Smart Manufacturing (ISM), 2021, accepted for publication

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7.54

Interconnecting Calibration Services at the Vacuum Metrology Group of PTB

2nd International DCC-Conference

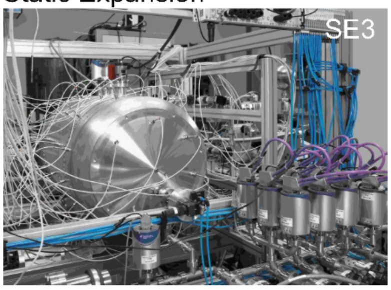
Matthias Bernien, Thomas Bock, Rolf Niepraschk, Karl Jousten

2. March 2022

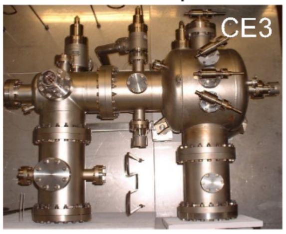
Calibration Services

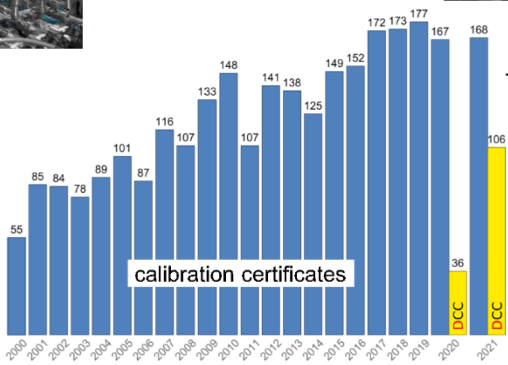
Pressures below 10^5 Pa: calibration of membrane, spinning rotor and ionization vacuum gauges

Static Expansion



Continuous Expansion

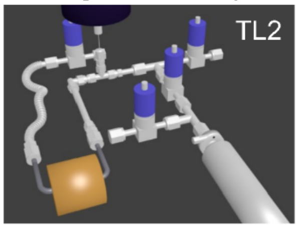




Gas flows below 10^{-5} Pa m^3/s: calibration of reference leaks

Test leak against vacuum

Test leak against atmosphere



IT Infrastructure

CouchDB relax

- Schema-free (NoSQL), JSON
  - document based: self-contained data sets

python Jinja

- Template system for creating LaTeX, XML, HTML: text file is generated from text blocks with placeholders for the variables
- User interfaces based on HTML and JavaScript

python Flask

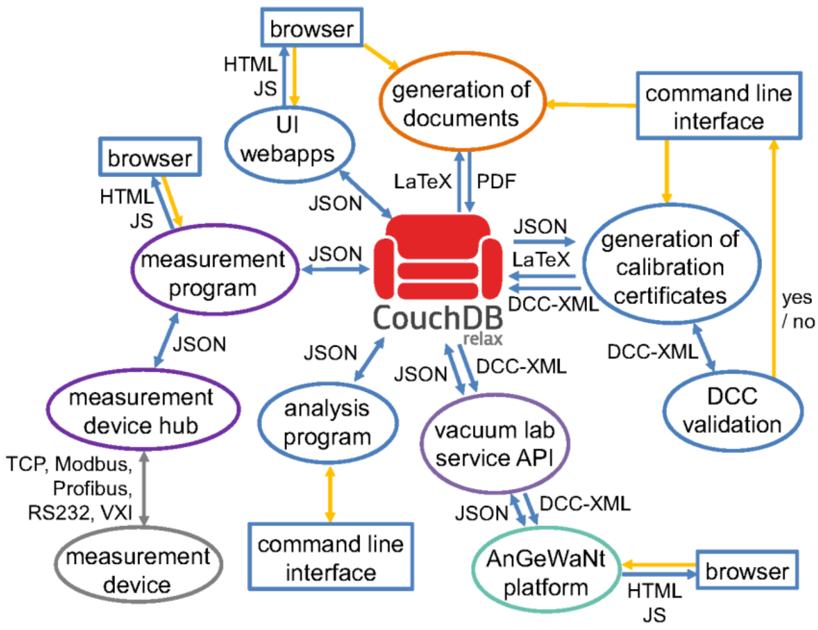
- Webservices via HTTP protocol
  - Statelessness (RESTful API)
- Communication with measuring devices via Clojure server
- Generation of documents via Node.js server

Server-Client Interaction

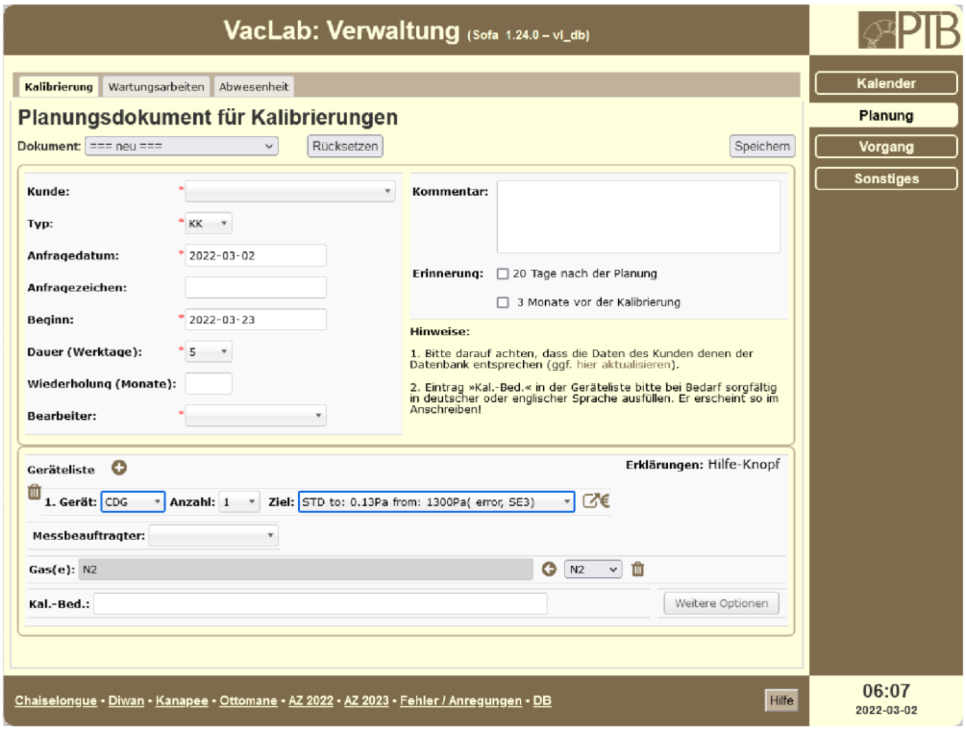
HTTP, RESTful API
user event / input
client

Webservices based on
Python / Flask
Clojure
Node.js
Java / Spring / Jetty

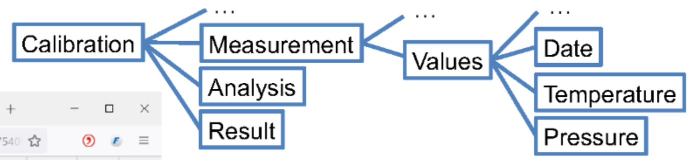
RESTful API
- Loose coupling
- Webservices can be developed independent of each other
- Beneficial when interacting with external services

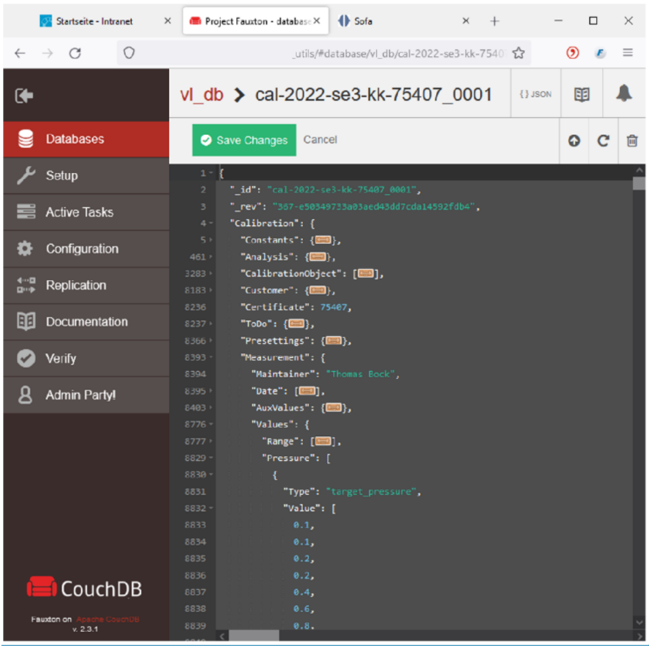


User Interface



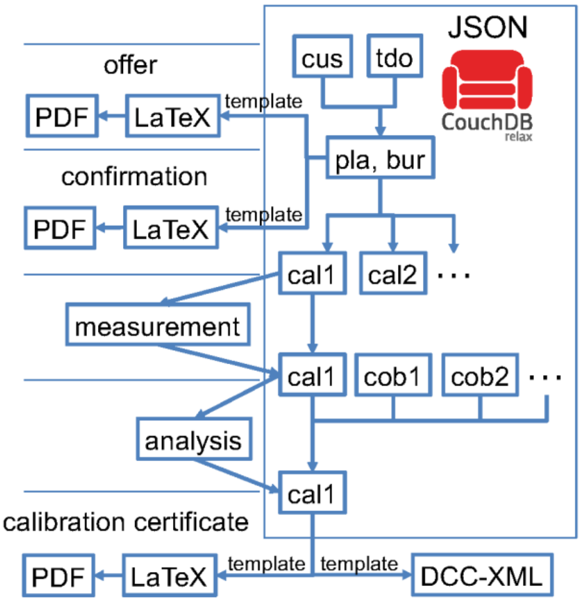
JavaScript Object Notation (JSON)





- Hierarchical key-value data structure
- Easy to extend
- Directly interpretable as JavaScript
- Easy to use in many programming languages
- Human readable (pure text format)
- CouchDB documents are JSON documents

Workflow



cus: customer
- list of customers: address, …

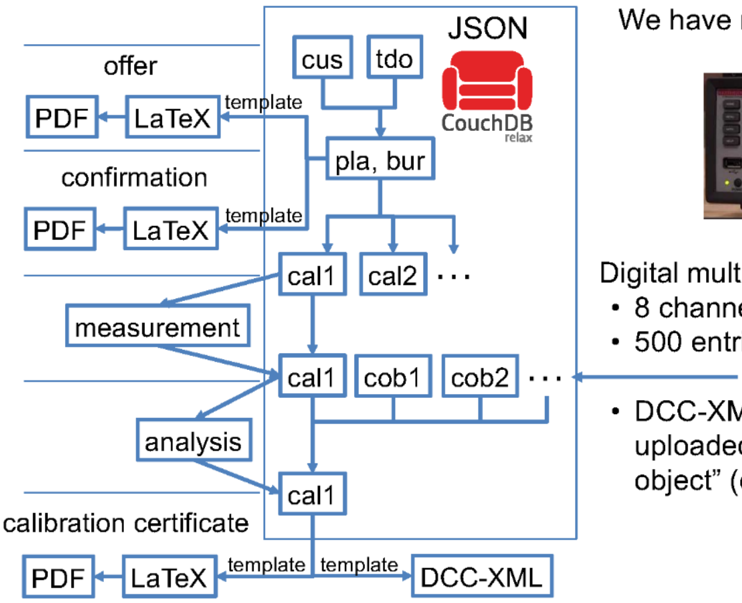
tdo: to do
- list of calibration targets: pressures, gas type, ...

pla: planning, bur: bureaucracy
- date, customer data, calibration target

cal: calibration
- calibration document: customer data, measurement data, result of the analysis, calibration data of measuring devices

cob: calibration object
- calibration data of measuring devices and constants: voltmeters, temperature sensors, earth acceleration, pressure gauges, …

Workflow

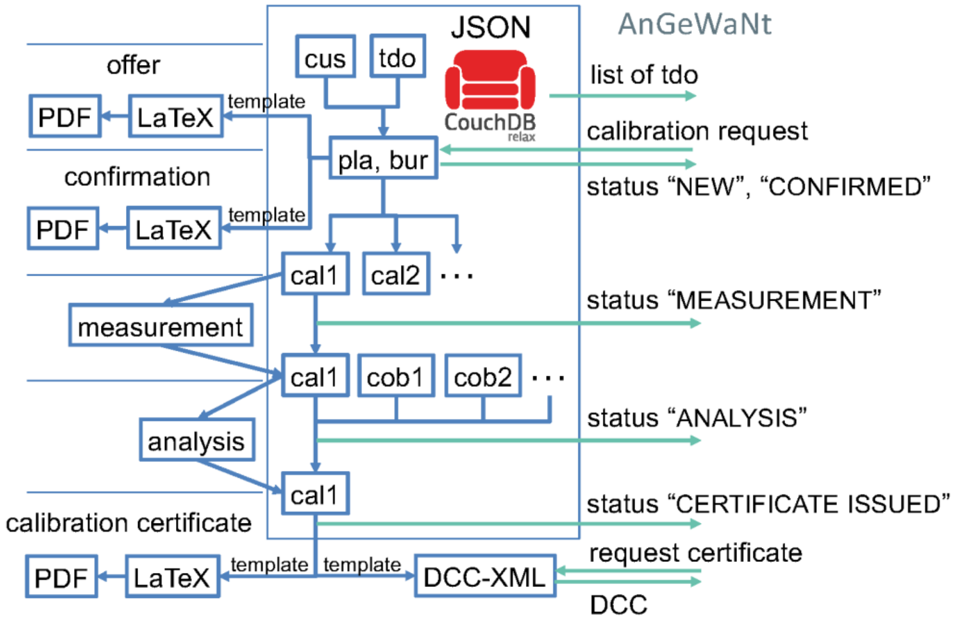


We have received 2 DCCs up to now.

Digital multimeter calibrated at CleverLab:
- 8 channels, -10 V to 10 V
- 500 entries in result table

- DCC-XML converted into JSON and uploaded to CouchDB as “calibration object” (cob) document

Vacuum Lab Service API



A. Oppermann *et al*.: "Digital Transformation in Metrology: Building a Metrological Service Ecosystem", International Conference on Industry 4.0 and Smart Manufacturing (ISM), 2021, accepted for publication

Modern data exchange platforms and the DCC

Presenting author Antonio Matamala, BEAMEX, Germany

Antonio.Matamala@beamex.com

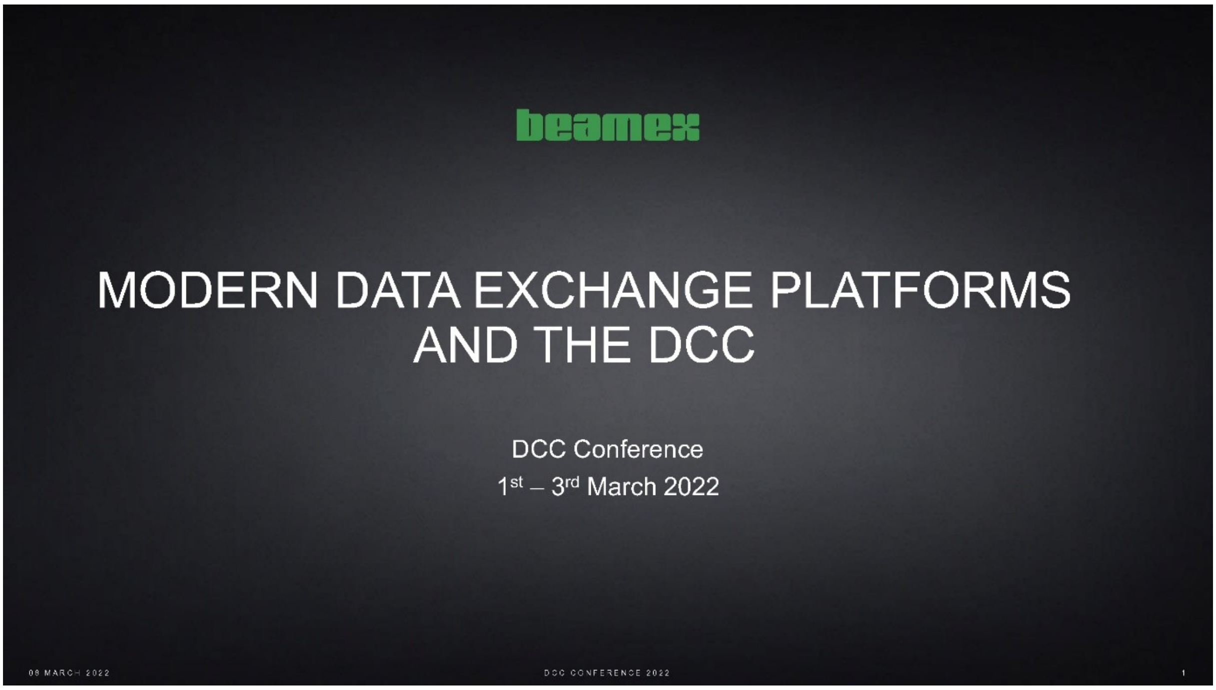
Additional author Juho Nummiluikki, BEAMEX, Finland

Abstract

The presentation summarizes the connection between DCC and digital megatrends and presents a vision for the integration of DCC as part of the future industrial system architecture. In addition, the presentation includes a demonstration of a proof-of-concept with automatic DCC creation, transfer of the DCC to another system, with data extraction and human-readable output.

Modern technologies for data exchange show how to significantly reduce or eliminate the traditional barriers that have made data exchange almost impossible for many organizations. The proposed Data Exchange Platform approach enables an automated and scalable transfer method for the DCCs. An example of a business case for the Data Exchange Platform is the exchange of calibration data between an industrial company and many external calibration service providers at the same time.

The presentation includes a demonstration that illustrates the use of DCC as an exchange medium in an industrial system environment. In the demonstration, a calibration is first assigned and performed in a calibration management system. After receiving the calibration results from the calibrator, a DCC is created in the calibration management system. The DCC is transferred and imported into another, separate calibration management system, where the data is stored and used to calculate the measurement uncertainty and produce a human-readable output.




beamex
THE VOICE OF THE INDUSTRY
Beamex is the industry's preferred calibration technology partner and is committed to finding better ways to calibrate.
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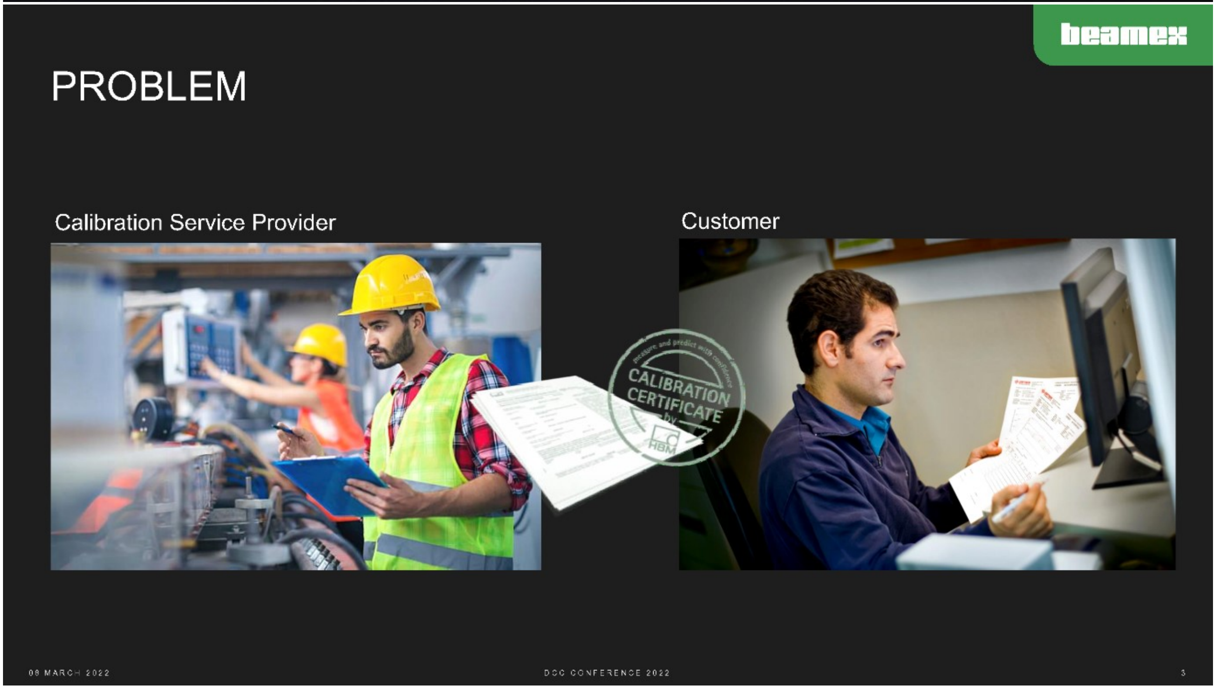
beamex
PROBLEM
Calibration Service Provider
Customer
CALIBRATION CERTIFICATE
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3


beamex
BIGGER PROBLEM
Calibration Service Providers
100-200 thousand per year
CALIBRATION CERTIFICATE
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THE TRAVELLERS PROBLEM
Problem
Solution ??
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5

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DEMONSTRATION

Roles

- Service Provider
  - Executes a calibration with equipment
  - Generates DCC with their software
  - Sends DCC to customer
  - Uses LOGiCAL (SaaS)

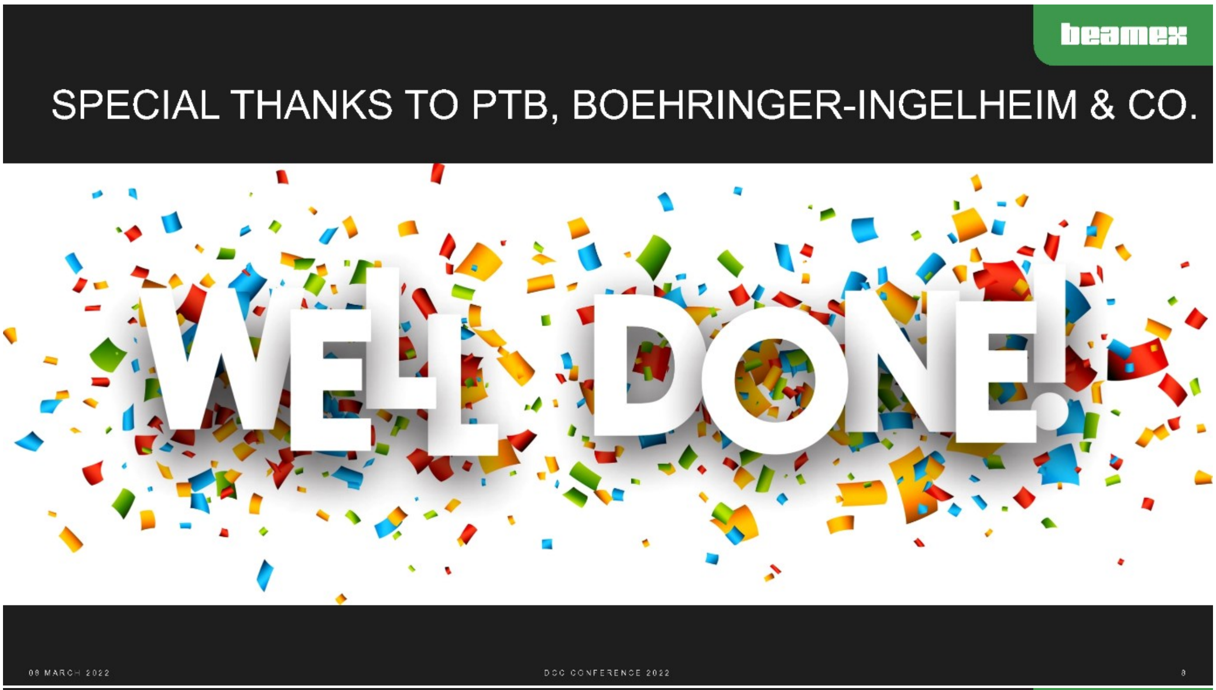
- Customer
  - Receives a DCC
  - Imports DCC into their own Calibration Management Software
  - Views / analyses data
  - Uses CMX (on promise desktop software)

Note: for demo purposes this demo has been done with Beamex technology, however, interoperability should be technology / vendor agnostic.

beamex

Video link to the DCC demo:
https://www.youtube.com/watch?v=R4Ch_Z4flzg

or ask the DCC team at Beamex if the above link does not work.


beamex
SPECIAL THANKS TO PTB, BOEHRINGER-INGELHEIM & CO.
WELL DONE!
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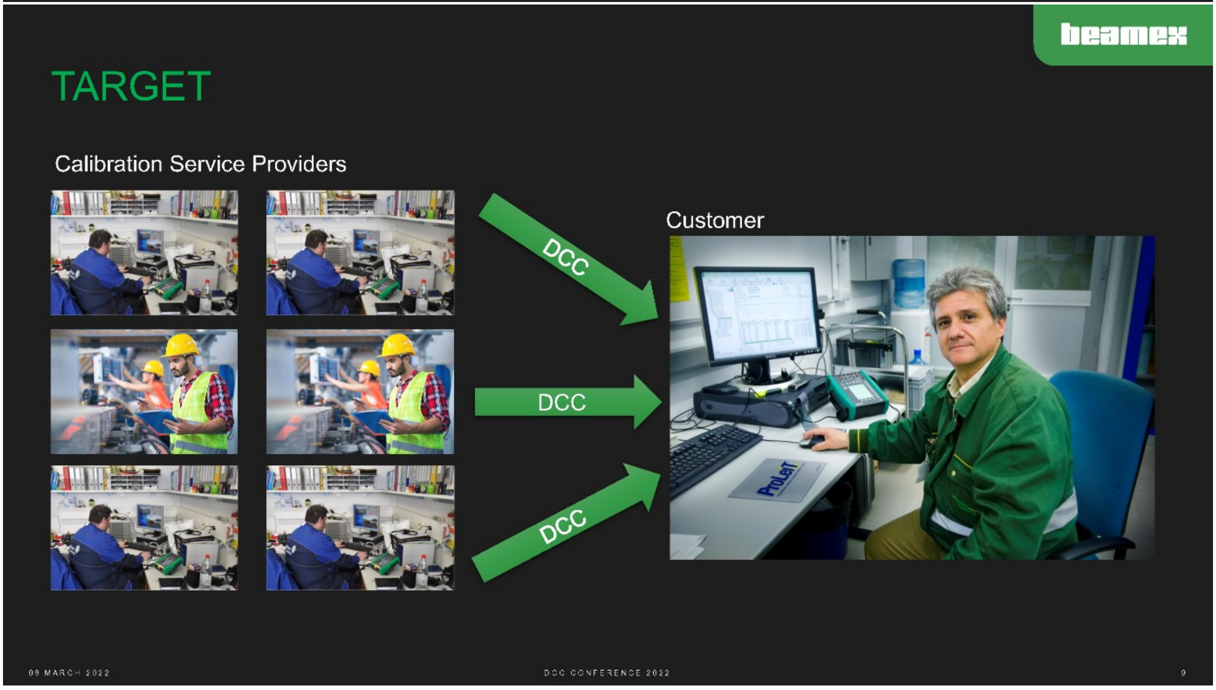
beamex
TARGET
Calibration Service Providers
Customer
DCC
DCC
DCC
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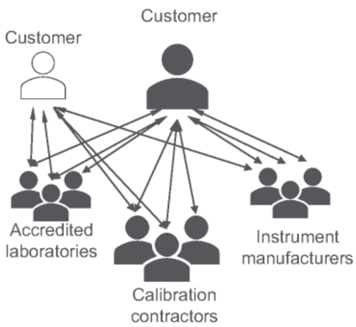
9

INFORMATION FLOW IN CALIBRATION INDUSTRY

1-ON-1 RELATIONSHIPS ARE DIFFICULT TO DIGITALISE EFFICIENTLY

- Calibration industry is based on bilateral relationships where calibration data is shared
- Each organisation sends and receives calibration certificates from several partners
- Digitalisation only possible as point-to-point integrations with each partner



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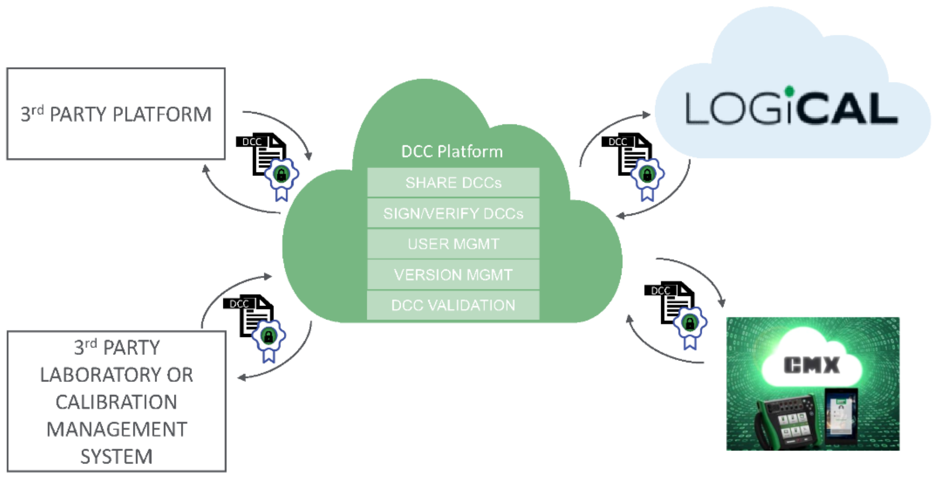
DCC DATA EXCHANGE PLATFORM



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Q&A

QUESTIONS AND ANSWERS

Curious or interested?

For additional information and discussions after the conference please contact Antonio Matamala

antonio.matamala@beamex.com

Session "DCC and Sensors"

Digital calibration system – Revolutionary sensor with digital calibrator mode

Presenting author Pavel Proskurin, CBO ASPECT Company, USA

info@digitalmetrolog.ru

Abstract

The presentation shows new digital technologies for industrial sensors revolution that enable digital automatic calibration of instrument channels (IC) and issuance of the digital calibration certificate (DCC).

Developed digital technologies realize new innovative digital calibrator mode for industrial sensors. This mode provides the IC digital calibration with automatic calculation of measurement errors. After calibration the industrial hardware and software complex forms the DCC with calculation results of measurement errors.

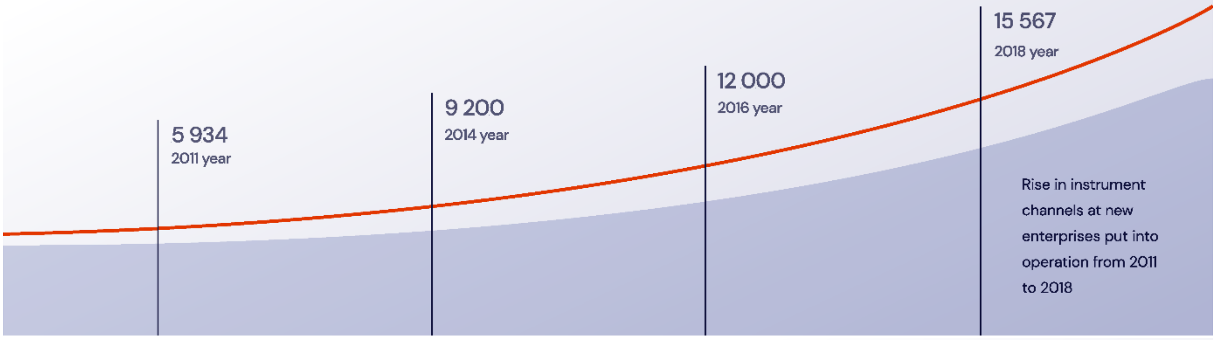
This automatically generated DCC is called «instrument channel DCC» (IC DCC).

The presentation includes technical concept of IC DCC forming and shows the realization results of digital calibrator mode in pressure sensors. This mode is realized at first time in sensor's technologies (patent № 2749304, international patent № WO2021246916). The presentation shows the arrived technical advantages and possibilities of IC DCC.

01 EXISTING PROBLEM OF MEASURING CHANNELS digitalmetrolog.com

2,5 ▲ There is a rapid increase in the number of instrument channels (IC) caused by automation and digitalization of any industry. The number of ICs has increased by more than 2.5 times since 1990s and has reached over 15,000 units in enterprises of strategic industries.

However, industrial calibration procedures are still based on methods relevant to the level of 1990s.



02 FEATURES OF INSTRUMENT CHANNELS CALIBRATION WITH ELECTRIC SIGNAL CALIBRATORS digitalmetrolog.com

1. Increased risks of false auto-protection triggering in case of use errors:

1.1) errors of cable switching in hardware and software complex

1.2) false calibration signal flow to the input of the instrument channel under operation.

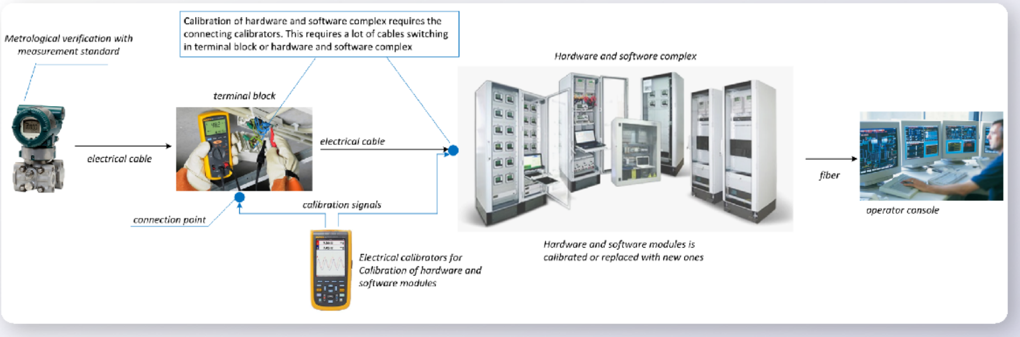
1. Multiple switching of cable lines increasing equipment amortisation,

2. Prolonged shutdown of processes for scheduled IC maintenance,

3. Big non-automated efforts and high labor costs for calibrating of software-hardware systems and ICs using electric signal calibrators:

4.1) Disconnection of many cable lines,

4.2) After that, calibrators are connected instead of each input hardware-software and instrument channel:



In the 1990s, these calibration methods were justified due to the relatively small number of instrument channels. According to various estimates, currently, it takes from 42,000 to 50,000 man-hours to perform just a single complete calibration of sensors and software-hardware systems of 15,000 measuring channels. Since calibration is regular in nature, the problem of reducing the shutdown maintenance duration is the challenge of the modern period in industry development.

$$\underbrace{15000}_{\text{measuring channels}} \times \underbrace{3}_{\text{hour average needed for calibration}} / (\underbrace{10}_{\text{people}} \times \underbrace{8}_{\text{hour per day}}) = \underbrace{562}_{\text{work days}}$$

AUTOMATION AND OPTIMISATION OF INSTRUMENT CHANNELS CALIBRATION IS CRUTIAL, it is a radically new approach in development of measuring technologies

Aspect is a team of young scientists involved in research activities in the field of digital measuring systems and metrology for various industries in following areas:

- creation of intelligent measuring instruments with metrologic self-control (SMART technologies);
- development of digital technologies for the development of HART communicators;
- creation of innovative technologies for automation and digitalisation of metrologic services.

Many years of experience and knowledge of our specialists are secured by numerous invention patents.
Our team is constantly working with leading specialists from Tomsk universities, collaborating in experimental and dissertational research.

2019-2022 Development of advanced technologies for digital calibration of industrial instrument channels. First-ever in instrumentation, the digital calibrator mode as a new operating mode of sensors has been developed and implemented (patent № 2749304, international patent PCT № WO2021246916)

2018-2020 Development of the digital model for correction of readings of measurements flow performed using differential pressure sensors. Approbation at the research reactor facility allowed to decrease the reduced measurement errors from 5.3% to 0.9%.

2016-2021 Development of intelligent multi-parameter liquid sensors with metrological self-check function.

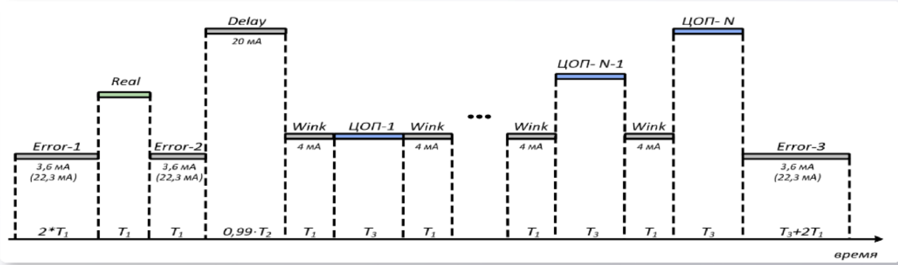
2013-2015 Development and implementation of the digital model for correction of readings of industrial hydrostatic level meters. Industrial implementation of the digital model reduced dynamic errors from 20% to 3%. The results are presented in the "Handbook for setting up industrial hydrostatic level meters" for ECI engineers.

2011-2020 Analysis of commissioning and operation of energetical and petrochemical industry facilities, statistics gathering and deep investigation of defects in instrument channels

Introducing a new patented way of working

Features of the new method:
An innovative digital calibrator mode is implemented within the sensor in addition to the measurement mode.
The following conditions are provided:
1) Wide range of digital calibration settings,
2) Starting the digital calibrator mode,
3) Digital calibration of the instrument channel:
    3.1) generation of calibration and warning signals from the sensor
    3.2) automatic calculation of errors in software-hardware complex and in entire instrument channel as a whole.
Detailed description is in patents № 2749304,international patent № WO2021246916

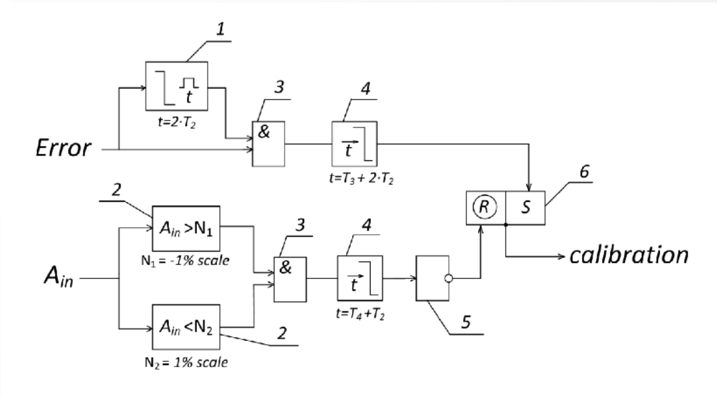
07 SENSOR OPERATION IN DIGITAL CALIBRATOR MODE digitalmetrolog.com



Warning and calibration signals generated in accordance with the digital calibrated value configured within the sensor

Detailed description is in patents № 2749304, international patent № WO2021246916.

08 SIGNALS DECODING IN HARDWARE-SOFTWARE COMPLEX digitalmetrolog.com

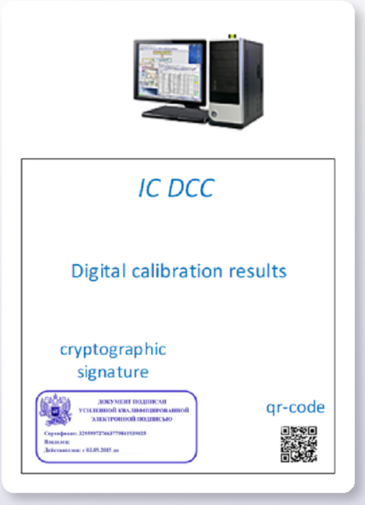


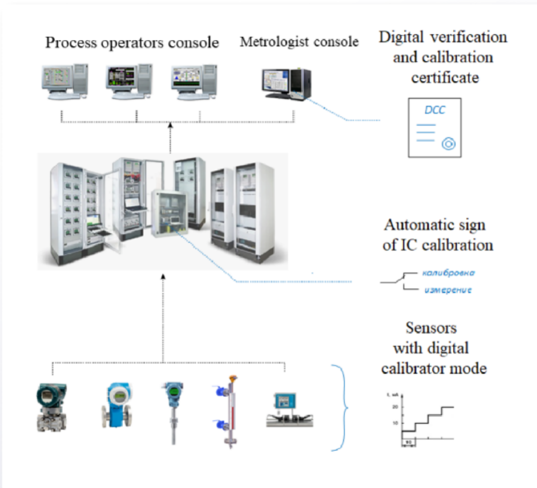
1% of measurement scale

Based on digital calibration results, the following is shown in the metrologist console:

1) Automatic calculation of errors in hardware-software complex
2) Automatic calculation of errors in entire measurment channel
3) Correction of readings in measurment channel when required
4) Issuance of the digital calibration certificate

Digital calibration certificate of an instrument channel (IC DCC)
Requirements of design and content for an IC DCC are in clarification





Increasing industrial safety by eliminating the risks of false alarms in automatic protection during instrument channel calibration

Ability to digitally calibrate the IC and its components at the same time, which greatly reduces labor costs

An instrument channel digital calibration certificate (IC DCC) is generated

IC DCC requirements are in clarification

Automation and optimization of metrological service

11 MAJOR INDICATORS digitalmetrolog.com

FEATURES OF IC CALIBRATION PROCEDURE	IC CALIBRATION WITH ELECTRICAL SIGNAL CALIBRATORS	DIGITAL IC CALIBRATION
Reduction of scheduled IC maintenance duration	NO	YES
Exclusion of metrological verification of sensors	NO	NO
No cables disconnection required	NO	YES
Protection against automation errors during calibration	NO	YES
Automatic errors calculation	NO	YES
Automatic readings correction	NO	YES
Automatic IC DCC generation	NO	YES

12 CONCLUSION digitalmetrolog.com

1. improving safety operation of facilities by reducing the risks of automatic protection false triggering, blocking and signaling accordingly to the modern level of instrumentation development,
2. verification and calibration of measuring instruments and systems without dismantling of equipment in fully automatic or pre-automated mode in real operating conditions,
3. ensuring the possibility of verifying IC and its components at any time in continuous technological processes,
4. avoiding errors in verification results and increasing accuracy of IC components verification due to DSV application and eliminating the need for numerous connections of verification equipment (voltmeters, ammeters, calibrators, simulators and other working standards of electrical signals), which is not part of IC,
5. providing the possibility of correcting total errors in IC or its components, which are determined in real operating conditions. In particular, the possibility of error correcting, individual calibration and adjustment of the DAC and ADC of sensors, hardware-software complex and measuring instruments is provided,
6. providing the possibility of remote automatic verification of measuring instruments and systems,
7. increasing the efficiency and simplification of metrological maintenance of IC measuring systems with hard-to-reach measuring components,
8. reducing the influence of harmful production factors over operating personnel during periodic metrological maintenance,
9. reducing operational labor costs for periodic metrological maintenance

13 CONCLUSION digitalmetrolog.com

10. ensuring possibility of verifying the IC and it's measuring components simultaneously by combining and using main advantages of component specific and complete IC verification at the same time:

– replacing the measuring component in the IC with a pre-verified component of the same type does not require an additional verification of the entire IC during operation (the advantage of component specific verification methods),

– verification and calibration of the entire IC measuring system does not require dismantling and/or disconnection of measuring components (advantage of complete verification methods),

– in fact, a practical method of estimating errors in the IC is implemented without using theoretical assumptions and known faulty calculation methods for estimating errors in entire IC for its individual components (the advantage of complete verification methods),

- implementing the metrological characteristics of the IC in real operating conditions (the advantage of complete verification methods),

11. achieving performance gains of enterprises via technical development and optimisation of metrological services, in particular, automatic digital verification:

– contribute to an increase of overhaul intervals in enterprises via possibility of verification in a continuous technological process,

– reduce the duration of scheduled maintenance of automated process control systems (APCS) by optimising metrological maintenance procedures.

14 BENEFITS OF NEW METHOD digitalmetrolog.com

- Remote verification
- Wide range of correction possibilities (error compensation)
- Simplification of metrological service for hard-to-reach control and measurement instruments
- Reduced labor costs for metrological services
- Minimising the impact of harmful factors over personnel
- Increasing service life of measuring instruments and channels for entire measuring system

Ready for cooperation

Pavel Proskurin
email: info@digitalmetrolog.ru

GEMIMEG-II – Status and progress report

Presenting author Thomas Engel, Coordinator GEMIMEG-II Project, Germany

engelthomas@siemens.com

Abstract

To ensure that the high-quality level "Made in Germany" also applies in a digitalised world, the Physikalisch-Technische Bundesanstalt (PTB), together with other research partners and companies, has launched the GEMIMEG-II project, which is funded by the Federal Ministry for Economic Affairs and Energy (BMWi) with 12 million euros. Under the title "Safe and robust calibrated measurement systems for the digital transformation", the 13 partners involved want to develop reliable standards to ensure reliable communication of digital data, information, and certificates in the processes of the quality infrastructure. The project will run for three years. The overarching goal is to advance the digital transformation and strengthen Germany as a business location.

GEMIMEG-II

A lighthouse project of the German Ministery of economic affairs and climate action

GEMIMEG-II – Status and Progress Report

Dr. Thomas Engel, Siemens AG, project coordinator

2nd international DCC Conference, March 2nd, 2022

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

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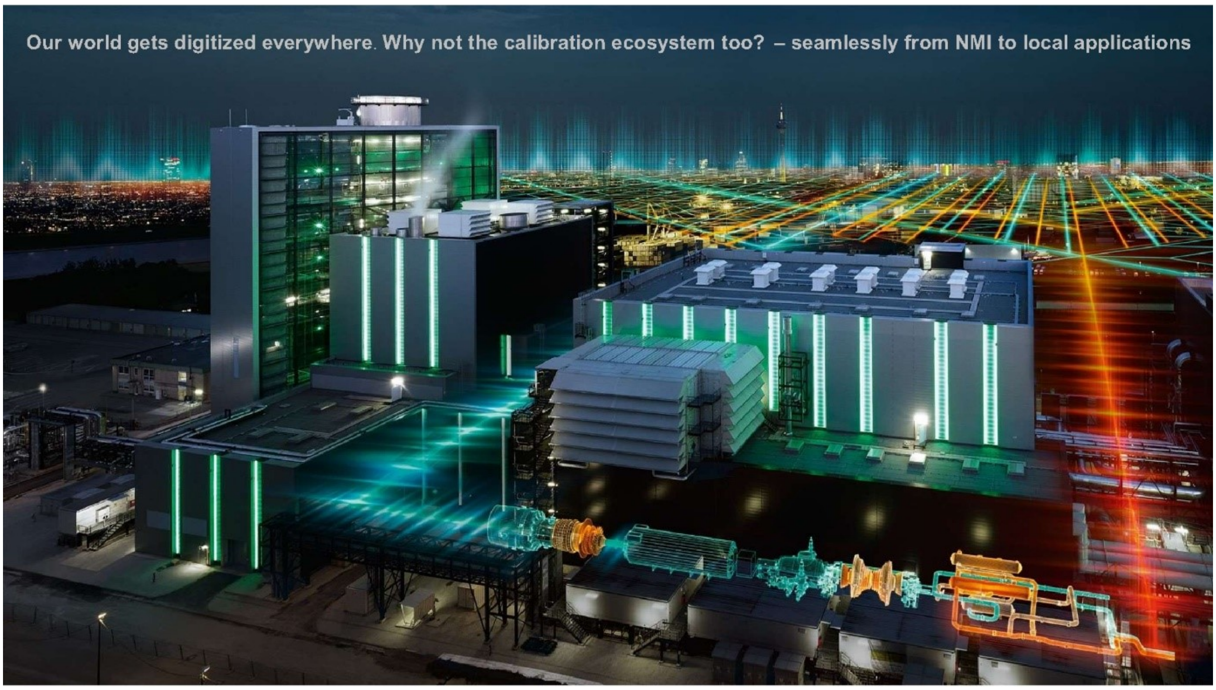

The Project in a Nutshell

https://dcc-conference-2020.ptb.de/videos/public/ckg7s796d0466mlh0xzah820v

GEMIMEG-II

Project start:	01.08.2020	
Funding budget:	11,2 M€	
Total project budget:	17,9 M€	
Project duration:	36 months	
Project end:	31.07.2023	
Project partners:	13	
	Industry:	8
	NMI:	PTB
	Applied Research:	1
	University:	3

PTB · Fraunhofer Heinrich-Hertz-Institut · Valeo · digiraster · T · · · BOSCH · ZEISS · KT Elektronik · SIEMENS · UNIKASSEL VERSITÄT · UNIVERSITÄT SIEGEN

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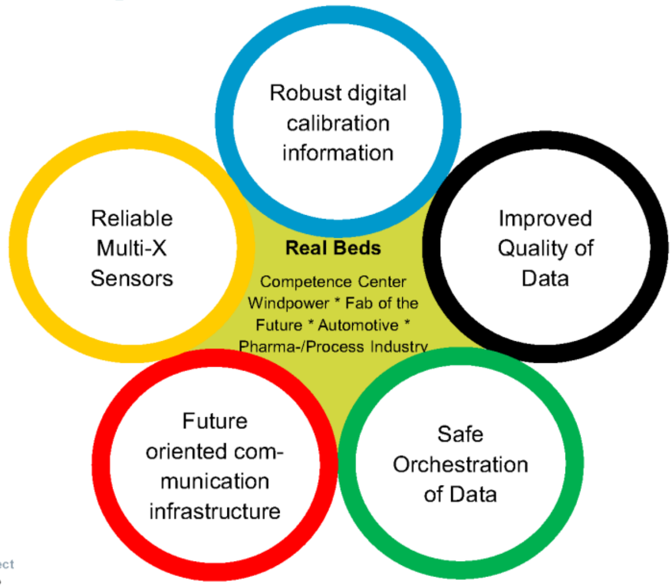
Our Research Agenda

GEMIMEG-II



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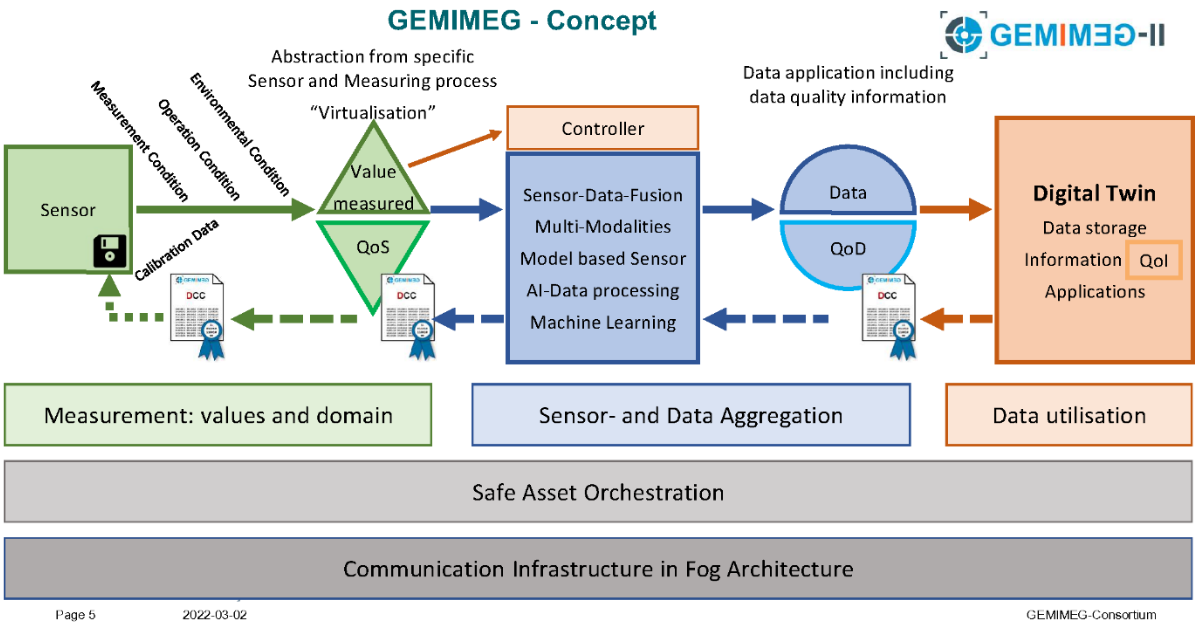
GEMIMEG - Concept
GEMIMEG-II
Abstraction from specific
Sensor and Measuring process
"Virtualisation"
Data application including
data quality information
Measurement Condition
Operation Condition
Environmental Condition
Calibration Data
Sensor
Value measured
QoS
Controller
Sensor-Data-Fusion
Multi-Modalities
Model based Sensor
AI-Data processing
Machine Learning
Data
QoD
Digital Twin
Data storage
Information QoI
Applications
DCC
Measurement: values and domain
Sensor- and Data Aggregation
Data utilisation
Safe Asset Orchestration
Communication Infrastructure in Fog Architecture
Page 5
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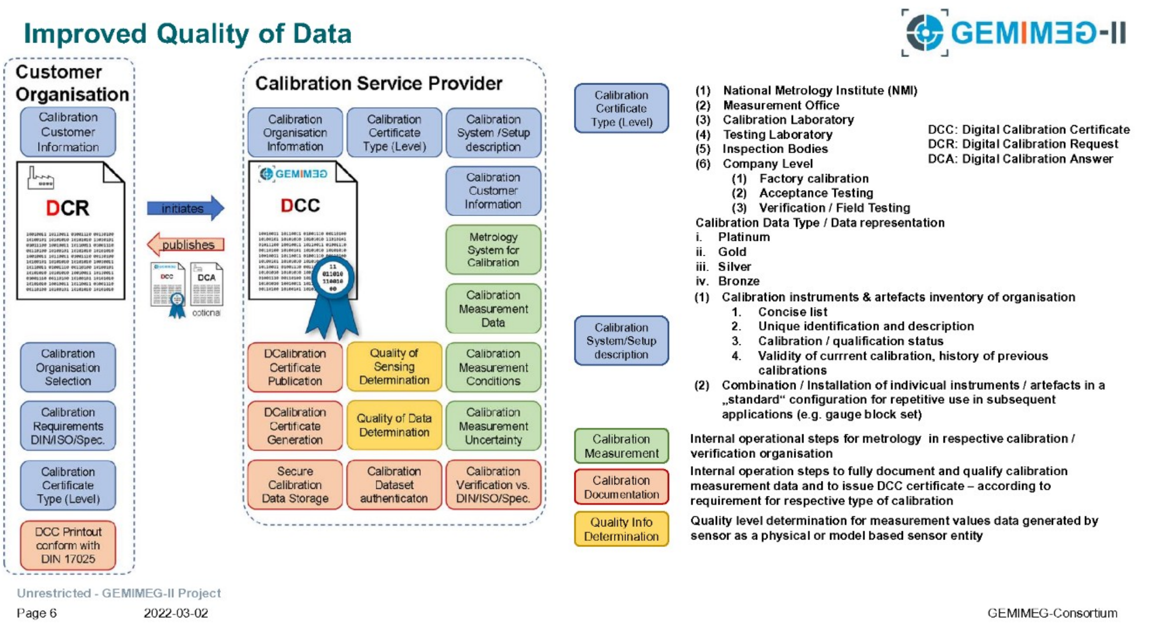
Improved Quality of Data
GEMIMEG-II
Customer Organisation
Calibration Customer Information
DCR
initiates
publishes
DCC
DCA
optional
Calibration Organisation Selection
Calibration Requirements DIN/ISO/Spec.
Calibration Certificate Type (Level)
DCC Printout conform with DIN 17025
Calibration Service Provider
Calibration Organisation Information
Calibration Certificate Type (Level)
Calibration System /Setup description
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
DCC: Digital Calibration Certificate
DCR: Digital Calibration Request
DCA: Digital Calibration Answer
Calibration Data Type / Data representation
i. Platinum
ii. Gold
iii. Silver
iv. Bronze
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 individual 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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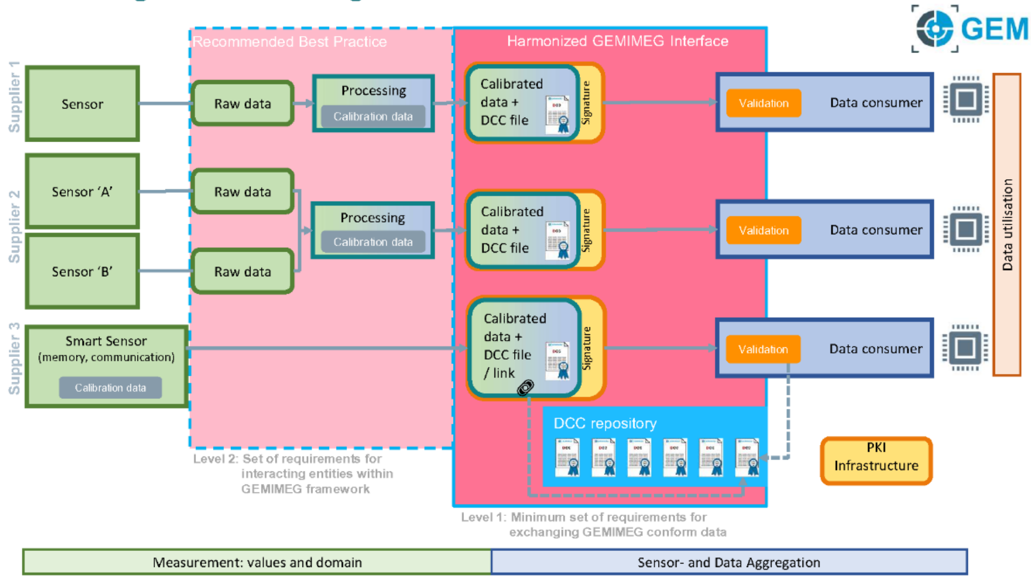
Data Augmented with Digital Calibration Certificate



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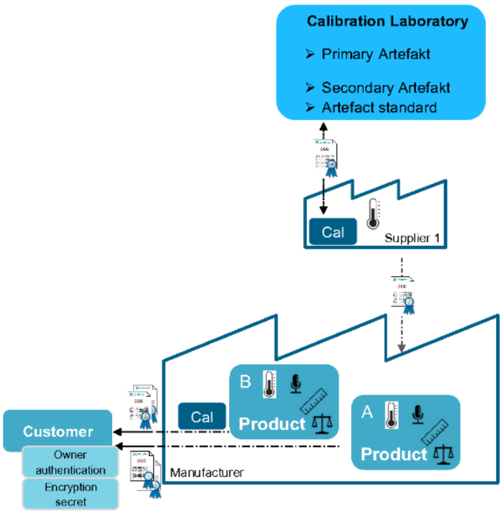
Calibration Information Chain from CalLab to Customer



Supplier n generates DCC and delivers to Manufacturer e.g.:

I. DCC stored on system/sensor or storage device incl. encryption secret

II. Link to DCC repository for download by customer incl. token

  I. Digital information

  II. QR-Code

III. Owner authentication by DCC + encryption secret + challenge

Manufacturer archives DCCs from suppliers 1 .. n.

Final product A not calibrated: Manufacturer forwards supplier DCC to customer, i.e. token, encryption secret, challenge

Final product B to be calibrated:

Manufacturer generates DCC for product and delivers to Customer e.g.:

I. DCC stored on system/sensor or storage device incl. encryption secret

II. Link to DCC repository for download by customer incl. token

  I. Digital information

  II. QR-Code

III. Owner authentication by DCC + encryption secret + challenge

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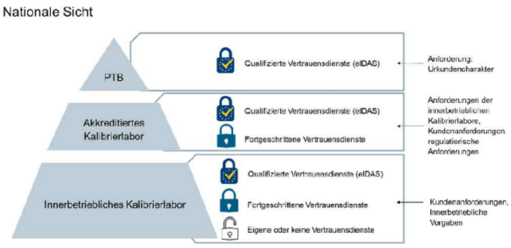
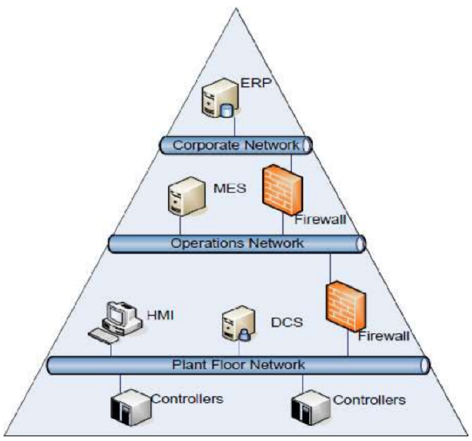
Trust service concept: “The DCC & PKI”

- discussion and definition of trust model
- signature format: enveloped xml signatures (XMLDSig) or XAdES
- parallel signatures: two or more independent signatures
  - meet requirements on trust services beyond the EU
- counter signatures: two or more consecutive dependent signatures
  - usage of digital seals in addition to digital signatures




```
<dcc:digitalCalibrationCertificate xmlns:dcc="https://ptb.de/dcc" xmlns:si="https://ptb.de/si" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    <!--
    <dcc:administrativeData>
    <dcc:measurementResults>
    <ds:Signature xmlns:ds="http://www.w3.org/2000/09/xmldsig#" Id="id-6d828f82c1492d9fbf98d2eee82691fe">
    <ds:Signature xmlns:ds="http://www.w3.org/2000/09/xmldsig#" Id="id-346fbd73e712cea7ecc2335cad93dca3">
</dcc:digitalCalibrationCertificate>
```


Architecture: Organisation of IT-Netzwork (Good Practice)



Quelle: OPC Unified Architecture, Stefan Hoppe, 2014

Green Zone

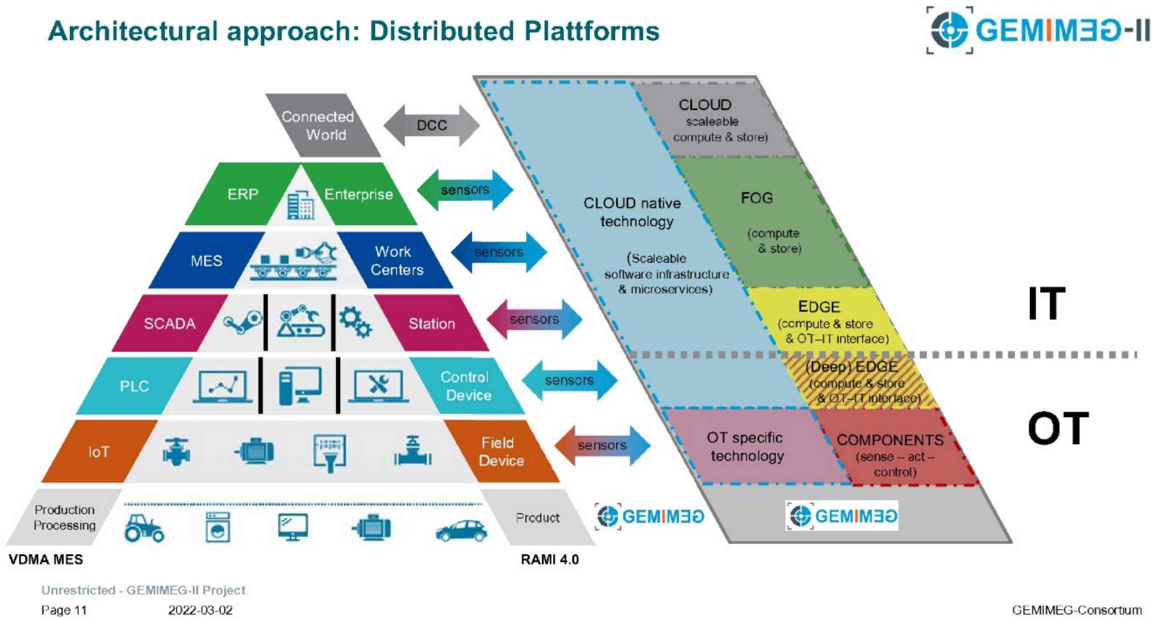
Corporate Network (connecting corporate services e.g. administration, development, ERP, …)

Yellow Zone

Operations Network (connecting operations services e.g. production planning, MES, localization, …)

Red Zone

Plant Floor Network (connecting plant floor services e.g. sensors, devices, machines, distributed control, HMI, …)


Architectural approach: Distributed Plattforms
GEMIMEG-II
Connected World
DCC
ERP
Enterprise
sensors
MES
Work Centers
SCADA
Station
PLC
Control Device
IoT
Field Device
Production Processing
Product
VDMA MES
RAMI 4.0
CLOUD
scaleable compute & store)
CLOUD native 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)
GEMIMEG
IT
OT
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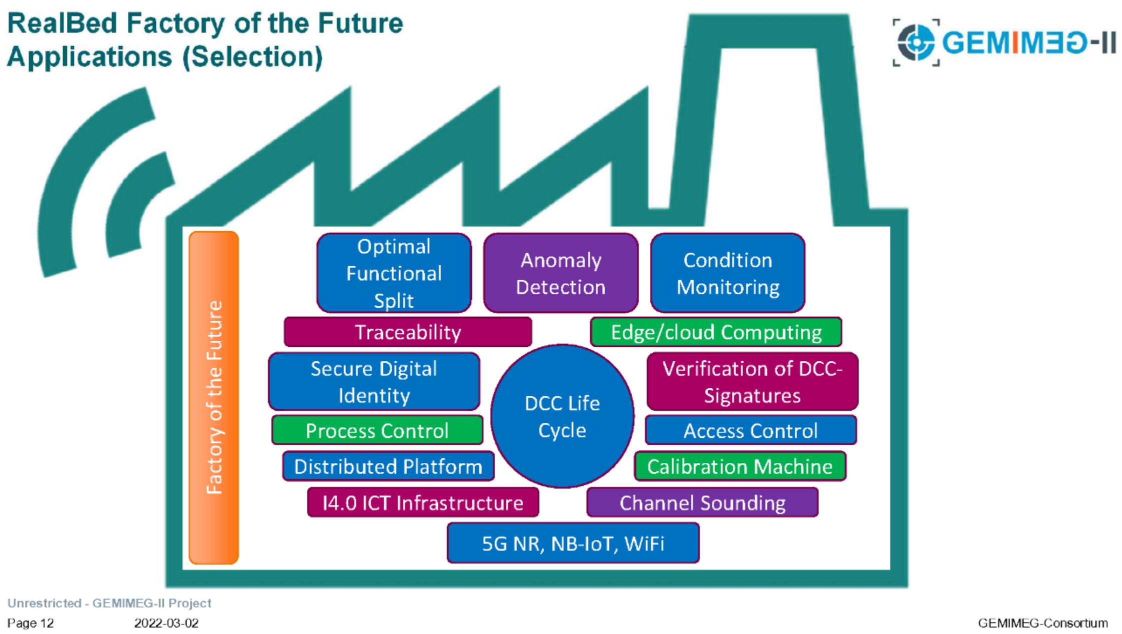
RealBed Factory of the Future
Applications (Selection)
GEMIMEG-II
Factory of the Future
Optimal Functional Split
Anomaly Detection
Condition Monitoring
Traceability
Edge/cloud Computing
Secure Digital Identity
DCC Life Cycle
Verification of DCC-Signatures
Process Control
Access Control
Distributed Platform
Calibration Machine
I4.0 ICT Infrastructure
Channel Sounding
5G NR, NB-IoT, WiFi
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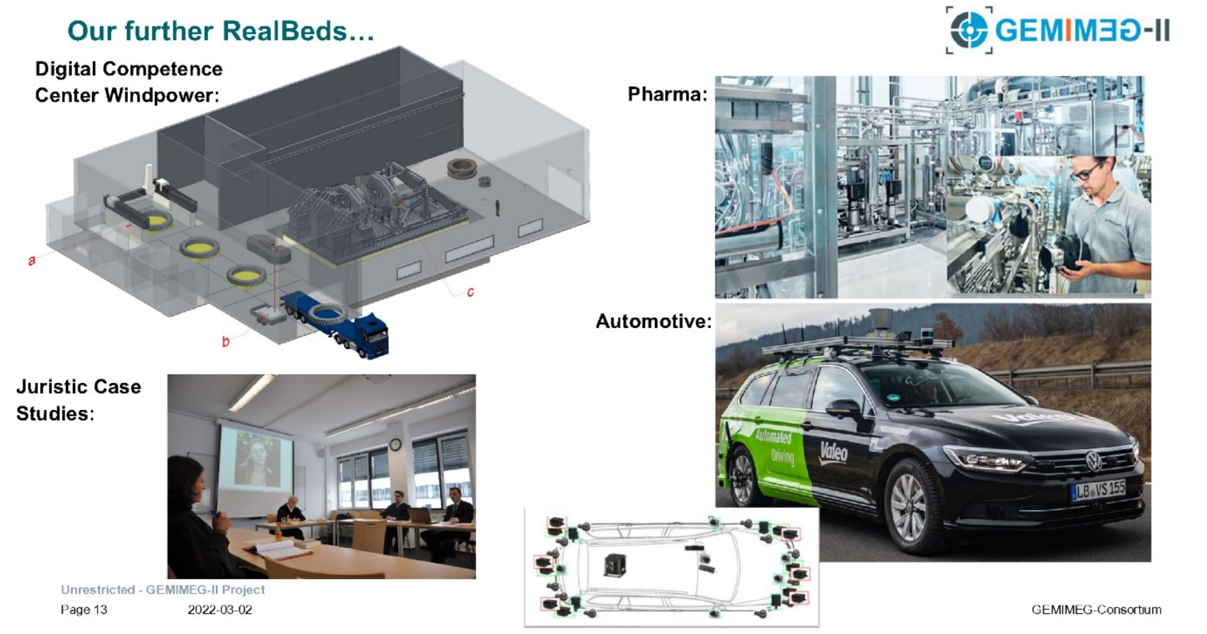
Our further RealBeds…
GEMIMEG-II
Digital Competence
Center Windpower:
Pharma:
Automotive:
Juristic Case
Studies:
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Trusted & traceable metrology
is the key enabler for IIOT for
all critical applications
– when trustworthiness matters!
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Associated Partners are welcome…

If your organisation wants to be informed about the progress of the GEMIMEG-II project and be part of the GEMIMEG-II associated partners framework, please register via: www.gemimeg.de

Timeline for associated partnership:

Application by:	**March 14th, 2022**
NDA contract send out for signature:	April 05th, 2022
return of signed NDA by new partner:	**May 9th, 2022**

Next GEMIMEG-II info round planned for May 30th, 2 pm – 4.30 pm (UCT + 2 h, CEST) *(date not finalized yet)*

Projectinfo: www.gemimeg.de

Or https://www.digitale-technologien.de/DT/Redaktion/DE/Standardartikel/Einzelprojekte/einzelprojekte_gemimeg2.html

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Session “Middleware I”

Generation of digital Calibration Certificates using Python and Excel

Presenting author Ian Smith, NPL, UK

ian.smith@npl.co.uk

Abstract

At the UK’s National Physical Laboratory (NPL), a significant number of measurement services involve the capture of calibration information, including both administrative and measurement data, in Microsoft Excel workbooks. Depending on the complexity of the information that is required to be presented on a calibration certificate, the process of transferring information to the certificate may largely be implemented manually, e.g., by copying and pasting information, or using software, e.g., written in Excel Visual Basic for Applications (VBA). As NPL moves towards implementation of digital calibration certificates (DCCs), consideration has begun of candidate software approaches to the generation of DCCs using information stored in Microsoft Excel workbooks.

This presentation focuses on the use of the Python programming language for this purpose, with the aim of generating DCCs that take the form of XML files that adhere to the publicly available DCC schema [1]. As a widely used, general purpose language, the advantages and disadvantages of Python are well known. One advantage that is often given is the ready availability of a huge number of supporting packages – see, e.g., the Python Package Index (PyPi) [2]. However, selecting which package to use from a number of options may not be straightforward. The presentation describes alternative approaches to DCC generation, discusses the level of knowledge of XML that the programmer requires, and considers DCC generation from the point of view of software quality management.

References

[1] Digital Calibration Certificate v3.0.0.

https://www.ptb.de/dcc/v3.0.0/

[2] Python Package Index (PyPI). https://pypi.org/

NPL
National Physical Laboratory

Generation of digital calibration certificates using Python and Excel

Ian Smith, Data Science department, NPL

DCC Conference 2022
1-3 March 2022

Outline

- Background
  - Survey of measurement services at NPL
  - Identification of case study
- Case study implementation
  - Input, Output, Programming language, XML expertise, DCC complexity
- Next steps
- Software and software quality considerations
- Conclusions

Background
Survey of measurement services at NPL

Survey aims

Overview of calibration approaches

Assess readiness for digitalisation

Identify DCC generation approaches

Raise awareness of DCCs

Background
Survey of measurement services at NPL

NPL National Physical Laboratory

Survey aims

- Overview of calibration approaches
- Assess readiness for digitalisation
- Identify DCC generation approaches
- Raise awareness of DCCs

Survey findings

- Paper and PDF certificates
- Provision of auxiliary information
- Provision of non-SI units
- Use of Microsoft Excel workbooks

Background
Survey of measurement services at NPL

NPL National Physical Laboratory

Survey aims

- Overview of calibration approaches
- Assess readiness for digitalisation
- Identify DCC generation approaches
- Raise awareness of DCCs

Survey findings

- Paper and PDF certificates
- Provision of auxiliary information
- Provision of non-SI units
- Use of Microsoft Excel workbooks

Background
Identification of case study

Identify DCC generation approaches

Use of Microsoft Excel workbooks

Case study: Generation of a DCC from information stored in a Microsoft Excel workbook

- Focus on administrative data and measurement result
- DCC generated by pressing a button or running a script
- Validation against D-SI and DCC schemas

Case study implementation

- **Input**
  - Microsoft Excel workbook containing calibration information
- **Output**
  - DCC whose content adheres to DCC and D-SI schemas

Calibration information in Microsoft Excel workbook

Validated DCC

Case study implementation

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- **Programming language**
  - Read information from Microsoft Excel
  - Parse and validate XML
  - Chose to work with Python
  - Identified packages `openpyxl` and `xmlschema`
  - Not ruling out working with other packages or software in future

Case study implementation

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- **XML expertise**
  - Some knowledge of XML structure required
  - Not necessary to know everything

Case study implementation

- **Complexity of DCC**
  - Decided to start with something as simple as possible then look to increase complexity
  - Mandatory elements only, no repeated element, attributes not considered
  - One real measurement result with expanded uncertainty

Case study implementation

- **Approach**
  - Identify contents of DCC
  - Generate template file from schema (using XMLSpy followed by small amount of editing)
  - Load template XML file, read data from workbook, update element values, save XML file, validate XML file

Contents of DCC

digitalCalibrationCertificate	> dcc:administrativeData	> dcc:dccSoftware	>> dcc:software	> dcc:name	>> dcc:content	
				> dcc:release		
		> dcc:coreData	> dcc:countryCodeISO3166_1			
			>> dcc:usedLangCodeISO639_1			
			>> dcc:mandatoryLangCodeISO639_1			
			> dcc:uniqueIdentifier			
			> dcc:beginPerformanceDate			
			> dcc:endPerformanceDate			
			> dcc:performanceLocation			
		> dcc:items	>> dcc:item	> dcc:name	> dcc:content	
				> dcc:manufacturer	> dcc:name	>> dcc:content
				> dcc:identifications	>> dcc:identification	> dcc:issuer
						> dcc:value
		> dcc:calibrationLaboratory	> dcc:contact	> dcc:name	>> dcc:content	
				> dcc:eMail		
				> dcc:location	> dcc:streetNo	
					> dcc:street	
					> dcc:city	
					> dcc:postCode	
					> dcc:state	
					> dcc:countryCode	
					> dcc:postOfficeBox	
		> dcc:respPersons	>> dcc:respPerson	> dcc:person	> dcc:name	>> dcc:content
		> dcc:customer	> dcc:name	>> dcc:content		
			> dcc:eMail			
			> dcc:location	> dcc:streetNo		
				> dcc:street		
				> dcc:city		
				> dcc:postCode		
				> dcc:state		

- Interpretation of contents of simple DCC
- ~40 pieces of information

Template file

```
<?xml version="1.0" encoding="UTF-8"?>
<dcc:digitalCalibrationCertificate xmlns:dcc="https://ptb.de/dcc" xmlns:si="https://ptb.de/si" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
schemaVersion="3.0.0" xsi:schemaLocation="https://ptb.de/dcc dcc.xsd">
    <dcc:administrativeData>
        <dcc:dccSoftware>
            <dcc:software>
                <dcc:name>
                    <dcc:content>String</dcc:content>
                </dcc:name>
                <dcc:release>String</dcc:release>
            </dcc:software>
        </dcc:dccSoftware>
        <dcc:coreData>
            <dcc:countryCodeISO3166_1>AA</dcc:countryCodeISO3166_1>
            <dcc:usedLangCodeISO639_1>aa</dcc:usedLangCodeISO639_1>
            <dcc:mandatoryLangCodeISO639_1>aa</dcc:mandatoryLangCodeISO639_1>
            <dcc:uniqueIdentifier>String</dcc:uniqueIdentifier>
            <dcc:beginPerformanceDate>1957-08-13</dcc:beginPerformanceDate>
            <dcc:endPerformanceDate>1957-08-13</dcc:endPerformanceDate>
            <dcc:performanceLocation>laboratory</dcc:performanceLocation>
        </dcc:coreData>
        <dcc:items>
            <dcc:item>
                <dcc:name>
                    <dcc:content>String</dcc:content>
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                <dcc:eMail>String</dcc:eMail>
                <dcc:location>
                    <dcc:streetNo>String</dcc:streetNo>
                    <dcc:street>String</dcc:street>
```

- ~100 lines of code
- Dummy values assigned

Running Python code

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Core data in template file

```
<dcc:coreData>
    <dcc:countryCodeISO3166_1>AA</dcc:countryCodeISO3166_1>
    <dcc:usedLangCodeISO639_1>aa</dcc:usedLangCodeISO639_1>
    <dcc:mandatoryLangCodeISO639_1>aa</dcc:mandatoryLangCodeISO639_1>
    <dcc:uniqueIdentifier>String</dcc:uniqueIdentifier>
    <dcc:beginPerformanceDate>1957-08-13</dcc:beginPerformanceDate>
    <dcc:endPerformanceDate>1957-08-13</dcc:endPerformanceDate>
    <dcc:performanceLocation>laboratory</dcc:performanceLocation>
</dcc:coreData>
```

Information in Microsoft Excel

A	B
Data for element dcc:coreData	
Country code	GB
Used language code	en
Mandatory language code	en
Unique identifier	Unique identifier
Begin performance date	2020-03-01
End performance date	2020-03-01
Performance location	laboratory

Snippet of Python code

```
import openpyxl
wb = load_workbook('CalibrationInformation1.xlsx')
ws2 = wb['Core Data']
cd_countryCode = ws2['B2'].value

import xmlschema
dccSchema = xmlschema.XMLSchema('dcc.xsd')
obj = dccSchema.decode('dccTemplate_v1.xml')
d1 = obj['dcc:administrativeData']
d2 = d1['dcc:coreData']
d2['dcc:countryCodeISO3166_1'] = cd_countryCode
```

Core data in generated XML file

```
<dcc:coreData>
    <dcc:countryCodeISO3166_1>GB</dcc:countryCodeISO3166_1>
    <dcc:usedLangCodeISO639_1>en</dcc:usedLangCodeISO639_1>
    <dcc:mandatoryLangCodeISO639_1>en</dcc:mandatoryLangCodeISO639_1>
    <dcc:uniqueIdentifier>Unique identifier</dcc:uniqueIdentifier>
    <dcc:beginPerformanceDate>2020-03-01</dcc:beginPerformanceDate>
    <dcc:endPerformanceDate>2020-03-01</dcc:endPerformanceDate>
    <dcc:performanceLocation>laboratory</dcc:performanceLocation>
</dcc:coreData>
```

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Next steps

NPL National Physical Laboratory

- Build in additional validation (Microsoft Excel and Python)
  - Drop-down list to ensure only a valid value may be selected
  - Test that value of coverage probability does not exceed unity
- Apply more modular approach to Python code
  - Similar actions being repeated multiple times
- Apply to more complicated (and real) DCCs
  - Allow optional elements, repeated elements and setting of attribute values
  - May lead to use of different or additional Python packages
- Apply to existing measurement services
  - Focus first on less complex cases

Software and software quality considerations

- Development of software for DCC generation requires appropriate rigour
- Representation of DCC contents is key aspect of user requirements for software
  - Challenging for large amounts of data
- DCCs different for different measurement services and metrology areas but much underlying functionality of software is the same
  - Points towards software development to be undertaken “centrally”, ensuring reuse, not reinvention, of software
- Challenges in working with existing measurement services
  - Flexibility in data storage and software implementation

Conclusions

- Need for “Excel to DCC” pathway is recognised at NPL (and other NMIs)
- Implemented an approach to generation of a (simple) DCC using Python
  - For now, not an optimal approach, just an approach that works
  - Limited previous use of Python and knowledge of XML
  - Relatively straightforward to implement but still needs planning
- Need for continued collaboration to share approaches and help identify good practice

A software solution for the practical creation of DCC files

Presenting author Maik Stotz, Stotz Software, Germany

Abstract

In this lecture, a software solution for the practical creation of DCC files is presented. This software is currently under construction and is being developed by STOTZ-Software.

In calibration laboratories, it is common for measurement, order, and customer data to be recorded using a wide variety of programs. As a result, there is a large variety of databases used in laboratories in which the recorded data is stored.

The software presented here for creating digital calibration certificates supports all of these common database types and allows mapping to the structure of the DCC to be set up. In order to keep this mapping dynamic, formulas and conditions can be stored using a simple script language.

Once such a mapping has been set up, digital calibration certificates can then be created fully automatically and in large numbers.

The possibilities of this software will be presented in the lecture.

The structure of a mapping is then demonstrated using a concrete example and finally a digital calibration certificate is created.

A Fluke MET/TEAM database is used for this.

A software for creating DCC's

AnyDcc

About

STOTZ software

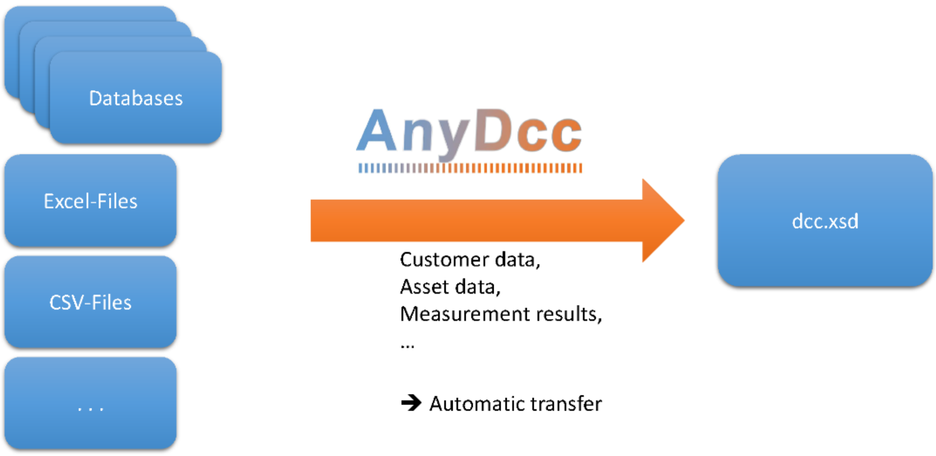
Founded in 2001

Offering
- Individual Software-Development, databases and automations for calibration laboratories
- Training courses for MET/CAL and MET/TEAM

Located near Frankfurt, Germany

STOTZ software

DCC - Current situation and problem



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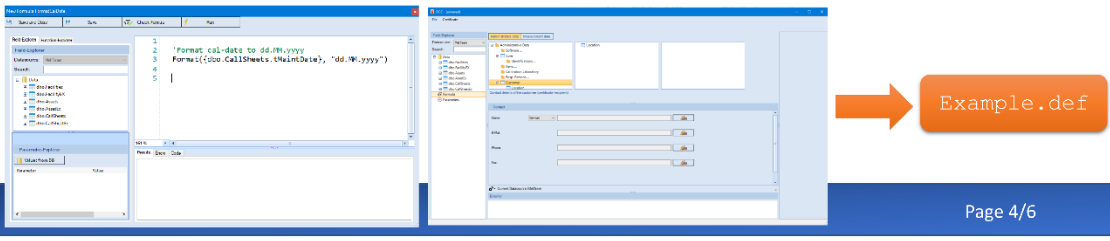
STOTZ software

Create DCC's – Step 1

- Step 1: Create mapping between datasource and xsd-template
  - Build mapping between your special datasources and dcc-template
  - This work has to be done only once
  - This work is carried out together by IT specialists and laboratory personnel
  - The result is a file in which all data sources and mapping assignments are defined



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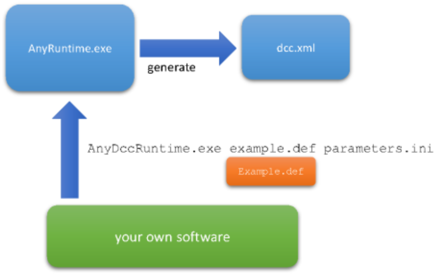
STOTZ software

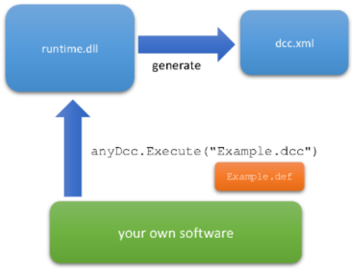
Create DCC's – Step 2

- Step 2: execute the mapping-file with AnyDcc - Runtime

Call the `AnyDccRuntime.exe` an pass name of def-File



Developers can use a runtime DLL to create dcc's from their own programs



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STOTZ software

Roadmap, Beta-Version and Release

- Roadmap
  - June / July → Beta-Version available / Test runs in selected laboratories (Germany)
  - October → Release
    - Workshop at conference Metrologietage 12. – 13. 10.2022 in Böblingen

www.metrologietage.de

- Stay in Contact.. for beta version.. and newest information
  maik.stotz@stotz-software.de / www.stotz-software.de

Thank you!!

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From Excel to DCC and human readable calibration certificate – user-friendly middleware and digital signature at work

Presenting author Caroline Stobe, Reference Institute for Bioanalytics, Germany

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Abstract

Harmonization of DCC templates within the community of calibration laboratories has been identified as one of the major objectives of DCC design in order to facilitate integration of DCC data into customers' systems. However, there are several reasons calibration laboratories have to be able to individualize these templates, e. g.

• customers' individual requirements regarding calibration and/or data presentation,

• changes in accreditation requirements (by the accreditation body or based on standard revisions),

• different types of calibration for the same measurand within a laboratory,

• changes in the calibration method and consequent changes in data presentation.

Additionally, multiple software solutions exist to create "classic" calibration certificates within the calibration laboratory community. To achieve a harmonization in this field is, most certainly, impossible. Thus, in order to establish workflows to generate DCCs in the calibration laboratories based on their individual software, suitable middleware is needed. Especially smaller calibration laboratories still rely on Microsoft Excel or similar spreadsheet applications to generate their certificates.

The Python based middleware "Ex2DCC" by Dr. Hans Koch enables calibration laboratories to generate DCCs and human readable certificates at the same time – applying their own individual Excel spreadsheet templates. Both, the spreadsheets, and the middleware itself may be customized to the laboratory's needs whenever needed.

In this presentation RfB's calibration laboratory Cologne likes to share

• its DCC template for clinical measurands,

• its process of creating a DCC and a human readable certificate with "Ex2DCC",

• its approach of digitally signing the DCC applying the commercial signature product of D-TRUST (Bundesdruckerei).

In addition to the mere results, questions to be asked within the process of establishing a DCC workflow and challenges regarding the laboratory's individual requirements as well as requirements for accreditation, will be presented.

From Excel to DCC & human readable calibration certificate – user-friendly middleware & digital signature at work

Dr. Caroline Stobe
Reference Institute for Bioanalytics
Calibration Laboratory 1, Cologne

2nd International DCC-Conference, March 1st to March 3rd 2022

Acknowledgement

Prof. Dr. Hans Koch

- Former head of division 8 „Medical Physics and Metrological Information Technology“ at PTB
- Apl. Prof. at TU Berlin
- Member of DKD
- Lead auditor for management systems at DAkkS
- Expert on DCC and developer of middleware “Ex2DCC”

datenanalyse + dokumentation

da+d

https://www.da-plus-d.de/

Agenda

- Framework: What we do and what we need
- Workflow "Ex2DCC"
- Digital signature: Signature card & digiSeal® office
- Customized XML template

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Framework: RfB's calibration lab Cologne

- RfB: EQA provider, officially charged by the German Medical Association
  - ➢ Quality in laboratory medicine and patient care
  - ➢ Metrological traceability in laboratory medicine
- Accreditation: DIN EN/ISO 17025 & 15195
- Listed in the JCTLM database

DAkkS Deutsche Akkreditierungsstelle D-K-15117-01-00

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Framework: RfB's calibration lab Cologne

- 5 lab technicians + head of laboratory
- Reference measurement procedures, but with different types of calibration!
- Data processing mostly
- 1 of 4 accredited German calibration labs for clinical measurands

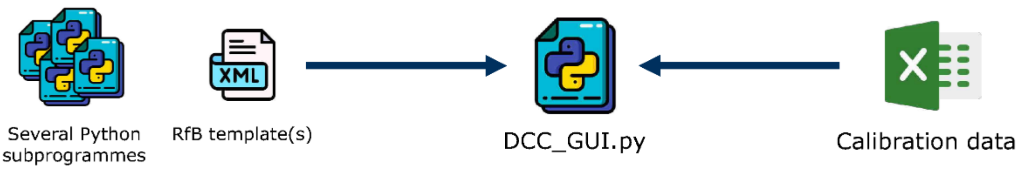
RfB ≈ 120 samples / year

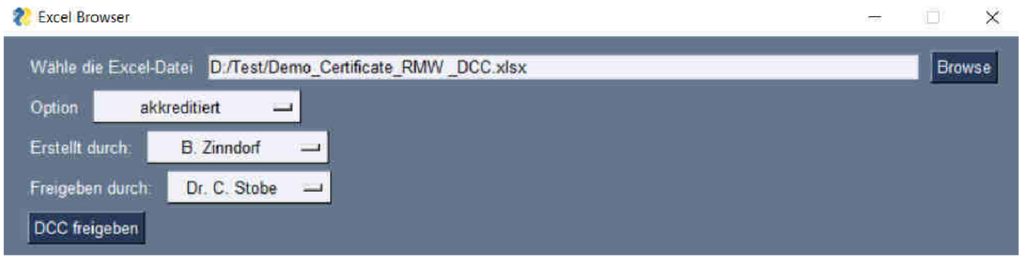
IVD EQA

≈ 40-50 samples / year

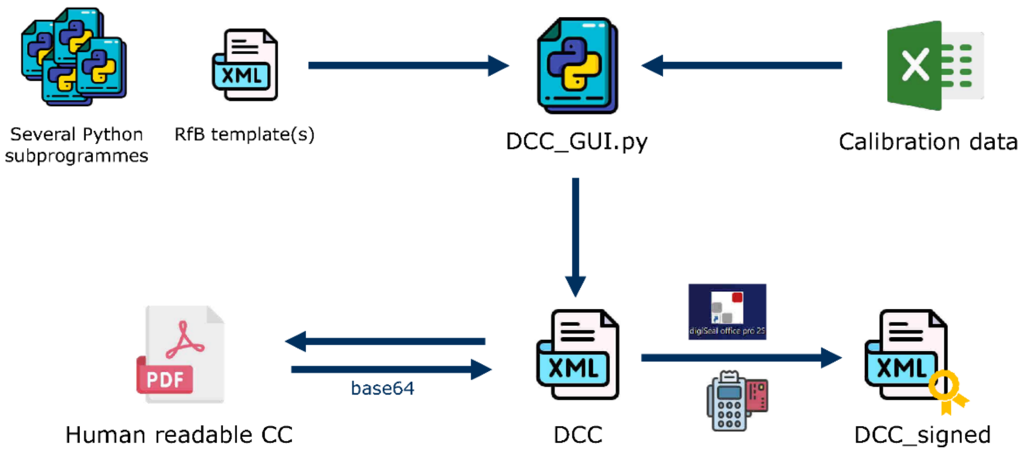
➢ Feasible, highly customisable solutions needed!

From Excel to DCC & human readable CC





From Excel to DCC & human readable CC



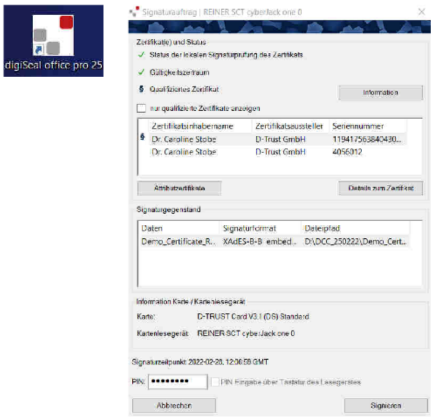
Digital signature: the concept

- Generation of signature = commercial solutions
  - ➢ Signature card from D-TRUST (Bundesdruckerei) → 129 € / year
  - ➢ cyberJack® one card reader → 79,90 €
  - ➢ digiSeal® office pro 25 → 189 € / 2 years
  - ✓ affordable
  - ✓ ready to use
  - ✓ QES in agreement with eIDAS

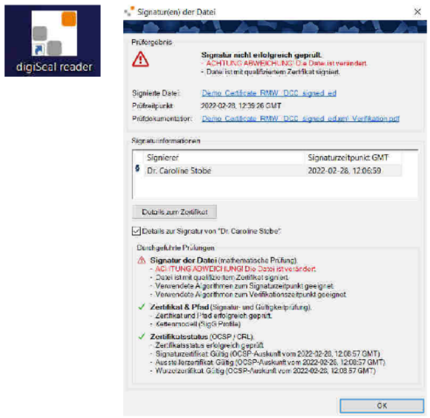
- Verification of signature = free solutions available, e. g. digiSeal® reader

Digital signature

Laboratory:



Customer:



XML template for clinical measurands

```
▼<dcc:digitalCalibrationCertificate xmlns:dcc="https://ptb.de/dcc" xmlns:si="https://ptb.de/si" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="https://ptb.de/dcc https://ptb.de/dcc/v3.1.0/dcc.xsd" schemaVersion="3.1.0">
  ▶<dcc:administrativeData>
    ...
   </dcc:administrativeData>
  ▶<dcc:measurementResults>
    ...
   </dcc:measurementResults>
  ▶<dcc:document>
    ...
   </dcc:document>
  ▶<ds:Signature xmlns:ds="http://www.w3.org/2000/09/xmldsig#" Id="XMLSignature_8FB42BCD07A3CECA5A9D74CF01058098D212190A">
    ...
   </ds:Signature>
 </dcc:digitalCalibrationCertificate>
```

- PTB scheme version 3.1.0
- DAkkS logo & human readable pdf embedded as base64
- All necessary statements according to 17025 accreditation
- XML signature via digiSeal® office and signature card

XML template – measurement results & MU

```
<dcc:results>
  <dcc:result id="measurementValues">
    <dcc:name>
      <dcc:content lang="de">Messergebnisse</dcc:content>
      <dcc:content lang="en">Measurement results</dcc:content>
    </dcc:name>
    <dcc:description>
      <dcc:content lang="de">Einzelmesswerte in mmol/mol unter Angabe des Kalibrierdatums:</dcc:content>
      <dcc:content lang="en">Single values in mmol/mol with corresponding date of calibration:</dcc:content>
    </dcc:description>
    <dcc:data>
      <dcc:list refType="gp_table1">
        <dcc:list refType="gp_value1">
          <dcc:quantity>
            <dcc:name>
              <dcc:content lang="de">1. Wert</dcc:content>
              <dcc:content lang="en">1. value</dcc:content>
            </dcc:name>
            <si:realListXMLList>
              <si:labelXMLList>D1 D2 D1 D2 D1 D2 </si:labelXMLList>
              <si:valueXMLList>42.62 43.92 41.70 37.59 39.72 39.93 </si:valueXMLList>
              <si:unitXMLList>\milli\mole\mole\tothe{-1}</si:unitXMLList>
              <si:dateTimeXMLList>2022-01-24T00:00:00Z 2022-01-26T00:00:00Z 2022-01-28T00:00:00Z 202
            </si:realListXMLList>
          </dcc:quantity>
```

	D1	D2	D1	D2	D1	D2
	24.01.2022	**26.01.2022**	**28.01.2022**	**31.01.2022**	**07.02.2022**	**07.02.2022**
1. Wert *1. value*	42,62	43,92	41,70	37,59	39,72	39,93
2. Wert *2. value*	37,79	37,09	41,63	38,60	39,82	39,62
3. Wert *3. value*	37,52	37,34	38,95	38,65	39,31	39,36
4. Wert *4. value*	36,73	36,95	37,37	38,06	38,87	38,01

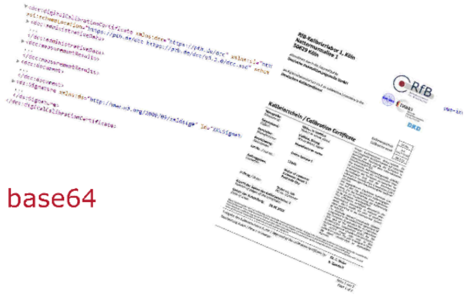
XML template – measurement results & MU

```
<dcc:quantity refType="basic_referenceValue">
  <dcc:name>
    <dcc:content lang="de">Referenzmethodenwert</dcc:content>
    <dcc:content lang="en">Reference measurement value</dcc:content>
  </dcc:name>
  <si:real>
    <si:label>mmol/mol</si:label>
    <si:value>39.0</si:value>
    <si:unit>\milli\mole\mole\tothe{-1}</si:unit>
    <si:expandedUnc>
      <si:uncertainty>0.8</si:uncertainty>
      <si:coverageFactor>2.1</si:coverageFactor>
      <si:coverageProbability>0.95</si:coverageProbability>
    </si:expandedUnc>
  </si:real>
</dcc:quantity>
```

Referenzmethodenwert: ***Reference measurement value:***	**39,0**	**mmol/mol**
Erweiterte Messunsicherheit: *Expanded measurement uncertainty:*	0,8	mmol/mol
Rel. erweiterte Messunsicherheit: *Rel. expanded measurement uncertainty:*	2,1	%
Erweiterungsfaktor *k* / *Coverage factor k*:	2,1	

Summary

- Customised, Python based middleware „Ex2DCC" by Prof. Dr. Koch:
  - DCC & human readable pdf from Excel-Datafile



- XML-DCC:
  - PTB scheme 3.1.0
  - Customised for calibration of clinical measurands
  - Embedding of accreditation logo & human readable via base64
  - QES via signature card & commercial software

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Thank you very much for your attention!

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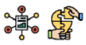
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A no-code Excel tool for generating DCCs

Presenting author Dirk Röske, PTB, Germany

dirk.roeske@ptb.de

Abstract

Based on an idea presented at the 2021 IMEKO World Congress (https://doi.org/10.1016/j.measen.2021.100175), a tool is developed which allows the digital calibration certificate (DCC) to be generated in Excel without any coding by the user. This is especially useful if all data that should be used in the certificate is already available in Excel, which is often the case since many calibration laboratories use this spreadsheet software for the data acquisition and the results calculation. The presented tool implements the version 3.0 of the DCC schema definition (dcc.xsd) and the version 2.0 of the D-SI (SI-Format.xsd). For using the tool, Excel macros must be enabled. If this is the case, the tool's VBA source code and the necessary worksheets can be copied to the user's own Excel file automatically. In this file, the structure of the DCC can be created by clicking and answering questions or entering data. The last can be text, links to cells or formulas. It is also possible to use the tool only for setting up the structure of the DCC and entering the data using Excel functionality without macros. Both methods allow the DCC to be set up as a template, that means, the final DCC as XML file will always incorporate the current values of cells and formula results. If all data fields are filled with the relevant data, the DCC is created by clicking one button. The no-code approach – no xml coding is necessary – makes the DCC available to laboratories not having professional programming skills or resources.

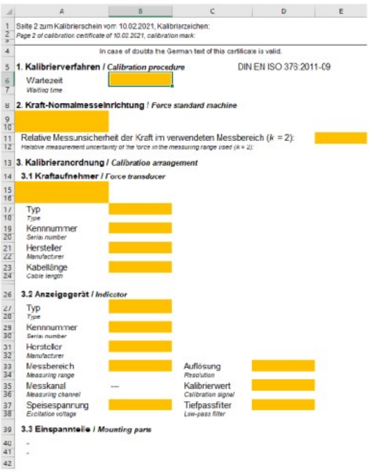
Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
National Metrology Institute

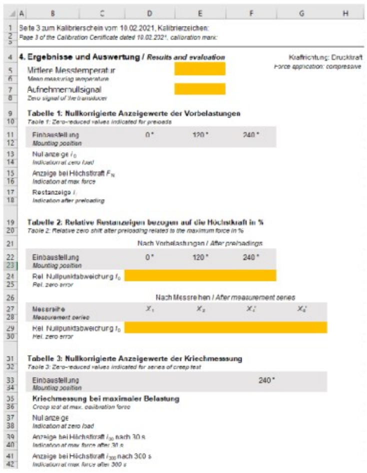
A no-code Excel tool for generating DCCs

Dirk Röske, PTB, Germany

General ideas

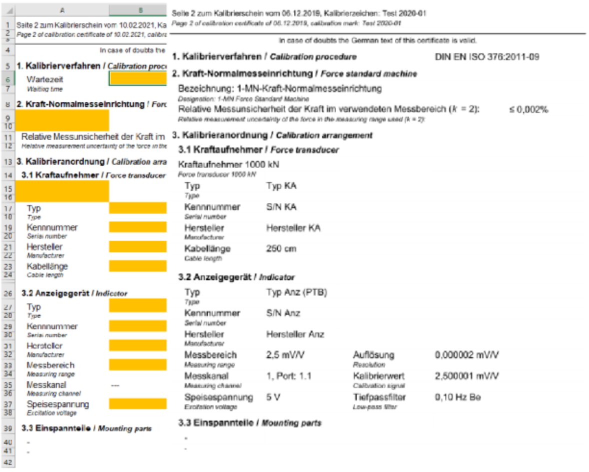
Calibration certificates for static force and torque calibrations in PTB (for example, ISO 376)





General ideas

Calibration certificates for static force and torque calibrations in PTB (for example, ISO 376)



General ideas

Calibration certificates for static force and torque calibrations in PTB

- All data and all necessary certificate results in the required layout available in Excel (a kind of DCC in an *.xl* file, an Excel-DCC)
- Certificate saved as PDF directly out of Excel (a PDF-DCC)

- Aims:
  - To save the XML, based on the dcc.xsd and the SI_Format.xsd, directly out of Excel as XML-DCC
  - To generate the XML with low programming effort (low-code or even no-code) and focus on the structure and content.

The way to a no-code tool - Steps

Analysis of the DCC and SI_Format schemas
- XSD Diagram (freeware) and
- DCC Wiki

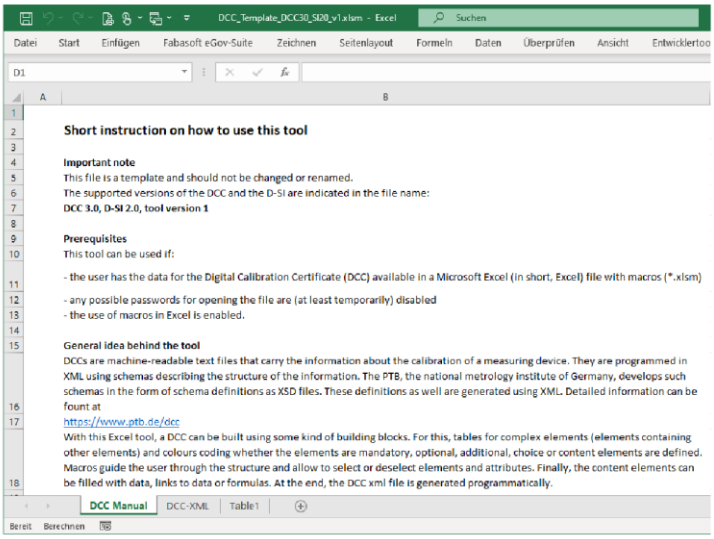
Definition of elements in Excel using names and including
- their frequency of occurrence (mandatory, optional, additional, different types of choices, …)
- child elements and
- attributes.

Programming of macros.

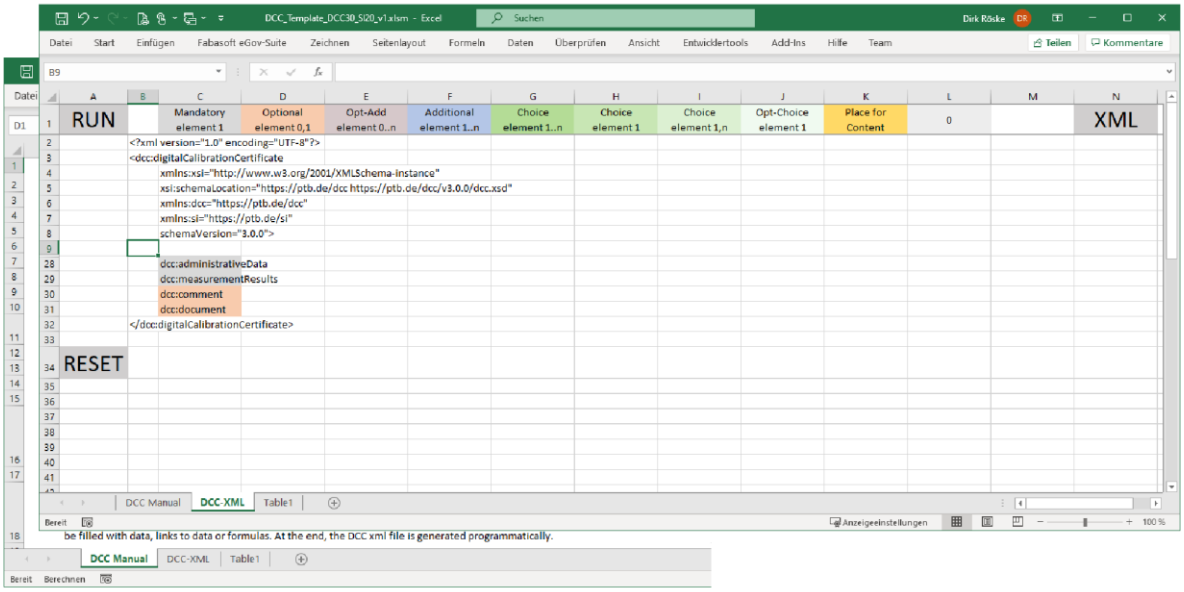
The way to a no-code tool - Timeline

End of 2020: first ideas
Early in 2021: first tests with
 dcc.xsd, version 2.3.0 and
 SI_Format.xsd, version 1.3.0
End of summer 2021: publication of the main principles
 IMEKO World Congress
End of 2021: new version from scratch with
 dcc.xsd, version 3.0.0 and
 SI_Format.xsd, version 2.0.0
Since 2022: tests of the current version
 DCC_Template_DCC30_SI20_v1.xlsm

The way to a no-code tool – Current state



The way to a no-code tool – Current state



How to use the tool – Four simple rules

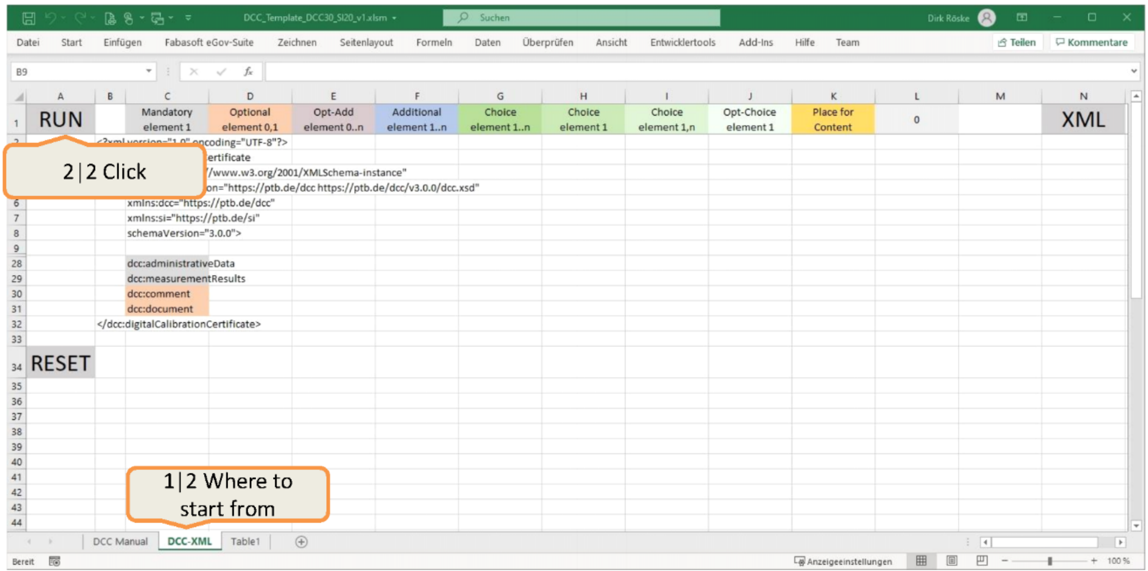
The tool must be integrated in the user's Excel file
- this is supported by macros.

The user must activate (Click on RUN) the DCC-XML worksheet and process all coloured cells excluding that in row 1 and RESET .

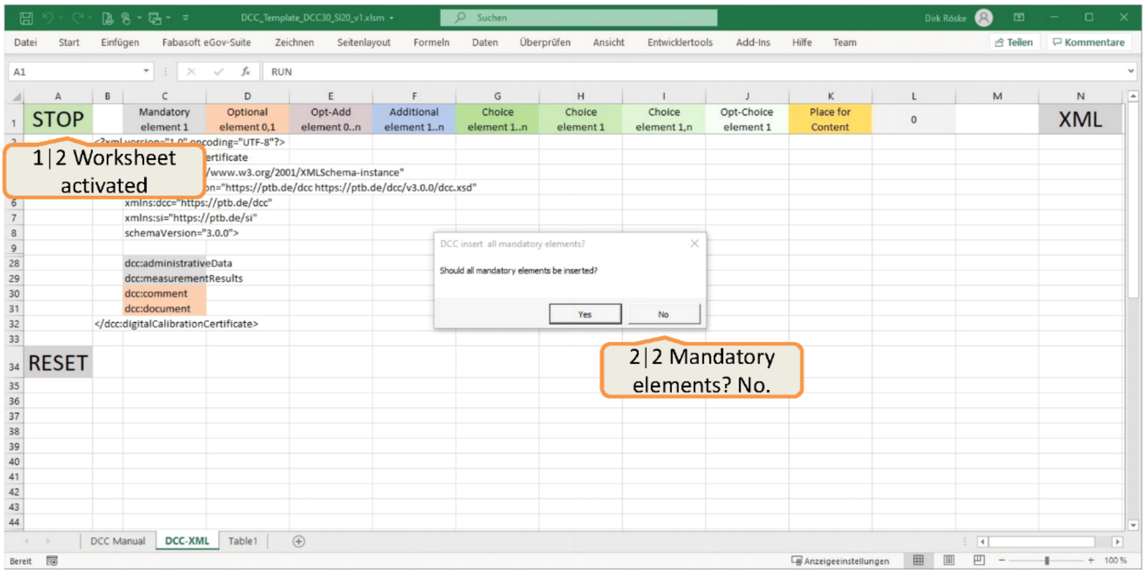
Cells with golden background colour will carry the data of the DCC, all other cells define the structure (a counter shows the number of golden cells which need input).

At the end the XML is generated with click on XML .

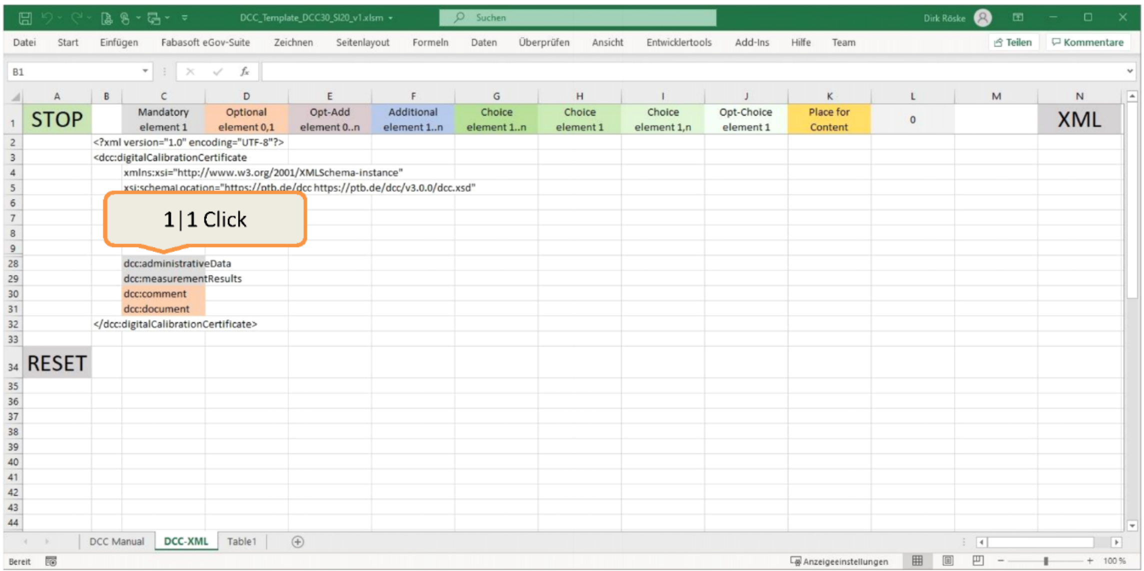
How to use the tool – Some details



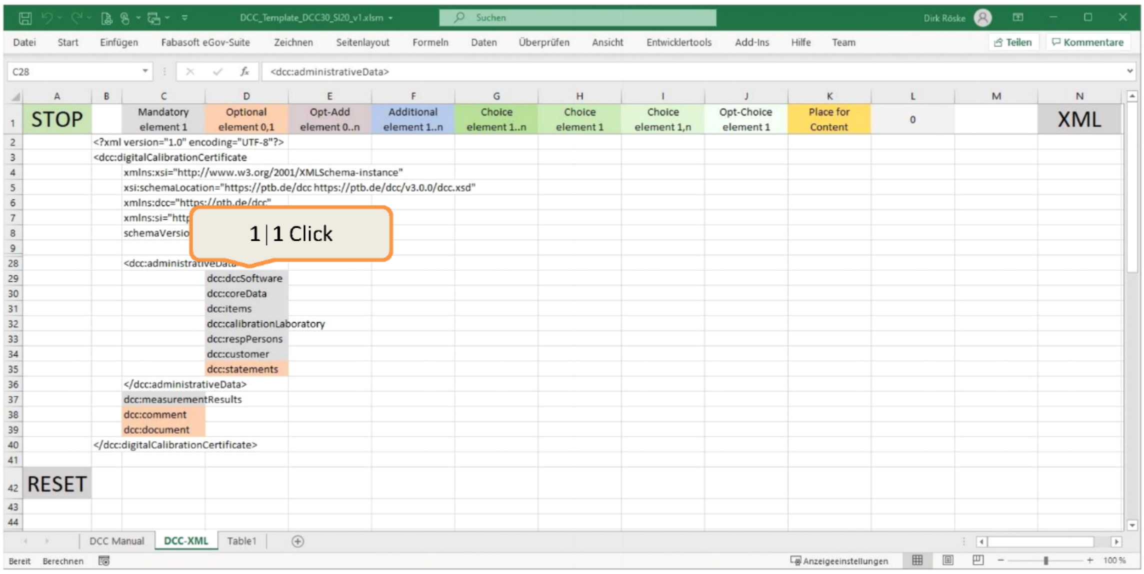
How to use the tool – Some details



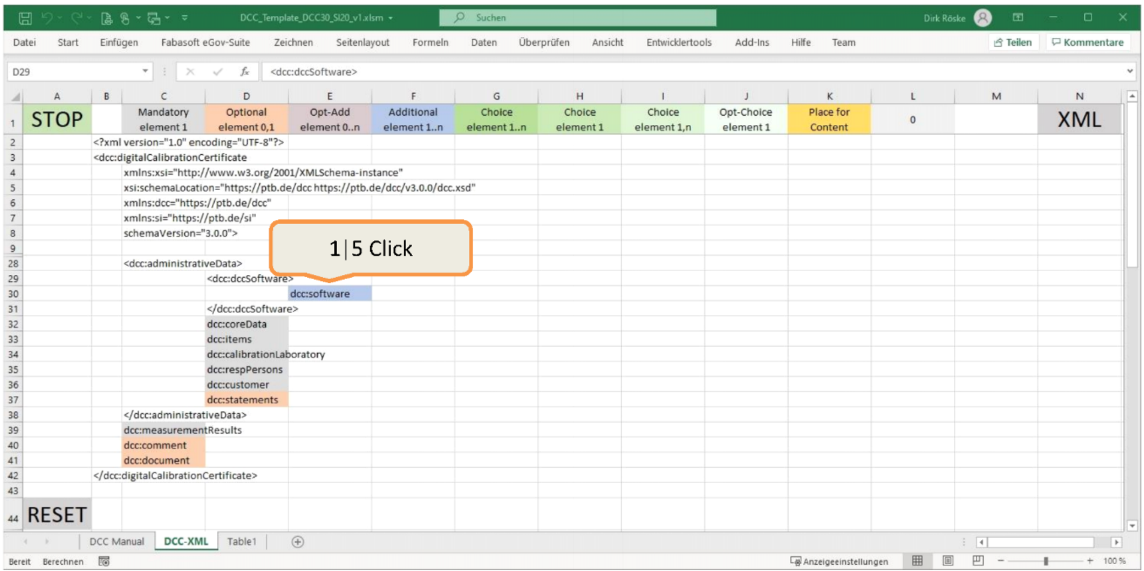
How to use the tool – Some details



How to use the tool – Some details



How to use the tool – Some details



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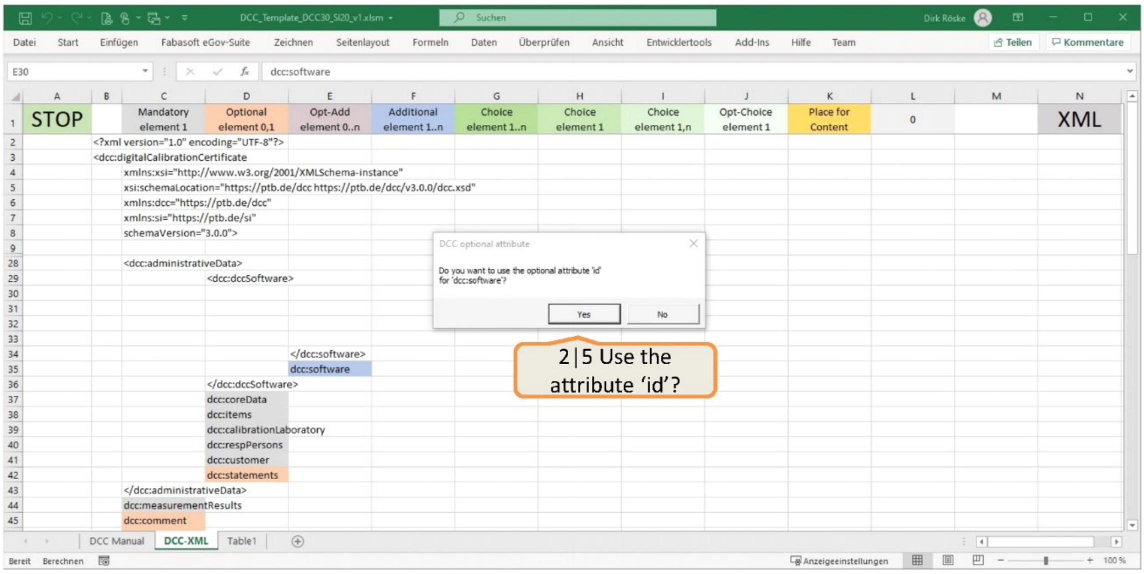

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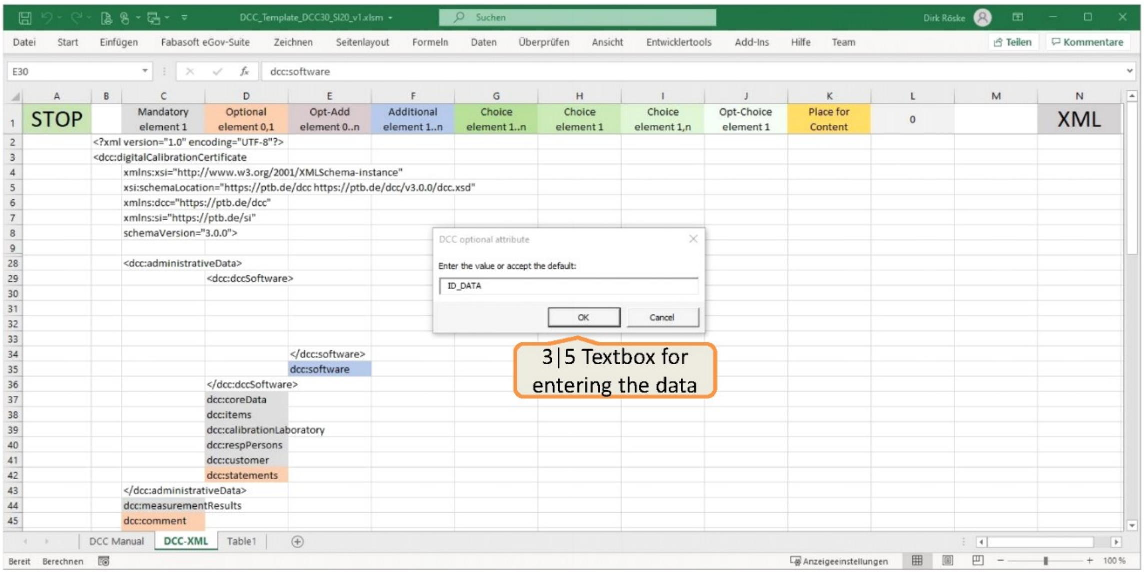
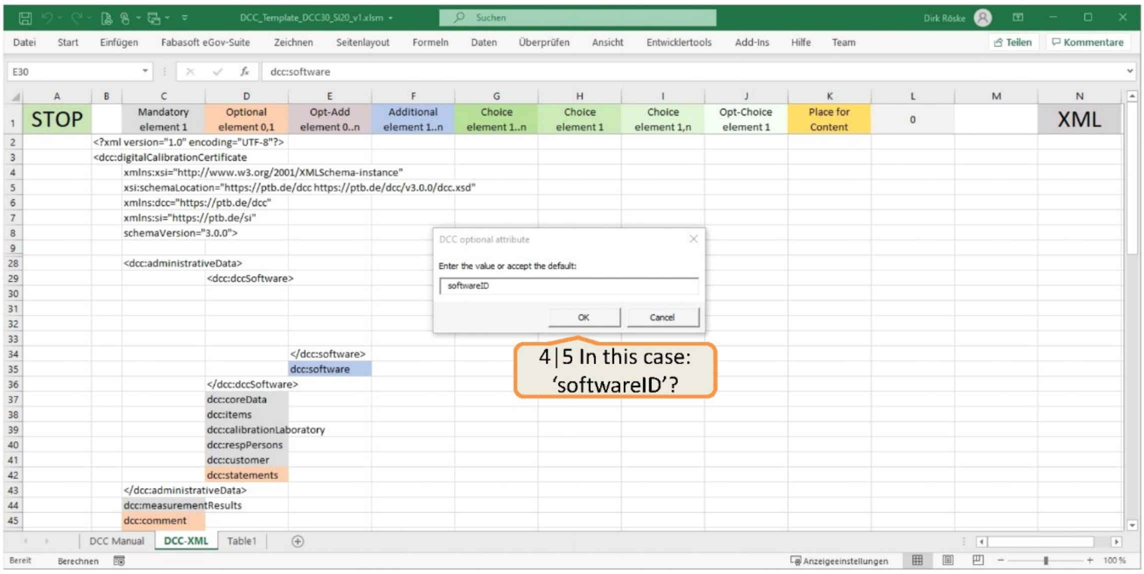
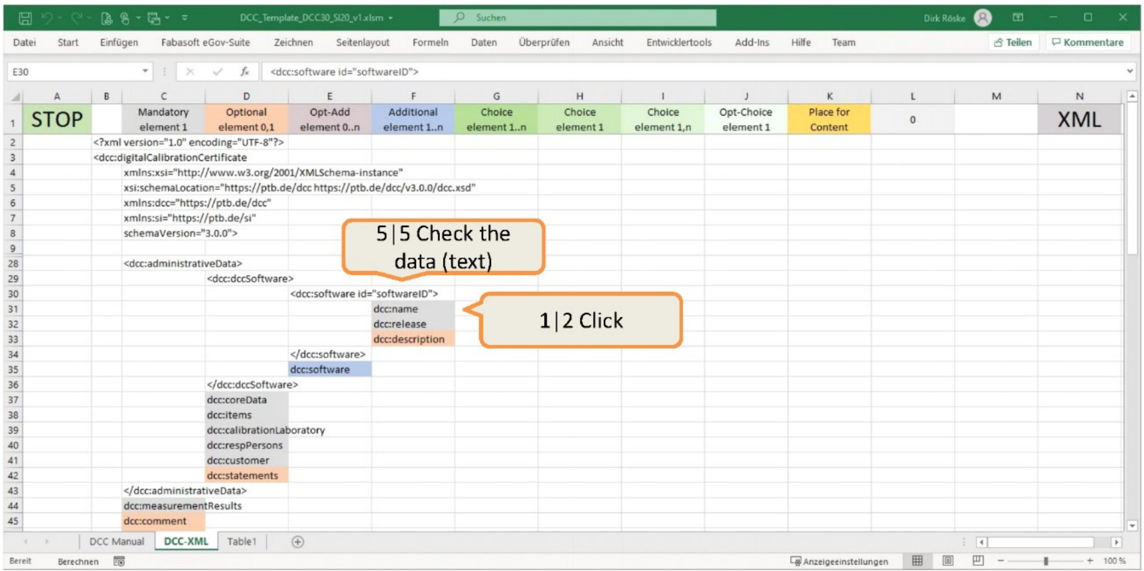


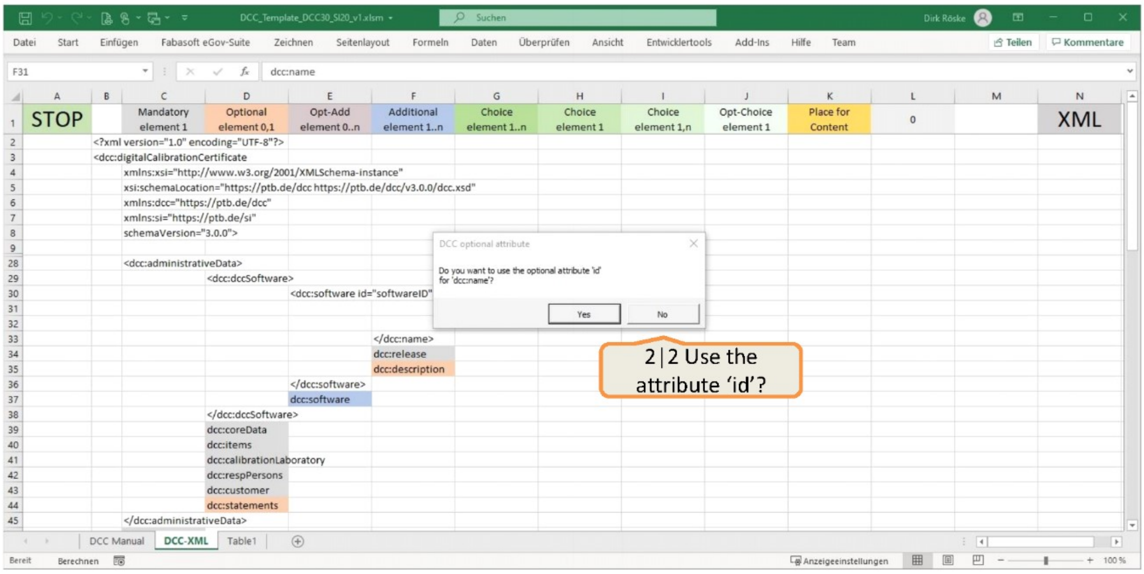
How to use the tool – Some details



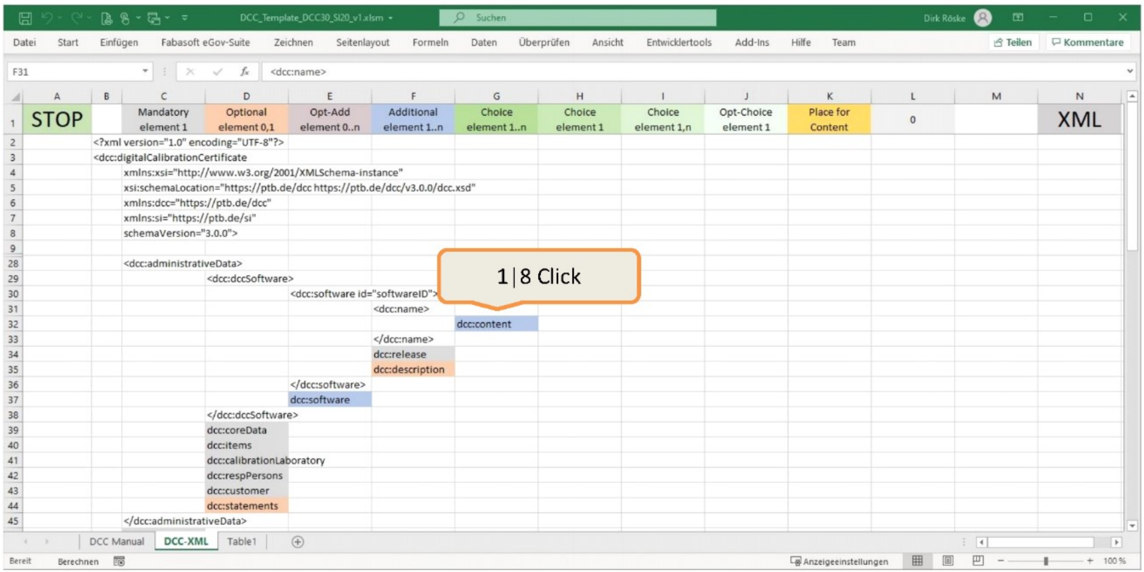
How to use the tool – Some details



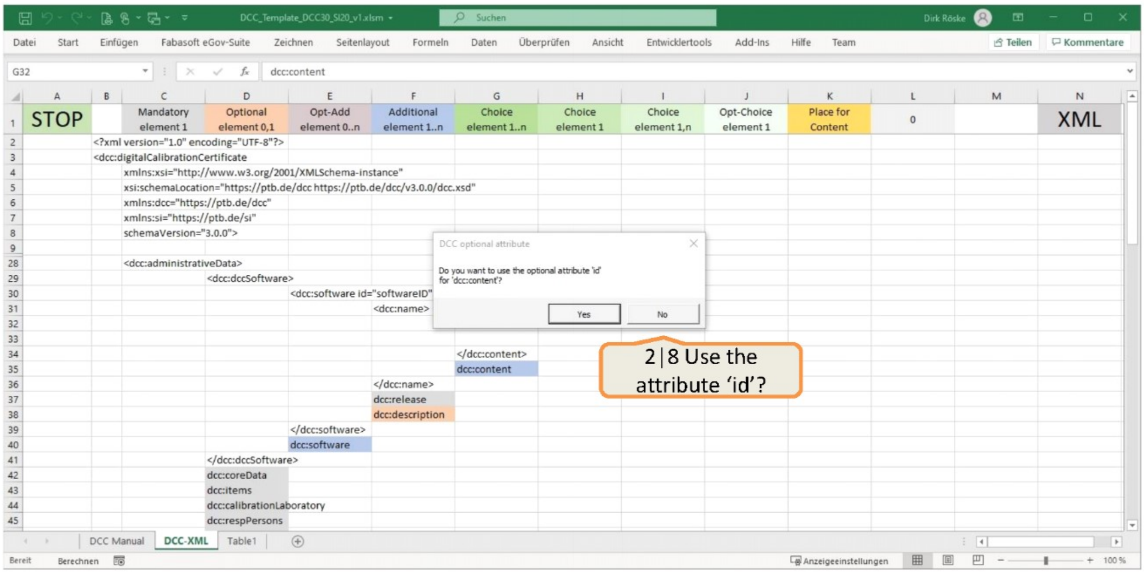
How to use the tool – Some details



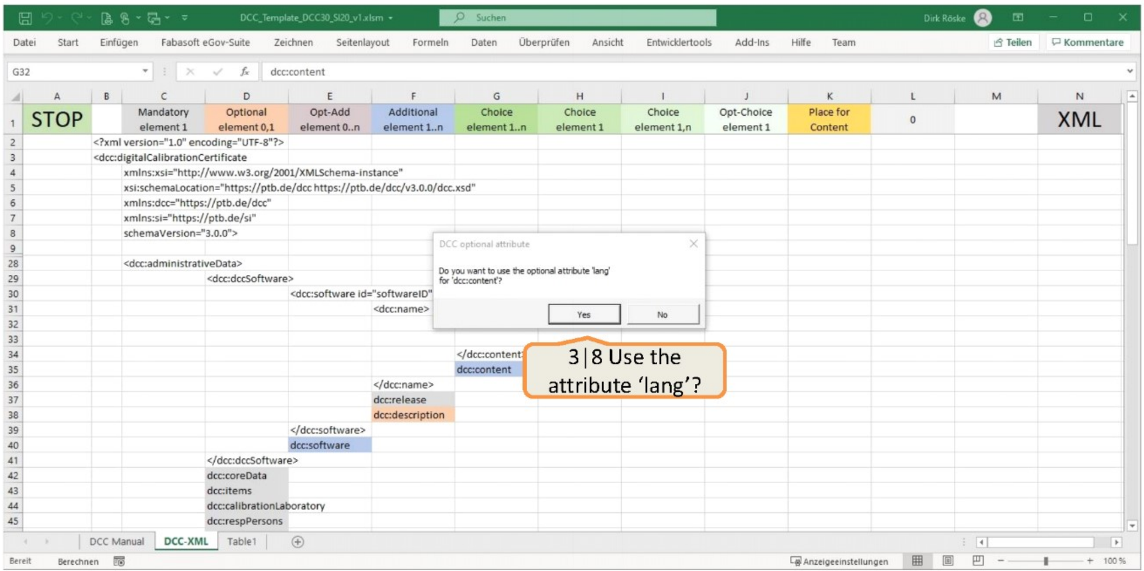
How to use the tool – Some details



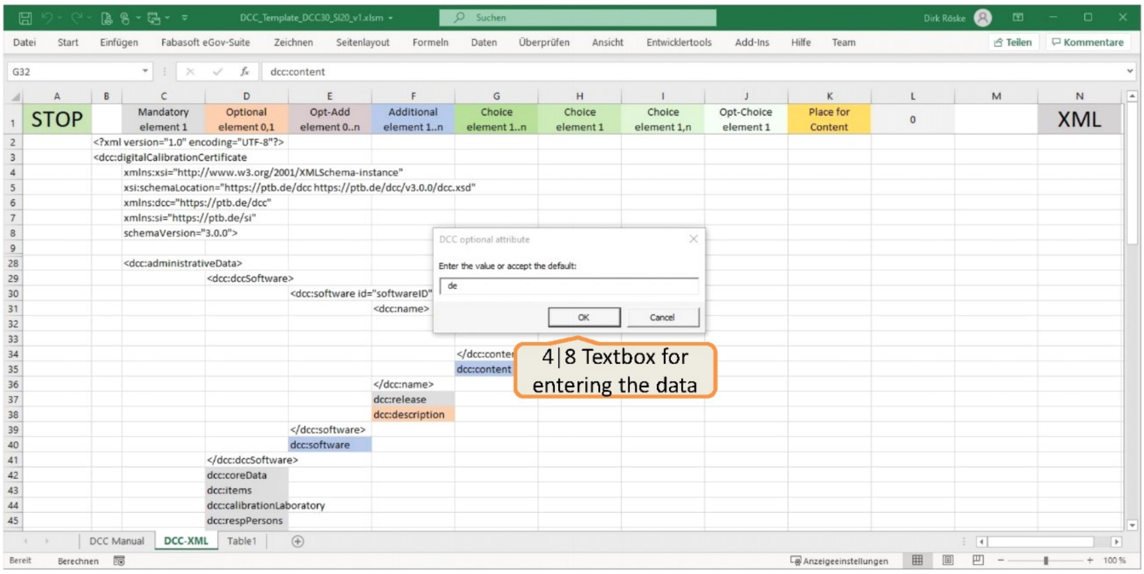
How to use the tool – Some details



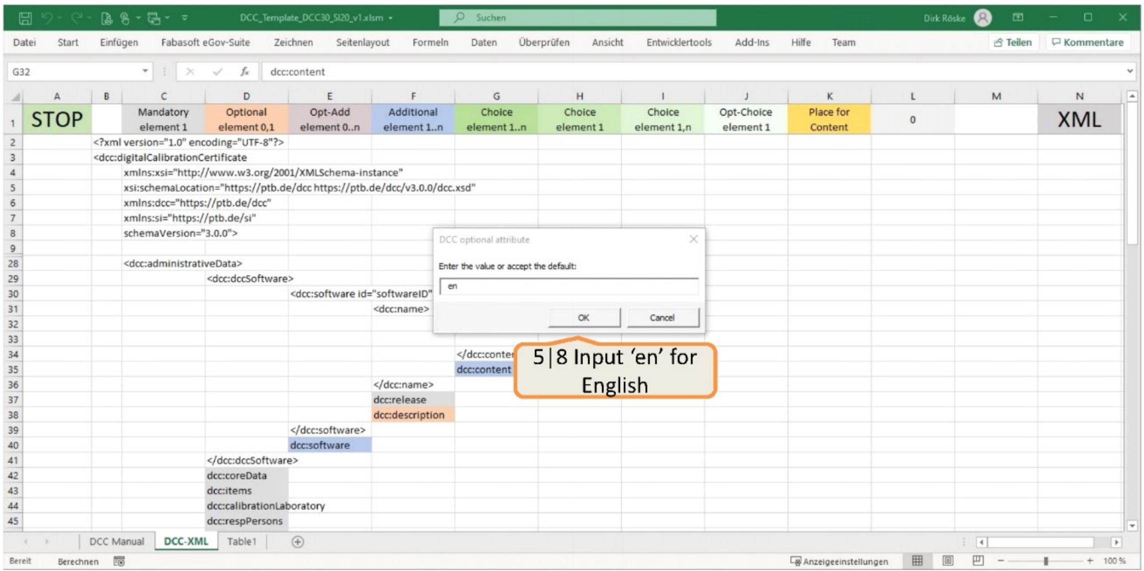
How to use the tool – Some details



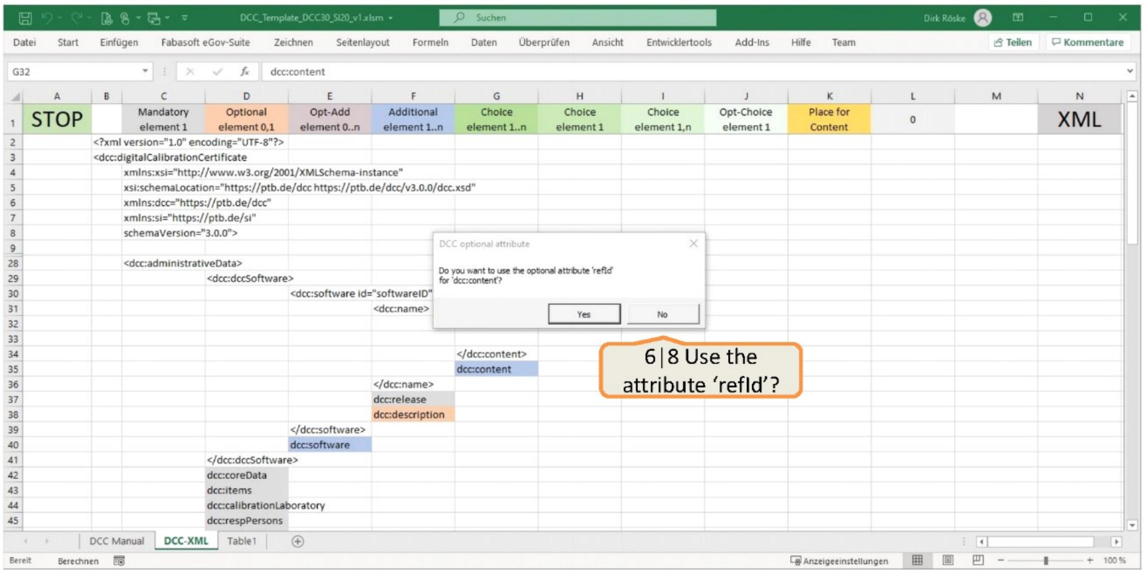
How to use the tool – Some details



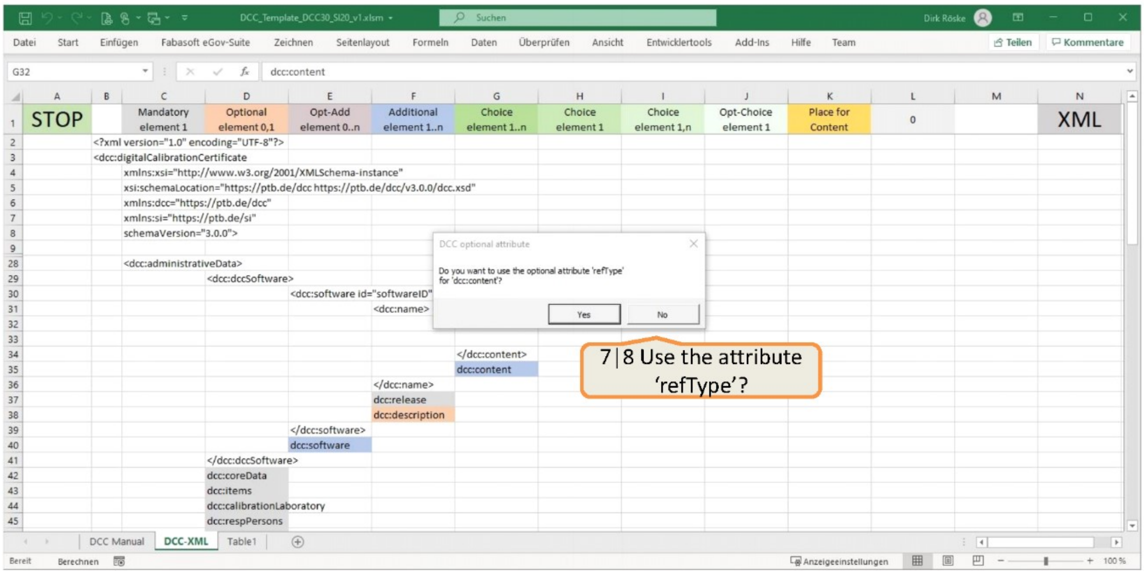
How to use the tool – Some details



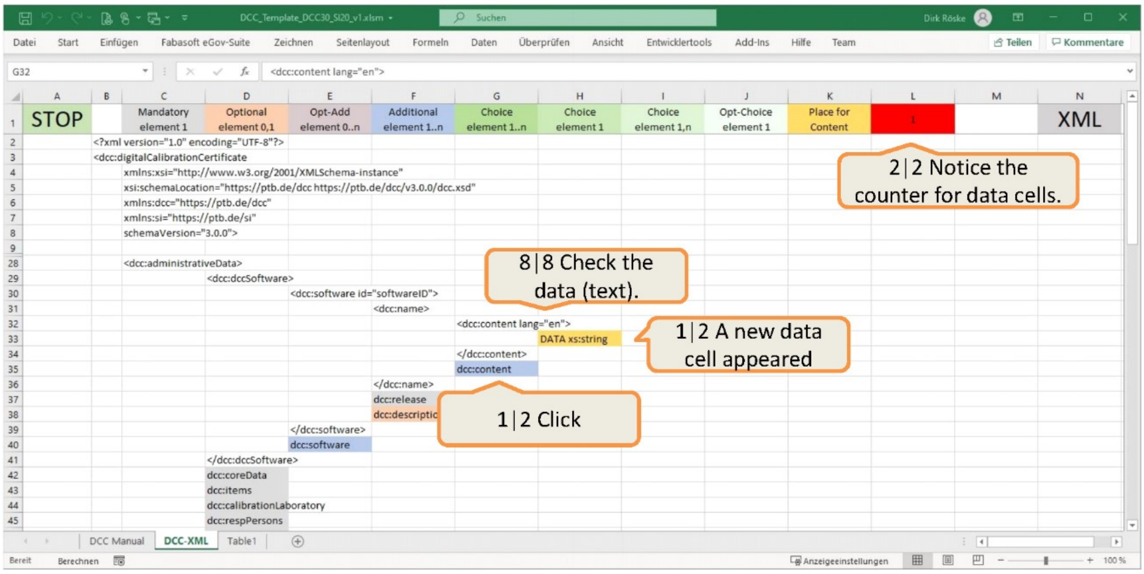
How to use the tool – Some details



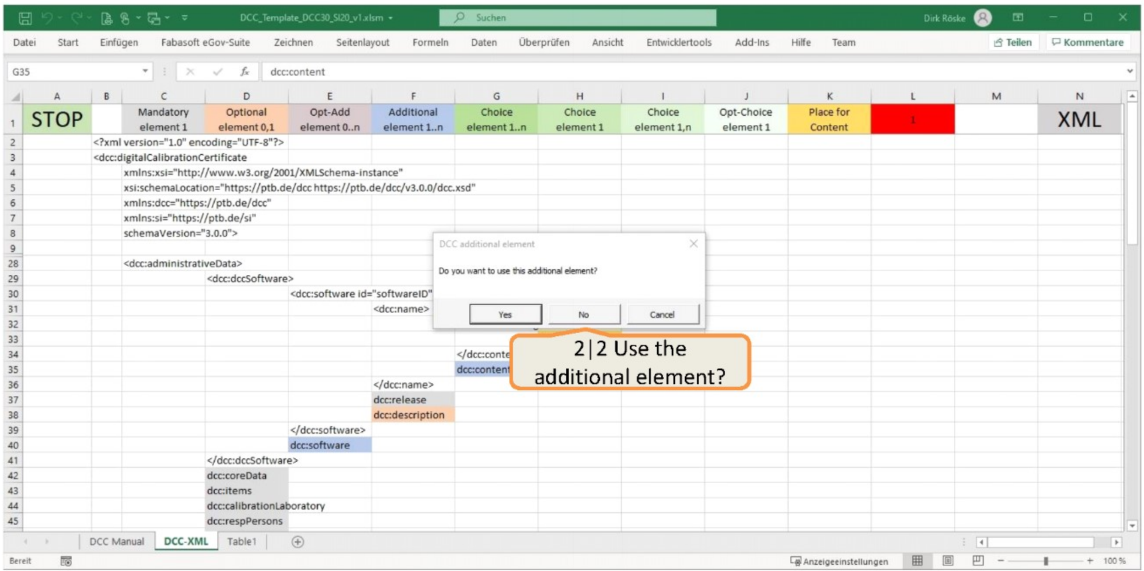
How to use the tool – Some details



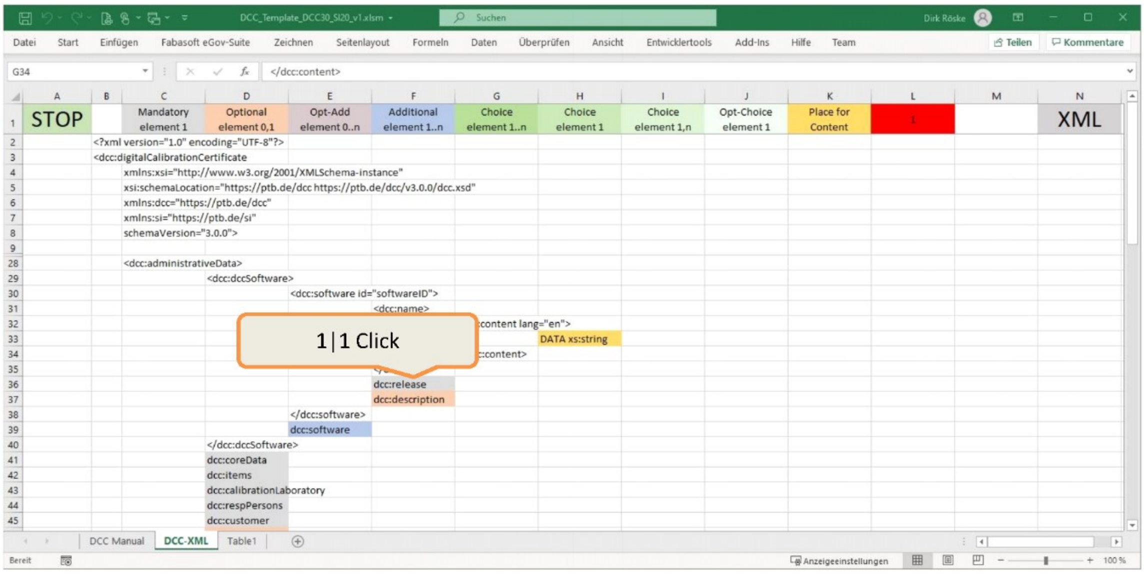
How to use the tool – Some details



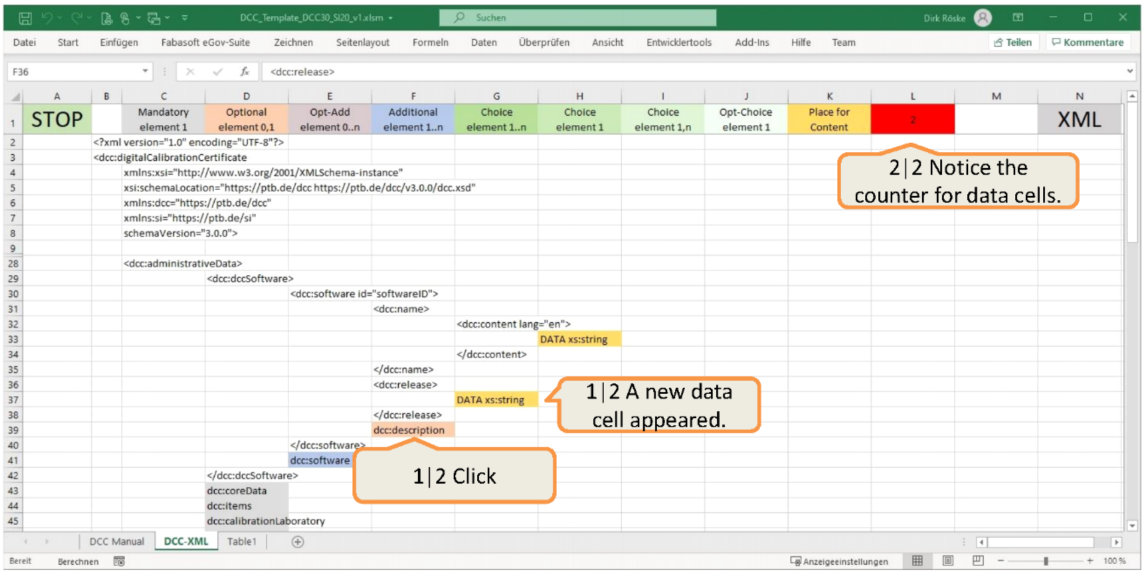
How to use the tool – Some details



How to use the tool – Some details



How to use the tool – Some details



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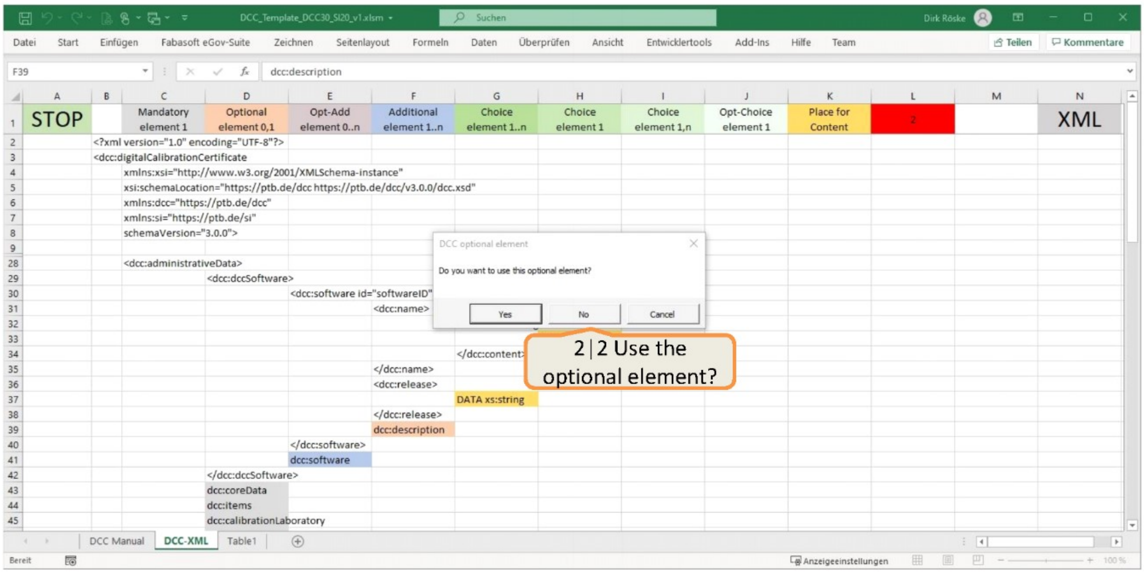
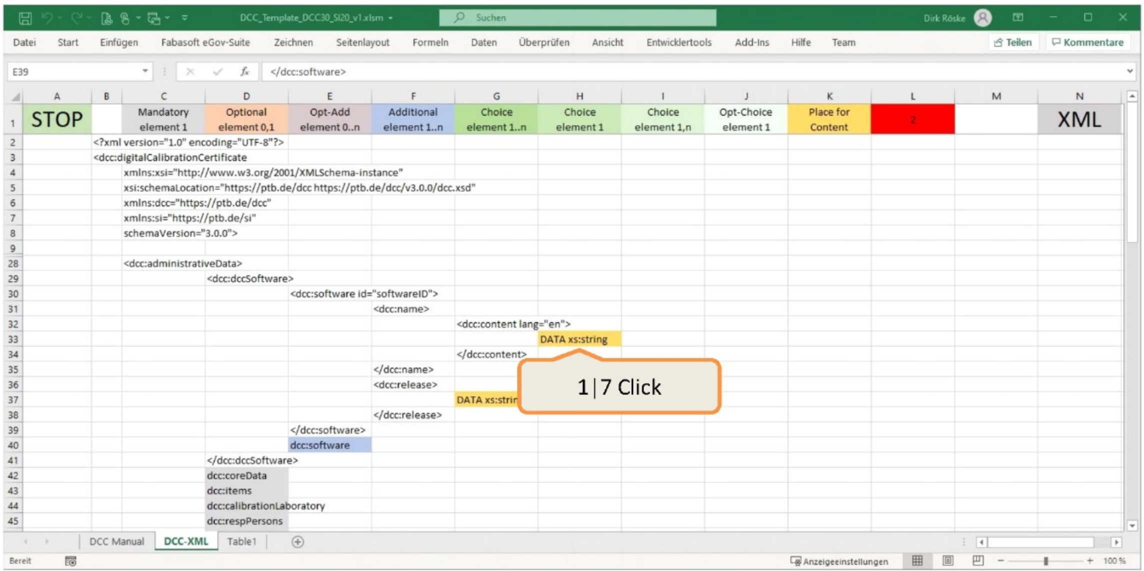
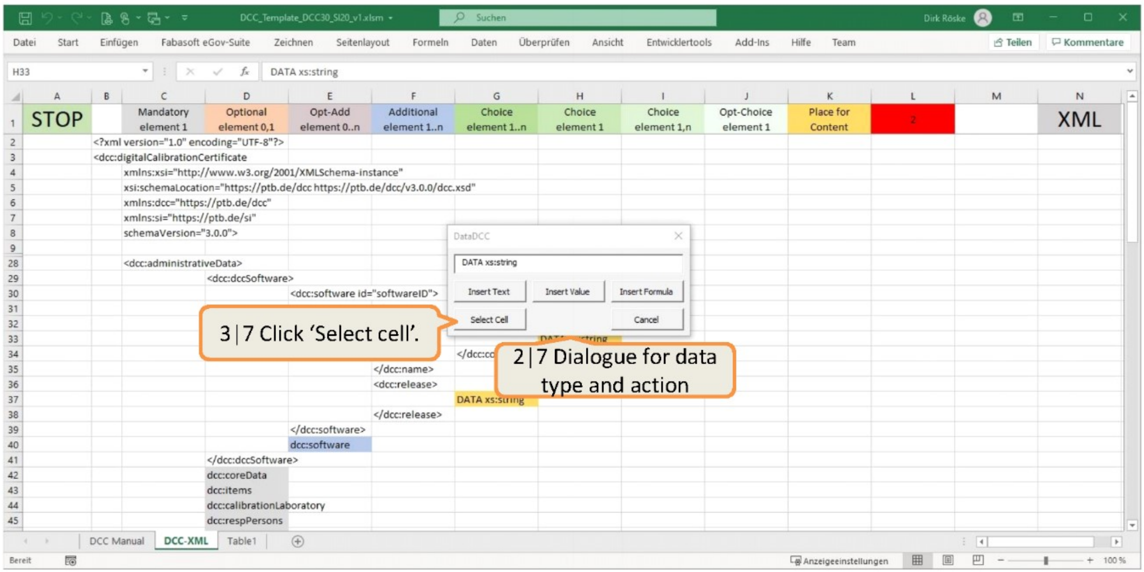


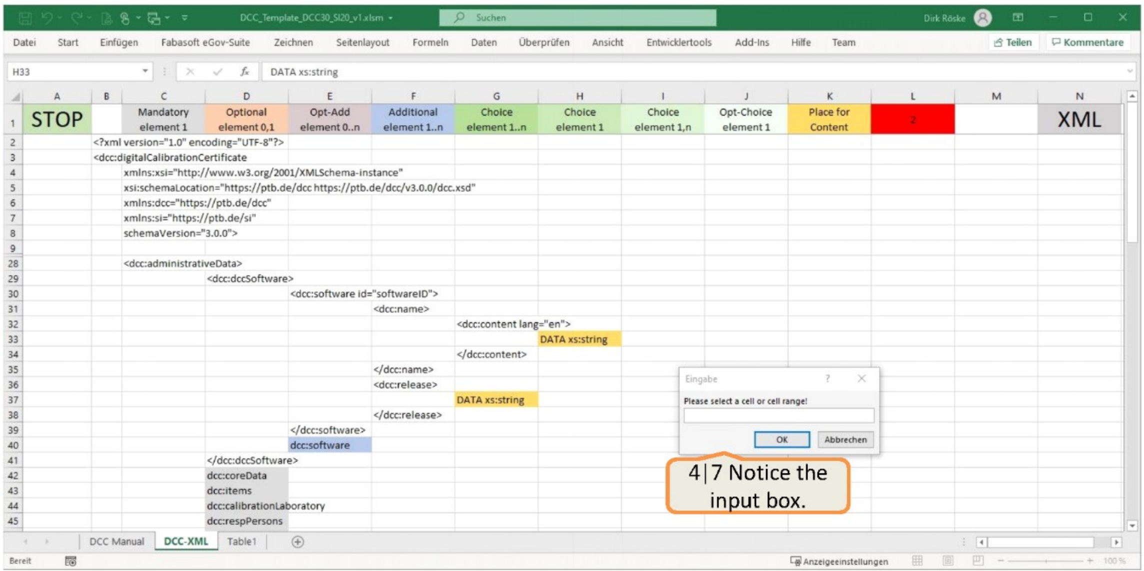
How to use the tool – Some details



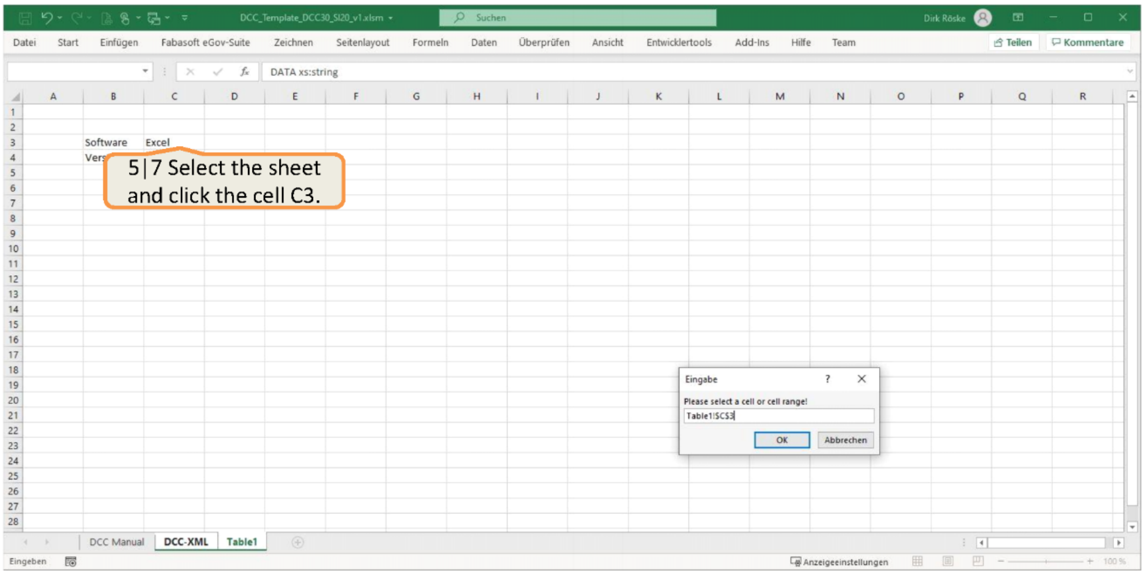
How to use the tool – Some details



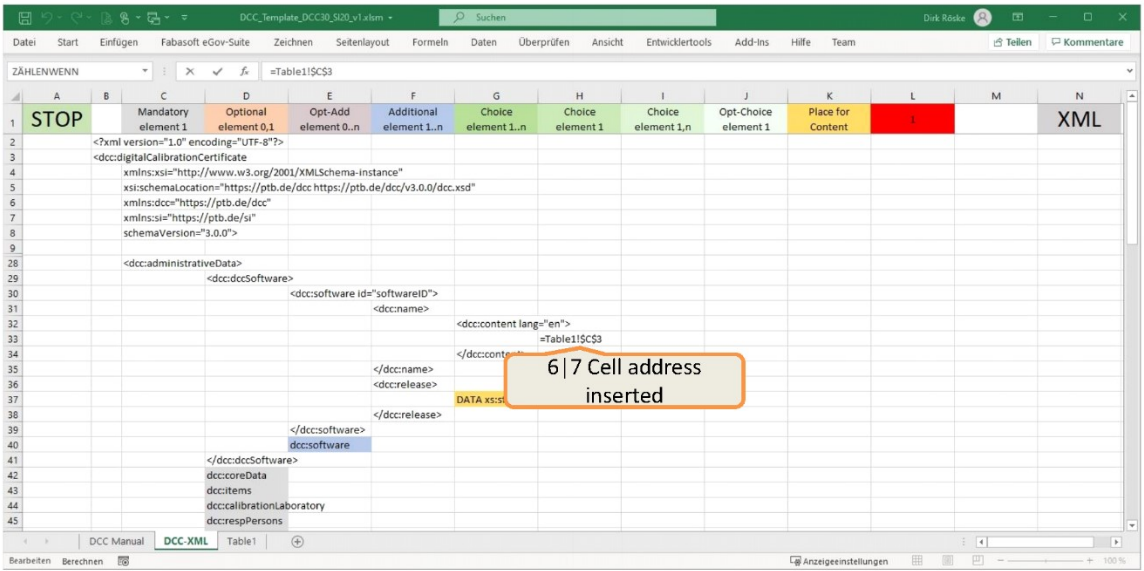
How to use the tool – Some details

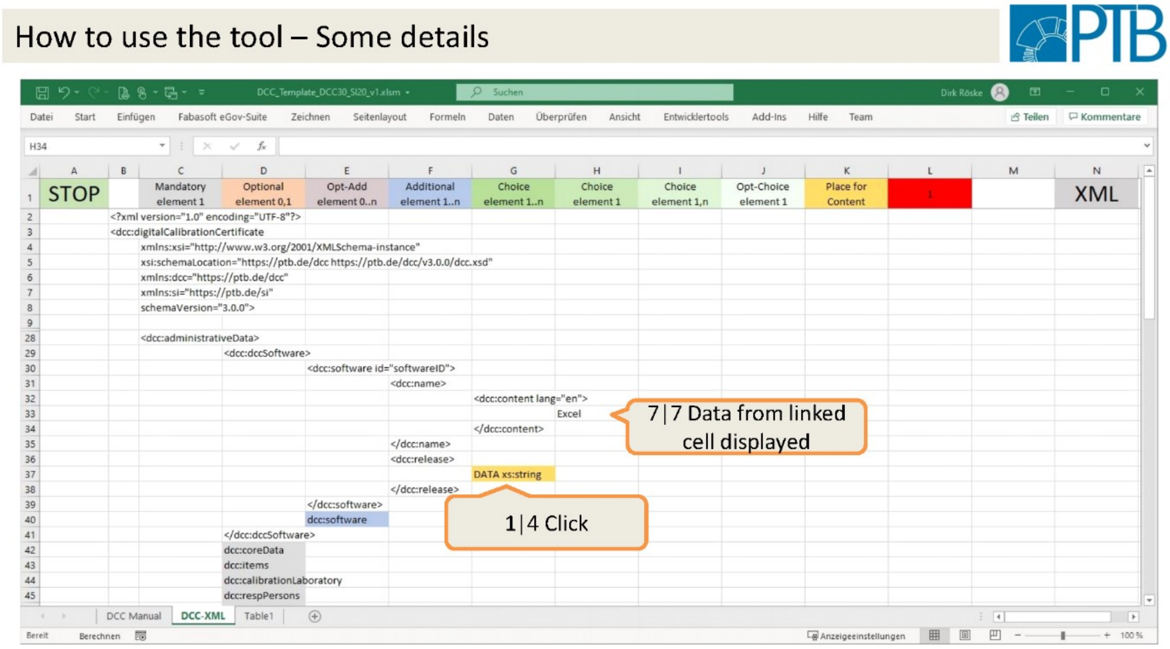


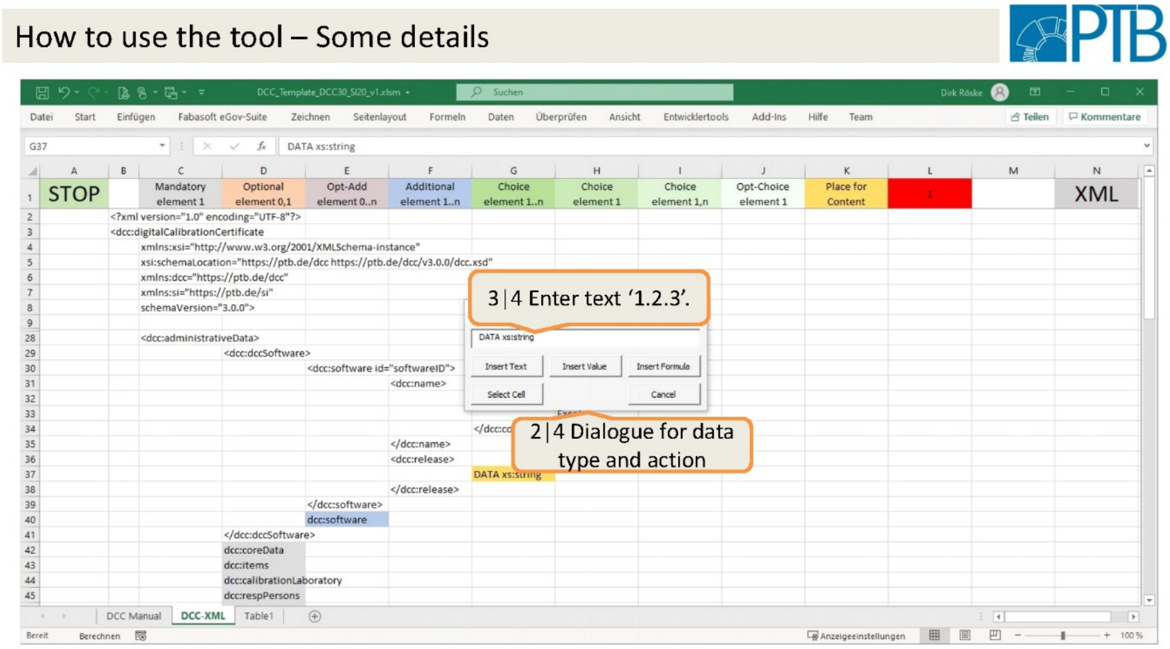
How to use the tool – Some details



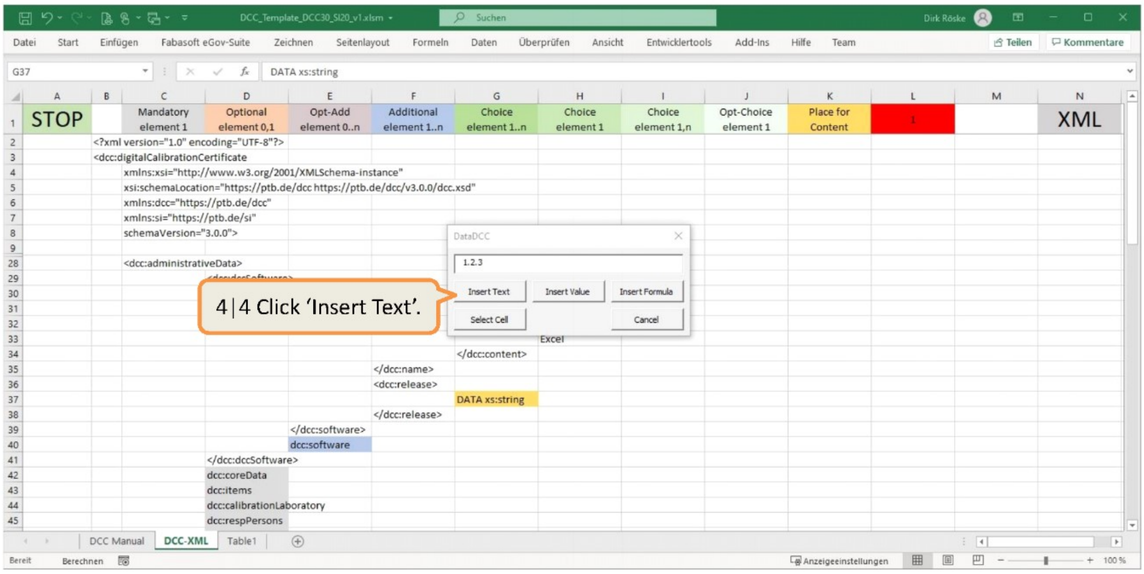
How to use the tool – Some details



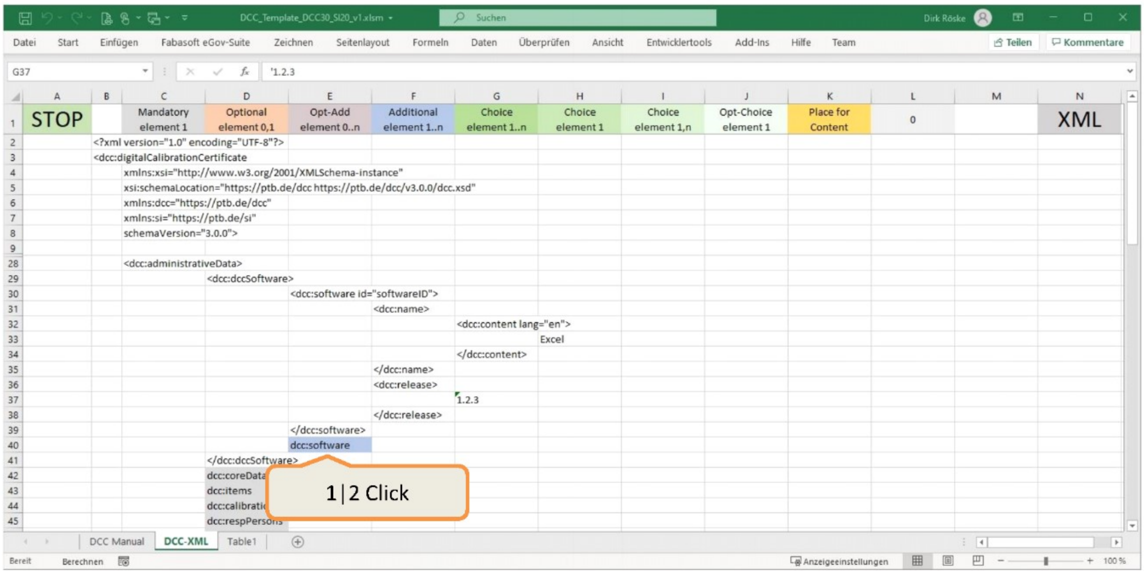

How to use the tool – Some details
STOP
Mandatory element 1
Optional element 0,1
Opt-Add element 0..n
Additional element 1..n
Choice element 1..n
Choice element 1
Choice element 1,n
Opt-Choice element 1
Place for Content
XML
<?xml version="1.0" encoding="UTF-8"?>
<dcc:digitalCalibrationCertificate
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="https://ptb.de/dcc https://ptb.de/dcc/v3.0.0/dcc.xsd"
xmlns:dcc="https://ptb.de/dcc"
xmlns:si="https://ptb.de/si"
schemaVersion="3.0.0">
<dcc:administrativeData>
<dcc:dccSoftware>
<dcc:software id="softwareID">
<dcc:name>
<dcc:content lang="en">
Excel
</dcc:content>
</dcc:name>
<dcc:release>
DATA xs:string
</dcc:release>
</dcc:software>
dcc:software
</dcc:dccSoftware>
dcc:coreData
dcc:items
dcc:calibrationLaboratory
dcc:respPersons
7|7 Data from linked cell displayed
1|4 Click
DCC Manual
DCC-XML
Table1


How to use the tool – Some details
DATA xs:string
3|4 Enter text '1.2.3'.
Insert Text
Insert Value
Insert Formula
Select Cell
Cancel
2|4 Dialogue for data type and action
DCC Manual
DCC-XML
Table1

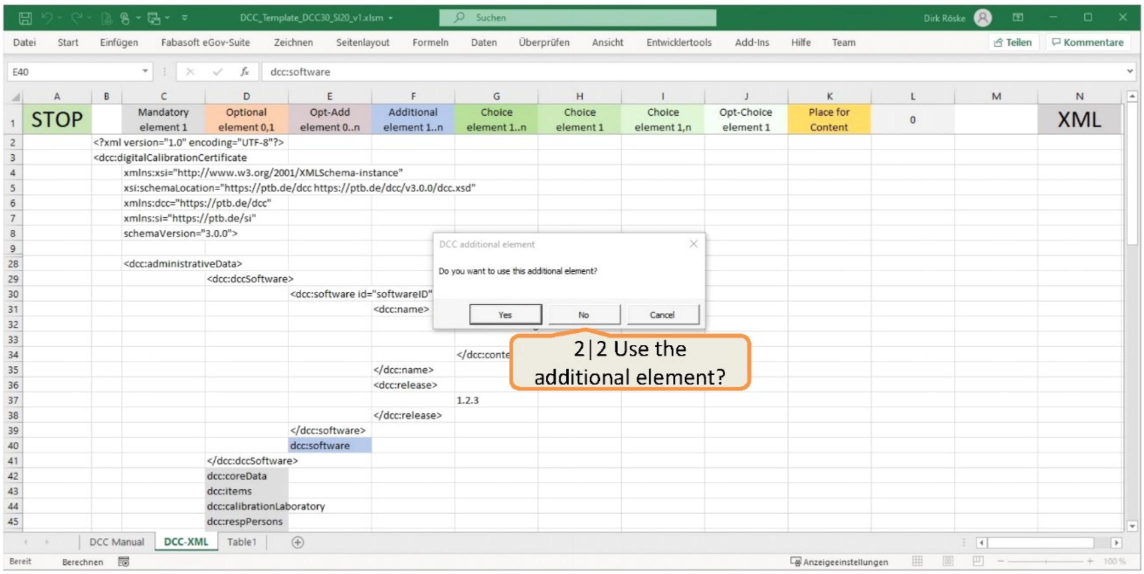
How to use the tool – Some details



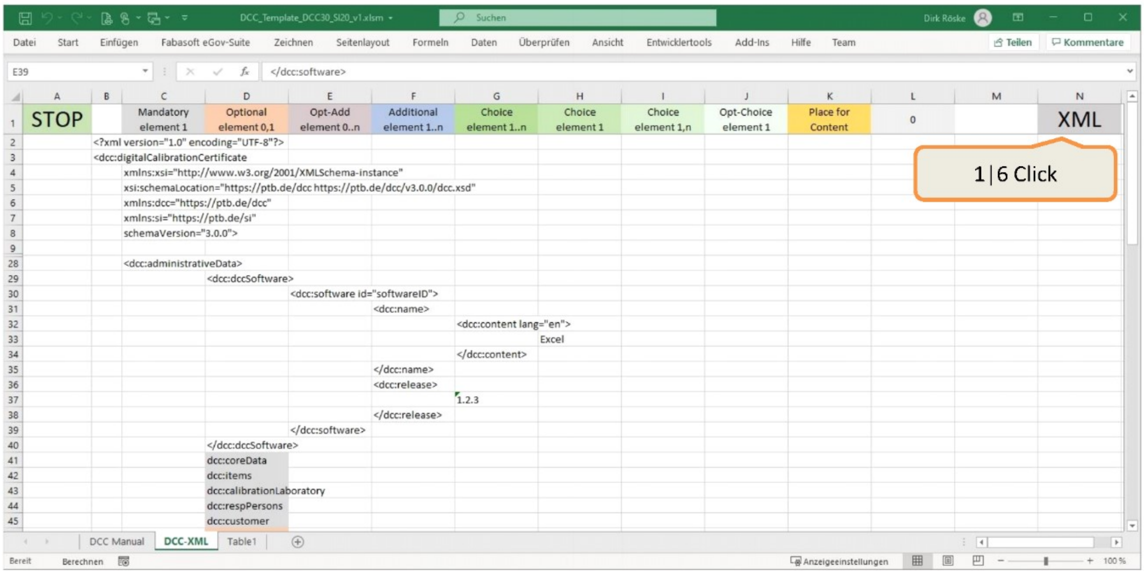
How to use the tool – Some details



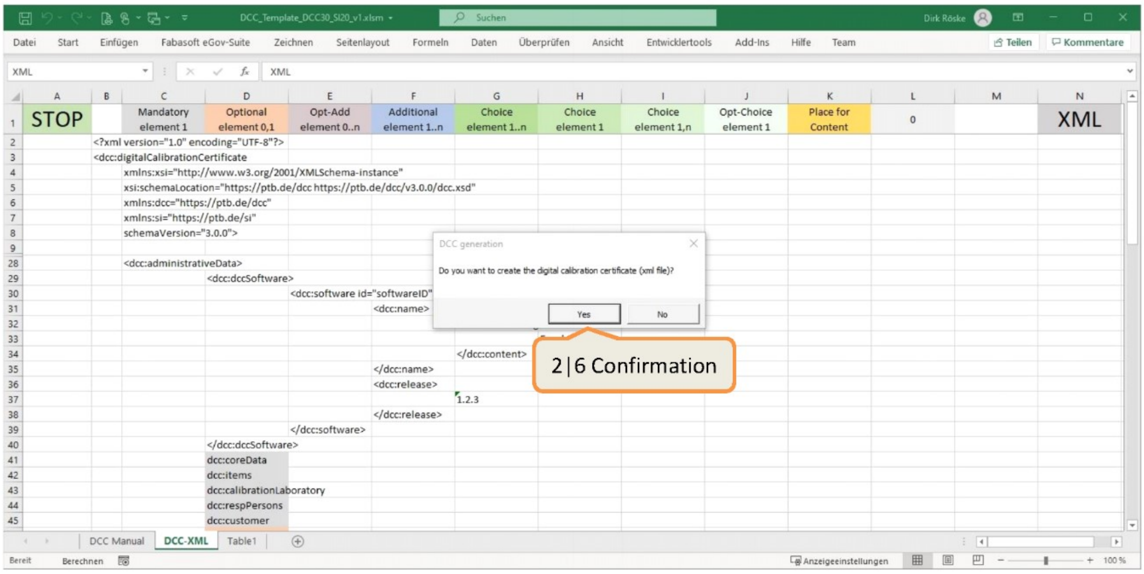
How to use the tool – Some details



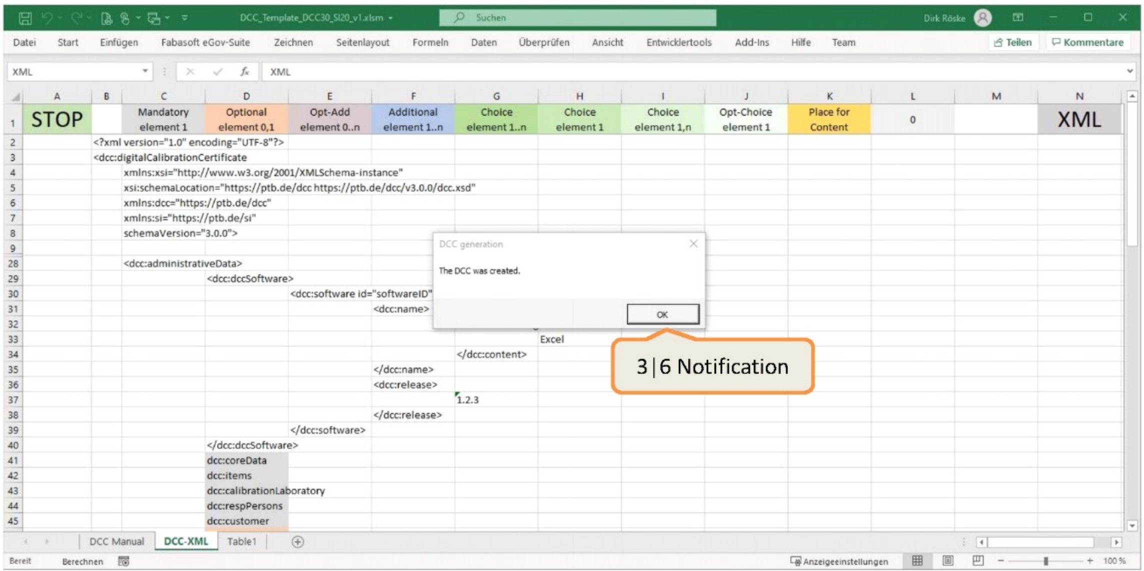
How to use the tool – Some details



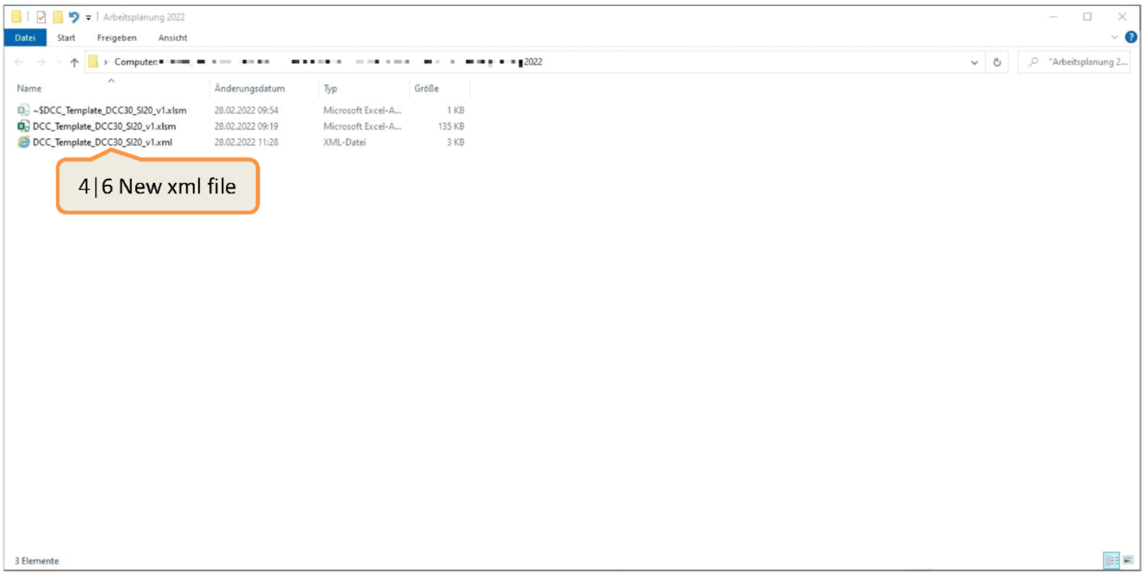
How to use the tool – Some details



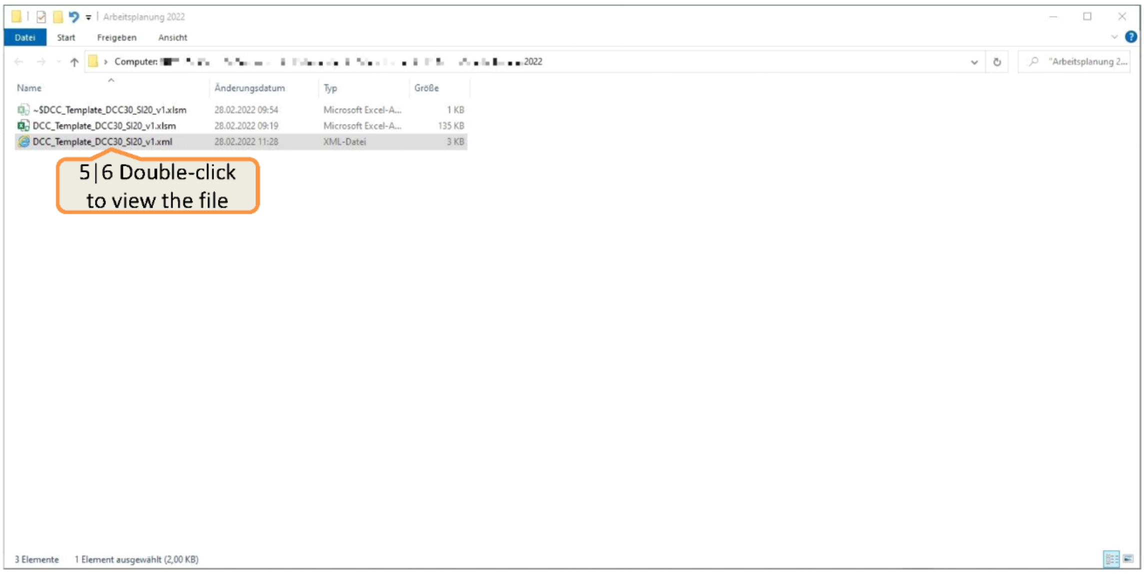
How to use the tool – Some details



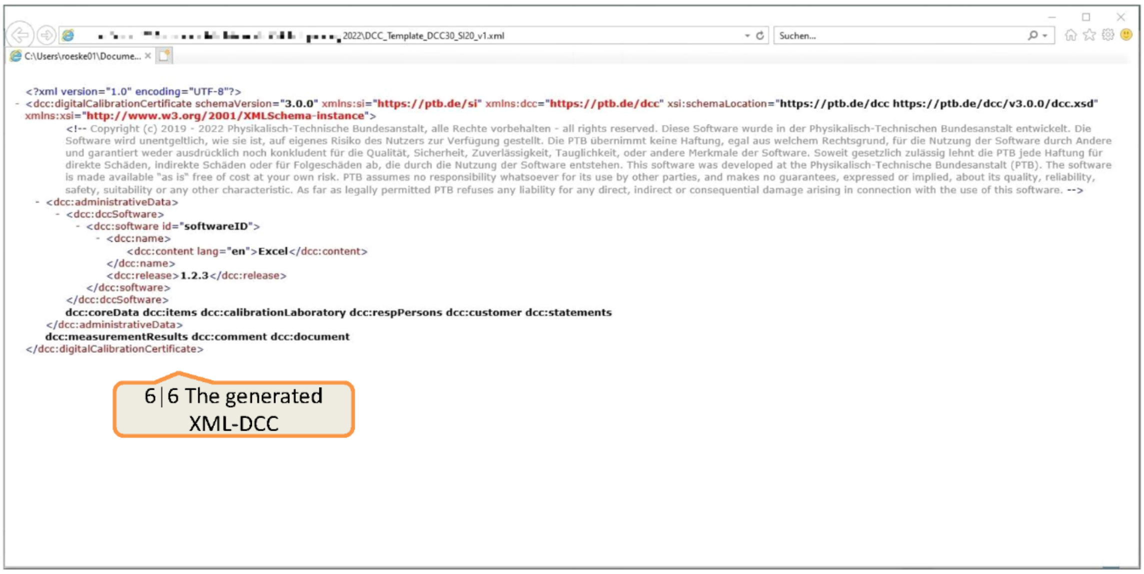
How to use the tool – Some details



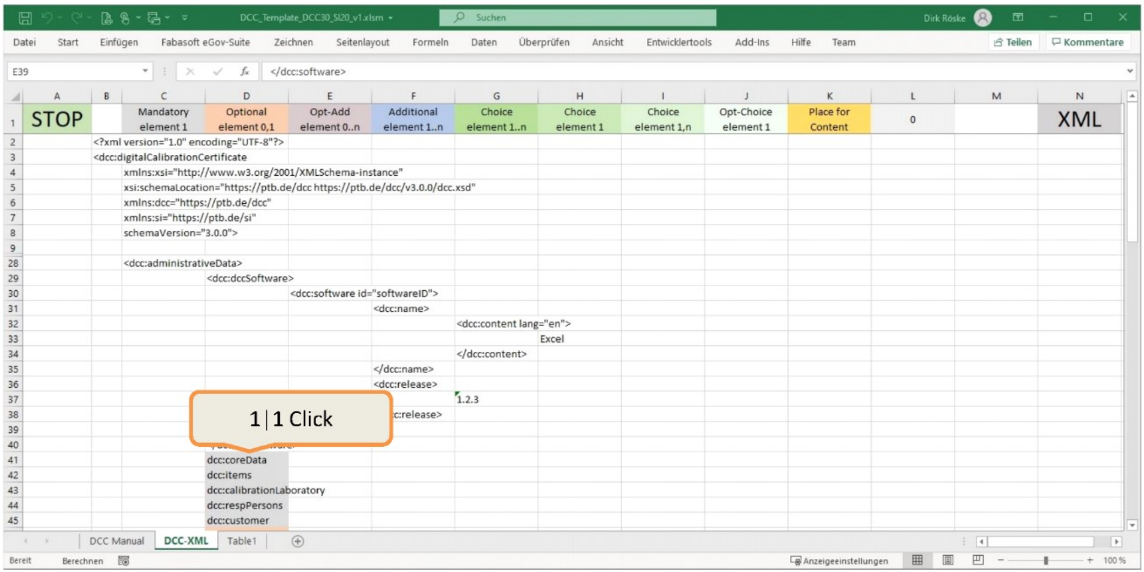
How to use the tool – Some details



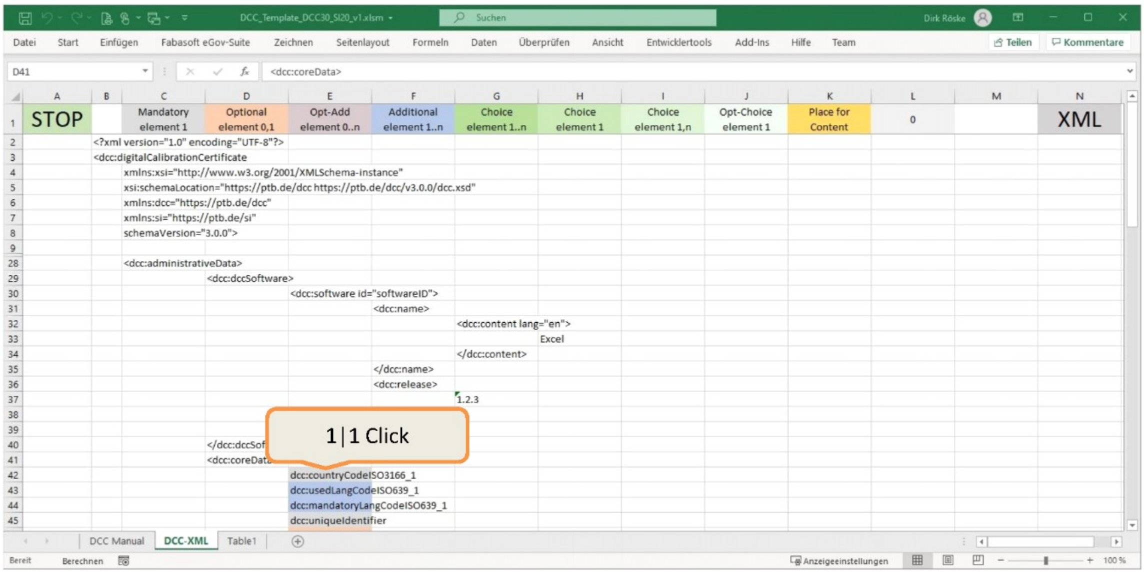
How to use the tool – Some details



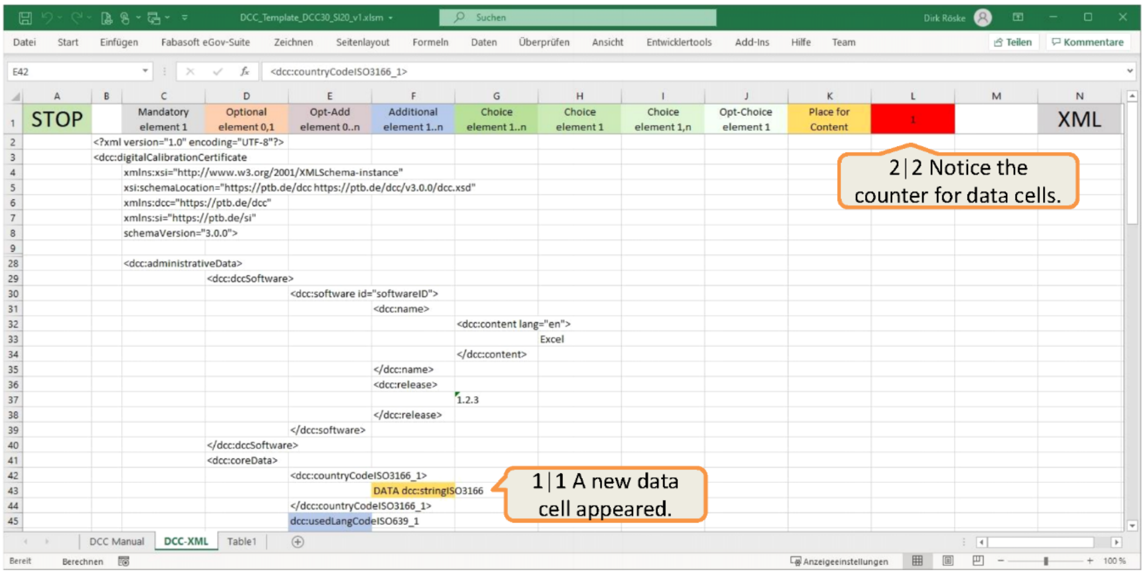
How to use the tool – Some details



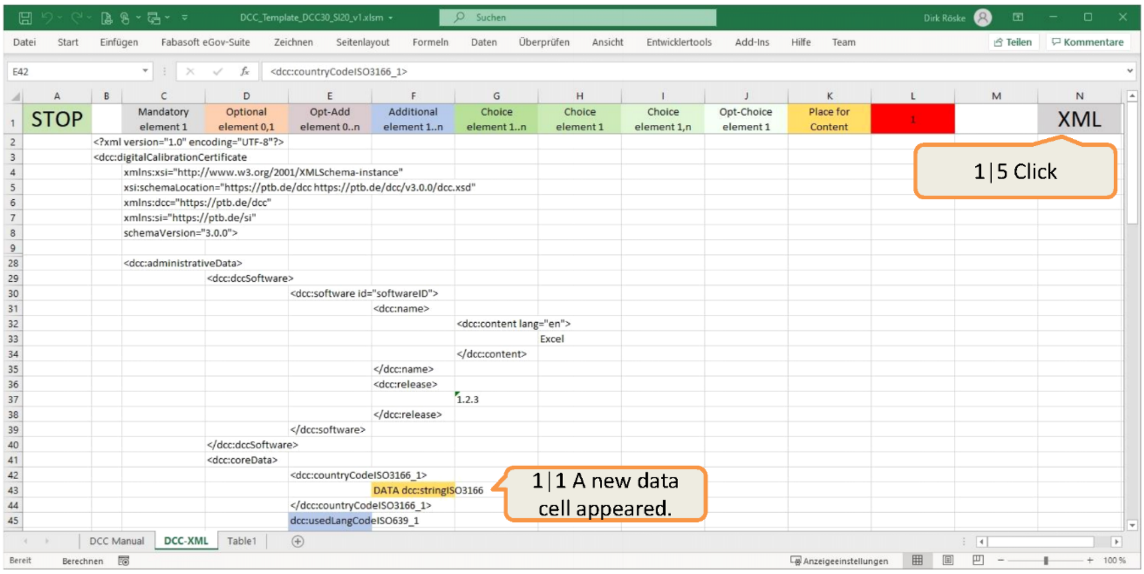
How to use the tool – Some details



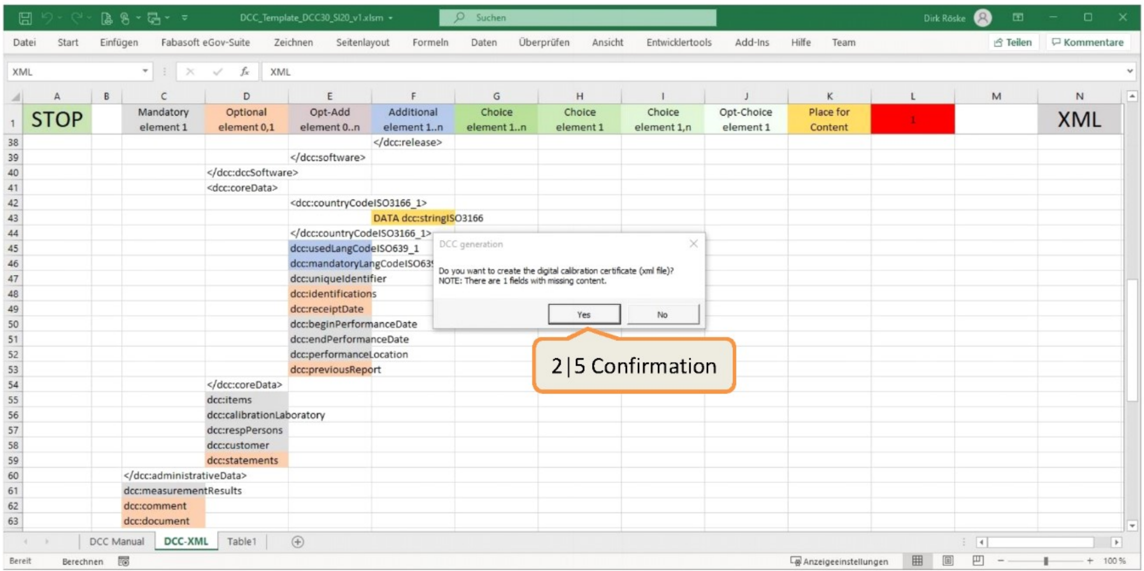
How to use the tool – Some details



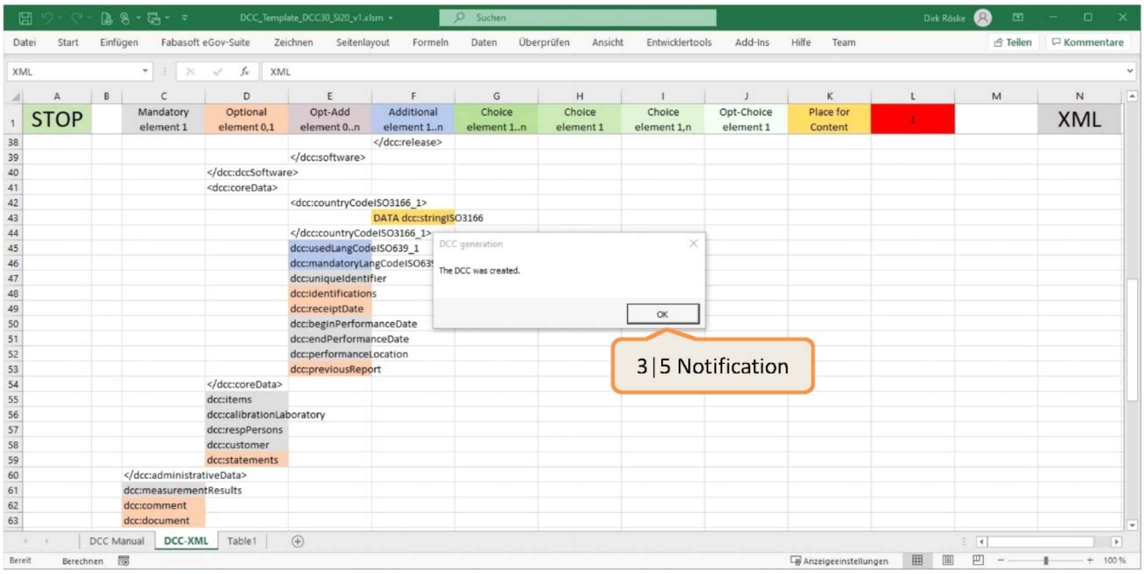
How to use the tool – Some details



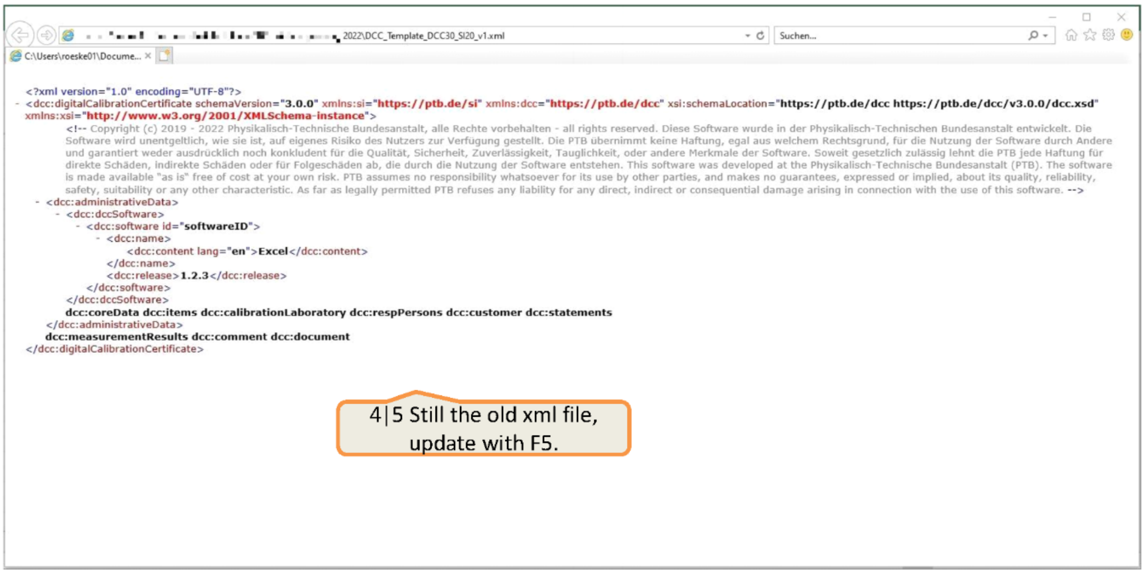
How to use the tool – Some details



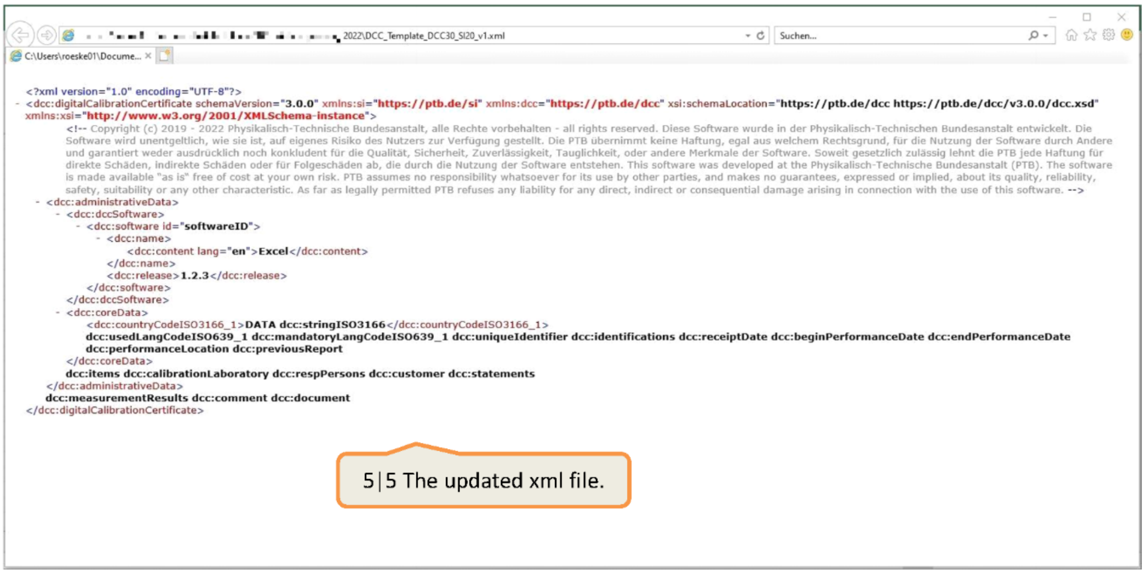
How to use the tool – Some details



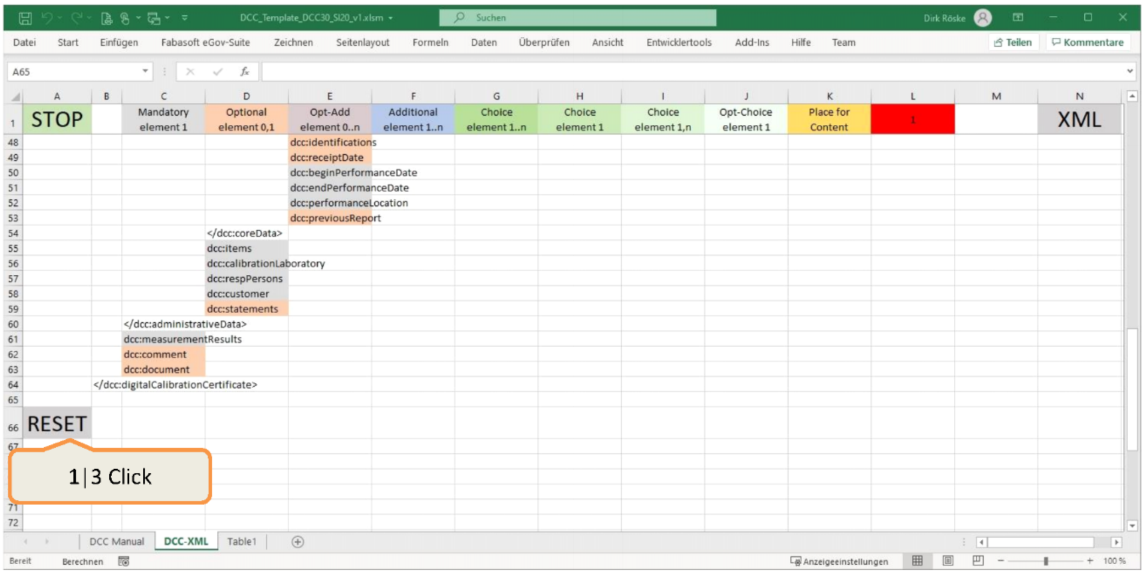
How to use the tool – Some details



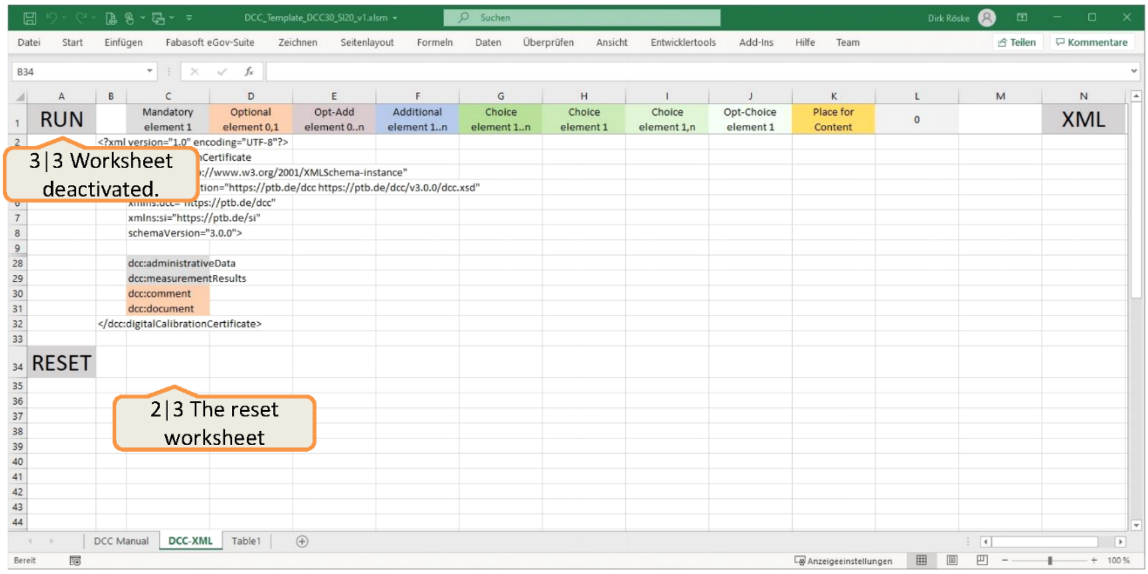
How to use the tool – Some details



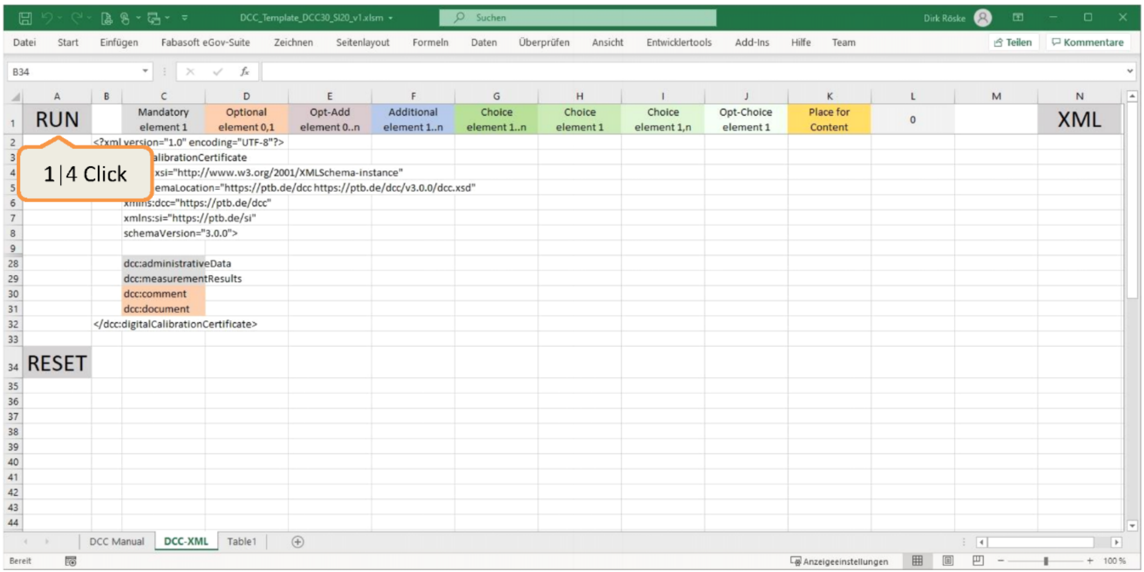
How to use the tool – Some details



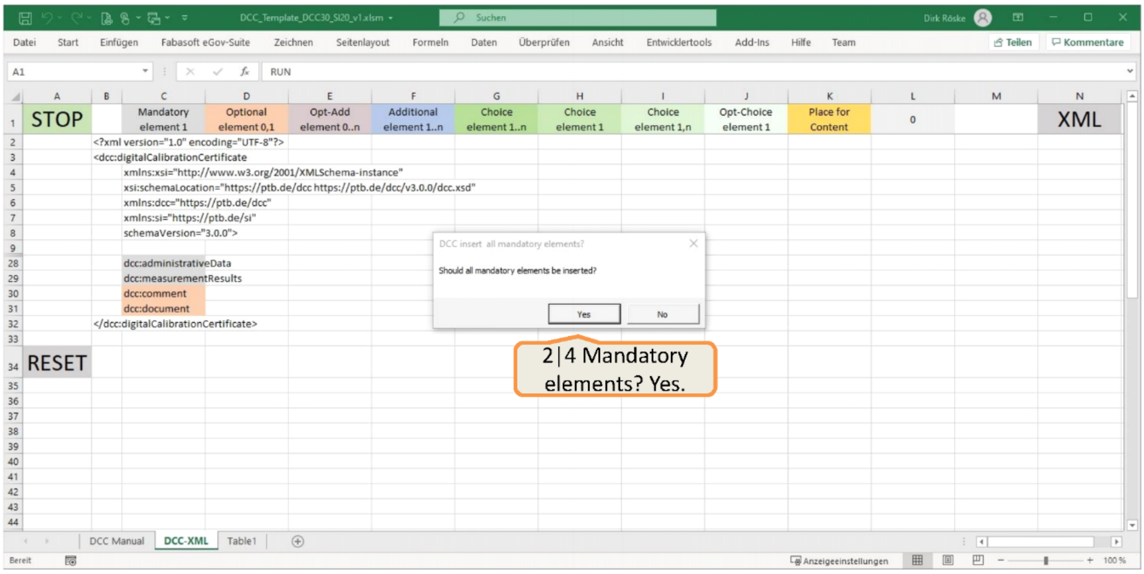
How to use the tool – Some details



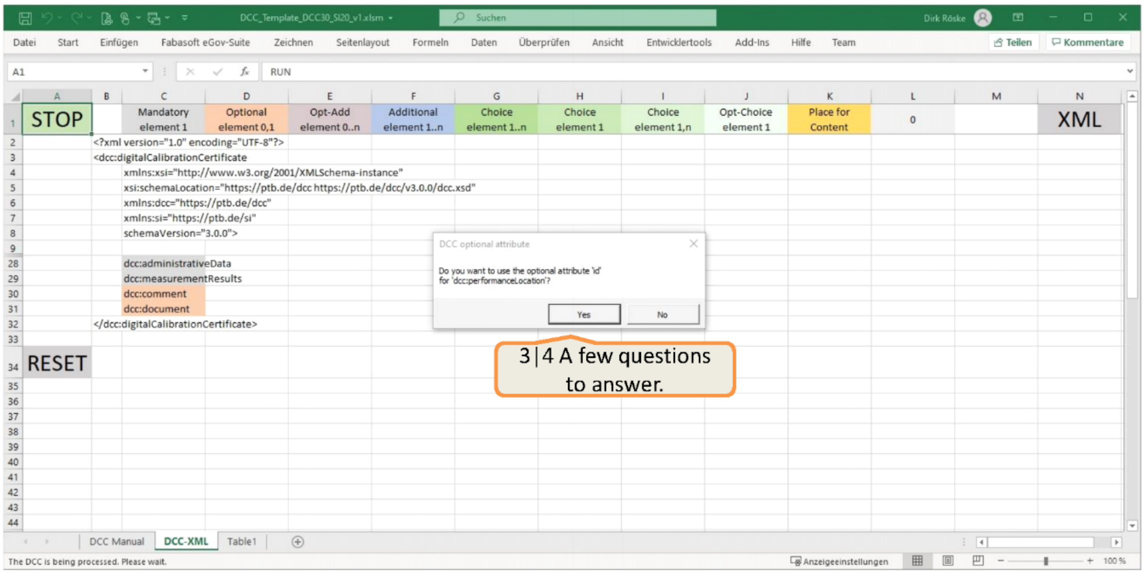
How to use the tool – Some details

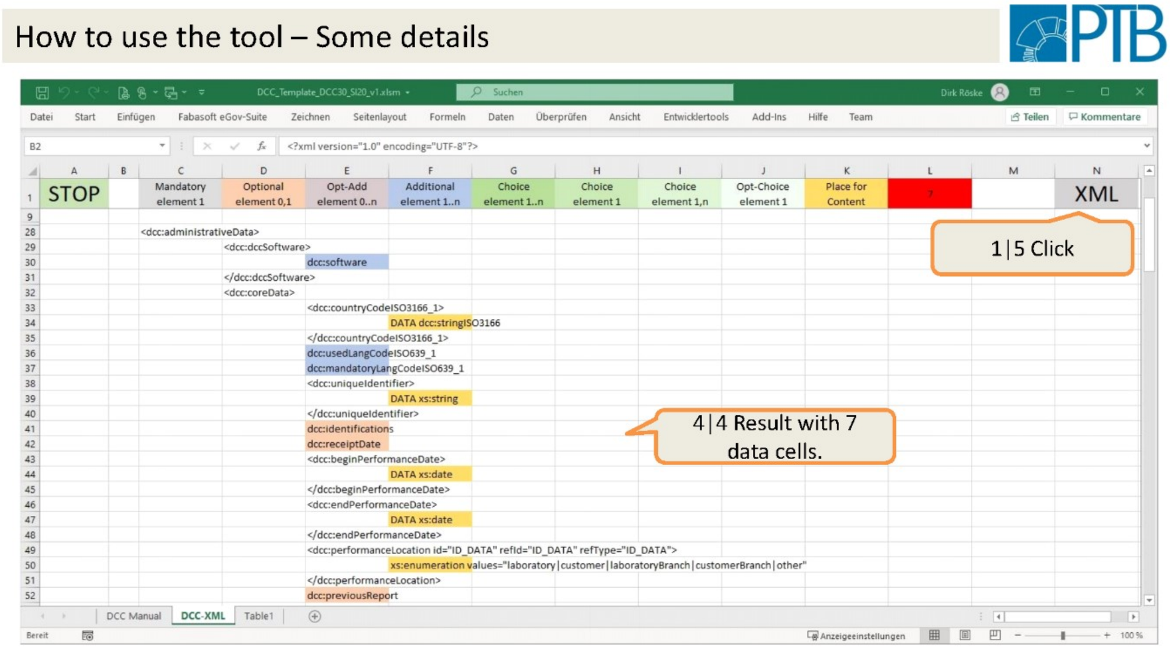


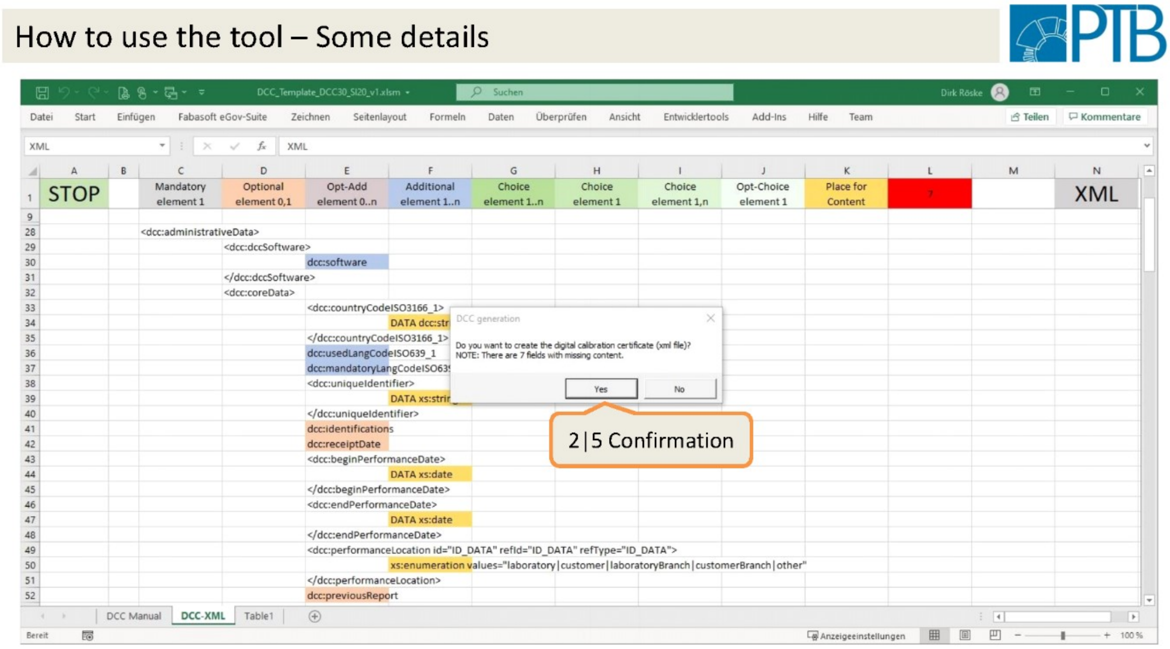
How to use the tool – Some details



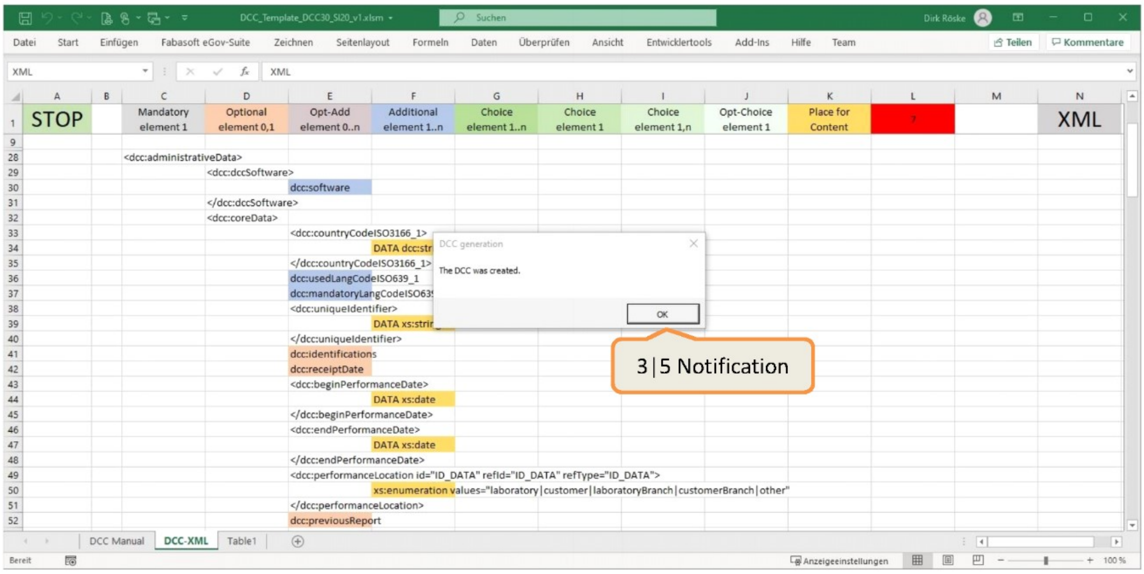
How to use the tool – Some details



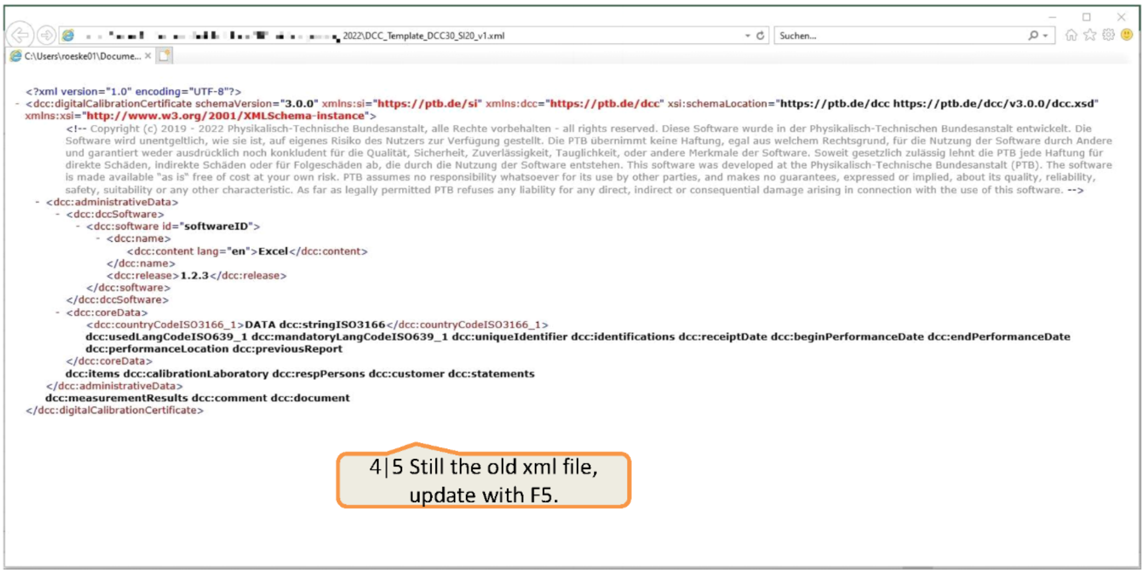

How to use the tool – Some details
STOP
Mandatory element 1
Optional element 0,1
Opt-Add element 0..n
Additional element 1..n
Choice element 1..n
Choice element 1
Choice element 1,n
Opt-Choice element 1
Place for Content
XML
1|5 Click
4|4 Result with 7 data cells.
DCC Manual
DCC-XML
Table1


How to use the tool – Some details
STOP
Mandatory element 1
Optional element 0,1
Opt-Add element 0..n
Additional element 1..n
Choice element 1..n
Choice element 1
Choice element 1,n
Opt-Choice element 1
Place for Content
XML
DCC generation
Do you want to create the digital calibration certificate (xml file)?
NOTE: There are 7 fields with missing content.
Yes
No
2|5 Confirmation
DCC Manual
DCC-XML
Table1

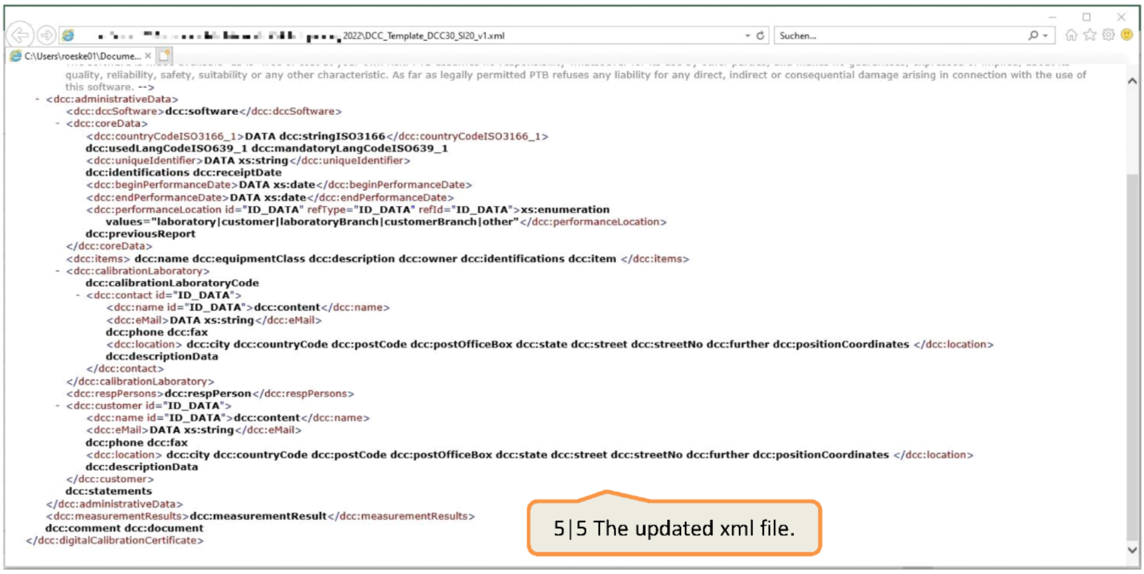
How to use the tool – Some details



How to use the tool – Some details



How to use the tool – Some details



Summary

Advantages:

1. The no-code tool allows to focus on the most important questions: the structure of and the data for the XML-DCC.
2. The tool is working with the data in Excel, no import is necessary.
3. No programming effort for generating valid XML is necessary.
4. The work can be interrupted an any time and continued later.
5. The user is guided by the tool and any further functions (series of data, blocks of elements) can be included in later versions.
6. The XML-DCC can be produced for a single type of calibration certificate and be used as template for many calibrations.
7. Minor updates of the XSDs can be implemented easily.

Summary

Disadvantages/Limitations:

1. A lot of clicking and question-answering is necessary.
2. Major updates of the XSDs will probably require to make a new version of the tool from scratch.
3. Some elements (#any, external files) are not well supported yet.
4. No validation is included …

but, ‘Keep it smart and simple’ means to start with a simple version. Further development is possible.

I hope the tool will be useful.

Thank you for your interest
In this presentation.

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E-mail: dirk.roeske@ptb.de
Web: https://www.ptb.de

Session “DCC and Accreditation”

Digitizing the Scope of Accreditation / Digital Accreditation Information

Presenting author Michael L. Schwartz, Cal Lab Solutions, USA

MSchwartz@CalLabSolutions.com

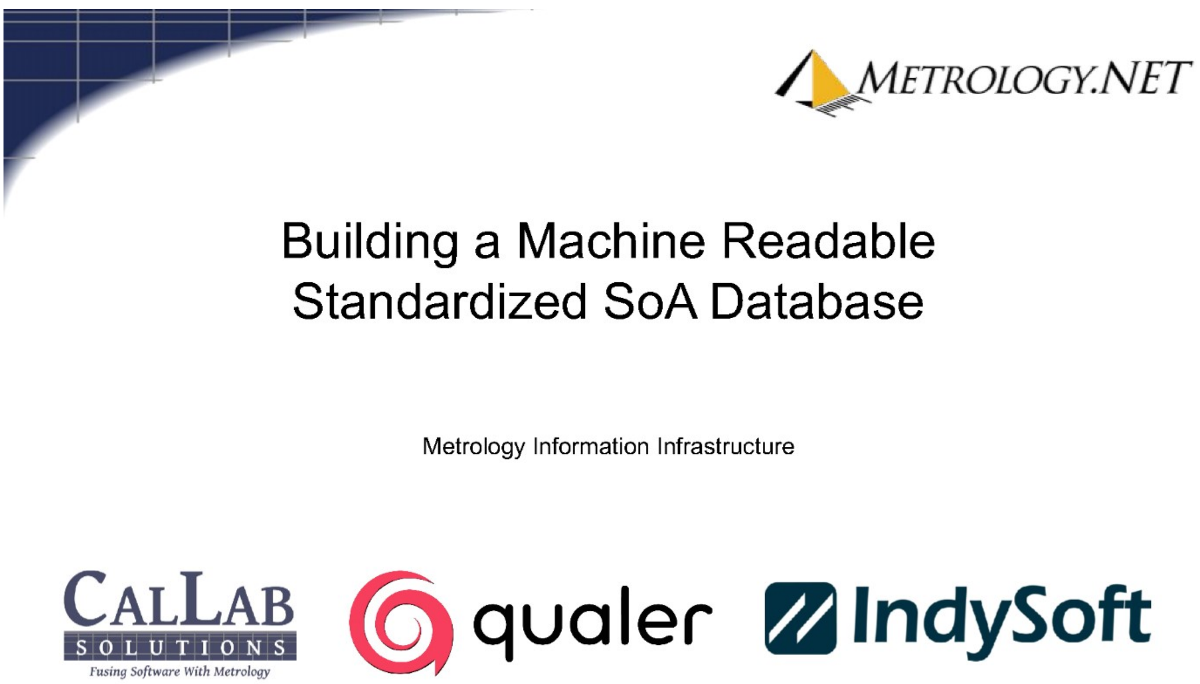
Additional author Greg Cenker, Indysoft, USA

Greg.Cenker@indysoft.com

Abstract

DCC is not only about the certificate of calibration. The Goal is to digitize everything related to the DCC. And the NCSLI Metrology Information & Infrastructure 141 Committee for the past 5 years has been working to create a digital version of a Scope of Accreditation. It has been a huge undertaking with lots of setbacks, but we now have a version 1.0 of the editor ready to present to the industry.

This presentation will cover a brief history of the project with a demo of the current version of the software. We want to encourage the metrology community to use and provide feedback on the editor and tools. Our goal is to work out the details related to the object model and XML file format the present the file format and/or editor to ILAC for review and adoption to digitize the SoA. Soon to be named Digital Accreditation Information DAI.



Metrology Data Exchange Standards

The 21st Century is here
But Metrology isn't measuring up!

While the business world is running on data standards the best metrology has is PDFs.

RIGHT NOW…. The Technology and Infrastructure is available

- Businesses already use the technologies
- They are proven safe & secure
- We just need to use them

So let's create a set of Metrology Data Exchange Standards and bring the World of Metrology Together!

Let's Stop the Madness!

We copy results from our Excel calculations into the Word document we send to the Accreditation body to get back a PDF document.

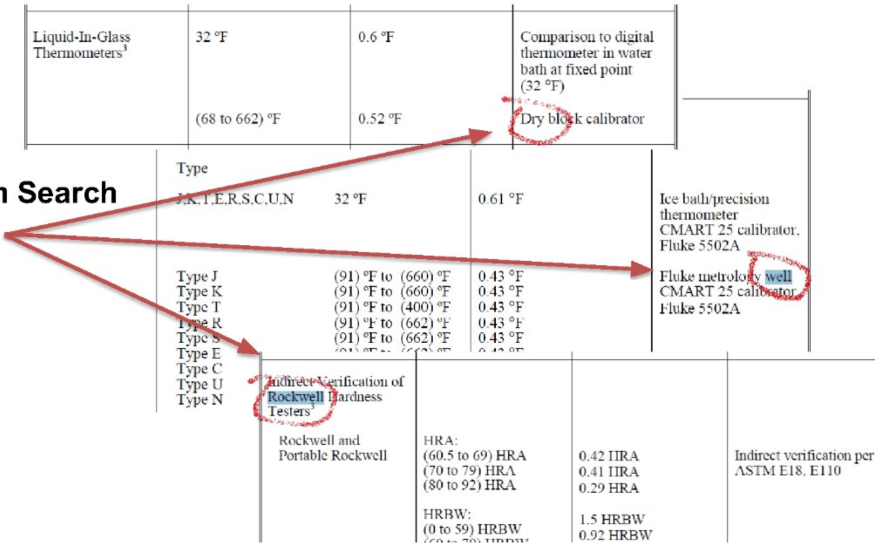
Accredited Capabilities are 100% disconnected from:

- our original uncertainty calculations, and
- our daily calibration product.

What is needed is a way to tie all this data together!

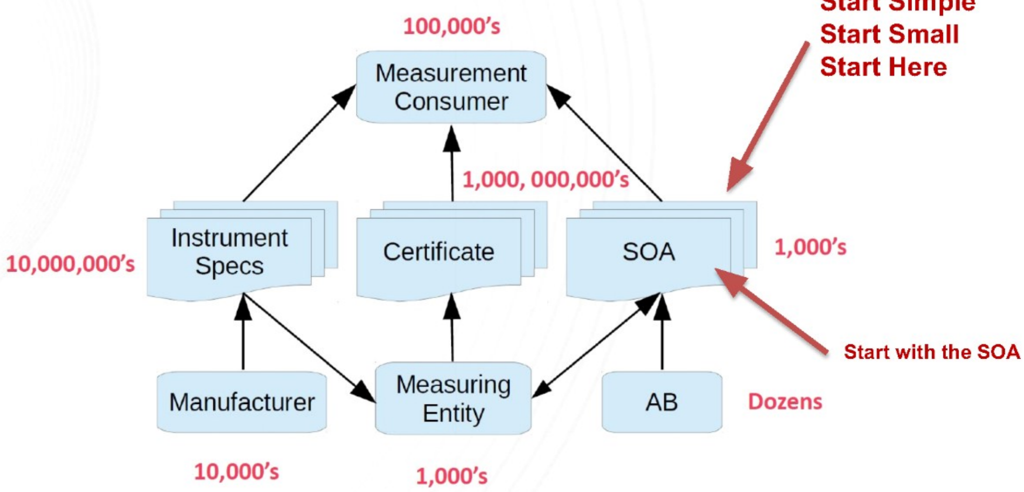
Unusable / Impractical / Broken Search

"Dry well" Calibration Search Using Keywords



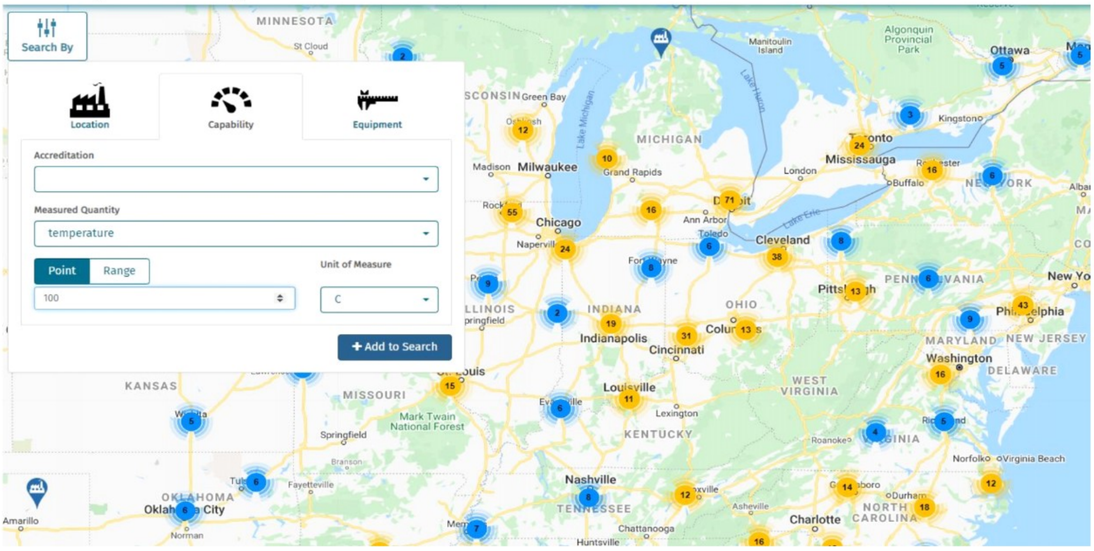
This format is **Unusable!**

WHERE TO START?



Qualer Search Proof of Concept

https://search.qualer.com/



Find Specific SoA CMC Calculation

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2] (±)	Comments
DC Voltage – Generate	(0 to 220) mV (220 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1000) V	4.2 µV/V + 0.4 µV 2.3 µV/V + 0.7 µV 1.1 µV/V + 2.5 µV 1.1 µV/V + 4 µV 2.2 µV/V + 40 µV 3.2 µV/V + 400 µV	Fluke 5720

Volts =

-220e-3 to +220e-3
-2.2 to +2.2
-11 to +11
-22 to +22
-220 to +220
-1000 to +1000

NOTE: This SOA tells me they can't source voltage below 0 Volts.

** This is not machine readable

Quantities & Units of Measure

Units of Measure isn't enough!

- 400 fpm
- 1.7 g
- 22 °
- 101 Nm
- 98.5 %
- 10 V @ 1 kHz

Units are really about "Scale"

- Scale or Count of a Quantity

We need Quantity Definitions

- To Exchange data between systems
- Convert between Scales

Metrology Taxonomy

The industry needs to build a Taxonomy of Measurements so we can index, catalog, and easily share measurement related data.

Category Hierarchy

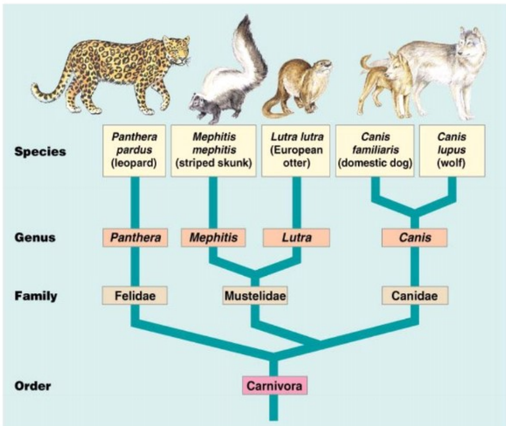
1) Source / Measure

2) Quantity Measured

3) Sub Category

  Sub Category

    Sub Category

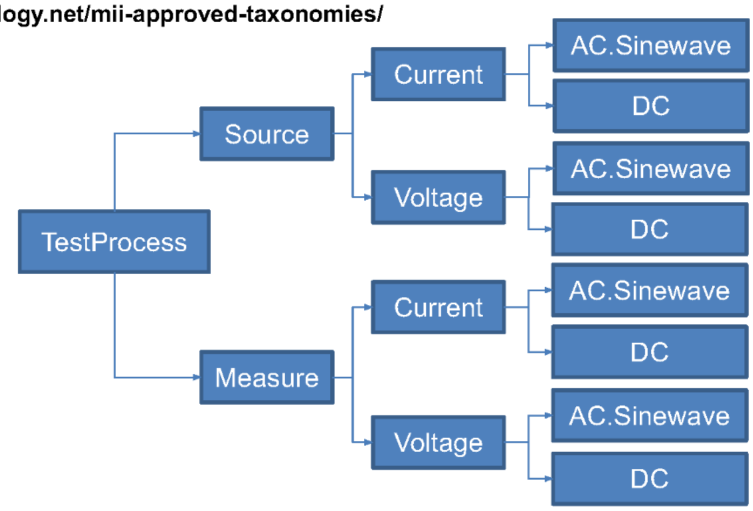


Building a Metrology Taxonomy

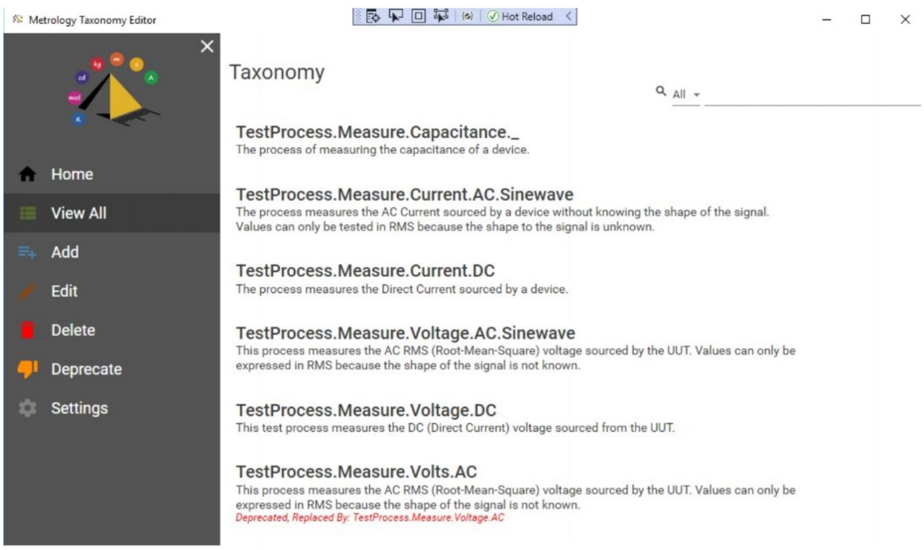
https://www.metrology.net/mii-approved-taxonomies/

131 - Taxonomies Approved

Meet once a week



Metrology Taxonomy Editor



Find Specific SoA CMC Calculation

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC² (±)	Comments
DC Voltage – Generate	(0 to 220) mV (220 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1000) V	4.2 µV/V + 0.4 µV 2.3 µV/V + 0.7 µV 1.1 µV/V + 2.5 µV 1.1 µV/V + 4 µV 2.2 µV/V + 40 µV 3.2 µV/V + 400 µV	Source.Voltage.DC Source.Voltage.DC w/ Fluke 5720A

Add
Metrology Taxonomy

Add
Measurement Technique

Volts =

-220e-3 to +220e-3
-2.2 to +2.2
-11 to +11
-22 to +22
-220 to +220
-1000 to +1000

NOTE: This SOA tells me they can't source voltage below 0 Volts.

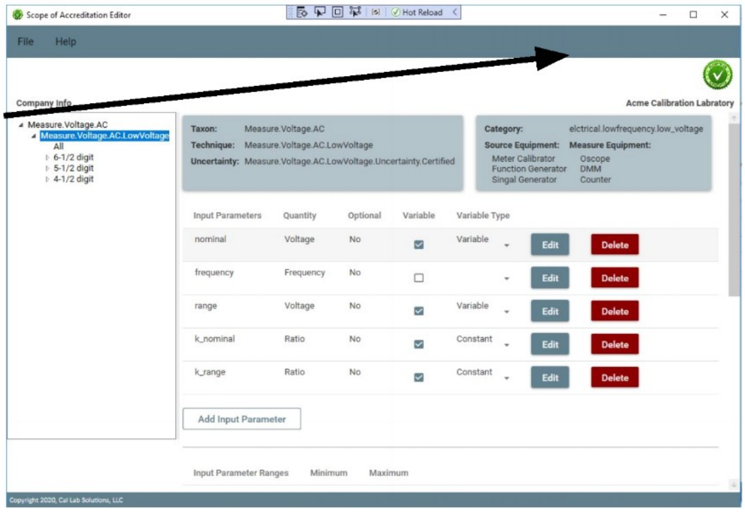
** This is not machine readable

SoA Editor

Editor Features

- Colors are skinned and changeable
- AB Brand able
- AB Logo & Signature
- Supports Multiple Address

Windows Desktop Applications
Open Source Project
.NET 5.0 Unified Platform



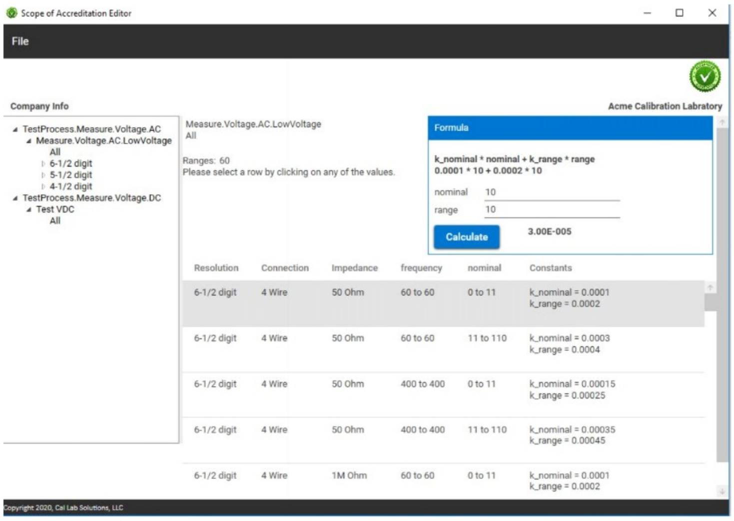
The SoA Editor that "Does Math"

Editor Features

- Entry for each CMC Line
- Range & Limits
- Live Calculations
  - Constant Values
  - Parameter Values

Beta Version Ready for Testing
Q1 - 2022

Sign Up For Beta Release & Testing



Join the Team Today

Do you have what it takes to create a Metrology Standard?

Moving forward!

- **Load some REAL SoA**
- **Add to the Metrology Taxonomy**
- **Accreditation Body Branding**
- **Education & Training for Users**

Weekly Meeting -

Mondays 2:00 pm Mountain Time
Gotomeeting ID 909-871-373

Questions

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URLs

https://search.qualer.com
http://miiknowledge.wikidot.com/start
https://github.com/CalLabSolutions/Metrology.NET_Public

Call for Papers https://ncsli.org/page/WS22CP

Fluke 8588A Spec's Digitized

Creating a Fluke 8588A Spec / SoA
To a digital format

2022 - Q1/2

DC Voltage [1][2][3][4]

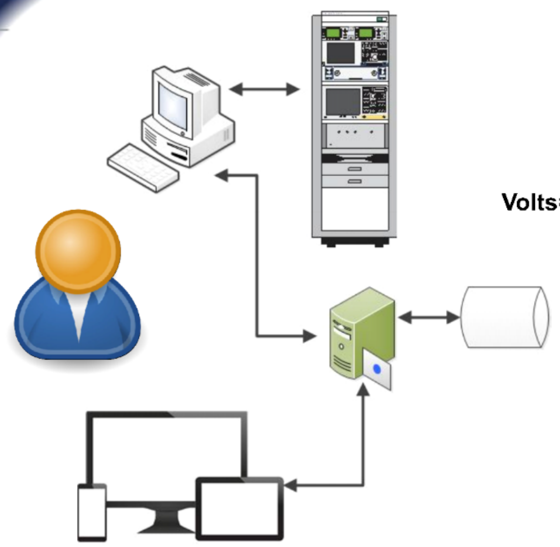
DC Voltage maximum resolution is 8 digits

Aperture ≥ 100 µs

95 % Confidence

Range	Zin	Full Scale	Relative Accuracy ± (µV/V of reading + µV/V of range) Transfer, 20 min [15]	24 Hour Tcal ± 1 °C	90 day Tcal ± 1 °C	365 day Tcal ± 1 °C	2 years Tcal ± 1 °C	Absolute Accuracy 365 day Tcal ± 1 °C	365 day Tcal ± 5 °C	2 year Tcal ± 5 °C
100 mV	Auto, 10 MΩ, 1 MΩ	202 mv	0.2 + 2.0	0.7 + 2.0	1.4 + 2.0	2.7 + 2.0	5.4 + 2.0	5.1 + 2.0	7.5 + 2.0	15 + 2.0
1 V	Auto, 10 MΩ, 1 MΩ	2.02 V	0.06 + 0.3	0.5 + 0.3	1.4 + 0.3	2.7 + 0.3	5.4 + 0.3	2.8 + 0.3	4.0 + 0.3	8.1 + 0.3
10 V	Auto, 10 MΩ, 1 MΩ	20.2 V	0.05 + 0.05	0.5 + 0.05	1.4 + 0.05	2.7 + 0.05	5.4 + 0.05	2.8 + 0.05	4.0 + 0.05	8.0 + 0.05
100 V	Auto, 10 MΩ	202 V	0.4 + 0.3	1.0 + 0.3	2.6 + 0.3	4.0 + 0.3	8.0 + 0.3	4.1 + 0.3	6.5 + 0.3	13 + 0.3
100 V	1 MΩ	202 V	2.0 + 5.0	2.0 + 5.0	4.5 + 5.0	9.0 + 5.0	18 + 5.0	9.0 + 5.0	15 + 5.0	30 + 5.0
1000 V	Auto, 10 MΩ	1050 V	0.4 + 0.5	1.0 + 0.5	2.6 + 0.5	4.0 + 0.5	8.0 + 0.5	4.3 + 0.5	6.7 + 0.5	13 + 0.5
1000 V	1 MΩ	1050 V	4.0 + 25	4.0 + 25	4.5 + 25	9.0 + 25	18 + 25	9.1 + 25	15 + 25	30 + 25

Uncertainty Check On Every Test Point



Run Live Calculations

Source.Voltage.DC (Fluke 5720A)

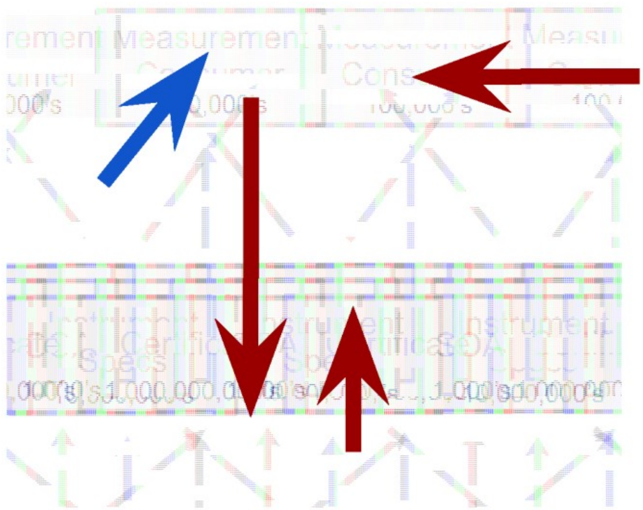
Volts= 10

Check Scope of Accreditation

Source.Voltage.DC (Fluke 5720A)

If test point calculated uncertainty is less than the SoA uncertainty, then use SoA uncertainties and store the test point uncertainties for next accreditation, otherwise use test point calculated uncertainty.
* Mark data point as Verified Accredited.

Model Driven Software Engineering



Customer Requirement

Pass those needs digitally to the lab
Based on the Model

The Lab can perform the exact calibration
Because Details are in the Model
Custom Test Points
Manufacturer's Test Points
Military Spec Test Points

All Automatic
Low-Code to **No-Code**

Embedding the Digital Calibration Certificate

Presenting author Susanne Kuch, DAkkS, Germany

susanne.kuch@dakks.de

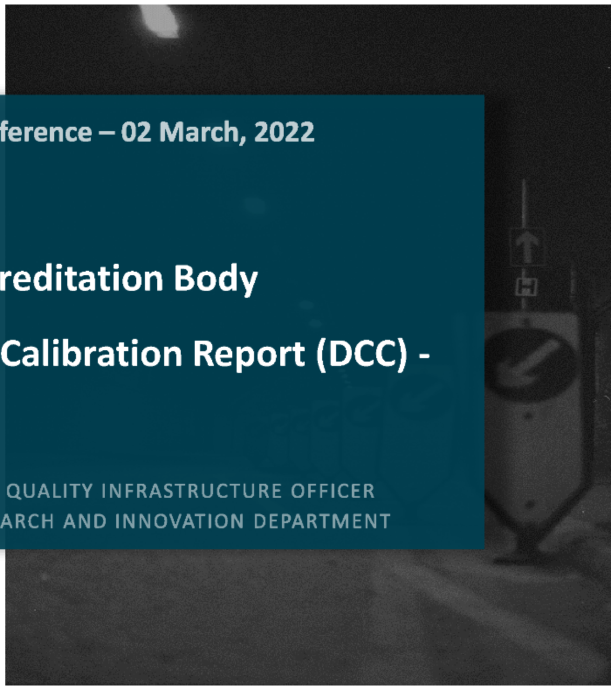
Additional authors Raoul Kirmes, Florian Witt, (all DAkkS, Germany)

Abstract

As national accreditation body DAkkS supports the implementation of the DCC as digital variant of a result report in the specific form of a calibration certificate. Since both, the XML scheme and the methods used for electronic signatures are based on international standards, the integrity of electronic result reports can be ensured. Thus, the DCC can be used worldwide without media breaks or obstructions.

In this lecture, DAkkS will present the technical implementations necessary on the side of the accreditation body in order to apply electronic signatures to result reports such as the DCC. Results reports that meet these requirements might be used in accreditation worldwide.

With the further networking of industrial applications, the DCC is also an important tool, e.g., with regard to Industry 4.0 applications. Working closely together on these developments is thus even more important.



The 2nd International DCC-Conference – 02 March, 2022

DAkkS

Germany‘s National Accreditation Body

- Embedding the Digital Calibration Report (DCC) -

SUSANNE KUCH - DIGITAL POLICY FOR QUALITY INFRASTRUCTURE OFFICER
- ACCREDITATION GOVERNANCE, RESEARCH AND INNOVATION DEPARTMENT

DAkkS
Deutsche
Akkreditierungsstelle

EN ISO/IEC 17025 mentions option of using digital (calibration) reports

Reports can be issued as hard copies or by electronic means, provided that the requirements of this document are met.
(7.8.1.2, Note 2)

In this context, “documents” can be policy statements, procedures, […] etc. **These can be on various media, such as hard copy or digital.**
(8.3.1, Note)

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2 | DAkkS – Embedding the Digital Calibration Report (DCC)

Catalogue of requirements to be considered for the implementation of digital calibration reports

IMPORTANT REMARKS:

- The following points out of **EN ISO/IEC 17025** and its mentioned **requirements** shall give an **overview of different aspects** that a **digital calibration report has to fulfil** in order to be **securely and correctly applied in the digital world** within the normative sense.
- **The following catalogue of requirements is already covered within the current version of the DCC in combination with the provision of a digital Seal by DAkkS** and can **–** if the DCC structure and implementation is followed – be applied securely**.**
- **All calibration reports need to fulfil the same requirements –** no matter if those are on paper or digital

  → The **processes** known out of the **analogue world** shall be only **transferred to the digital world**

  → Regarding the single realization within a laboratory, DAkkS is absolutely **neutral** regarding the **technologies used** as long as the requirements can be fulfilled.

Requirements out of EN ISO/IEC 17025 regarding digital calibration reports (document)

The results shall be reviewed and authorized prior to release (7.8.1.1).

→ "**Release**" signifies an **embodiment of information** since it implies an **active handover** of a "file" or paper. The customer needs to receive the report **on purpose and bindingly**.

✔ → The **DCC fulfils the requirement** since the report can be transferred to the customer as an XML file and can be easily converted into a PDF-file if required.

→ A simple implementation of an interface (e.g. via HTML homepage) to the laboratories own database where the **customer has to actively access these data** is **not fulfilling** the requirements.

Requirements out of EN ISO/IEC 17025 regarding digital calibration reports (document)

- ***Each report shall include at least the following information, unless the laboratory has valid reasons for not doing so, thereby minimizing any possibility of misunderstanding or misuse:***
  […] b) the name and address of the laboratory (7.8.2.1 lit. b));
  […] o) identification of the person(s) authorizing the report (7.8.2.1 lit. o)).

  → The report reflects a **clear and binding declaration of intent** since the report is undeniably issued by the laboratory through adding its name and address and mentioning the authorizing person.

  → In the digital world, the requirements can be fulfilled by implementing an undeniable connection that does satisfy the **non-repudiation** and secures the **authenticity of identity** (e.g. through a digital seal by the legal entity [CAB]).

  → The **DCC fulfils the requirement in combination with a digital seal issued by DAkkS**

  → DAkkS enables the fulfilment of the requirement by offering a cryptographic method in the form of this digital seal (undeniably bound to the accredited laboratory)

5 | DAkkS – Embedding the Digital Calibration Report (DCC)

Requirements out of EN ISO/IEC 17025 regarding digital calibration reports (document)

- ***[…] unique identification that all its components are recognized as a portion of a complete report and a clear identification of the end*** *(7.8.2.1 lit. d)).*

  → It implies that the report needs to fulfill the closing and covering function as well as the integrity for content

  → The **DCC fulfils the requirement** by its clear structure and **in combination with the digital seal issued by DAkkS**

  → DAkkS enables the fulfilment of the requirement by offering a cryptographic method in the form of this digital seal (undeniably bound to the accredited laboratory)

6 | DAkkS – Embedding the Digital Calibration Report (DCC)

Requirements out of EN ISO/IEC 17025 regarding digital calibration reports (document)

- ***When an issued report needs to be changed, amended or re-issued, any change of information shall be clearly identified and, where appropriate, the reason for the change included in the report***(7.8.8.1).
- ***Amendments to a report after issue shall be made only in the form of a further document, or data transfer, which includes the statement "Amendment to Report, serial number... [or as otherwise identified]", or an equivalent form of wording*** (7.8.8.2).
  → The **integrity and identity** of the report needs to be secured. In case of changes or amendments, a **visible marking** as well as a **clear reference** to the original report is necessary.
  → The **DCC fulfils the requirement** in combination with the **digital seal issued by DAkkS** or with **digital time stamps**

REMARKS:

- The processes known out of the analogue world shall be transferred to the digital world
- Regarding the single realisation within a laboratory, DAkkS is absolutely neutral regarding the technologies used as long as the requirements can be fulfilled.

7 | DAkkS – Embedding the Digital Calibration Report (DCC)

Requirements out of EN ISO/IEC 17025 regarding digital calibration reports (laboratory)

- The **laboratory needs to fulfil the requirements** on calibration reports and needs to **protect the integrity**
- Laboratory is responsible for:
- ***The laboratory shall be responsible for all the information provided in the report, except when information is provided by the customer*** (7.8.2.2).
  → The laboratory is **responsible for all the information within the report,** but need to identify those items that are provided by the customer. The laboratory cannot deny this responsibility.
  → Technically, within the digital report the characteristic of **non-repudiation** is necessary (7.8.2.1 lit. b)). This means that the laboratory needs a clear **authentication of identity** (of legal entity) connected to the report to protect the integrity.
  → The **DCC fulfils this requirement in combination with the digital seal issued by DAkkS**
  → DAkkS enables the fulfilment of the requirement by offering a cryptographic method in the form of this digital seal (undeniably bound to the accredited laboratory)

8 | DAkkS – Embedding the Digital Calibration Report (DCC)

Requirements out of EN ISO/IEC 17025 regarding digital calibration reports (laboratory)

- Laboratory is responsible for:
  - ***Protection of the information by using a laboratory information management system that is protected from unauthorized access** (7.11.3 lit. a)), **safeguarded against tampering […]** (7.11.3 lit. b)) **and maintained in a manner that ensures the integrity of the data and information** (7.11.3 lit. d))* ;

    → To implement a DCC a laboratory needs to have a **robust IT-environment**

    → The DCC as one part of the document management system has to fulfil all these goals as well

    → This means that the IT security goals of **integrity, confidentiality and availability** needs to be secured

NOTE:
Due to the human verification and release function (7.8.1.1/ 7.8.2.1 lit. o)), the (digital) calibration report is always a **proof of evidence within a juridical context** (§ 416 ZPO/ § 371a ZPO) and not merely a so-called "technical record".

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9 | DAkkS – Embedding the Digital Calibration Report (DCC)

Accreditation of calibration laboratories

- The accreditation body proves if **all necessary requirements** out of legal provisions and out of standards, especially EN ISO/IEC 17025, and further rules (e.g. (EG) 765/2008; EN ISO/IEC 17011; ILAC-P14; SymbolVO; etc.) **are met** by the laboratory
- **Regarding digital calibration reports (DCC) - DAkkS wants to keep it simple**
  - Legally as well as normatively, the **usage of digital calibration reports is accepted** equally to paper based ones as long as the requirements are met

→ The **DCC fulfils this requirement in combination with the digital seal issued by DAkkS**

→ The assessment process won't change since there is **no difference in the procedure**

REMARKS:

- In order to **enable accredited laboratories** in the implementation of the DCC, DAkkS will establish a system based on **international standards** and the **EU eIDAS regulation** to provide a **digital attribute of ‚accreditation'** in form of a **digital seal** (bound to the legal entity) to ultimately secure the protection of **integrity for content and identity.**
- This ensures **worldwide technical compatibility** of the electronic seals for the DCC report.

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10 | DAkkS – Embedding the Digital Calibration Report (DCC)

Accreditation of calibration laboratories

- Available EU - Technical requirements (ETSI)
  - **EN 319 102-1 & TS 119 102-1**: Procedures for Creation and Validation of AdES Digital Signatures; Part 1: Creation and Validation
  - **TS 119 102-2**: Procedures for Creation and Validation of AdES Digital Signatures; Part 2: Signature Validation Report
  - **TS 119 112**: Most significant differences between AdES/ASiC ENs and previous TSs
  - **EN 319 122-1**: CAdES digital signatures; Part 1: Building blocks and CAdES baseline signatures
  - **EN 319 122-2**: CAdES digital signatures; Part 2: Extended CAdES signatures
  - **TS 119 122-3**: CAdES digital signatures; Part 3: Incorporation of Evidence Record Syntax (ERS) in CAdES
  - **EN 319 132-1**: XAdES digital signatures; Part 1: Building blocks and XAdES baseline signatures
  - **EN 319 132-2**: XAdES digital signatures; Part 2: Extended XAdES signatures
  - **TS 119 132-3**: XAdES digital signatures; Part 3: Incorporation of Evidence Record Syntax (ERS) mechanisms in XAdES
  - **EN 319 142-1**: AdES digital signatures; Part 1: Building blocks and PAdES baseline signatures
  - **EN 319 142-2**: PAdES digital signatures; Part 2: Additional PAdES signatures profiles
  - **TS 119 142-3**: PAdES digital signatures; Part 3: PAdES Document Time-stamp digital signatures (PAdES-DTS)
  - **EN 319 162-1**: Associated Signature Containers (ASiC); Part 1: Building blocks and ASiC baseline containers
  - **EN 319 162-2**: Associated Signature Containers (ASiC); Part 2: Additional ASiC containers
  - **TS 119 172-1**: Signature policies; Part 1: Building blocks and table of contents for human readable signature policy documents
  - **TS 119 182-1**: JAdES digital signatures; Part 1: Building blocks and JAdES baseline signatures

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11 DAkkS – Embedding the Digital Calibration Report (DCC)

Accreditation of calibration laboratories

- Available international Technical requirements
  - **ISO/IEC JTC 1/SC 27/WG4 CD 27099**: PKI - Practices and Policy framework
  - **ISO/IEC TR 14516:2002/ITU-T X.842:2000**: Guidelines for the use and management of trusted third party services
  - **ISO/IEC 15945:2002/ITU-T X.843**: Specification of TTP services to support the application of digital signatures
  - **ISO/IEC 9594-8:2017 (with reference to ITU standard X.509v3)**
  - **RFC 5652 Cryptographic Message Syntax (CMS)**
  - **ISO/IEC TS 29003:2018**: Identity proofing
  - **ISO 17090-1:2013**: Health Informatics - Part 1: overview of certificate services
  - **ISO 17090-2:2015**: Health Informatics - Part 2: Certificate profile
  - **ISO 17090-3:2008**: Health Informatics - Part 3: Policy Management of CA
  - **ISO 17090-4:2014**: Health Informatics - Part 4: Digital Signatures for healthcare documents
  - **ISO 17090-5: 2017**: Health Informatics - Part 5: Authentication using Healthcare PKI credentials
  - **ISO/IEC 9594-8, ITU-T X.509**: The Directory: Public-key and attribute certificate frameworks
  - **ISO 32000-1:2008**: **Portable document format — Part 1: PDF 1.7 /Portable document format — Part 2: PDF 2.0**
    ISO 32000-2:2017
  - **ISO 14533-1** (CAdES): Long term signature profiles — Part 1: Long term signature profiles for CMS Advanced Electronic Signatures (CAdES)
  - **ISO 14533-2** (XAdES): Long term signature profiles — Part 2: Long term signature profiles for XML Advanced Electronic Signatures (XAdES)
  - **ISO/IEC 21320-1:2015** (ASiC): Document Container File — Part 1: Core

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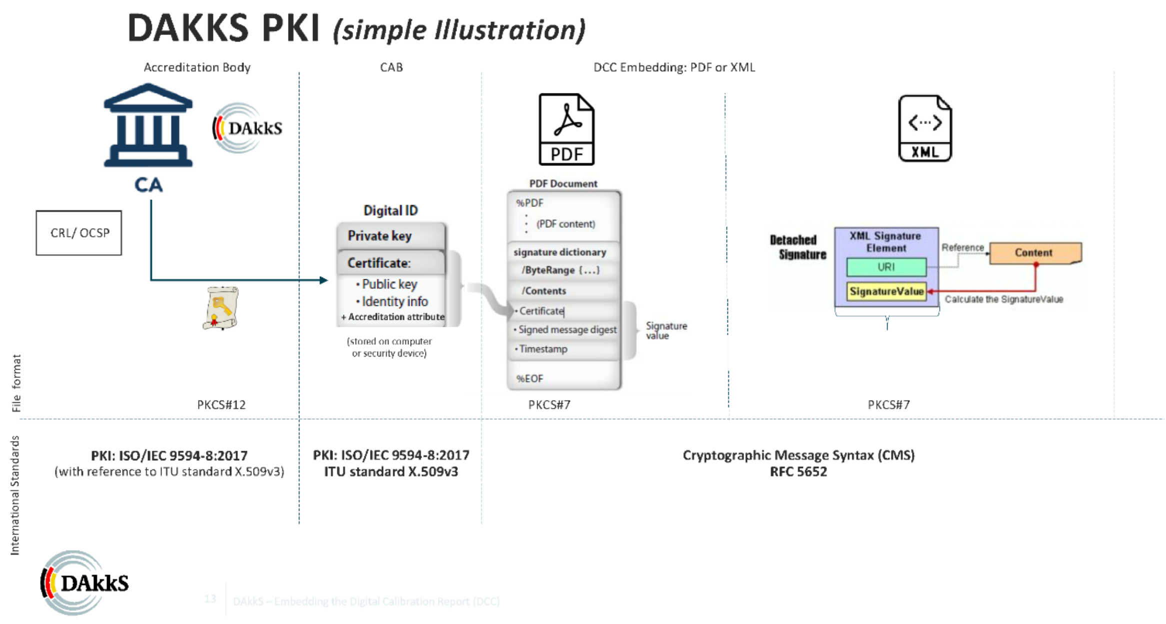
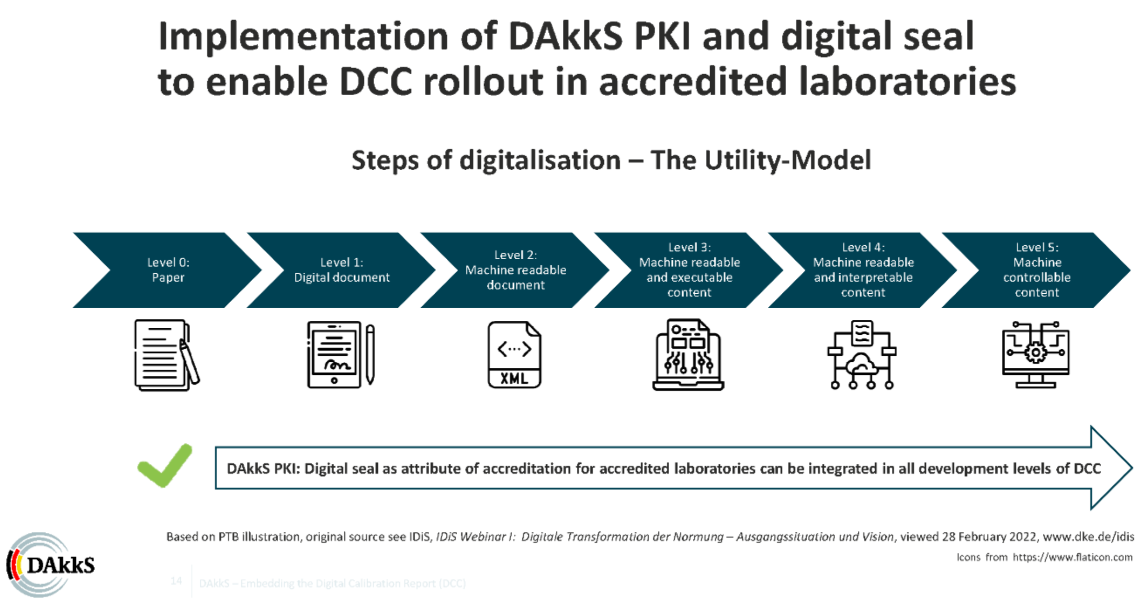
12 DAkkS – Embedding the Digital Calibration Report (DCC)


DAKKS PKI *(simple Illustration)*
Accreditation Body
CAB
DCC Embedding: PDF or XML
DAkkS
CA
CRL/ OCSP
Digital ID
Private key
Certificate:
• Public key
• Identity info
+ Accreditation attribute
(stored on computer or security device)
PDF
PDF Document
%PDF
(PDF content)
signature dictionary
/ByteRange [...]
/Contents
• Certificate
• Signed message digest
• Timestamp
%EOF
Signature value
XML
Detached Signature
XML Signature Element
URI
SignatureValue
Reference
Content
Calculate the SignatureValue
File format
PKCS#12
PKCS#7
PKCS#7
International Standards
PKI: ISO/IEC 9594-8:2017
(with reference to ITU standard X.509v3)
PKI: ISO/IEC 9594-8:2017
ITU standard X.509v3
Cryptographic Message Syntax (CMS)
RFC 5652
DAkkS
13 DAkkS – Embedding the Digital Calibration Report (DCC)


Implementation of DAkkS PKI and digital seal to enable DCC rollout in accredited laboratories
Steps of digitalisation – The Utility-Model
Level 0: Paper
Level 1: Digital document
Level 2: Machine readable document
Level 3: Machine readable and executable content
Level 4: Machine readable and interpretable content
Level 5: Machine controllable content
XML
DAkkS PKI: Digital seal as attribute of accreditation for accredited laboratories can be integrated in all development levels of DCC
Based on PTB illustration, original source see IDiS, *IDiS Webinar I: Digitale Transformation der Normung – Ausgangssituation und Vision*, viewed 28 February 2022, www.dke.de/idis
Icons from https://www.flaticon.com
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14 DAkkS – Embedding the Digital Calibration Report (DCC)

Imprint and Contact

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Source reference

- DIN Deutsches Institut für Normung e. V. / Beuth Verlag GmbH (ed.) (2018): *EN ISO/IEC 17025:2017*
- DIN Deutsches Institut für Normung e. V. / Beuth Verlag GmbH (ed.) (2018): *EN ISO/IEC 17011:2017*

- Slide 7:
  - Adobe (ed.): *Digital Signatures in a PDF*, p. 4, https://www.adobe.com/devnet-docs/etk_deprecated/tools/DigSig/Acrobat_DigitalSignatures_in_PDF.pdf (viewed March 02, 2022)
  - Icons:
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    - PDF Icon made by Smashicons from www.flaticon.com
    - XML Icon made by iconixar from www.flaticon.com
    - XML Signature Element image by Masato Terada, Hitoshi Takasaki, Chika Nukui and JVN Working Group (JPCERT/CC, IPA) (ed.), http://jvnrss.ise.chuo-u.ac.jp/jtg/xsig/en/index.02.html (viewed March 02, 2022)
- Slide 8:
  - Icons:
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    - Level 1 Icon made by nawicon from www.flaticon.com
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Session “DCC Syntax 4.0”

The DCC SchemaX / DX

Presenting author Justin Jagieniak, PTB, Germany

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Additional author Siegfried Hackel, Gamze Söylev-Öktem, Benjamin Gloger, Lutz Doering (all PTB, Germany)

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Abstract

Through the results of the upcoming second international DCC conference as well as through further digitisation considerations, the DCC schema is being further adapted to the needs of the international community. It can be seen that the digitisation considerations listed in another lecture in direct and indirect connection with the DCC on the development of a uniform schema for these digitised items seems to make sense.

The structure and advantages / synergy effects of this common schema are shown and discussed. We have given this schema the abbreviation "DX" (Digital SchemaX). For example, the Digital Calibration Request (DCR) can transmit the requirements to the calibration laboratory in the same schema without the need for a transformation into another language world. Another example is shown in the area of transmitting medically relevant data in connection with accident events (Digital Accident Report - D-AR).

Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
National Metrology Institute

Digital SchemaX (DX)

Modularisation of the

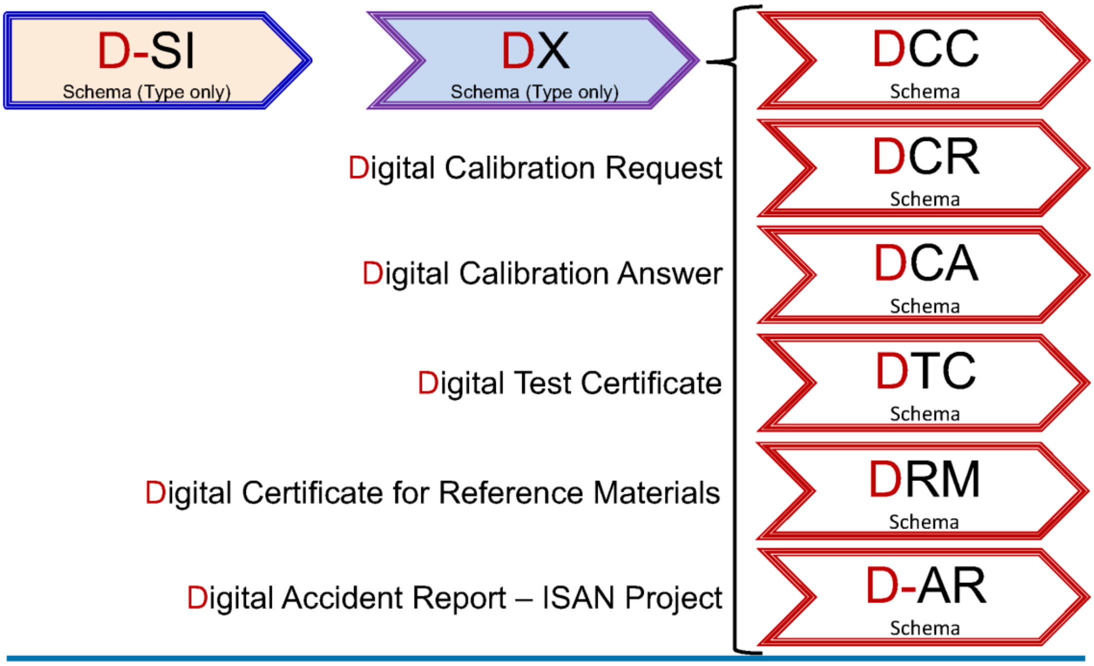
Digital Calibration Certificate (DCC)

Presenting author:
Justin Jagieniak, AG 1.24

Advantages of Modularisation

- Better reading comfort of the DCC
  - Better understanding
  - Avoid mistakes
- Allows inheritance
  - Not only the DCC profites from the DX:
    - D-AR (Digital Accident Report – ISAN Project)
    - DCR (Digital Calibration Request)
    - DCA (Digital Calibration Answer)
    - DTC (Digital Test Certificate)
    - DRM (Digital Certificate for Reference Materials)
    - EDC (Envelope Digital Certificate)
    - ...

Advantages of Modularisation



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2018-05-09 3 ppt-folie-vorlage

DCC 4.0 and DX

- DCC
  - Contains tree structures and related elements
  - Refers to DX
- DX
  - Contains types only
  - Doesn‘t have a tree structure, every type is independend

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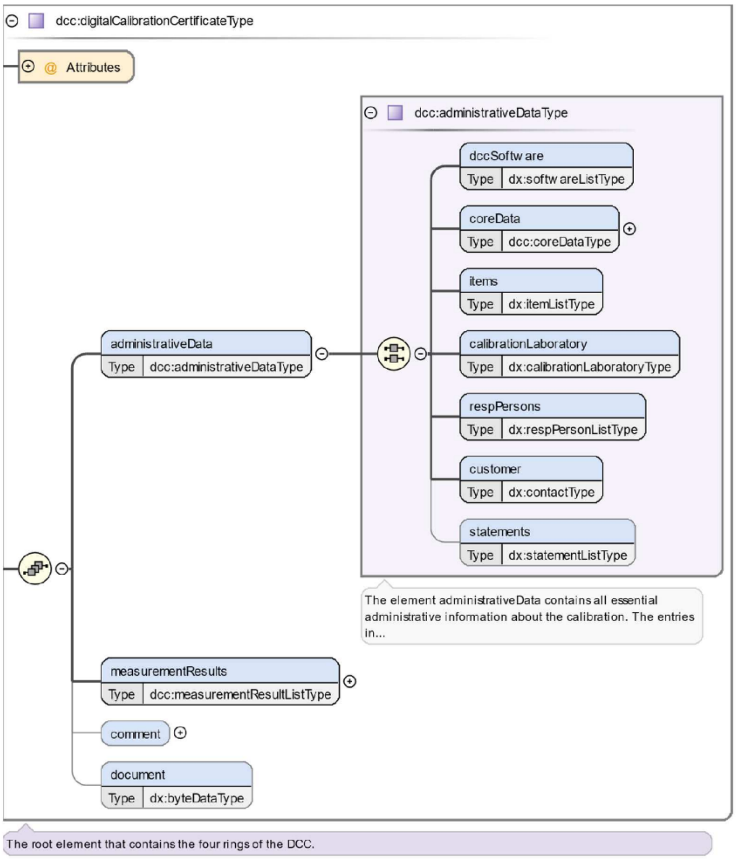
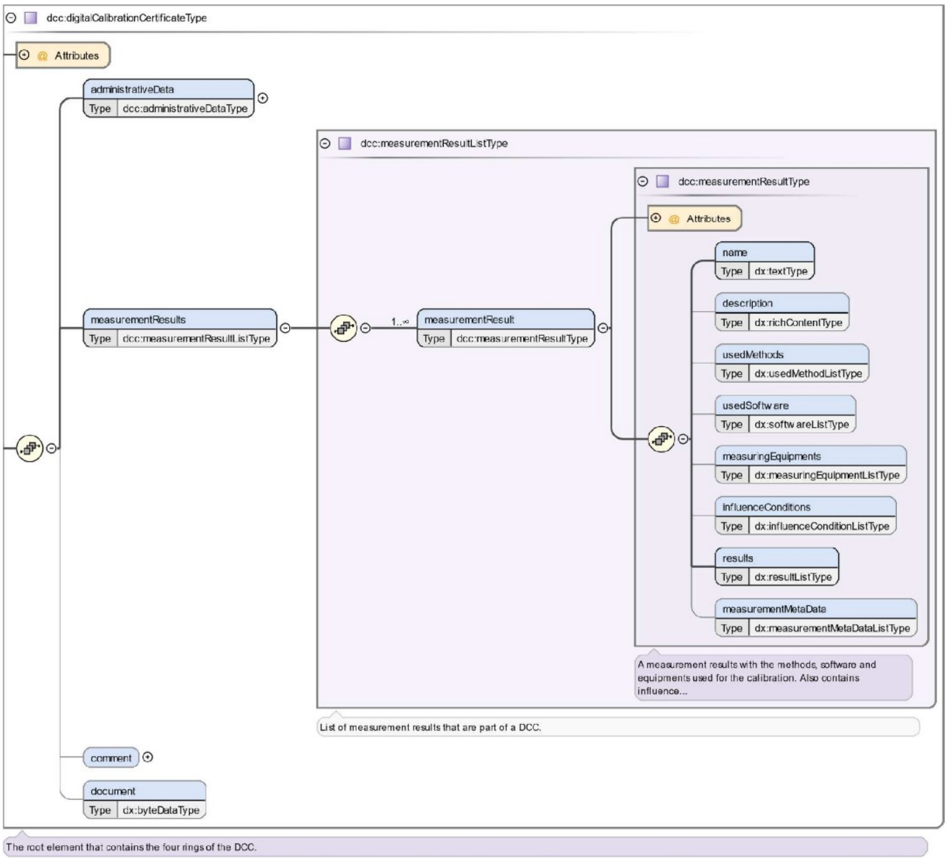
2022-03-02 4


dcc:digitalCalibrationCertificateType
Attributes
administrativeData
Type dcc:administrativeDataType
dcc:administrativeDataType
dccSoftware
Type dx:softwareListType
coreData
Type dcc:coreDataType
items
Type dx:itemListType
calibrationLaboratory
Type dx:calibrationLaboratoryType
respPersons
Type dx:respPersonListType
customer
Type dx:contactType
statements
Type dx:statementListType
The element administrativeData contains all essential administrative information about the calibration. The entries in...
measurementResults
Type dcc:measurementResultListType
comment
document
Type dx:byteDataType
The root element that contains the four rings of the DCC.

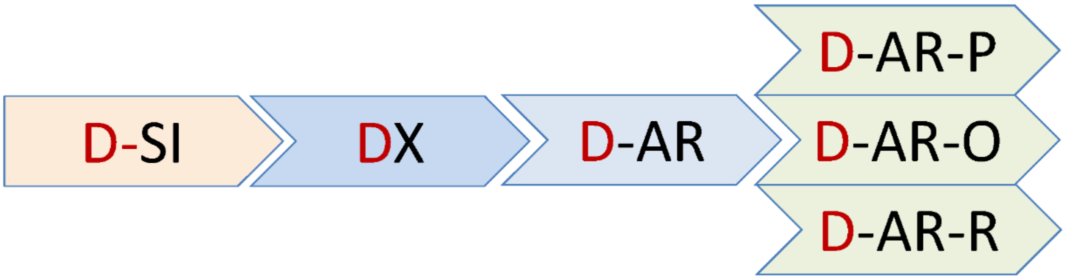
2022-03-02


dcc:digitalCalibrationCertificateType
Attributes
administrativeData
Type dcc:administrativeDataType
measurementResults
Type dcc:measurementResultListType
dcc:measurementResultListType
1..∞
measurementResult
Type dcc:measurementResultType
dcc:measurementResultType
Attributes
name
Type dx:textType
description
Type dx:richContentType
usedMethods
Type dx:usedMethodListType
usedSoftware
Type dx:softwareListType
measuringEquipments
Type dx:measuringEquipmentListType
influenceConditions
Type dx:influenceConditionListType
results
Type dx:resultListType
measurementMetaData
Type dx:measurementMetaDataListType
A measurement results with the methods, software and equipments used for the calibration. Also contains influence...
List of measurement results that are part of a DCC.
comment
document
Type dx:byteDataType
The root element that contains the four rings of the DCC.

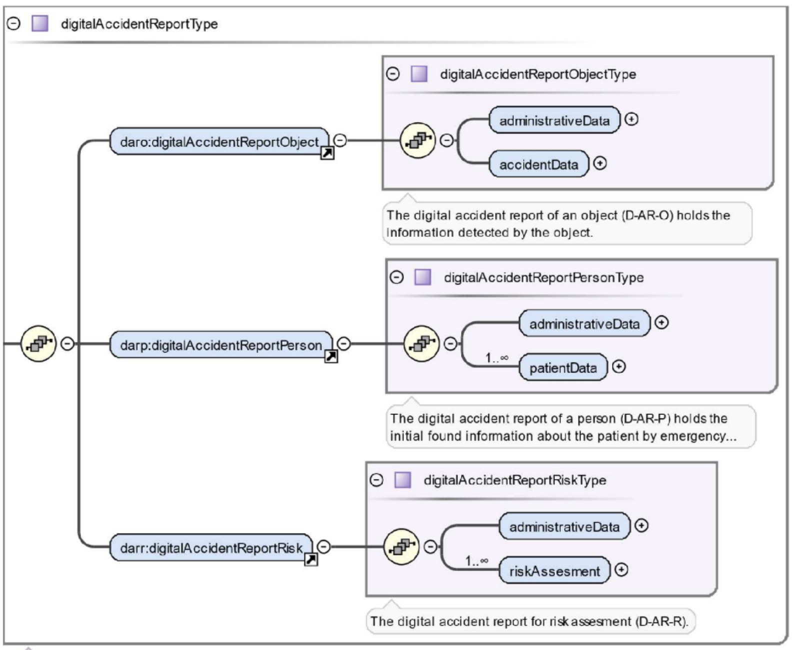
D-AR example

What is D-AR?

- Part of the ISAN Project in cooperation with TU Braunschweig / MHH
- Digital Accident Report
  - D-AR-P => for the Person
  - D-AR-O => for the Object
  - D-AR-R => for the Risk



D-AR example



The definition of the main components of D-AR: D-AR-O, D-AR-P, D-AR-R.

D-AR example

- D-AR-O contains the physical sensor datas of the object
  - Similar to the Digital Calibration Certificate it contains:
    - measurementResults
    - measurementUncertainties
    - Informations about the sensor devices

=> Perfect candidate for DX

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2022-03-02 9

Thank you for your attention!

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Digital Calibration Request (DCR), Digital Calibration Answer (DCA), Digital Test Certificate (DTC) and the Digital Certificate for Reference Materials (DRM)

Presenting author Siegfried Hackel, PTB, Germany

siegfried.hackel@ptb.de

Additional author Shanna Schönhals, Justin Jagieniak, Gamze Söylev-Öktem, Benjamin Gloger, Lutz Doering (all PTB, Germany)

dcc@ptb.de

Abstract

The digitisation considerations directly related to the DCC are the subject of this presentation. The necessity of the Digital Calibration Request (DCR) and Digital Calibration Answer (DCA) was already discussed at the first international DCC conference. During the discussion with the international community, two further areas of application were added: the Digital Test Certificate (DTC) and the Digital Certificate for Reference Materials (DRM). Since these reports are also based on the ISO / IEC 17025 standard, it makes sense to use the Digital SchemaX (DX) presented in another lecture. First developments will be presented, and a call will be made to the international community to continue working together on these topics.

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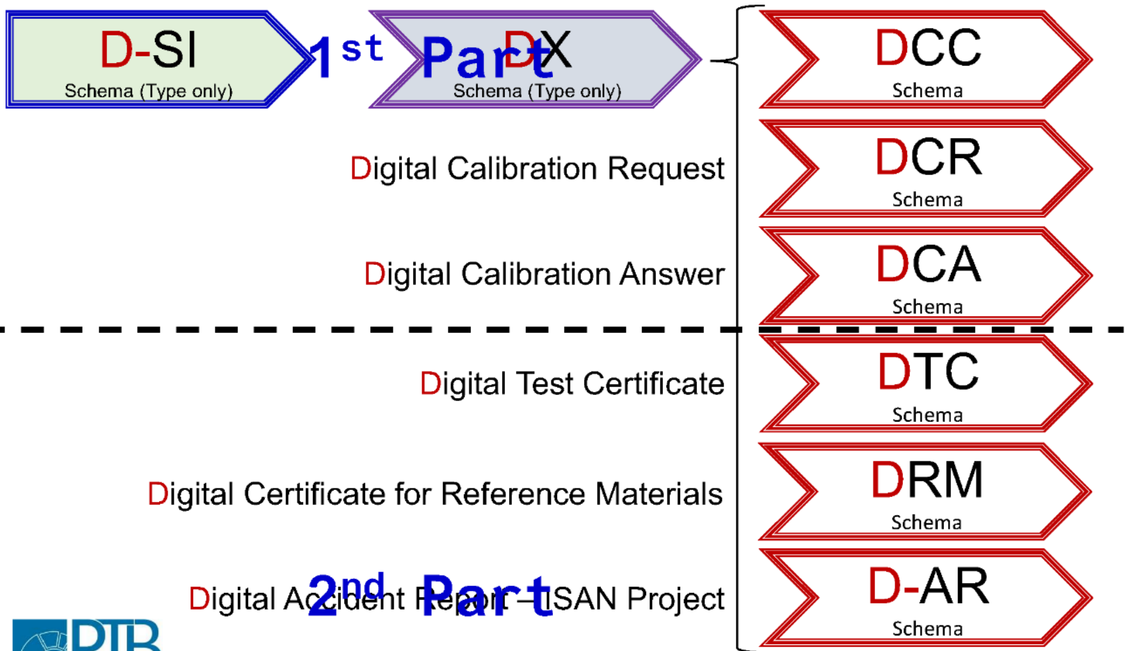
DCR, DCA, DTC, DRM

Siegfried Hackel

02

Structure of the presentation



03

DCR Schema → DCA Schema

- Will be a part of the next Proof of Cpncept (PoC)
- Source: GEMIMEG-II
- GP Temperature will be used
- Partners:
  - ✓ Boehringer Ingelheim
  - ✓ Siemens
  - ✓ Beamex
  - ✓ PTB

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04

DCR Schema → DCA Schema

- Request of:
  - ✓ usedMethods
  - ✓ validityRange
  - ✓ conformity
  - ✓ ...
- Transfer/use of:
  - ✓ GP Temperature
  - ✓ GP Temperature Sub-Scheme
  - ✓ Schematron-Checker
  - ✓ ...

14:00	Quality and Validation of the DCC	60'	Design and Implementation of a Digital Calibration Certificate Network Service Test System	Xiong Xingchuang, NIM, People's Republic of China
14:15			Verifying DCCs	Hans Koch, da+d, Germany
14:30			Digital Calibration Certificates (DCC) using the Quality Information Framework (QIF)	Robert Brown, Mitutoyo America Corporation, USA
14:45			Using Schematron to Verify DCCs	Gamze Söylev-Öktem, PTB, Germany

05

XML-Scheme & XML-Dataset

- XML-Schema defines
  - ✓ Structure
  - ✓ Elements
  - ✓ Attributes

  of an assigned XML-Dataset
- Validation

.xsd

- XML-Dataset includes
  - ✓ Documentation in
    - – Elements
    - – Attributes

.xml

DCC-Scheme linked with XML-Dataset:

- ISO 17025-conformity of DCC
- Transformation to others
  - ✓ JSON, Protobuf, ...
  - ✓ I4.0-compatible

DCR Schema

DCA Schema

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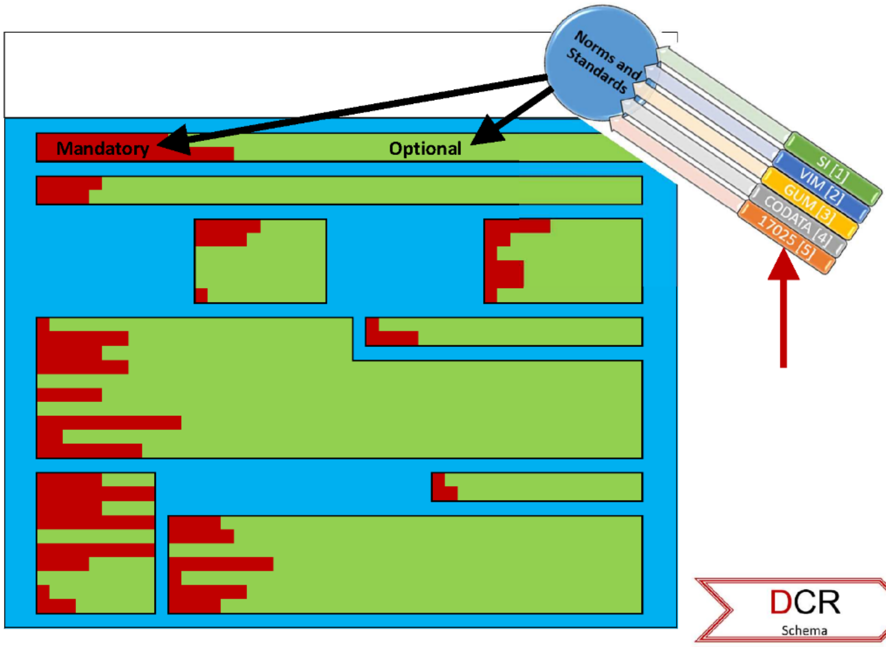
06a

A comparison with a stencil



DCR Schema

DCA Schema

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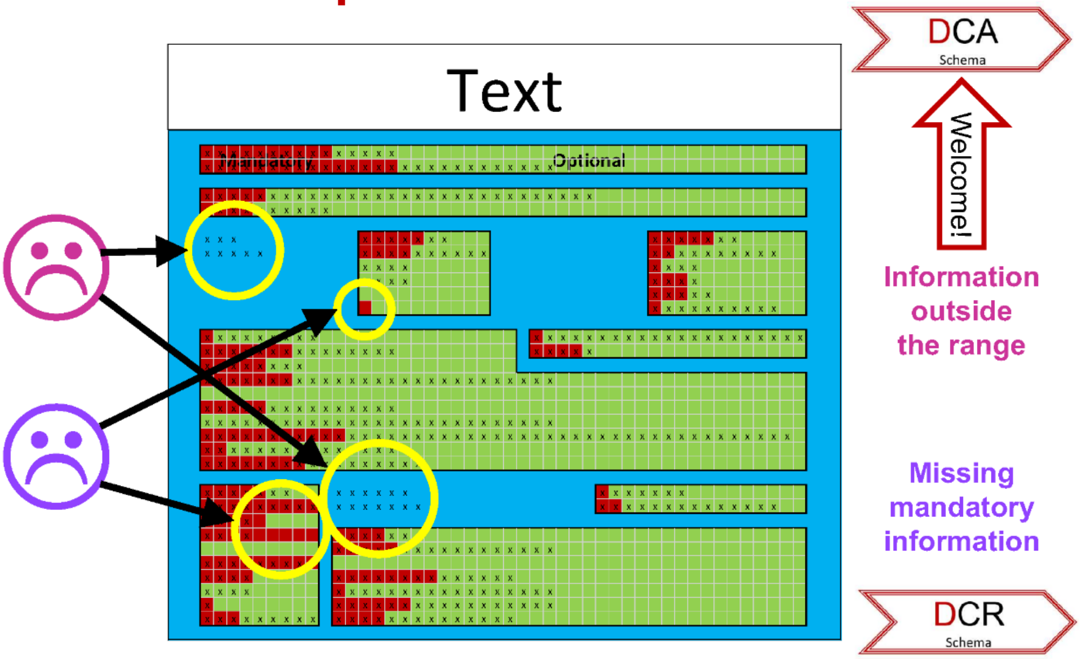
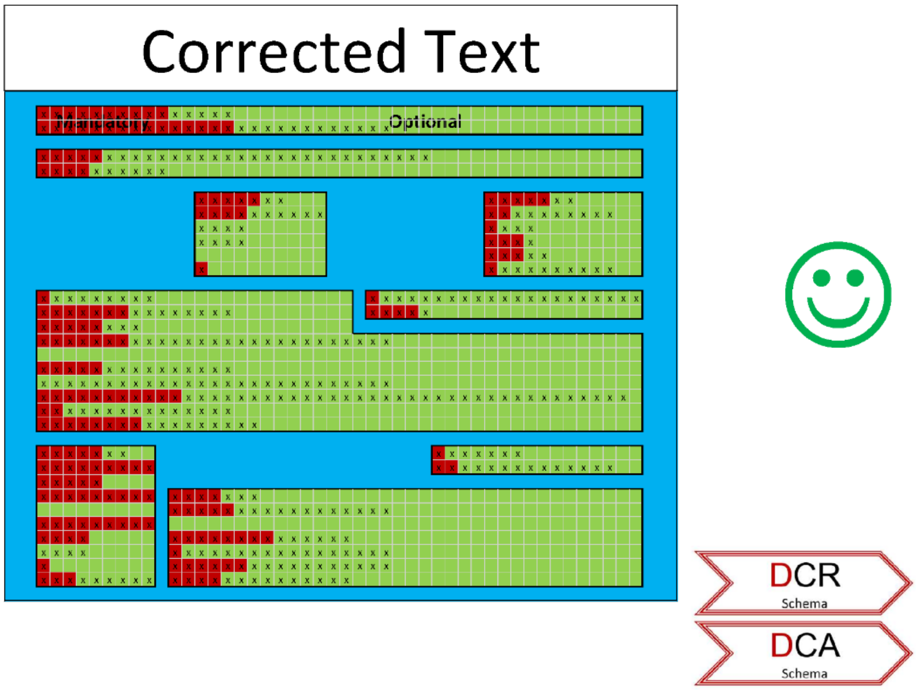
06b

A comparison with a stencil



06c

A comparison with a stencil



06d

A comparison with a stencil

- XML-Schema defines
  - ✓ Structure
  - ✓ Elements
  - ✓ Attributes

  of an assigned XML-Dataset
- Validation

.xsd

- XML-Dataset includes
  - ✓ Documentation in
    - Elements
    - Attributes

.xml

DCC-Scheme linked with XML-Dataset:

- ISO 17025-conformity of DCC
- Transformation to others
  - ✓ JSON, Protobuf, …
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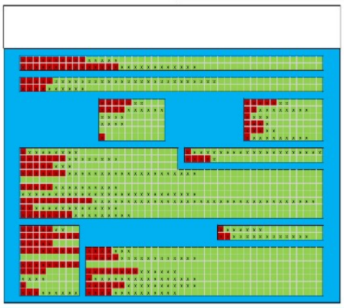

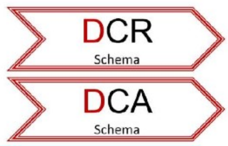

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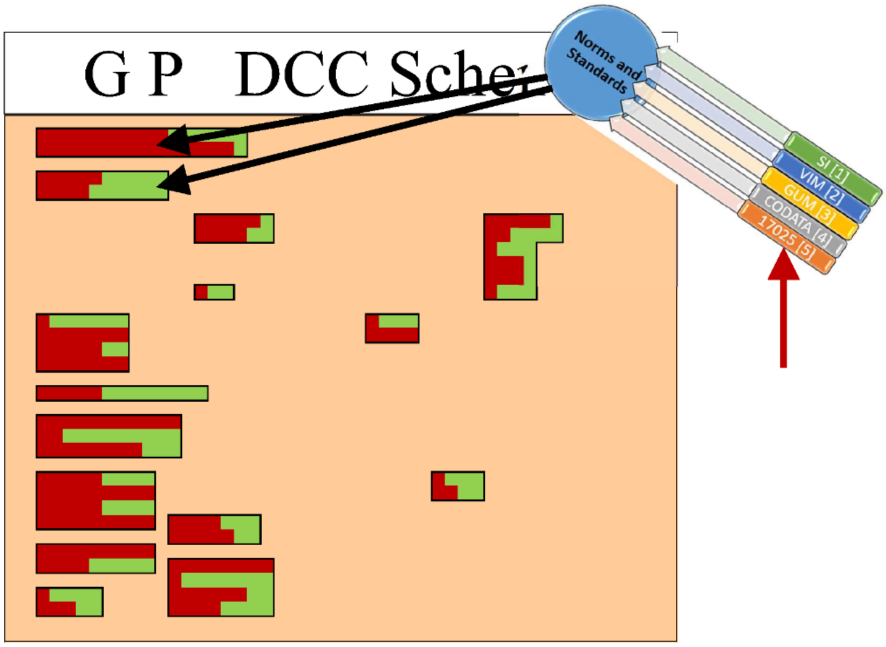
07

Evaluate a Good Practice DCC Scheme



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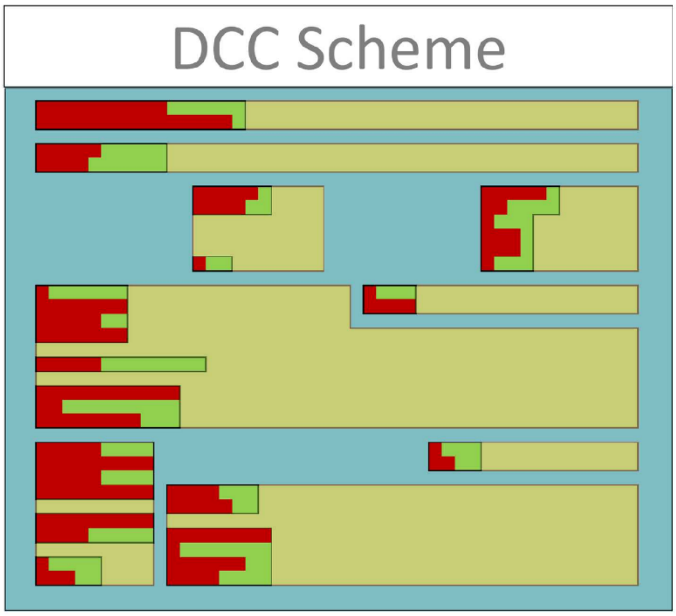
08

Compatibility Check



09

2nd Part

Digital Test Certificate

ISO 17025

DTC
Schema

Digital Certificate
for Reference Materials

ISO 17034

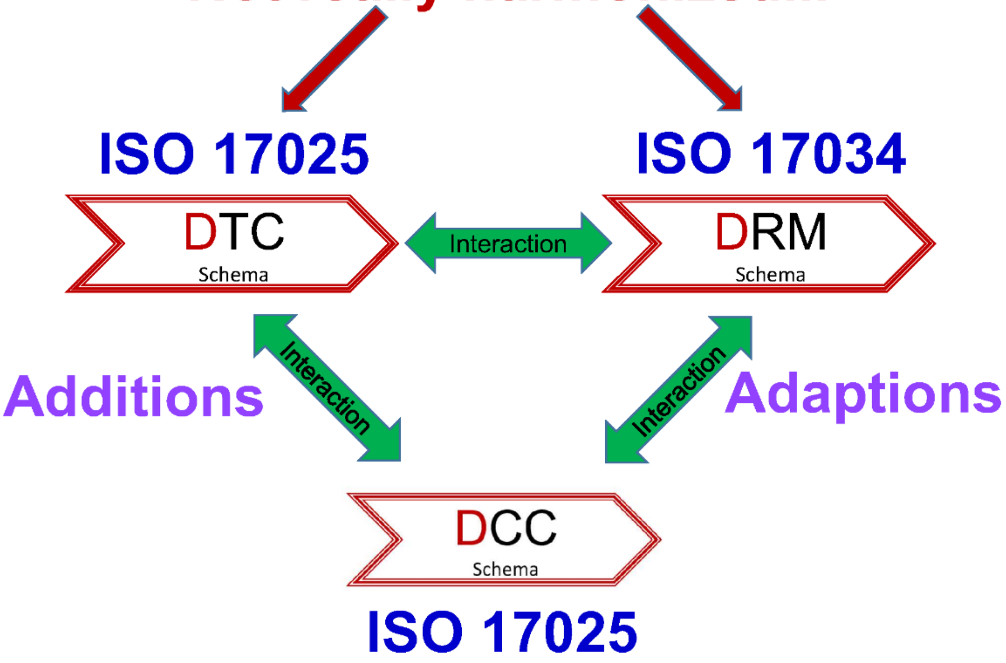
DRM
Schema

DCC
Schema

ISO 17025

10

Not really harmonized...



11

Interested in active cooperation?

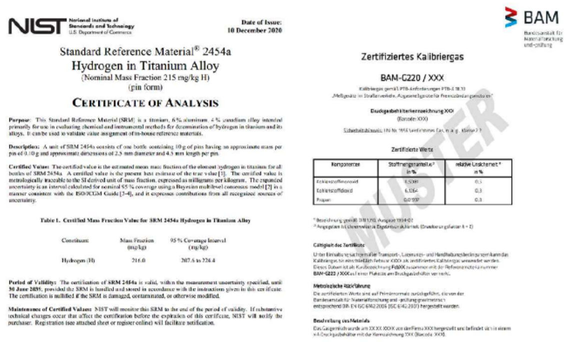
DCC Schema dcc@ptb.de

DCR Schema dcr@ptb.de

DCA Schema dca@ptb.de

DTC Schema dtc@ptb.de

DRM Schema drm@ptb.de



12

The PTB-DCC-Team

alphabetical sequence

Benjamin Gloger
Daniel Hutzschenreuter
Frank Härtig
Gamze Söylev-Öktem
Jan Loewe
Justin Jagieniak
Lutz Doering
Shanna Schönhals
Thorsten Schrader

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More questions? Please contact:

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www.ptb.de/dcc

2022-03-03

DCC Envelope

Presenting author Gamze Söylev-Öktem, PTB, Germany

gamze.soeylev-oektem@ptb.de

Additional author Siegfried Hackel, Justin Jagieniak, Benjamin Gloger, Lutz Doering (all PTB, Germany)

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Abstract

In addition to the already known advantages, digitalisation in the field of calibration has the advantage that work processes can be optimised both at the customer's and in the calibration laboratory by splitting the calibrations into sensible sub-areas (keyword: keep it smart). Examples of this are the calibrations of multimeter, pieces of mass or gauge blocks. Different recalibration intervals are also conceivable, which further optimises the effort for recalibrations.

The overall result is typically presented in several DCCs. These DCCs can be combined into a DCC envelope (workbook) and passed on to the client in a single, logically coherent file.

With this technology, it is also possible to connect other logically related digital certificates of any kind.

The DCC Envelope technology is presented using the example of a mass set.

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Envelope

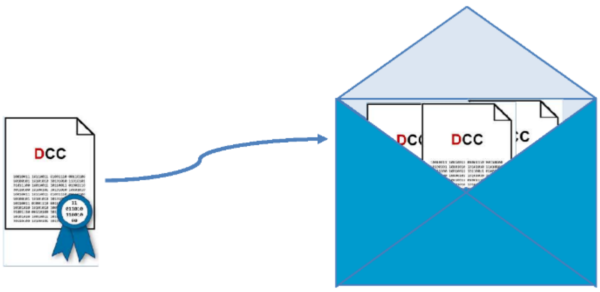
Grouping of the Digital Certificates as Envelope

2^{nd} International DCC Conference

Gamze Söylev-Öktem (PTB)
Benjamin Gloger (PTB)
Justin Jagieniak (PTB)
Dr. Lutz Doering (PTB)
Dir. u. Prof. Dr. Siegfried Hackel (PTB)

Why do we need Envelope?

- „Keep it simple“
  - Every calibrated item has its own certificate

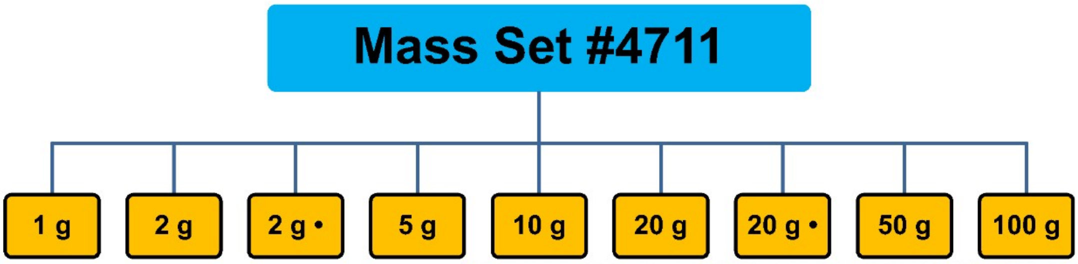


In which areas can envelope be used?

- Mass piece,
- Multimeters,
- Gauge blocks,
- etc..

Source: Beginning XML; Fawcett, Quin, Ayers

Mass Set

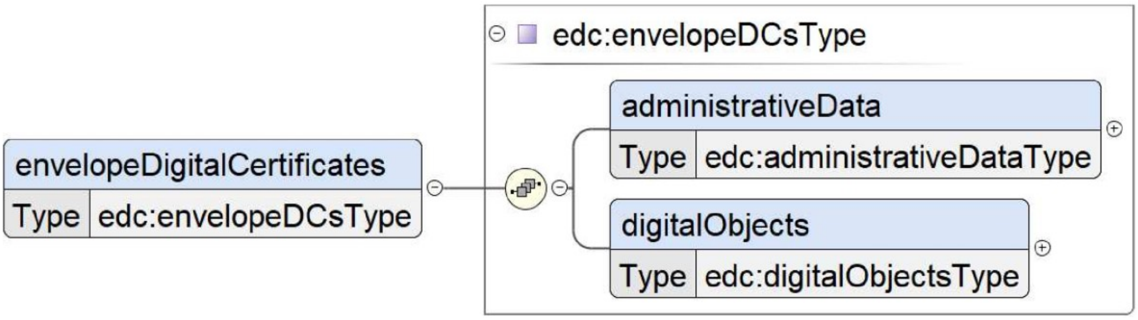


Advantages of Using an Envelope

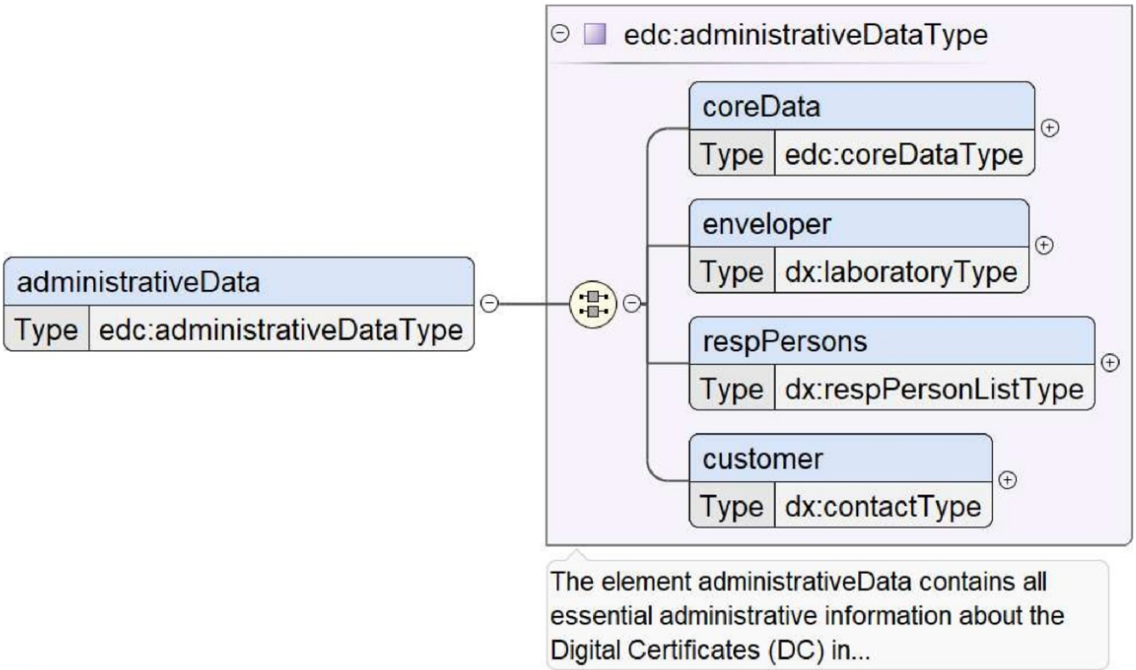
- Optimization of the process for the industry
- Less work
- Future-proof

Source: Beginning XML; Fawcett, Quin, Ayers

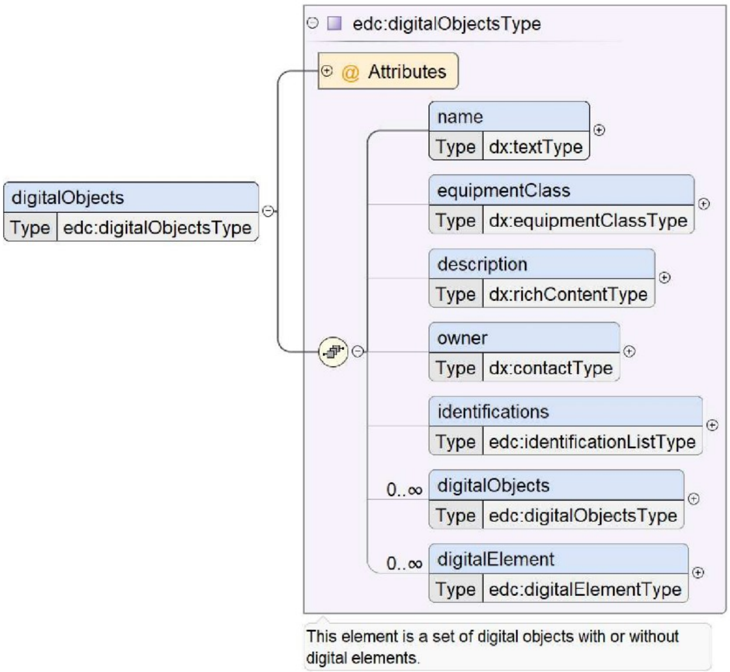
dc-envelope.xsd



dc-envelope.xsd: administrativeData



dc-envelope.xsd: digitalObjects



Demonstrator: envelopeTool

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2022-03-03 9

Thank you very much for listening!

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Session “IT-Security”

Metrological Digital Transformation and Cyber Security Protection of Documents in Saudi Arabia

Presenting authors Saad Ali Haj Bakri, King Saud University, Saudi Arabia Talaat Al-Rahali, Advisor to the NMCC, Saudi Arabia

Abstract
While calibration is a process used to maintain the accuracy of a measurement device, a calibration certificate is a document that contains information about the device’s calibration, and its ownership. Since this information is important and private, it should enjoy integrity and confidentiality throughout its processing and use. With the continuation of the world-wide digital transformation, the calibration process and its certificate will be handled electronically via the cyberspace, and this requires various general and special cybersecurity protection controls to be put into practical use.

The proposed presentation is concerned with the current advances of Saudi Arabia in providing protected digital transformation in general, and in giving protected digital metrological transformation in particular. The general digital transformation provides the essential controls for all activities in the cyberspace; while the particular digital metrological transformation emphasizes additional specific controls for the metrological activities include digital calibration. Saudi Arabia has its own National Cybersecurity Authority (NCA) responsible for the general level controls, and the country ranked 2nd at the world level in the latest publication of the Global Cybersecurity Index (GCI) of the International Telecommunication Union (ITU).

Regarding the specific level of metrology, Saudi Arabia Standards Organization (SASO) has its own National Measurements and Calibration Centre (NMCC), which has 30 laboratories concerned with a wide range of measurement and calibration activities in various fields, in addition to having its own computing cloud. These activities are, so far, partly digital providing digital calibration certificates (DCC). In doing so, various secure digital actions are involved, considering the international ISO 17025 general requirements for the competence of testing and calibration laboratories.

The targeted presentation will provide details of the above, hoping to draw a clear picture of the current advances of Saudi Arabia in giving well protected digital calibration certificates.

NATIONAL METROLOGY INSTITUTE

The 2nd International DCC-Conference

DDC: Digital Calibration Certificate

2022 March 1- 3

Chosen Conference Topic:

Current Advances of the Digital Calibration Certificate

Presentation Title

Metrological Digital Transformation and Cyber Security Protection of Documents in Saudi Arabia

Presenters

Talaat Al-Rahali Advisor to the National Measurement & Calibration Center (NMCC)

E-Mail:T.rahali@saso.gov.sa

Saad Al-Hajj Bakri is a professor in the Department of Computer Engineering at King Saud University

Member In SASO's Technical Committee for Artificial Intelligence

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NMCC
المركز الوطني للقياس والمعايرة
National Measurement & Calibration Center

Agenda

1- Digital transformation How and why NMCC?

2- Digital Transformation Strategy for the Quality Infrastructure System SASO/NMCC

3 - Cybersecurity and Digital Transformation of Metrology Documents DCC

Presentation question and problem

The lesson is not the abundance of resources around you, the lesson is its usefulness when you need it

Q1 / What is the Goal of transformation؟
Q2 / What is the business model؟
Q3 / Why does NMCC need to change and digital transformation?

Q&A / If you could see the future of digital metrology... what would you do?

National Digital Transformation

The interest of the Saudi government in the digital economy, new technologies, industrial development and safe digital metrology services

- The SASO / NMCC has taken a decision to digitally transform metrology certificates and apply cybersecurity techniques to protect them and provide secure digital services

-Focusing on the digital transformation of the strategic metrology is one of the objectives and programs of the Kingdom's Vision 2030 as a global national visio

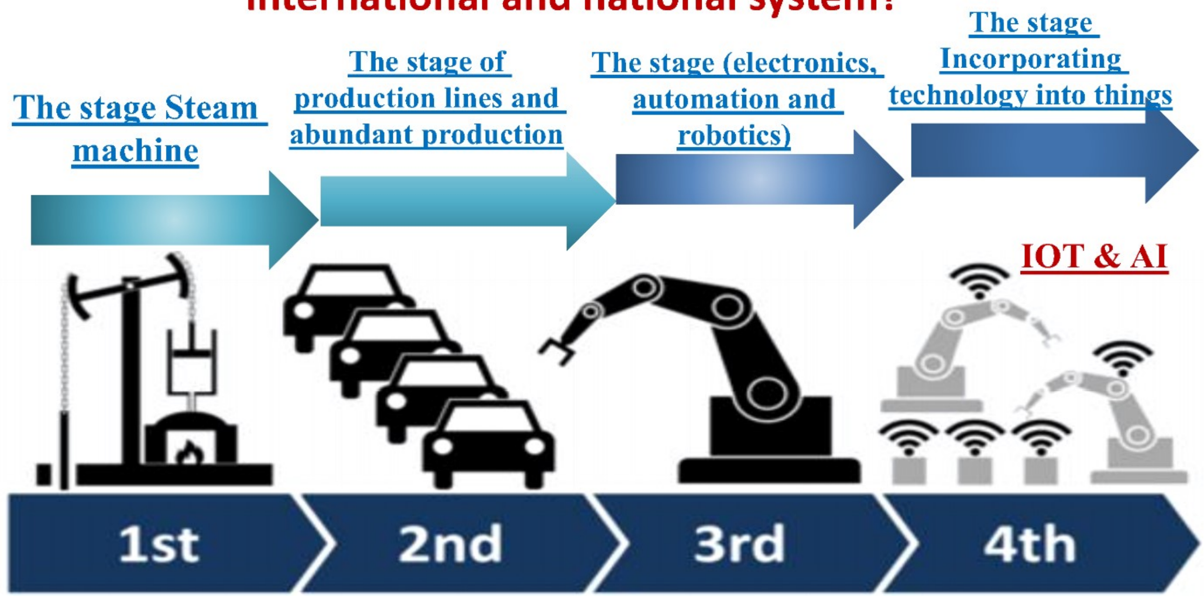
Presentation Brief of NMCC's Digital Transformation Journey

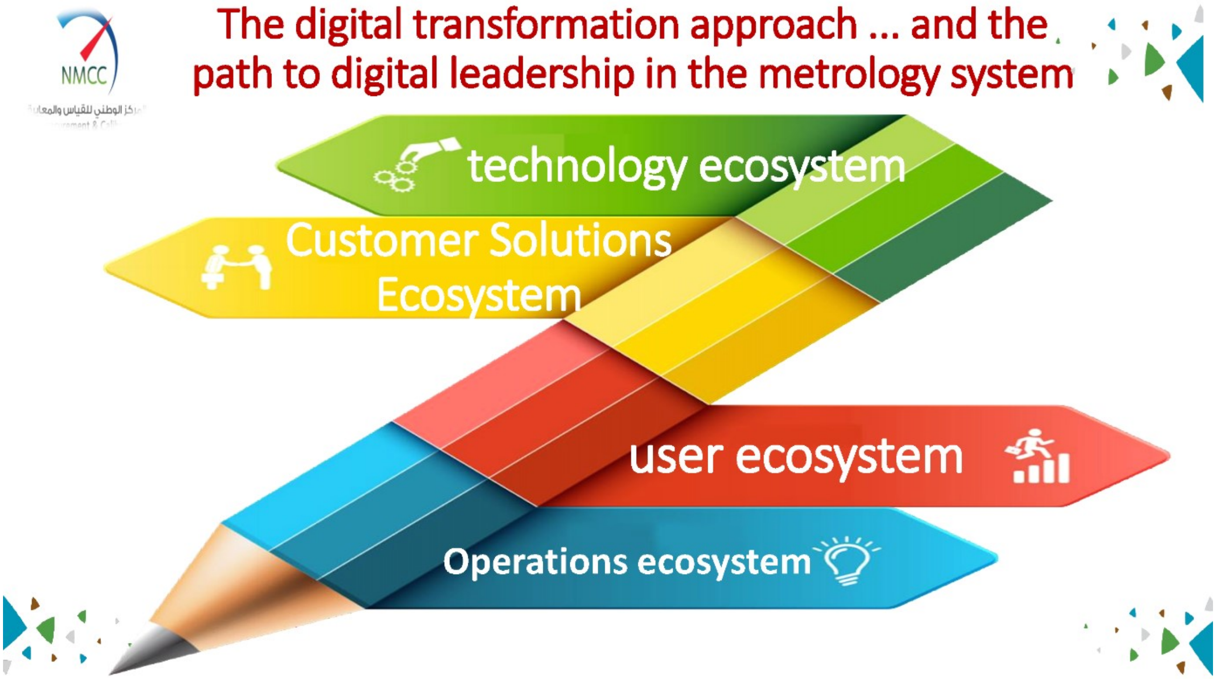
1. Availability of the National Metrological Cloud (NMCC).
2. Classifying and structuring data and unifying and linking relevant databases.
3. Defining the certificate file containing the data and information sourced from ISO/17025, fixed and variable, that are created when performing calibration in NMCC laboratories.
4. Entering the calibration results calculated automatically with uncertainty into the certificate file in the electronic system as "expert systems".

Presentation Brief of NMCC's Digital Transformation Journey

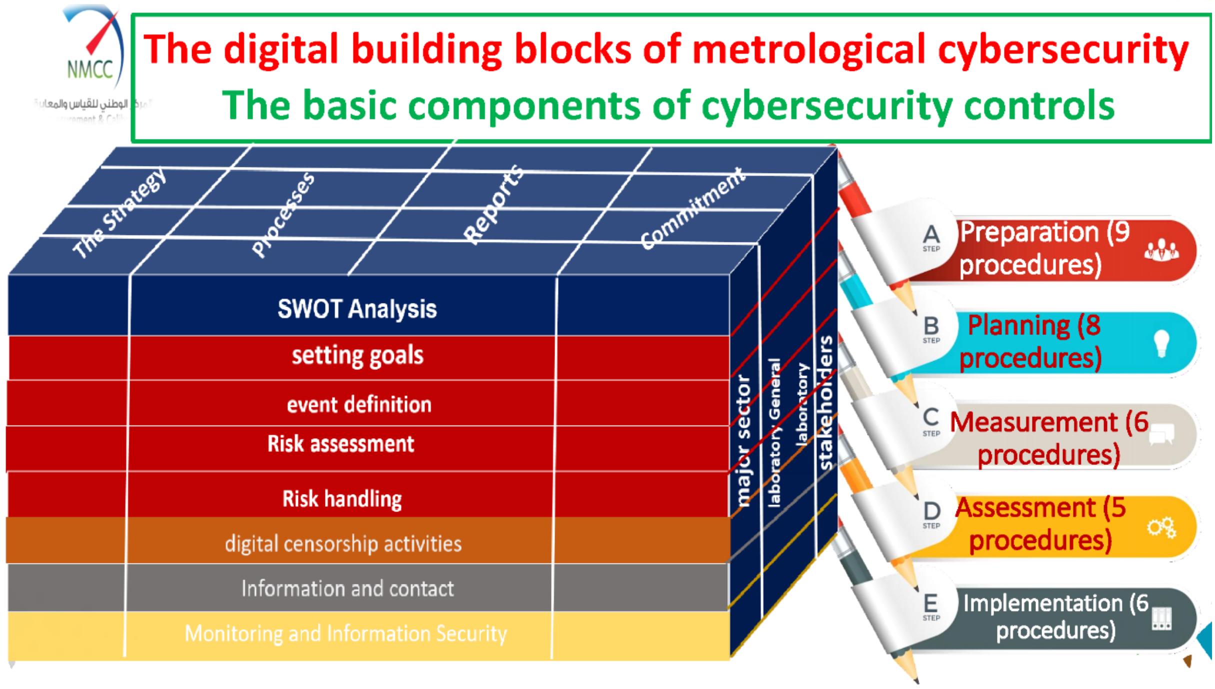
5. Reviewing the data "DATA Check" to ensure its validity through expert systems and institutional artificial intelligence tools.
6. Authentication and electronic signature of the certificate.
7. Applying the steps of data protection, cyber security, information, encryption and digital certificate control (DCC).
8. Include technical and legal solutions, and send digital certificates to the beneficiary in electronic form

Where is the global digital transformation and the international and national system?

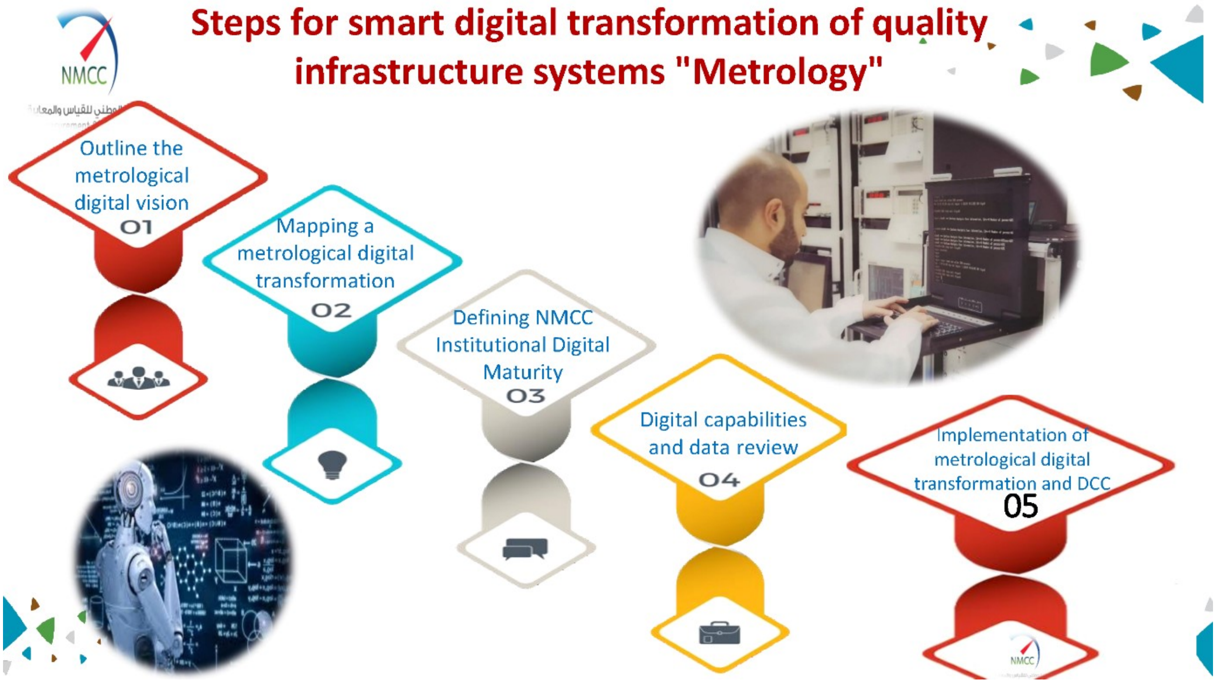




The digital transformation approach ... and the path to digital leadership in the metrology system
technology ecosystem
Customer Solutions Ecosystem
user ecosystem
Operations ecosystem



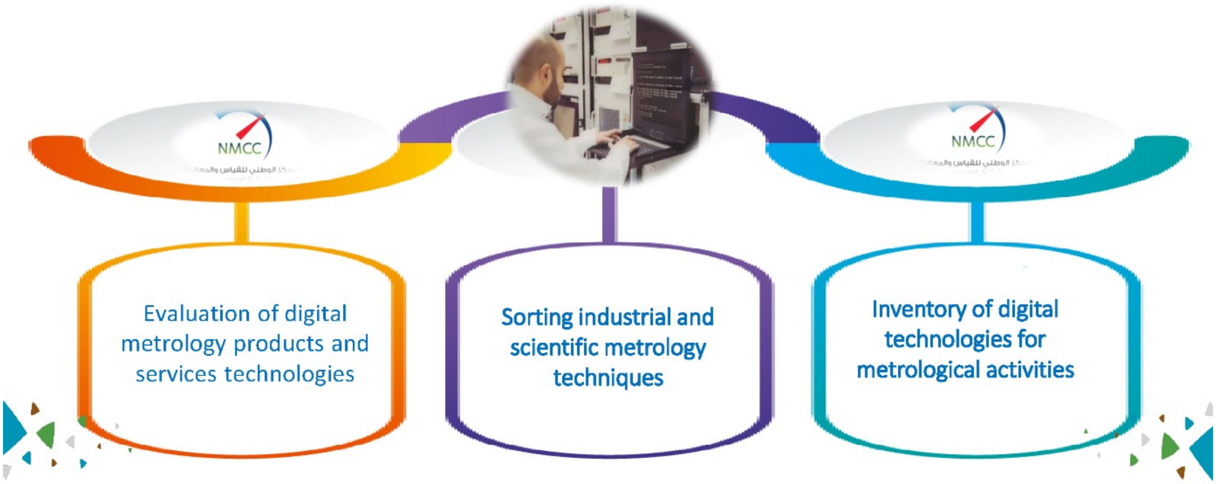
The digital building blocks of metrological cybersecurity
The basic components of cybersecurity controls
The Strategy
Processes
Reports
Commitment
SWOT Analysis
setting goals
event definition
Risk assessment
Risk handling
digital censorship activities
Information and contact
Monitoring and Information Security
major sector
laboratory General
laboratory
stakeholders
A STEP Preparation (9 procedures)
B STEP Planning (8 procedures)
C STEP Measurement (6 procedures)
D STEP Assessment (5 procedures)
E STEP Implementation (6 procedures)



Steps for smart digital transformation of quality infrastructure systems "Metrology"
NMCC
Outline the metrological digital vision
01
Mapping a metrological digital transformation
02
Defining NMCC Institutional Digital Maturity
03
Digital capabilities and data review
04
Implementation of metrological digital transformation and DCC
05

NMCC
The foundations of digital transformation in metrology
Data
Human resources
Operations and procedures
Technologies

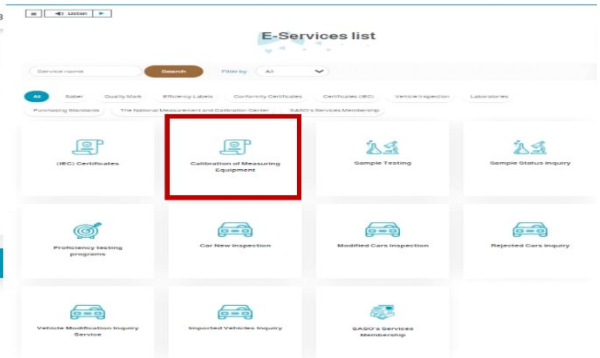
Digital Transformation Models and the Metrological Future



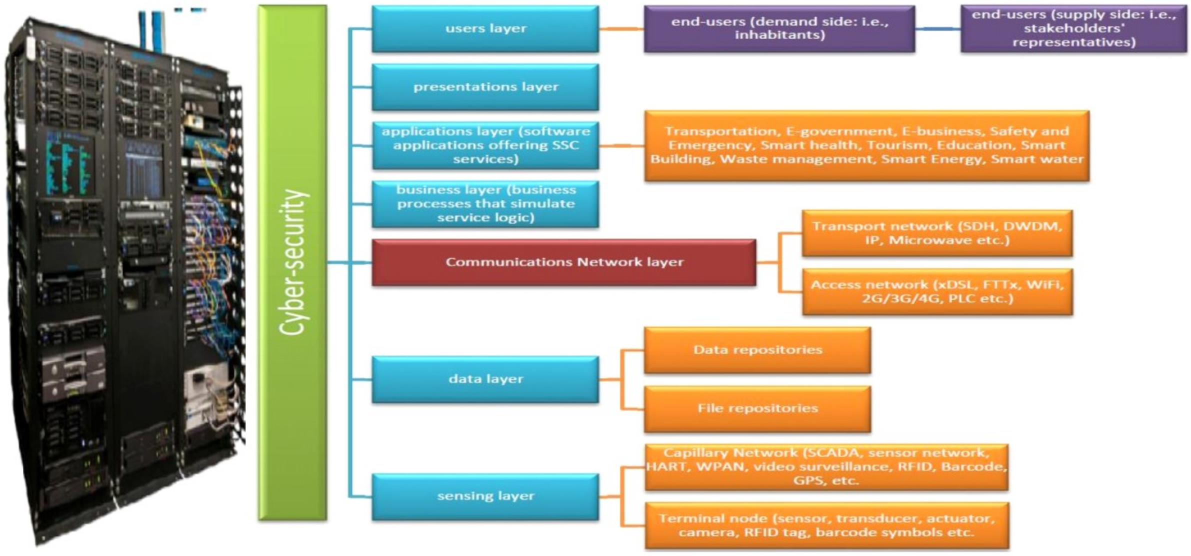
Digital e-services

Portal of the National Center for Measurement and Calibration Service Usage Guide

Enter the following link:
http://www.saso.gov.sa/en/eservices/pages/details.aspx?serviceid=379
Access to the service by clicking on the electronic services and then clicking on **the NMCC portal as shown in the picture**

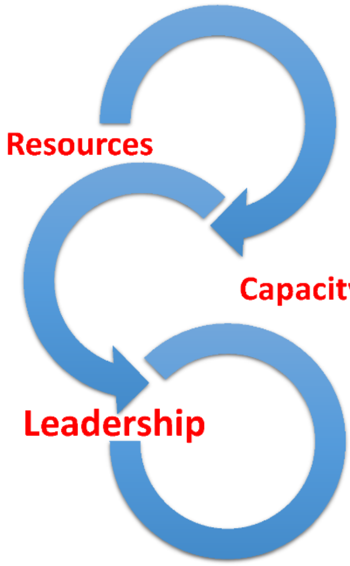


Metrological DCC Digital Data Flow and Management Protocol

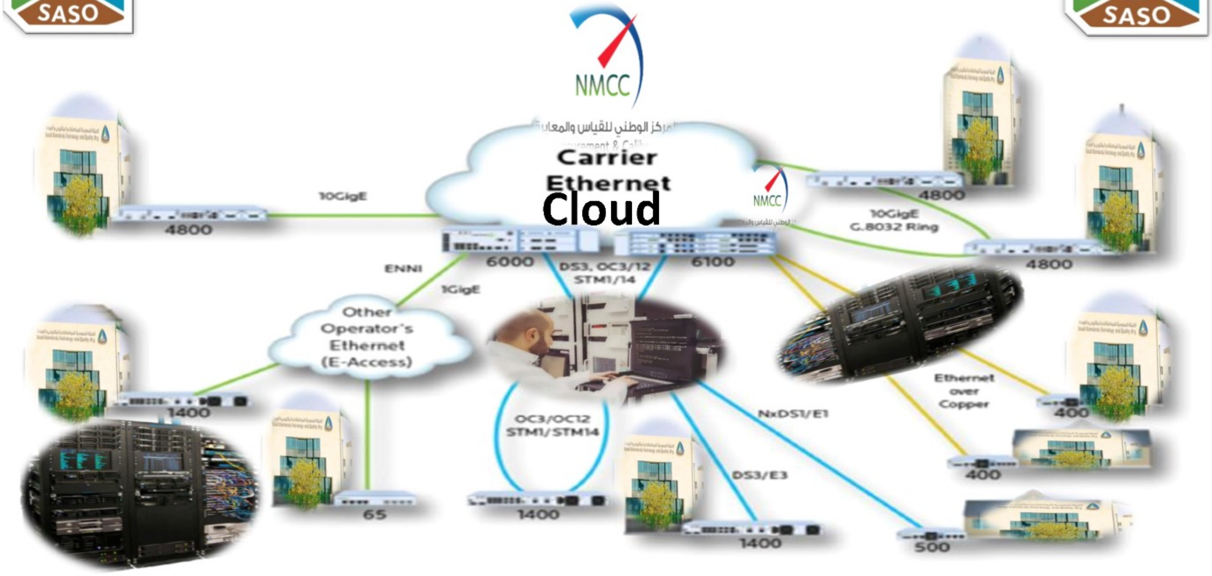


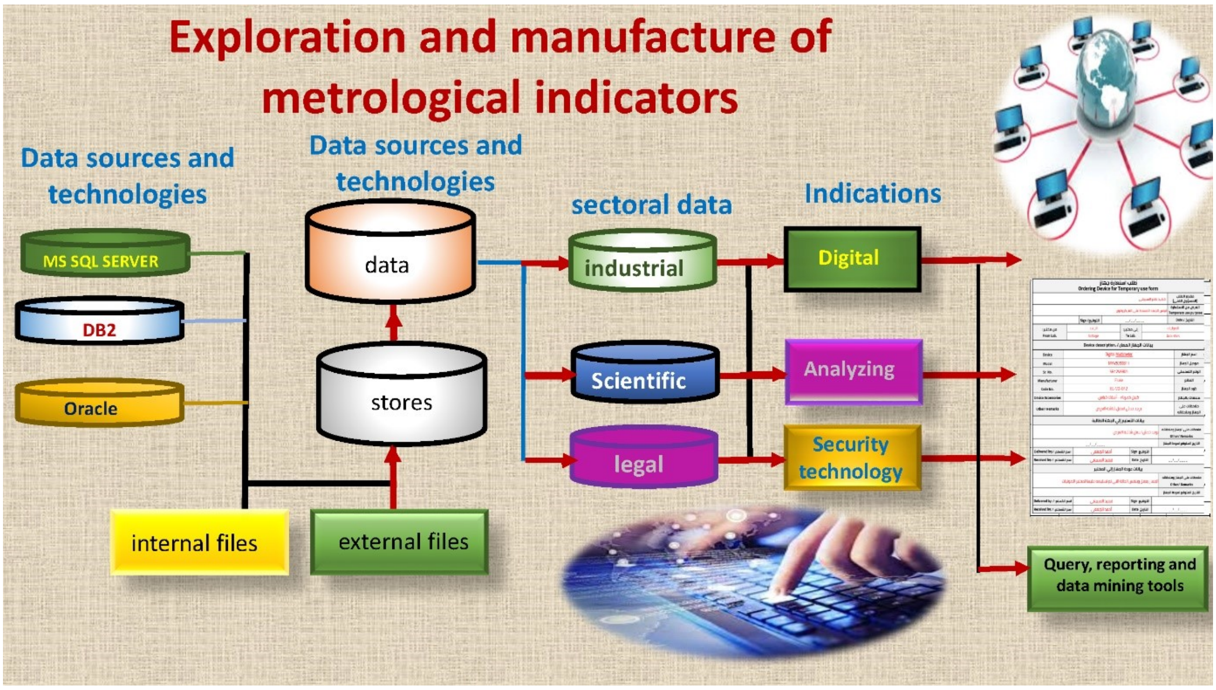
Closing the digital Gap in the metrology sector

Include technical and legal solutions, and send digital certificates to the beneficiary in electronic form



Managing Digital Transformation Protocol and Data Link Digital Metrology Business Continuity at NMCC






Basic Controls and Governance for Metrological Cyber Security
Essential Cybersecurity Controls
1-
1- Cybersecurity Governance
2-
2- Cybersecurity Defense
3-
3 Cybersecurity Resilience
4 -Third- party and Cloud Computing Cybersecurity
4
5 -ICS Cybersecurity
5


NMCC
SASO Digital Achievements
SASO obtained a free and open source government software license from the Digital Government Authority
The first place among government agencies in measuring digital transformation for the year 2021 ، issued by the Digital Government Authority.
Verify-Sy won the award for the best innovative project that uses smart technologies to serve energy efficiency, from the General Secretariat of the League of Arab States.
Achieving 100% in the Government Digital Services Maturity Index for 2021 ،issued by the Digital Government Authority.
Verify-Sy won the award for the best innovative project that uses smart technologies to serve energy efficiency, from the General Secretariat of the League of Arab States.
First place at the level of the government financial and commercial sector in the eighth measure of digital transformation for the year 2019.
Winning the Best Arab Smart Applications Award for the Authorities Sector and Administrative and Regulatory Bodies.
Achieving 98% in evaluating government products and services for the SASO website for the year 2021.
Verify-Sy won the Gulf Customer Experience Award in the category of Best Digital Government Use.

Presentation summary

- Digital development should be considered a global national vision, and it is a decision, not a choice.. an integrated economic and industrial project for a comprehensive and sustainable development for generations.
- It should be based on a comprehensive foundation of human resources, infrastructure, platforms, digital skills, applications and technology in the strategic areas of biometrics and calibration.
- Striving for this economy to be based on the credibility of reliable, fair and comprehensive data in order to provide the possibilities of digital and knowledge transformation for all sectors of metrology and calibration sciences.

Thank you and appreciate your attendance, participation and time

Talaat Al-Rahali Advisor to the
National Measurement & Calibration
Center (NMCC)

For further communication and inquiries, we welcome you to:

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T.rahali@saso.gov.sa 920009772

Security in DCC

Presenting author Lisa Busser, Technische Universität Kaiserslautern, Germany

Abstract

Security Aspects in DCC should be considered right from the beginning of the implementation. Therefore, every method of signing and encryption should be taken into account and the best one should be chosen. In my opinion not only hard criteria like international lawful requirements and state of the art cryptography should be taken into account but also the usability of the result. As an example, from our field of software development in mass meteorology an accredited laboratory is calibrating a weight and sends the resulting DCC to the customer. At this point signing this certificate would be enough to ensure the validity. Of cause encryption could additionally be chosen but then the customer needs his own key within the cryptosystem. If signing is enough, how can it be ensured that the customer has a possibility to verify the signature? Enabling a cryptosystem isn't enough the customer who might not be part himself also needs a good opportunity to check the signature otherwise it will probably never be checked.

Additionally, it needs to be discussed how laboratories worldwide can get their cryptography key due to the fact only our software is used in over 150 laboratories around the world.

I will discuss this and other questions in my Master Thesis next semester at the Technical University in Kaiserslautern supervised by Prof. Schmitt, the head of our cyber security chair. The goal is to not only find the best solution but also implement a prototype.

I would like to formulate the requirements we have already thought about and ask the auditory for more input we haven't thought about jet, so we can hopefully come up with a prototype of a middleware that fits the requirements of all units until the end of this year.

Security in DCC
Call for Help

Lisa Busser
TU Kaiserslautern
MARO Elektronik

March 3, 2022

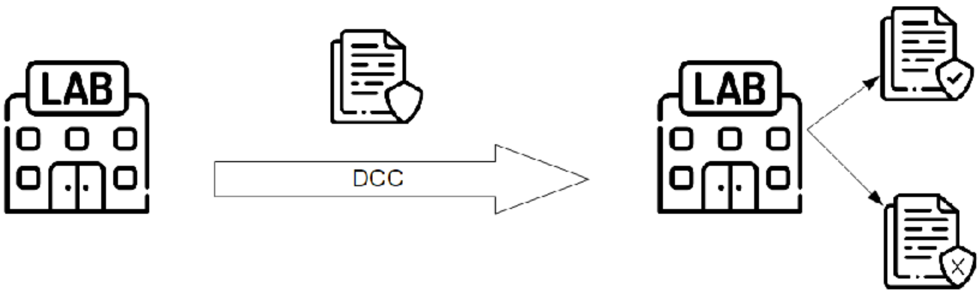
Master Thesis

- Thesis: determine optimal **structure** for enabling security goals in DCC
  - How can the certificates been provided and checked in a useful manner
  - Determine the edge cases
  - Structural analysis which structure suites the purpose best
    - Always under assumption that cryptography might not be used if the system is to complicated / process to costly (time/ resources)
    - Social engineering aspects
    - → Handling for user must be as easy as possible
- Providing a prototype as a proof of concept
- Must be working world wide

What's not the goal

- Find a specific company that provides the certificates
  - Goal: Building an open structure where different companies can join (e.g. Certificates of Websites)
- Exclude any country/customer by structure
  - Goal: Call for help for specific surrounding conditions
    - lisa.busser@maro.de

Control Signature

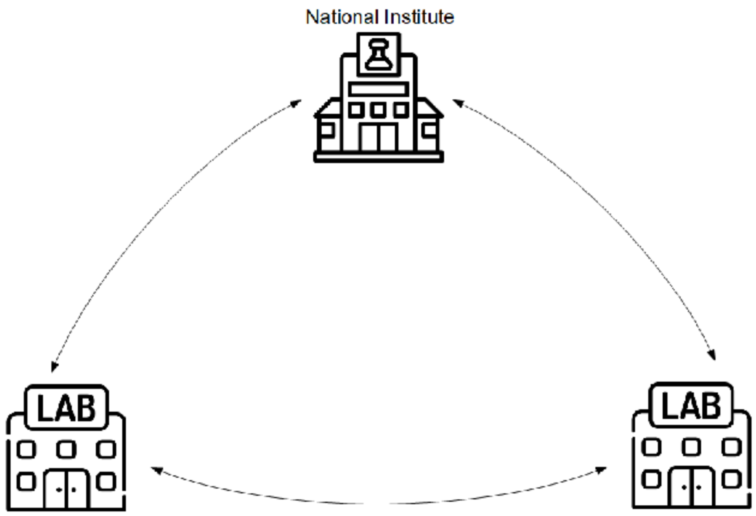


- Controlling signature is included in measurement software
- Check in the background after importing document

Goal
Control Signature
Additional Requirements

Closed System
Open System

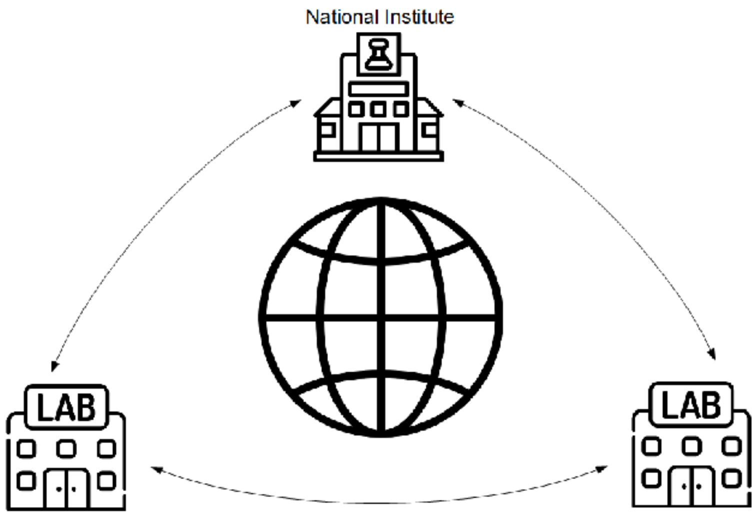
Signature Network



Goal
Control Signature
Additional Requirements

Closed System
Open System

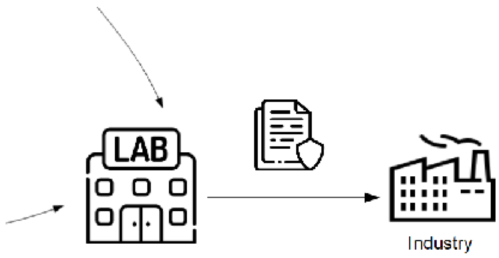
Signature Network World Wide



TECHNISCHE UNIVERSITÄT KAISERSLAUTERN
Lisa Busser TU Kaiserslautern MARO Elektronik
Security in DCC Call for Help

Control Signature

- In case of signatures partners in industry doesn't need to be part of signature network
- How do they check the validity of the signature
- Problem:
  - DCC is usable even without checking the validity
  - Confirming process must be as easy/fast as possible
- What happens in case of no connection to the internet at all



Additional Requirements

- Enable different signature providers
- Meet legal requirements
- Meet special regulations in all sectors of industry
- Exchangeable cryptographic methods
- Calibration certificates must be stored for certain time period
  - Typically signatures expired after 13 Months $\leftrightarrow$ verifying signature during during whole lifetime of DCC should be possible
  - What happens if a cryptography algorithm is broken
- Revoke process

I need your help

- lisa.busser@maro.de
- Describe your setup
- Describe your ”normal” and your ”edge case” of using DCC
- Informations about legal requirements are welcome

Goal
Control Signature
Additional Requirements
Requirements
Help

Thank you for your help

Technical security system for the signature, secure storage, and export of DCCs

Presenting author Matthias Kromphardt, D-TRUST GmbH, Germany

kromphardt@bdr.de

Abstract

This abstract presents a technical security system for the signature, secure storage, and export of Digital Calibration Certificates (DCC). DCC records are linked using both signature and transaction counters. Counters, DCC data and timestamps are signed together and thus securely linked. The proposed solution works with any DCC data format and thus with any payload data. However, payload data will not be defined within this abstract.

The proposed solution is a Technical Security System (TSS) in accordance with available Technical Regulations (TR), Protection Profiles (PP) and certifications of German Federal Office for Security in Information Technology. The TSS consists of a security module in accordance with TR-03153, secure storage, and a unified interface according to TR-03151. The Public Key Infrastructure (PKI) is certified in accordance with TR-03145.

The Security Module consists of a Crypto Service Provider (CSP) in accordance with BSI-CC-PP-0111 and a Secure Module Application (SMA) in accordance with BSI-CC-PP-0105. Signed data records can be downloaded in a structured TAR archive file format directly from the TSS or via the apparatus (the device which produces the calibration data).

The TSS can be used on an apparatus with or without data interface. The process of signing data is always performed in the following way:

• startTransaction, updateTransaction, finishTransaction.

The functions ‘startTransaction’ and ‘finishTransaction’ are mandatory while ‘updateTransaction’ can be used as required. In the future, repeated ‘updateTransaction’ could be used for the signature of continuous measurements.

Although payload data is not defined in this proposal, operating with a payload data structure using ‘processType’ (definition of the type of data to be signed, for instance ‘dccData’, ‘measurementData’ and ‘otherData’) and ‘processData’ (definition of the structure of such data) is recommended. Using such a data structure facilitates future upgradeability of the system, for instance, to digitally sign measurement data.

The proposed system includes a web service implementation of the CSP component which is installed at the certified data centre of D-Trust in Berlin, Germany and is accessible via public internet, a SMA implementation, which is installed locally at the premises of the system user, and an online management system which is mainly used for registration, rollout management and billing purposes.

*Abstract was shortened to one page

d-trust.

Technical Security System for DCC records

Automatic signature, secure storage and export of DCC

03.03.2022
Berlin
Matthias Kromphardt

Objectives of the automatic protection of DCC and other measurement records

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Objectives of the Presentation

- **Protection of authenticity and integrity of digital records:**
  - Digital Calibration Certificates (DCC)
  - Measurement data
  - Other data
- **Assurance of completeness of digital records:**
  - Concatenation (chaining) of records
- **Automatic protection of data:**
  - Prevention of human interference
  - Provision of an interface for data export and automatic survey

03/03/2022 Teil der Bundesdruckerei-Gruppe 2

Comparison of digital signature, digital seal and technical security system (TSS)

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Digital Signature, Digital Seal and Technical Security System

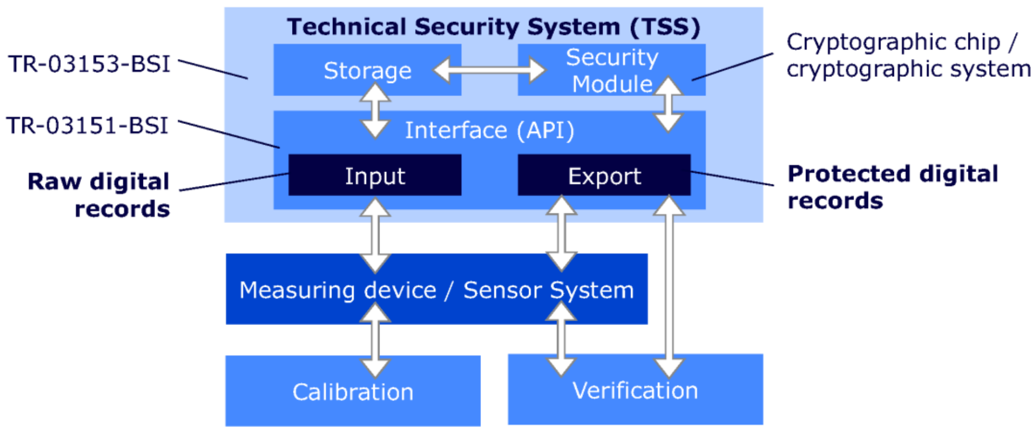
	Digital Signature	Digital Seal	Technical Security System (TSS)
Legal impact	Expression of will from a **natural person**	Proof of origin from an **institution**	Proof of origin and **completeness** from a **system/machine**
Security objectives	Integrity and authenticity of a document		Integrity, authenticity and **completeness of digital records**
Characteristics	Advanced signature Qualified signature	Advanced seal Qualified seal	Specific
Application	Manual	Manual / semi-automatic	**Fully automatic**
Examples	Contract	Legal decision	Fiscal records of a cash register

03/03/2022 Teil der Bundesdruckerei-Gruppe bdr. 3

Schematic overview of the technical security system (TSS)

d-trust.

Technical Security System

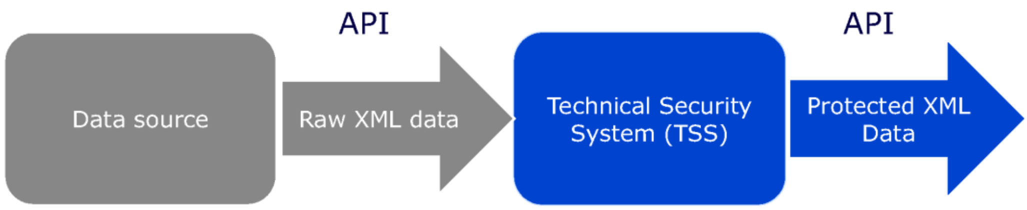


03/03/2022 Teil der Bundesdruckerei-Gruppe bdr. 4

Simplified protection process for digital records using a Technical Security System

d-trust.

Protection Process for Digital Records using a TSS



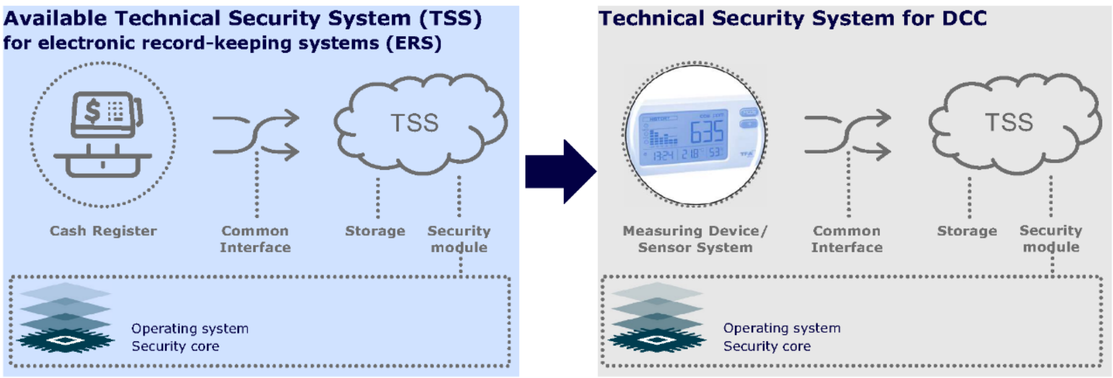
- **Automatic protection of records** without any human interference
- **Records are concatenated** (chain-linked) for proof of completeness
- **Any data** can be protected

03/03/2022 Teil der Bundesdruckerei-Gruppe 5

Short time-to-market due to re-use of existing technology

d-trust.

Re-Use Existing Technology to Protect DCC



03/03/2022 Teil der Bundesdruckerei-Gruppe 6

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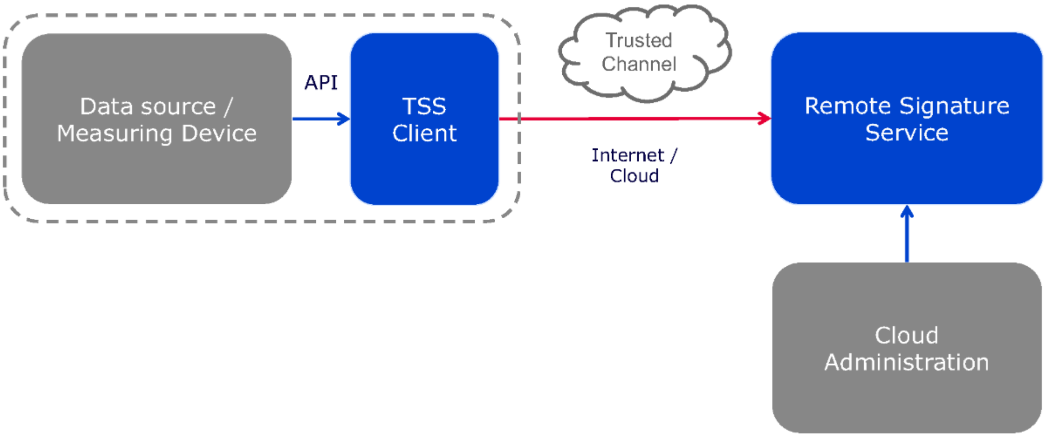
System Architecture



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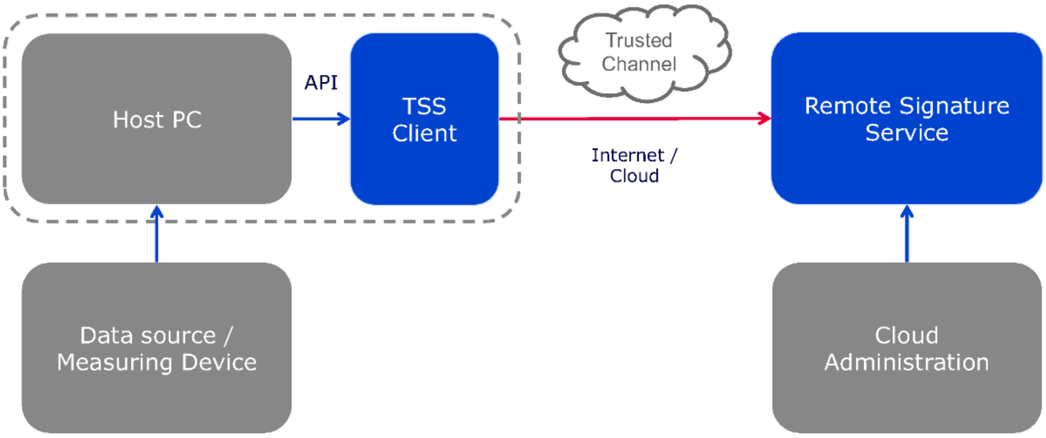
Alternative System Architecture



Specifications and Certification Scheme of the TSS

Full specification and certification scheme available:

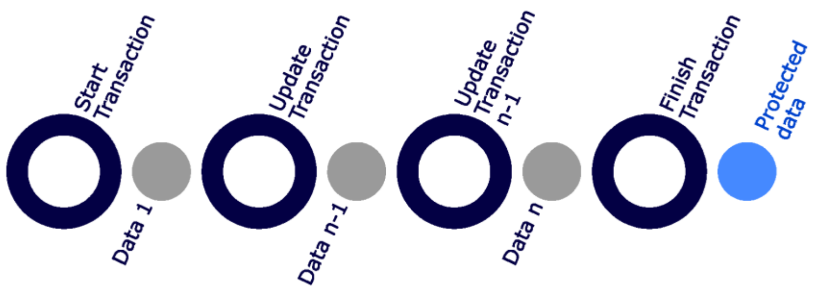
BSI Technical Regulations (BSI-TR)

- **Certification scheme for functionality and inter-operability**
- BSI TR-03153 – Technical Security System for Electronic Record-keeping Systems (ERS)
- **BSI TR-03151 – Secure Element API**
- BSI TR-03145 – Secure Certification Authority operation
- BSI TR-03116 – Cryptographic Guidelines

Common Criteria Protection Profiles (CC-PP)

- **Common Criteria security certifications**
- BSI-CC-PP-0105 – Secure Module Application (SMAERS)
- BSI-CC-PP-0111 – Cryptographic Service Provider (CSPL)

Future: Protection of (continuous) measurements



- One transaction can contain many individual data points
- New data updates the transaction
- Several transactions can be open at the same time
- All transactions are concatenated (chain-linked)
- Protection of continuous long-time measurements possible

Advantages of the Technical Security System

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Time-to-market
- Available system
- Short and easy integration of available API

Industry-proven technology
- Large-scale / high performance system already in place

Flexibility
- Suitable for any data
- Calibration data / measurement data / real-time continuous measurement data

Security
- Specification and certification by BSI
- Regular security updates and re-certification performed

Cost efficiency
- No development / certification / investment cost
- Monthly fee only

Security is what we do and what drives us

d-trust.

"With a history dating back more than **250 years,** we are particularly committed to serving the interests of government, citizens and society.

As a **government-owned security** company, we bear special responsibility:

With secure identities, secure data management and secure infrastructures, we create **trust** in the analog and digital world.

In this way, we are doing much to ensure that governments, private companies and citizens can act with **confidence** on the road to secure digitalization."

d-trust.

Thank you.

Matthias Kromphardt
D-Trust GmbH
E-Mail: matthias.kromphardt@bdr.de

Part of Bundesdruckerei group
bdr.

Session “Quality and Validation of the DCC”

Design and Implementation of a Digital Calibration Certificate Network Service Test System

Presenting author Xiong Xingchuang, NIM, China

xiongxch@nim.ac.cn

Abstract

The metrological calibration certificate is the main communication carrier for bottom-up value traceability in the calibration hierarchy. In the digital transformation of metrology, the machine-readable digital calibration certificate (DCC) is a difficult problem that needs to be solved first. PTB has designed a basic structure of DCC and implemented DCC in XML language. NIM is developing a DCC network service test system based on the basic structure of PTB's DCC while establishing infrastructure such as timestamp and CA system. This paper describes the design structure and preliminary implementation of the test system. The test system includes the XML metamodel of D-SI and DCC, the core measurement terms library, D-SI generation, and verification function module, the DCC generation function module, the DCC verification function module, the DCC related middleware library, the online automatic calibration service, the user Wizard-style operation interface, the user management service, and digital security service functions such as time stamp and digital signature service. On this test system, NIM's DCC-related new technologies and digital services can be tested, and the functions and performance of corresponding technologies and services can be continuously optimized. User-guided DCC generation services and time network automatic calibration DCC generation service cases have been initially implemented.

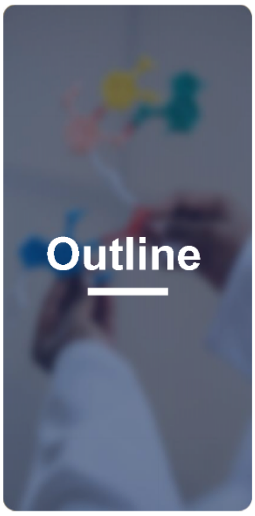
The 2nd International DCC-Conference

Design and Implementation of a Digital Calibration Certificate Network Service Test System

Xiong Xingchuang

Center for Metrology Scientific Data , NIM, China

March 3,2022 （Beijing）



1. Introduction
2. Design principle of test system
3. Functional design of test system
4. Structural design of test system
5. Process design of test system
6. Preliminary realization of test system
7. Conclusion

1.Introduction

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National Institute of Metrology,China

PTB has developed the structure, meta-model and Good Practice of DCC, which provide good reference and guidance for NMIs to develop DCC.

During the implementation, NIM faces several problems when developing its own DCC specifications and application systems:

- The calibration specifications and requirements of NMIs are not identical, so the development of DCC specifications cannot be completely consistent.
- The basic conditions for digitization of each NMIs are different, and the strategies adopted to develop DCC will be different.
- The degree of digitization of different metrology disciplines varies greatly. Some have been digitized, and some are far from being digitized. Therefore, the application methods of DCC are also different.

It is very necessary to establish a test system applying DCC. The system could provide more timely feedback and rapid iteration for the internationalization and universality of DCC.

2 Design principle of test system

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The development of the application DCC is still in the iterative process, so its application test system is required to be scalable and upgradeable. In order to realize the application test of DCC in many metrology disciplines, it needs to be developed to be networked. In order to meet this demand, we try to build an extensible and scalable network system to test the application of DCC.

- Extensibility: Allows adding new functional modules to the system
- Updatable: Allows the system to be upgraded and changed.
- Version Compatibility: All modules of the system are identified by version numbers, which are backward compatible
- Componentization: All components are Web Services, and the component communication protocol is a RESTful API based on HTTP(S).
- Networking: The system provides web interface and web service. The same function module interface is oriented to human operation and machine operation respectively.

3 Functional design of test system

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- **System service objects:** digital calibration terminals, client systems for generating or verifying DCC, users of DCC, developers of DCC application systems or modules.
- **System function:** DCC application test and practical application. DCC systems or modules are applied after passing the test, and new requirements are discovered in practical applications.
- **System service:** The system provides DCC generation and verification as the main line of functional application and application testing services.
- **Service mode of the system:** web wizard mode for human operation, web service for machine operation.
- **Application and testing combination:** The system provides application Demo for direct application, and also provides application testing API and documentation for testing and secondary development.

4 Structural Design of Test System

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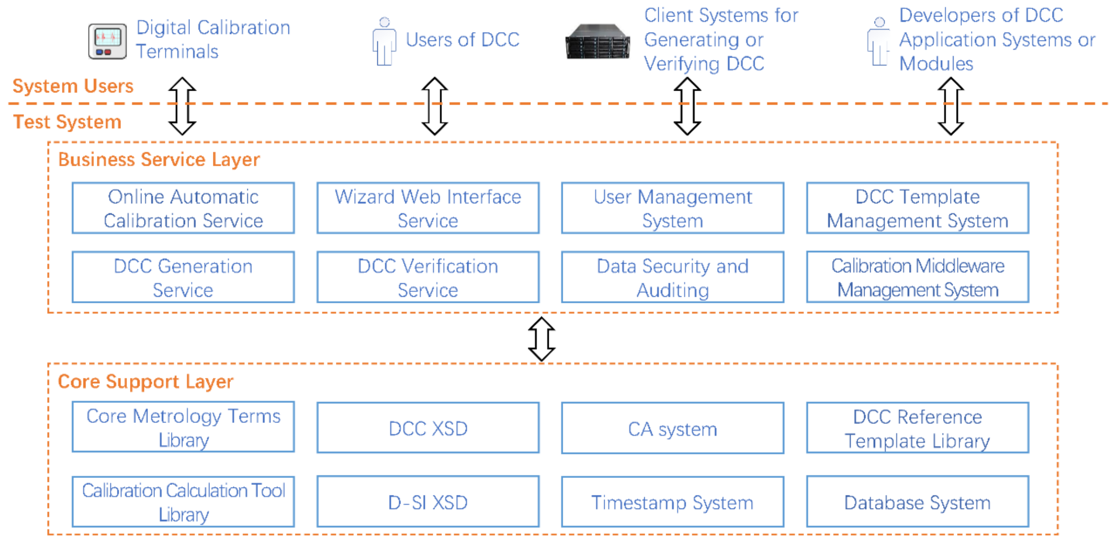

5 Process Design of Test System - Wizard-style Generation of DCC Flow

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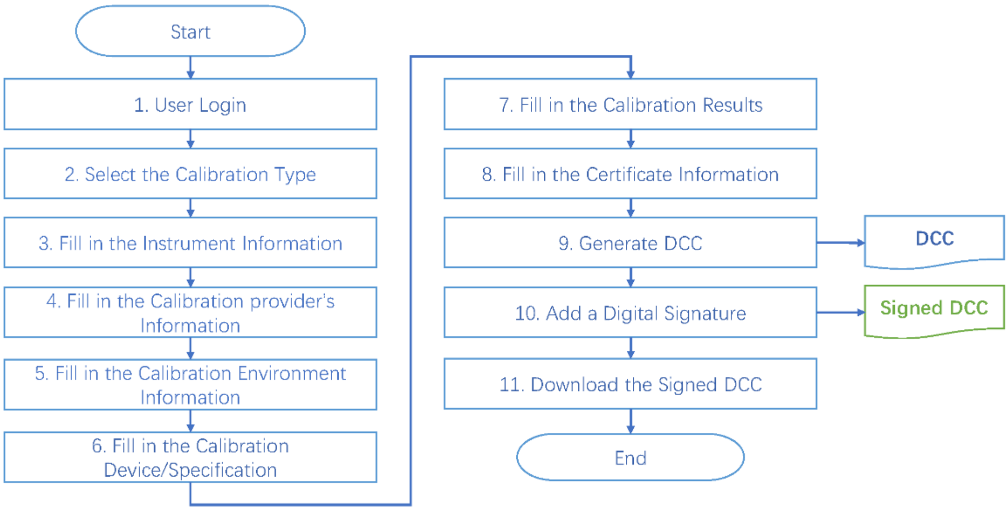

5 Process Design of Test System - Guided Verification DCC Process

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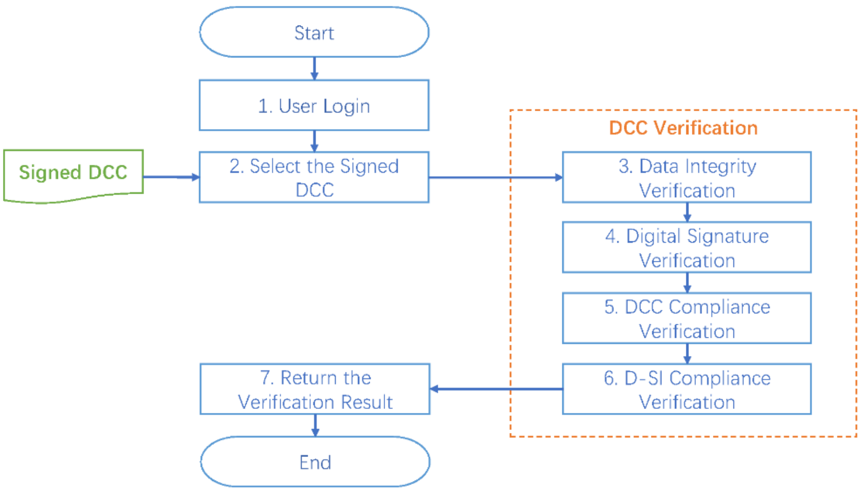
National Institute of Metrology,China



6.1 DCC Generation Wizard - Select Calibration Type

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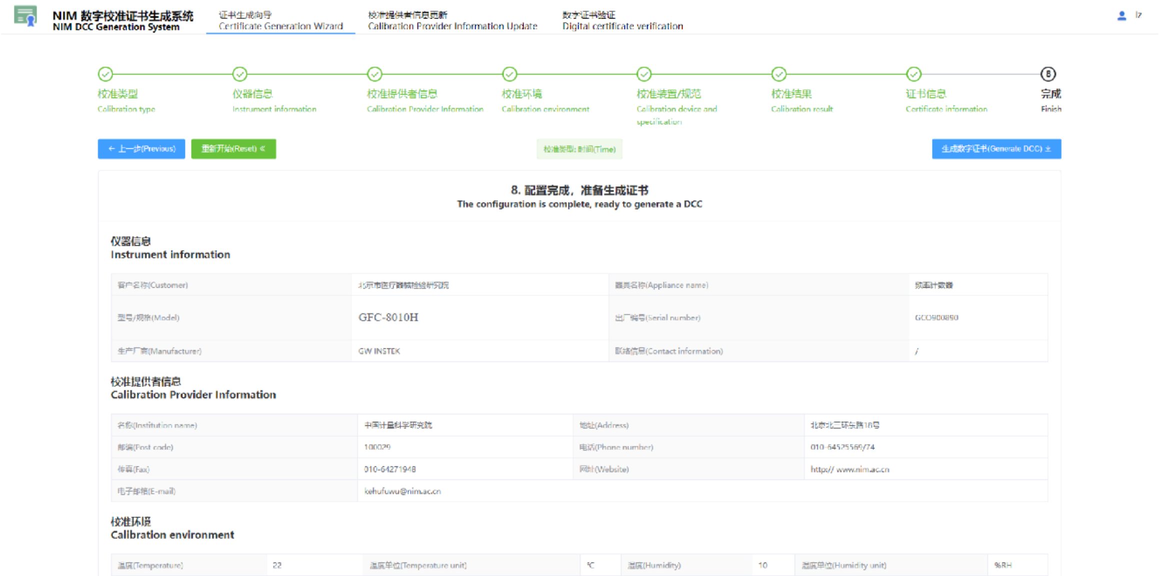

6.1 DCC Generation Wizard -the calibrated instrument information

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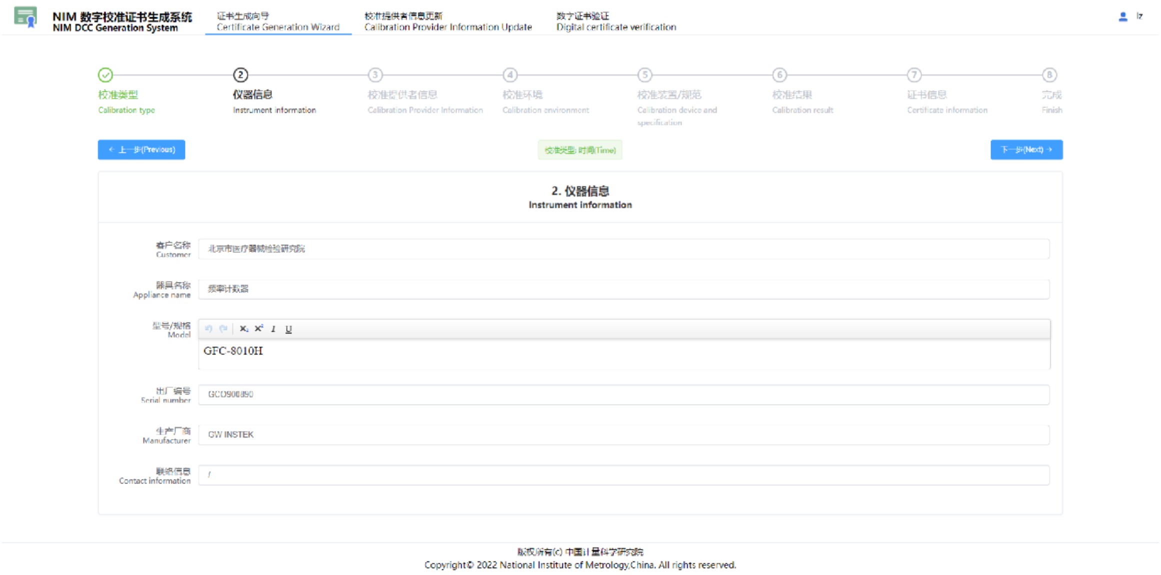

6.1 DCC Generation Wizard -calibration provider information

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6.1 DCC Generation Wizard –calibration environmental conditions and location

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6.1 DCC Generation Wizard -Calibration Devices and Specifications

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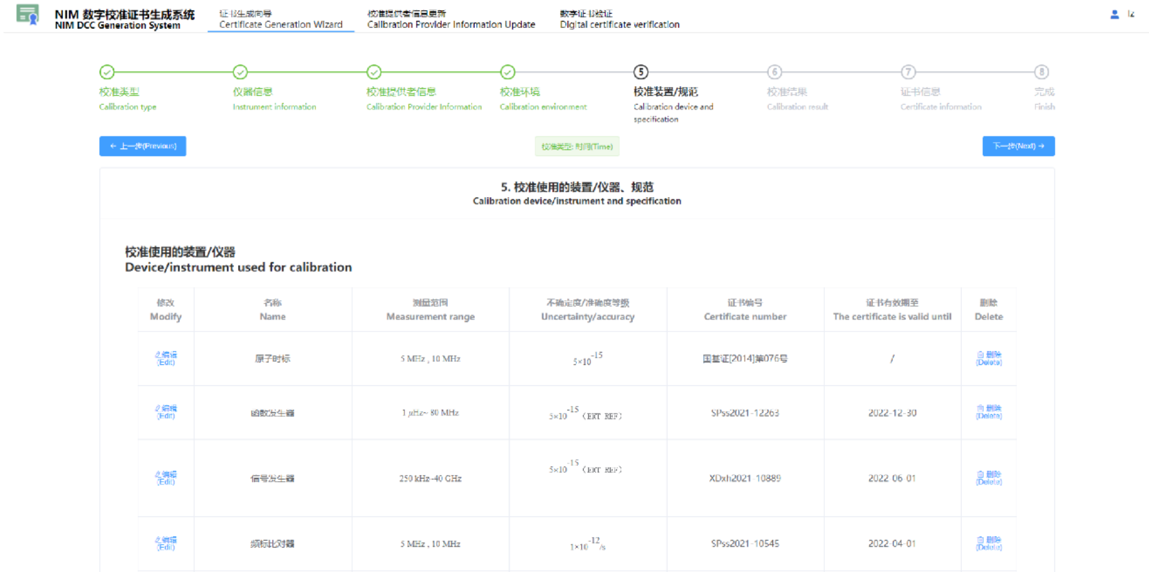

6.1 DCC Generation Wizard –Calibration result

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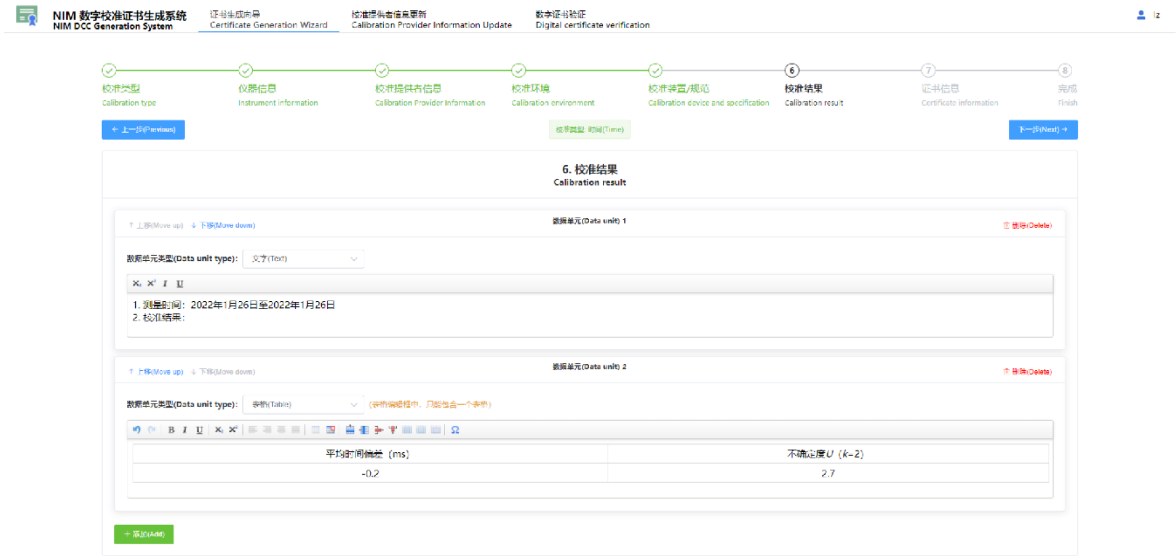

6.1 DCC Generation Wizard –Certificate auxiliary information

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6.1 DCC Generation Wizard -Certificate Information Preview

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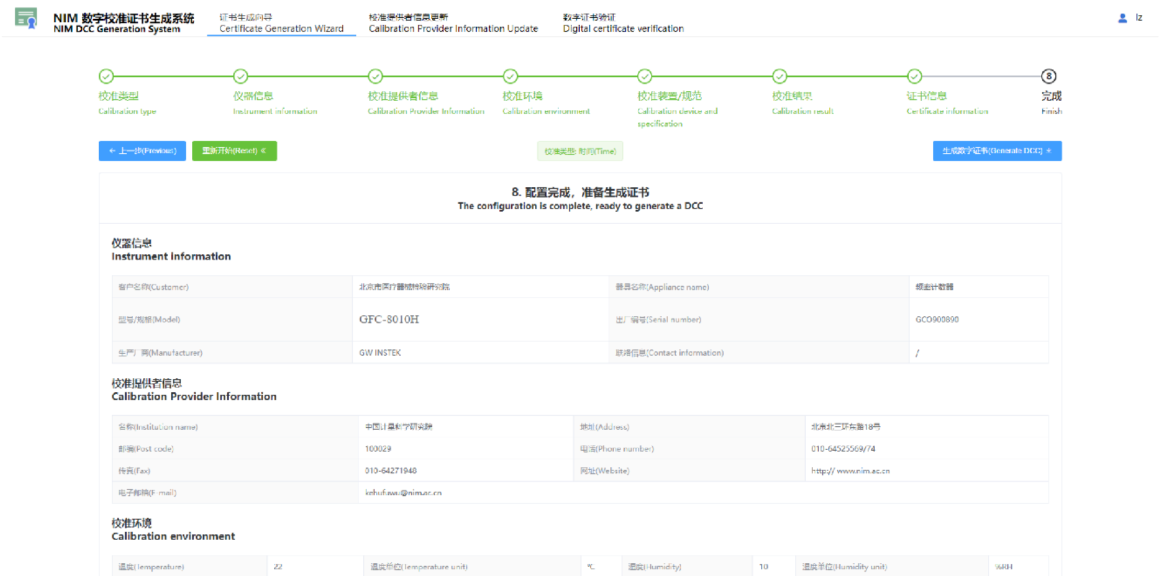
National Institute of Metrology,China



6.1 Calibration Provider Information Update

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6.2 DCC Verification-Select the DCC to verify

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6.2 DCC Verification-DCC Verification Results

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6.3 Preliminary realization of test system-digital test terminals

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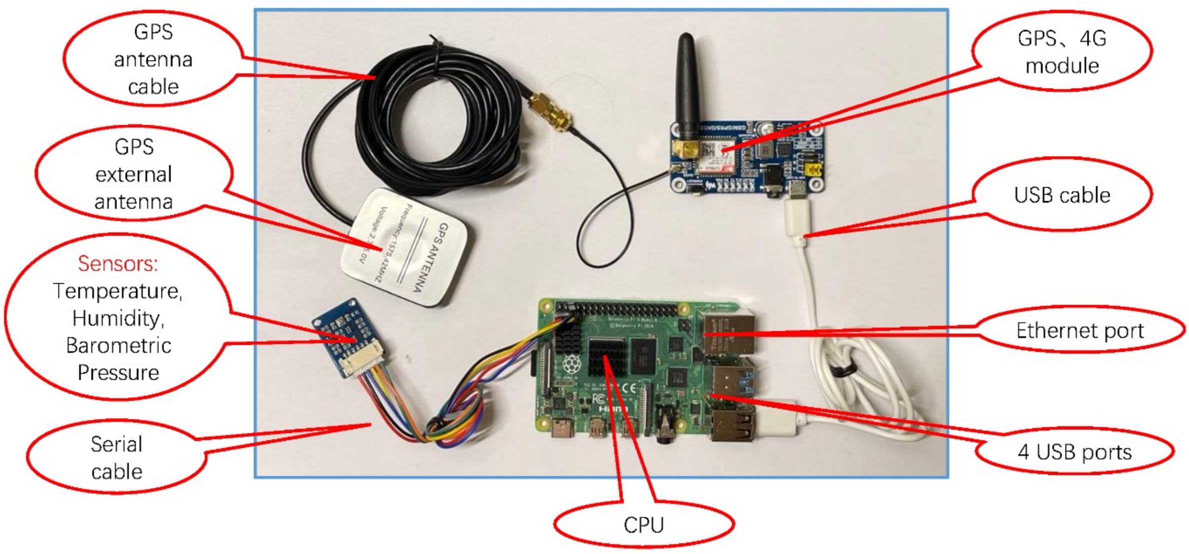
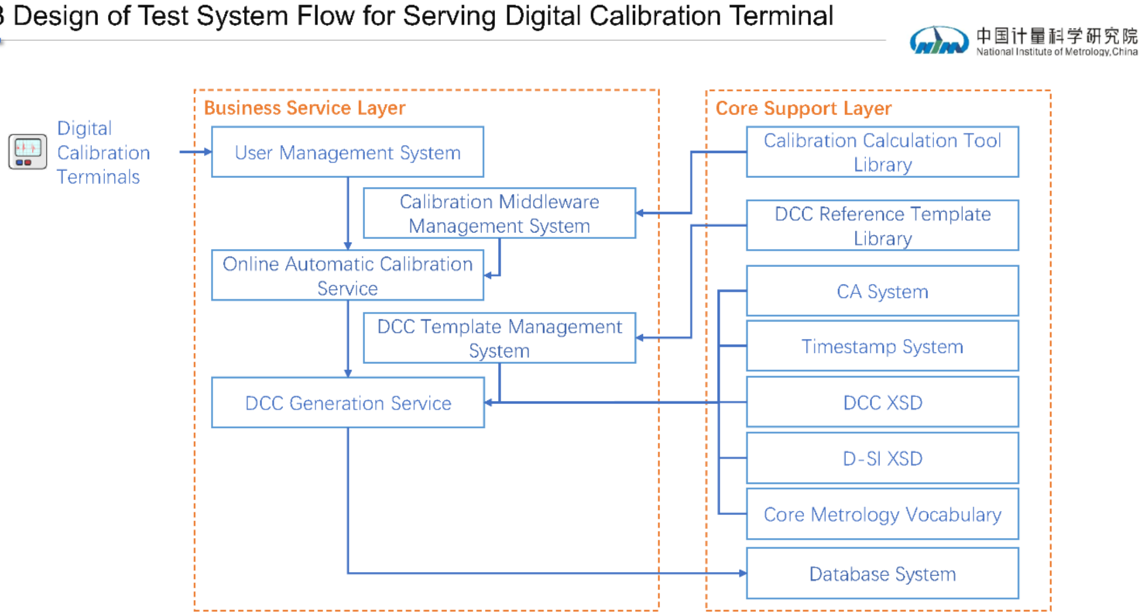
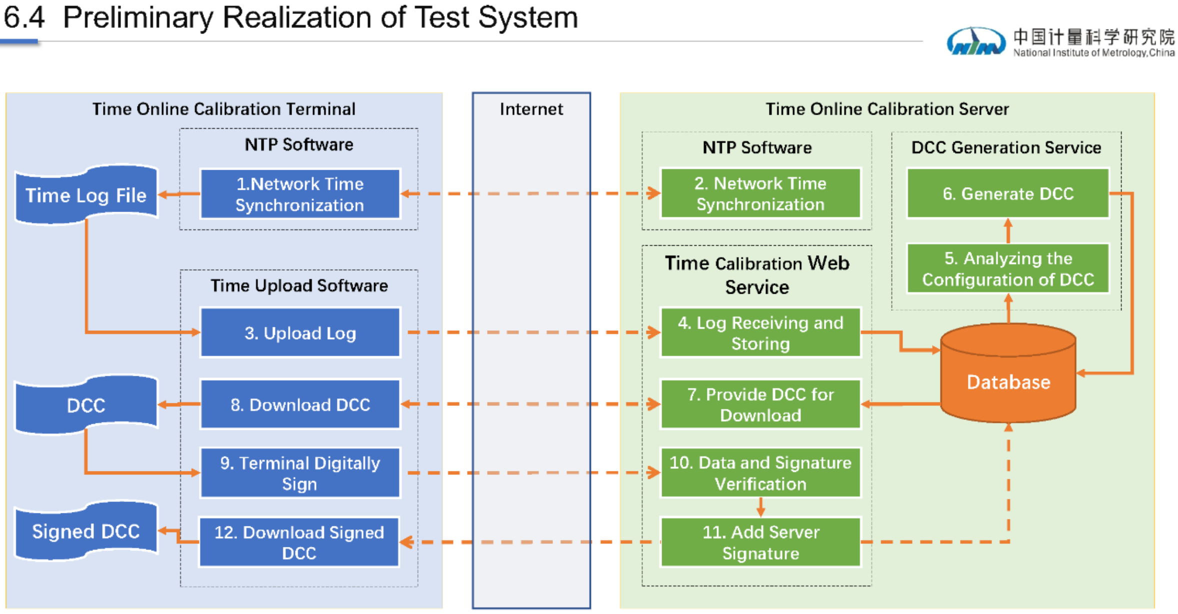
National Institute of Metrology,China



6.3 Design of Test System Flow for Serving Digital Calibration Terminal



6.4 Preliminary Realization of Test System



7 Conclusion

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National Institute of Metrology,China

1. The design and development of the system is preliminary
2. Multiple metrology disciplines and multiple methods of DCC application testing are required to iterate and improve the system
3. We will strengthen cooperation with NMIs such as PTB to achieve international mutual recognition of DCC.

Thanks

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Verifying DCCs

Presenting author Hans Koch, da+d, Germany

Abstract

Once in a while DCCs need to be verified by their own editors, customers and (accreditation) auditors.

This presentation will discuss some means to check the conformity with the schema version and with the requirements of the ISO/IEC 17025. In addition, it will be shown how to verify the authenticity and integrity of the DCC via a digital signature and whether the human readable output is in accordance with the content of the DCC.

Verifying DCCs

Hans Koch

www.da-plus-d.de

To whome it may concern?

- Small and medium sized calibration labs
  with little or only moderate IT-expertise
- DCC customers
- Auditors
- DCC middleware developers

Outline:

- Checking the validity of the digital signature
- Checking the conformity with the dcc.xsd
- 17025 auditing of a DCC
- Checking the numbers
- Checking the validity of the accreditation

A DCC is just an ordinary text-file

It can easily be modified and it is vulnarable (i.e. a favourite hacker tool! see: https://docs.python.org/3/library/xml.html#xml-vulnerabilities)

XML vulnerabilities

The XML processing modules are not secure against maliciously constructed data. An attacker can abuse XML features to carry out denial of service attacks, access local files, generate network connections to other machines, or circumvent firewalls.

The following table gives an overview of the known attacks and whether the various modules are vulnerable to them.

kind	sax	etree	minidom	pulldom	xmlrpc
billion laughs	**Vulnerable** (1)	**Vulnerable** (1)	**Vulnerable** (1)	**Vulnerable** (1)	**Vulnerable** (1)
quadratic blowup	**Vulnerable** (1)	**Vulnerable** (1)	**Vulnerable** (1)	**Vulnerable** (1)	**Vulnerable** (1)
external entity expansion	Safe (5)	Safe (2)	Safe (3)	Safe (5)	Safe (4)
DTD retrieval	Safe (5)	Safe	Safe	Safe (5)	Safe
decompression bomb	Safe	Safe	Safe	Safe	**Vulnerable**

ISO/IEC 17025:2018

7.8.2	**Common requirements for reports (test, calibration or sampling)**
7.8.2.1	Each report shall include at least the following information, unless the laboratory has valid reasons for not doing so, thereby minimizing any possibility of misunderstanding or misuse:
	d) unique identification that all its components are recognized as a portion of a complete report and a clear identification of the end;
	e) the name and contact information of the customer;
	f) identification of the method used;


```
  </dcc:document>
- <ds:Signature Id="XMLSignature_D096BC153F37C159569BA56A78427494F2EE4856"
  xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
  - <ds:SignedInfo>
      <ds:CanonicalizationMethod Algorithm="http://www.w3.org/TR/2001/REC-xml-c14n-
        20010315"/>
      <ds:SignatureMethod Algorithm="http://www.w3.org/2007/05/xmldsig-more#sha256-rsa-
        MGF1"/>
    - <ds:Reference Id="Reference_CD5CD13FAAC37FC4C19670C37FE552F821A80364" URI="">
      - <ds:Transforms xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
        - <ds:Transform xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
          Algorithm="http://www.w3.org/2002/06/xmldsig-filter2">
            <ds-xpath:XPath Filter="subtract" xmlns:ds-
              xpath="http://www.w3.org/2002/06/xmldsig-
              filter2">/descendant::ds:Signature</ds-xpath:XPath>
          </ds:Transform>
          <ds:Transform xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
            Algorithm="http://www.w3.org/TR/2001/REC-xml-c14n-20010315"/>
        </ds:Transforms>
        <ds:DigestMethod Algorithm="http://www.w3.org/2001/04/xmlenc#sha256"/>
        <ds:DigestValue>tfjQw0JrhctnJJNg7ZZBEaTo/Rk59dkfmFGsB2CI2nM=</ds:DigestValue>
      </ds:Reference>
    - <ds:Reference
      URI="#SignTime_XMLSignature_D096BC153F37C159569BA56A78427494F2EE4856"
      Type="http://uri.etsi.org/01903#SignedProperties">
        <ds:DigestMethod Algorithm="http://www.w3.org/2001/04/xmlenc#sha256"/>
        <ds:DigestValue>sCuT+uiW60MweM6wHlepG/8Mp3dKuFC/ZgAi5iFnsNU=</ds:DigestValue>
      </ds:Reference>
    </ds:SignedInfo>
    <ds:SignatureValue
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```
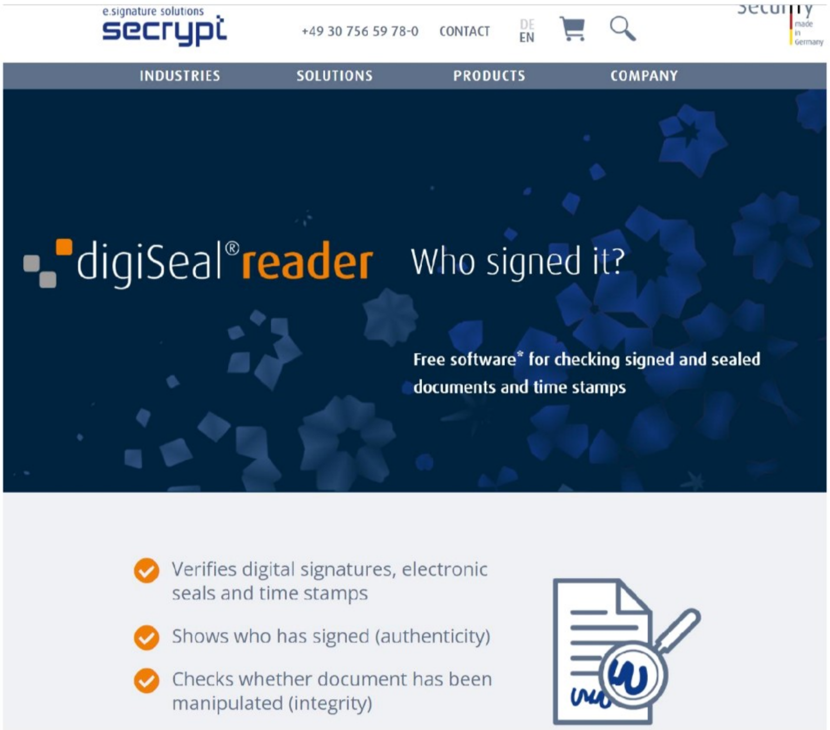
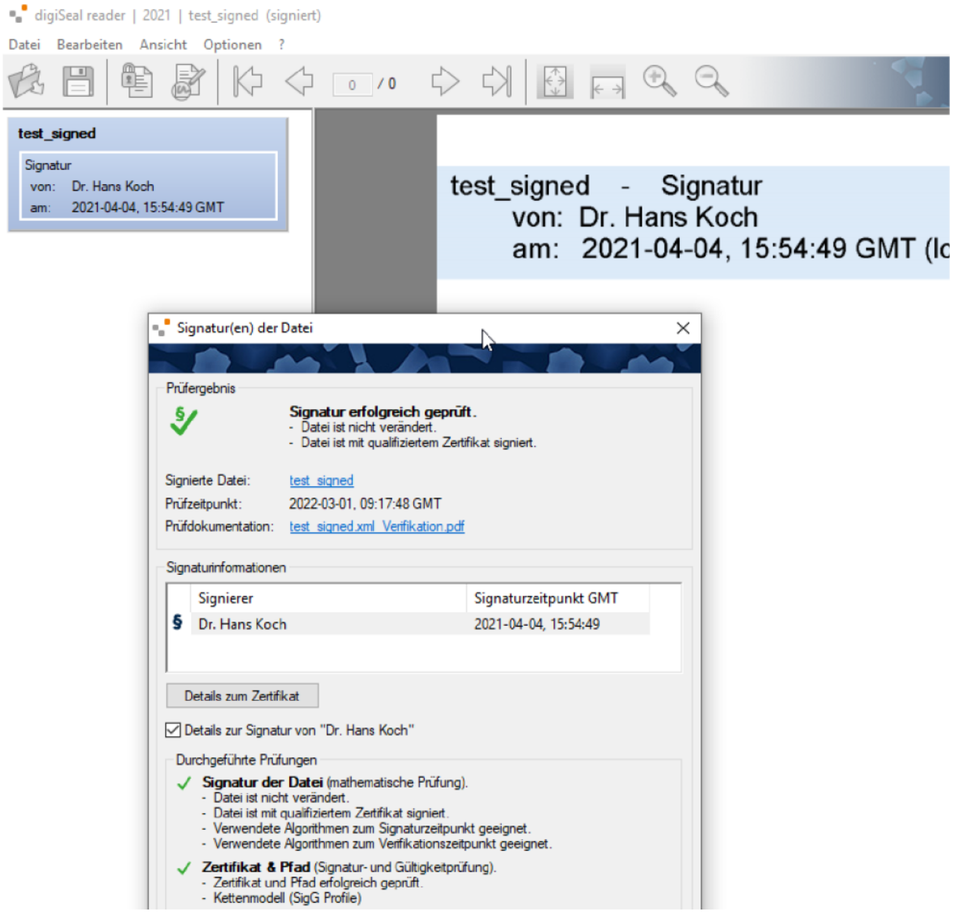
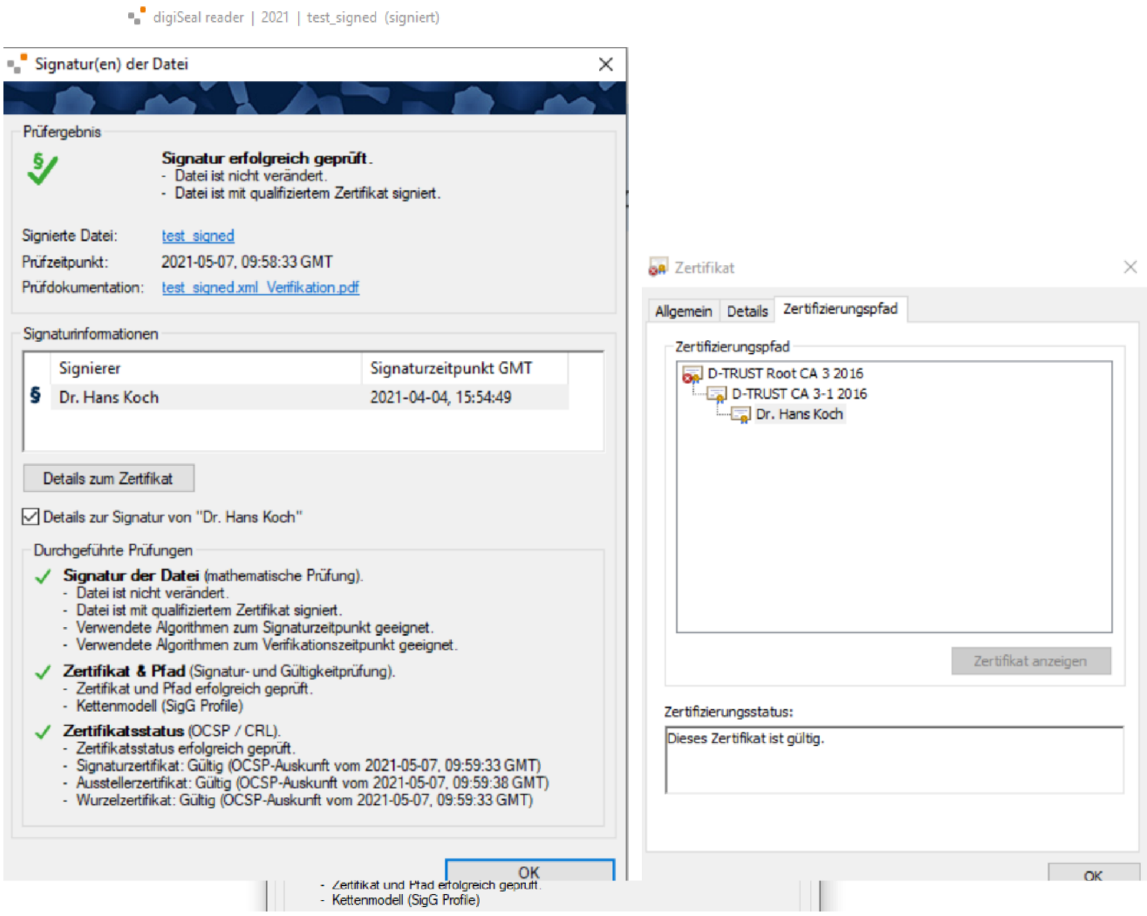
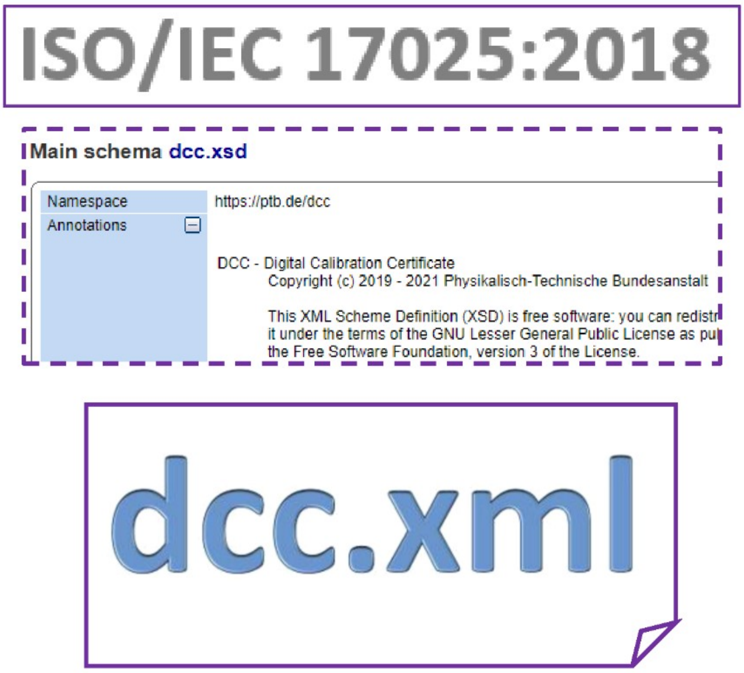
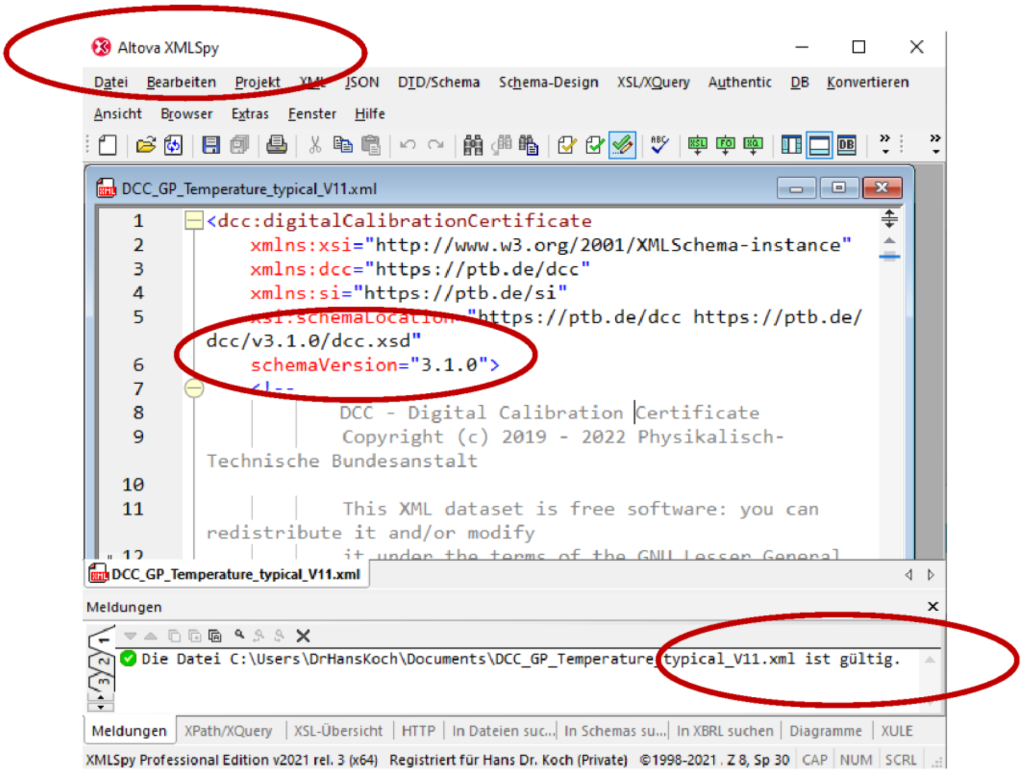

https://www.secrypt.de/en/digiseal-reader/

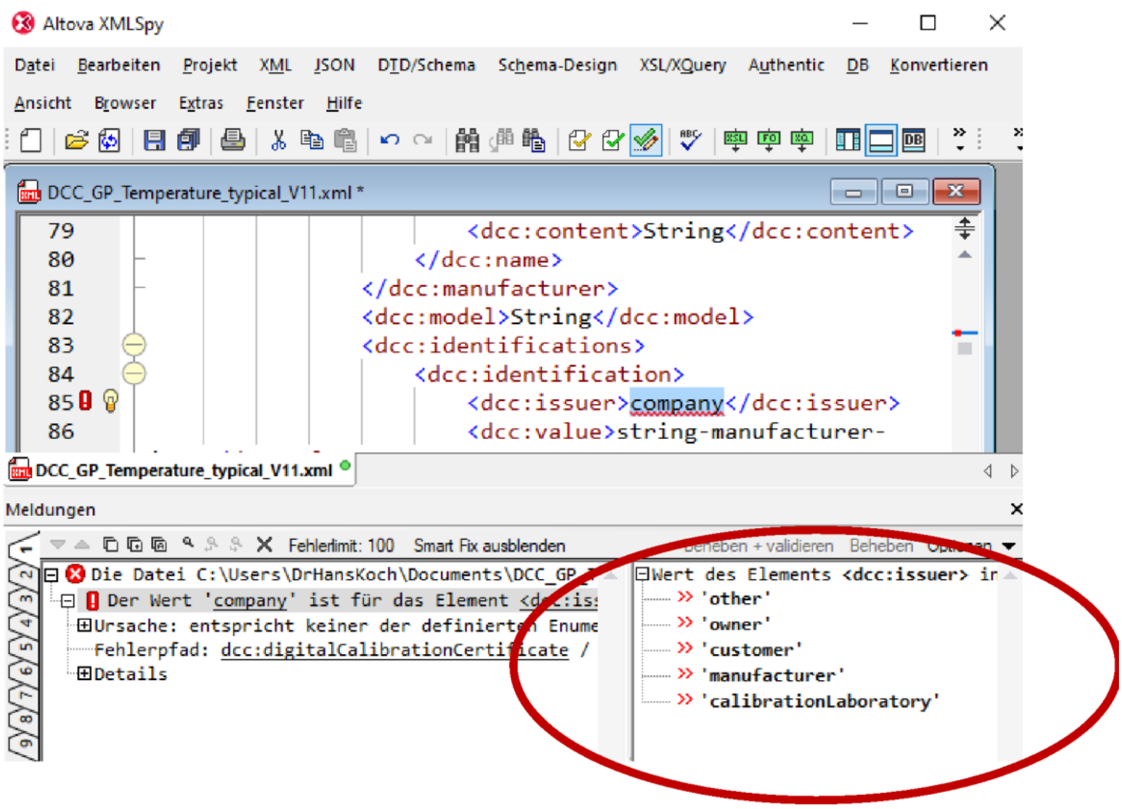





digiSeal reader | 2021 | test_signed (signiert)
Signatur(en) der Datei
Prüfergebnis
Signatur erfolgreich geprüft.
- Datei ist nicht verändert.
- Datei ist mit qualifiziertem Zertifikat signiert.
Signierte Datei: test_signed
Prüfzeitpunkt: 2021-05-07, 09:58:33 GMT
Prüfdokumentation: test_signed.xml_Verifikation.pdf
Signaturinformationen
Signierer | Signaturzeitpunkt GMT
Dr. Hans Koch | 2021-04-04, 15:54:49
Details zum Zertifikat
Details zur Signatur von "Dr. Hans Koch"
Durchgeführte Prüfungen
Signatur der Datei (mathematische Prüfung).
- Datei ist nicht verändert.
- Datei ist mit qualifiziertem Zertifikat signiert.
- Verwendete Algorithmen zum Signaturzeitpunkt geeignet.
- Verwendete Algorithmen zum Verifikationszeitpunkt geeignet.
Zertifikat & Pfad (Signatur- und Gültigkeitprüfung).
- Zertifikat und Pfad erfolgreich geprüft.
- Kettenmodell (SigG Profile)
Zertifikatsstatus (OCSP / CRL).
- Zertifikatsstatus erfolgreich geprüft.
- Signaturzertifikat: Gültig (OCSP-Auskunft vom 2021-05-07, 09:59:33 GMT)
- Ausstellerzertifikat: Gültig (OCSP-Auskunft vom 2021-05-07, 09:59:38 GMT)
- Wurzelzertifikat: Gültig (OCSP-Auskunft vom 2021-05-07, 09:59:33 GMT)
OK
- Zertifikat und Pfad erfolgreich geprüft.
- Kettenmodell (SigG Profile)
Zertifikat
Allgemein | Details | Zertifizierungspfad
Zertifizierungspfad
D-TRUST Root CA 3 2016
D-TRUST CA 3-1 2016
Dr. Hans Koch
Zertifikat anzeigen
Zertifizierungsstatus:
Dieses Zertifikat ist gültig.
OK


ISO/IEC 17025:2018
Main schema dcc.xsd
Namespace https://ptb.de/dcc
Annotations
DCC - Digital Calibration Certificate
Copyright (c) 2019 - 2021 Physikalisch-Technische Bundesanstalt
This XML Scheme Definition (XSD) is free software: you can redistr
it under the terms of the GNU Lesser General Public License as pu
the Free Software Foundation, version 3 of the License.
dcc.xml


Altova XMLSpy
Datei Bearbeiten Projekt XML JSON DTD/Schema Schema-Design XSL/XQuery Authentic DB Konvertieren
Ansicht Browser Extras Fenster Hilfe
DCC_GP_Temperature_typical_V11.xml
1 <dcc:digitalCalibrationCertificate
2 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
3 xmlns:dcc="https://ptb.de/dcc"
4 xmlns:si="https://ptb.de/si"
5 xsi:schemaLocation="https://ptb.de/dcc https://ptb.de/dcc/v3.1.0/dcc.xsd"
6 schemaVersion="3.1.0">
7 <!--
8 DCC - Digital Calibration Certificate
9 Copyright (c) 2019 - 2022 Physikalisch-Technische Bundesanstalt
10
11 This XML dataset is free software: you can redistribute it and/or modify
Meldungen
Die Datei C:\Users\DrHansKoch\Documents\DCC_GP_Temperature_typical_V11.xml ist gültig.
Meldungen XPath/XQuery XSL-Übersicht HTTP In Dateien suc... In Schemas su... In XBRL suchen Diagramme XULE
XMLSpy Professional Edition v2021 rel. 3 (x64) Registriert für Hans Dr. Koch (Private) ©1998-2021 Z 8, Sp 30 CAP NUM SCRL


Altova XMLSpy
Datei Bearbeiten Projekt XML JSON DTD/Schema Schema-Design XSL/XQuery Authentic DB Konvertieren
Ansicht Browser Extras Fenster Hilfe
DCC_GP_Temperature_typical_V11.xml *
79 <dcc:content>String</dcc:content>
80 </dcc:name>
81 </dcc:manufacturer>
82 <dcc:model>String</dcc:model>
83 <dcc:identifications>
84 <dcc:identification>
85 <dcc:issuer>company</dcc:issuer>
86 <dcc:value>string-manufacturer-
Meldungen
Fehlerlimit: 100 Smart Fix ausblenden
Die Datei C:\Users\DrHansKoch\Documents\DCC_GP_
Der Wert 'company' ist für das Element <dcc:iss
Ursache: entspricht keiner der definierten Enume
Fehlerpfad: dcc:digitalCalibrationCertificate /
Details
Wert des Elements <dcc:issuer> in
'other'
'owner'
'customer'
'manufacturer'
'calibrationLaboratory'

Verification

dcc.xml

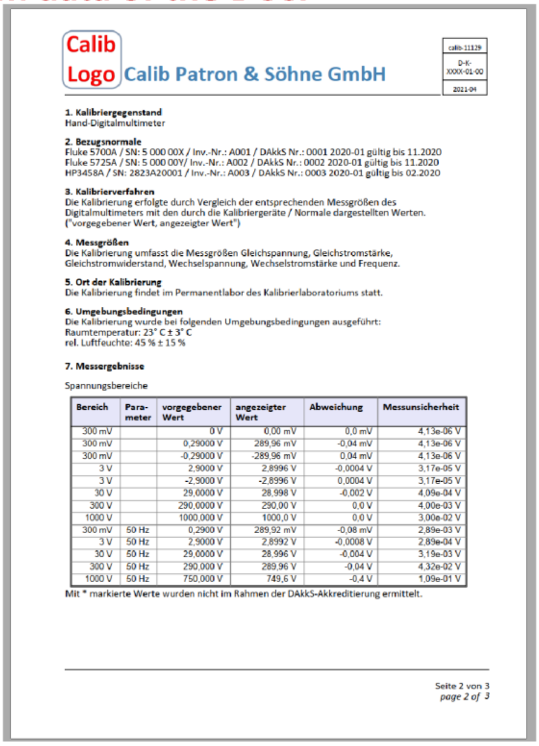
A DCC is human readable as well!

More comfortable:

A pdf-file generated solely from data of the DCC.

… and integrated into the DCC:


```
  </dcc:measurementResults>
- <dcc:document>
  - <dcc:name>
       <dcc:content>C:/Users/DrHansKoch/Documents/test_fold
    </dcc:name>
  - <dcc:description>
       <dcc:content lang="de">Menschenlesbare PDF-Datei</dcc:c
       <dcc:content lang="en">Human-readable PDF file</dcc:cont
    </dcc:description>
    <dcc:fileName>C:/Users/DrHansKoch/Documents/test_folder
    <dcc:mimeType>application/pdf</dcc:mimeType>
    <dcc:dataBase64/>.jQKJZOMi54gUmVwb3J0TGFiIEdlbmVyY
  </dcc:document>
- <ds:Signature Id="XMLSignature_D096BC153F37C159569BA56A7
```

Calib Logo Calib Patron & Söhne GmbH

calib-11129
D-K-XXXX-01-00
2021-04

1. Kalibriergegenstand
Hand-Digitalmultimeter

2. Bezugsnormale
Fluke 5700A / SN: 5 000 00X / Inv.-Nr.: A001 / DAkkS Nr.: 0001 2020-01 gültig bis 11.2020
Fluke 5725A / SN: 5 000 00Y/ Inv.-Nr.: A002 / DAkkS Nr.: 0002 2020-01 gültig bis 11.2020
HP3458A / SN: 2823A20001 / Inv.-Nr.: A003 / DAkkS Nr.: 0003 2020-01 gültig bis 02.2020

3. Kalibrierverfahren
Die Kalibrierung erfolgte durch Vergleich der entsprechenden Messgrößen des Digitalmultimeters mit den durch die Kalibriergeräte / Normale dargestellten Werten. ("vorgegebener Wert, angezeigter Wert")

4. Messgrößen
Die Kalibrierung umfasst die Messgrößen Gleichspannung, Gleichstromstärke, Gleichstromwiderstand, Wechselspannung, Wechselstromstärke und Frequenz.

5. Ort der Kalibrierung
Die Kalibrierung findet im Permanentlabor des Kalibrierlaboratoriums statt.

6. Umgebungsbedingungen
Die Kalibrierung wurde bei folgenden Umgebungsbedingungen ausgeführt:
Raumtemperatur: 23° C ± 3° C
rel. Luftfeuchte: 45 % ± 15 %

7. Messergebnisse

Spannungsbereiche

Bereich	Para-meter	vorgegebener Wert	angezeigter Wert	Abweichung	Messunsicherheit
300 mV		0 V	0,00 mV	0,0 mV	4,13e-06 V
300 mV		0,29000 V	289,96 mV	-0,04 mV	4,13e-06 V
300 mV		-0,29000 V	-289,96 mV	0,04 mV	4,13e-06 V
3 V		2,9000 V	2,8996 V	-0,0004 V	3,17e-05 V
3 V		-2,9000 V	-2,8996 V	0,0004 V	3,17e-05 V
30 V		29,0000 V	28,998 V	-0,002 V	4,09e-04 V
300 V		290,0000 V	290,00 V	0,0 V	4,00e-03 V
1000 V		1000,000 V	1000,0 V	0,0 V	3,00e-02 V
300 mV	50 Hz	0,2900 V	289,92 mV	-0,08 mV	2,89e-03 V
3 V	50 Hz	2,9000 V	2,8992 V	-0,0008 V	2,89e-04 V
30 V	50 Hz	29,0000 V	28,996 V	-0,004 V	3,19e-03 V
300 V	50 Hz	290,000 V	289,96 V	-0,04 V	4,32e-02 V
1000 V	50 Hz	750,000 V	749,6 V	-0,4 V	1,09e-01 V

Mit * markierte Werte wurden nicht im Rahmen der DAkkS-Akkreditierung ermittelt.

Seite 2 von 3
page 2 of 3

Not necessary, but nice to have:

- for the developer
- for the customer
- for the auditor

checking the numbers

Attention!
Declaration of uncertainties:

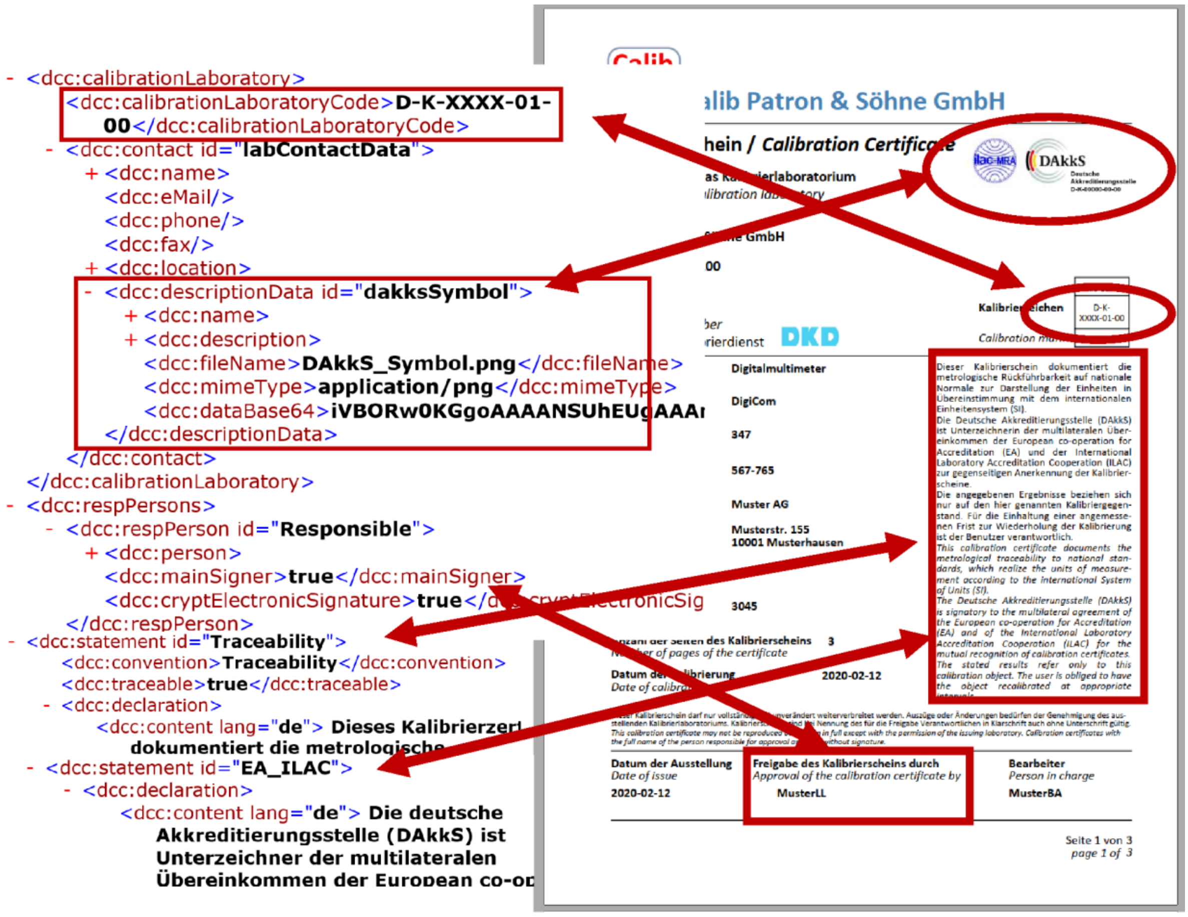
This value must be the expanded uncertainty!!!

```
- <si:realListXMLList>
     <si:valueXMLList>0.072 0.089 0.107 .009 -0.084</si:valueXMLList>
     <si:unitXMLList>\kelvin</si:unitXMLList>
   - <si:expandedUncXMLList>
        <si:uncertaintyXMLList>0.061</si:uncertaintyXMLList>
        <si:coverageFactorXMLList>2</si:coverageFactorXMLList>
        <si:coverageProbabilityXMLList>0.95</si:coverageProbabilityXMLList>
        <si:distributionXMLList>normal</si:distributionXMLList>
     </si:expandedUncXMLList>
  </si:realListXMLList>
```

Better, but not solvable?:

```
- <si:uncertaintyXMLList>
    <si:expandedUncXMLList> 0.061 </si:expandedUncXMLList>
      <si:coverageFactorXMLList>2</si:coverageFactorXMLList>
      <si:coverageProbabilityXMLList>0.95</si:coverageProbabilityXMLList>
      <si:distributionXMLList>normal</si:distributionXMLList>
  </si:uncertaintyXMLList>
```

Validity of accreditation



The XADES-signature ensures
Authenticity and Integrity

The end

Digital Calibration Certificates (DCC) using the Quality Information Framework (QIF)

Presenting author Robert Brown, Mitutoyo America Corporation, USA

robert.brown@mitutoyo.com

Additional author Ed Morse, University of North Carolina at Charlotte, USA

Abstract

A demonstration in how QIF can be used for a secure interoperable standard to exchange metrology equipment calibration certificate information A description on the history and scope of ISO 23592:2020 (Quality Information Framework 3.0 - QIF – https://qifstandards.org/) and demonstration of how QIF can be used for a secure interoperable standard to exchange metrology equipment calibration certificate information. Consideration of rationale and approach to harmonize the PTB DCC and the Dimensional Metrology Standards Consortium QIF standards.

History and Scope of the ISO Quality Information Framework (QIF) and applicability for Digital Calibration Certificates (DCC) using the QIF

The 2nd International DCC-Conference

DCC

March 3, 2022

DESCRIPTION OF THE QUALITY INFORMATION FRAMEWORK

Physikalisch-Technische Bundesanstalt
National Metrology Institute

Robert Brown – Mitutoyo America Corporation

Professor Edward Morse – The Center for Precision Metrology
The University of North Carolina at Charlotte

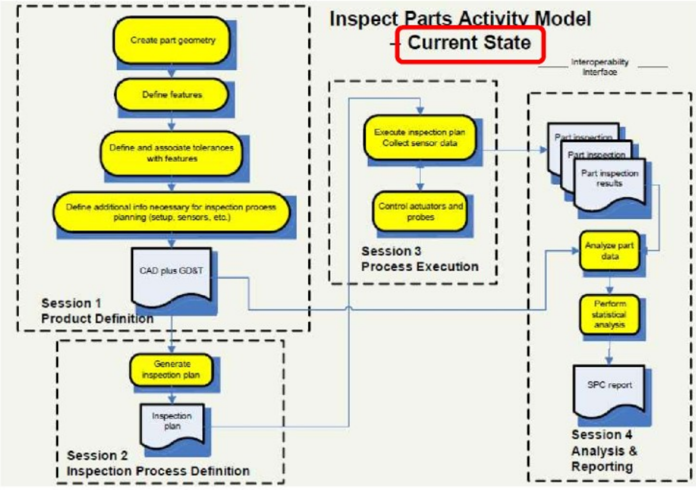
Interoperability: The ability of machines, devices, sensors, software and people to connect and communicate with each other

Information Transparency: Virtual copy of the real world enhancing digital models with sensor data – digital twinning

Technical Assistance: the ability for systems to support humans through aggregate visual support interfaces and the use of cyber physical systems.

Decentralized Decisions: The ability of systems to be smart and capable of autonomy in executing tasks

Four Principles of Industry 4.0 Smart Manufacturing



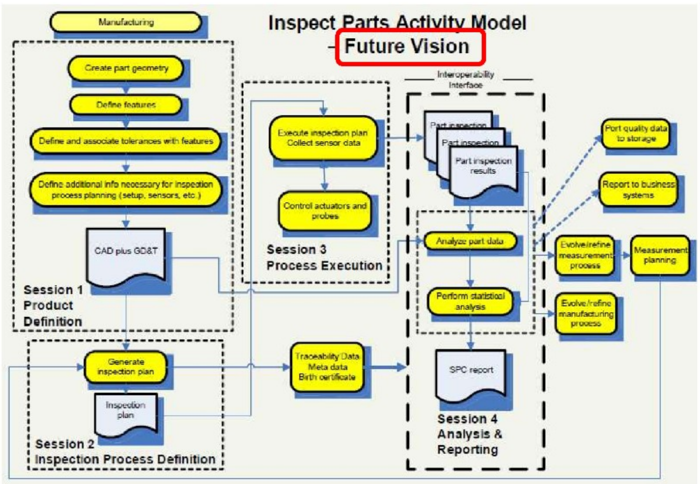
A defining event in the Advanced Manufacturing Enterprise

Downstream data flows

- Design
- Planning
- Execution
- Reporting and Analysis

At that time the applicable manufacturing quality interoperability standards were AP203, AP214, DML and QMD

NIST 2006 International Metrology Interoperability Summit – as is (WAS)



Work groups enhanced downstream data flows*

Identified of upstream data flows

Recent gains in interoperability via standards such as ISO AP 242, MTConnect and ANSI/ISO QIF

*well before the following terms were used:

- Industry 4.0
- Internet of things (IoT)
- Digital thread

NIST 2006 International Metrology Interoperability Summit – to be (NOW?)

DMSC objective . . .

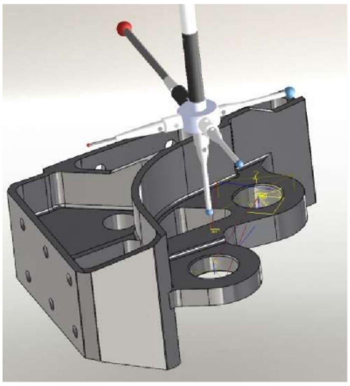
- To **reduce** the cost of quality,
- To gain the **freedom to choose** best in class / best in value solutions,
- Through **open, non-proprietary standards** for computer aided dimensional metrology.

Dimensional Metrology Standards Consortium DMSC

Who is the DMSC?

Dimensional Metrology Standards Consortium DMSC

- a **non-for-profit**, cooperative sponsorship organization.
- **focused on** or relating to digital **dimensional** metrology.
- dedicated to identifying, promoting, fostering, and encouraging the **development** and **interoperability** of standards that benefit the dimensional metrology community.
- **accredited national standard-making organization** with international presence.



Digital Metrology Standards Consortium

- Members from Government, Academic, Vendor and OEMs
- Actively develops and maintains ISO 23952:2020 (Quality Information Framework v3)
- Primary use cases for model-based enterprise and quality information workflows in advanced manufacturing

Dimensional Metrology Standards Consortium DMSC

What is QIF?

- The **Quality Information Framework (QIF)** is a unified XML framework standard for computer-aided quality QIF systems
- QIF enables the capture, use, and re-use of metrology-related information throughout the Product Lifecycle Management (PLM) and Product Data Management (PDM) domains.
- QIF is a set of XML Schemas that represent the following:
  - Model Based Definition
  - Quality Plans
  - Quality Resources
  - Quality Rules
  - Quality Results
  - Quality Statistics

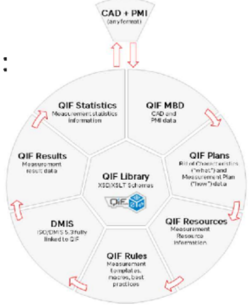
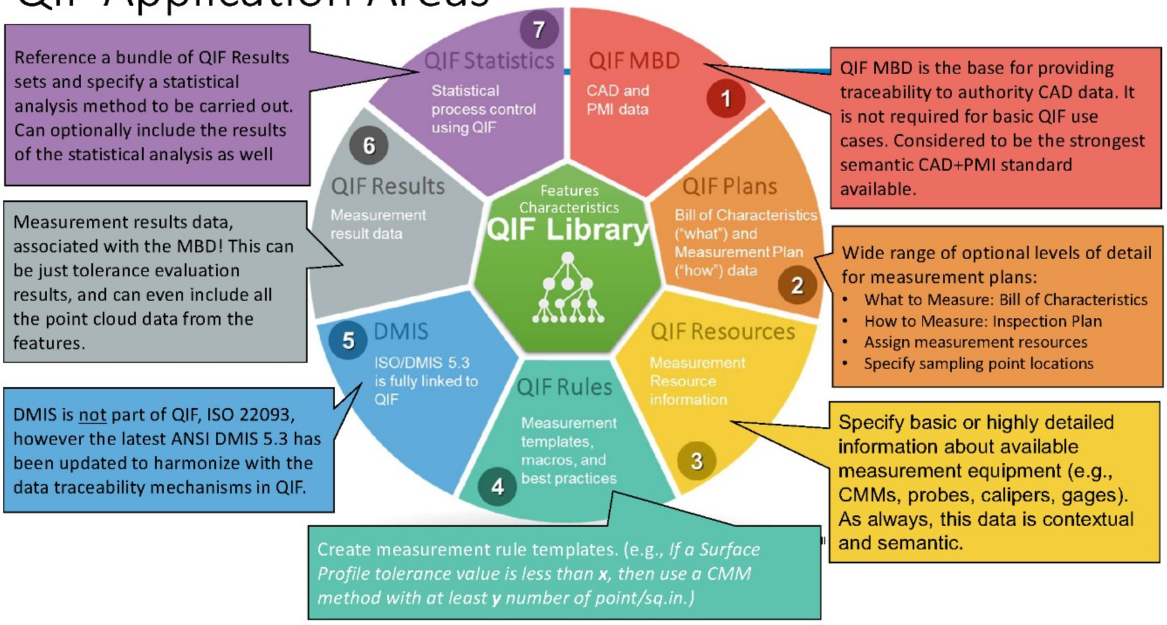


Figure 1 – QIF version 3.0 information architecture

QIF Application Areas

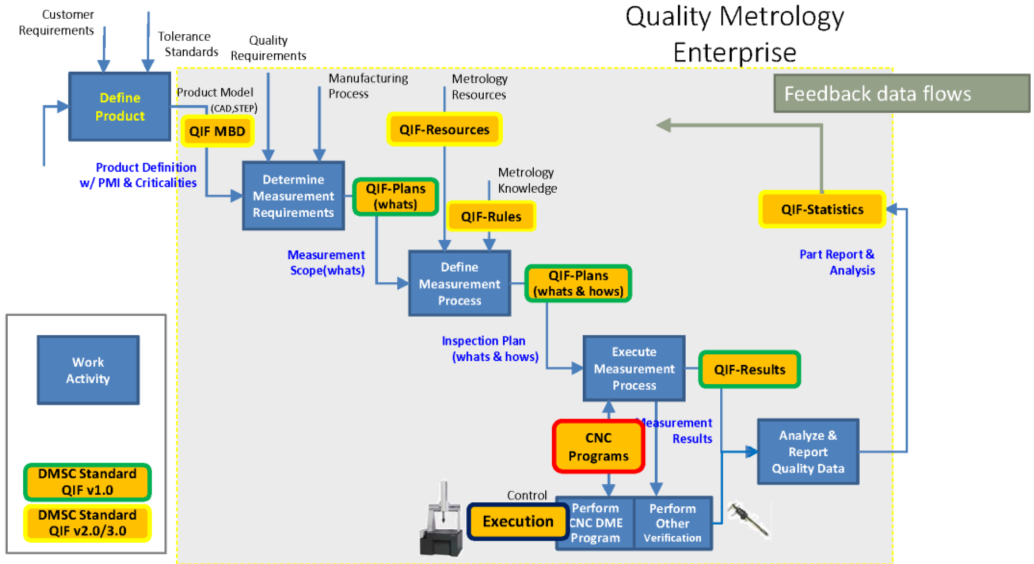


QPIDs – Persistent UUID within the QIF

QIF Persistent Identifier (QPId) *noun* Cu·pid \ˈkyü-pəd\

- Universally Unique Identifier (UUID) (adopted by Microsoft as GUID)
  - ISO/IEC 9834-8
  - 550e8400-e29b-41d4-a716-446655440000
- Chances of generating two that are the same within the universe are practically nil.
  - 340000000000000000000000000000000000000 (3.4x10^{38}) possible UUIDs
- **Allows information to be combined later without resolving identifier conflicts**
- Many software development libraries generate UUIDs
- QPIds uniquely identify
  - QIF Document
  - QIF Plan
  - QIF Result
  - QIF Rule Set
  - Feature Item
  - Characteristic Item
  - Product Item
  - Resource Item

Important Mechanism that facilitates Lifecycle Connectivity w/ Traceability

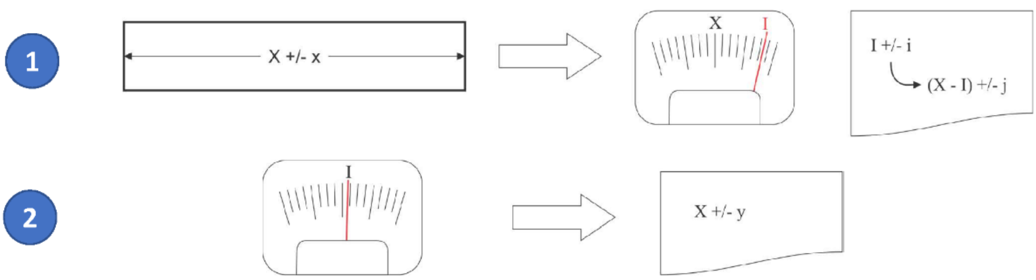


ANSI/ISO QIF v3.0 for Digital Product Verification

Definition of Calibration (VIM3)

calibration

operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication



Why Calibration ?

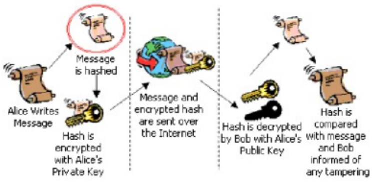
- Establish Metrological Traceability to:
  - The SI unit(s)
  - National/International Standards
- Calibration provides the end-user of instruments with confidence in the instrument measurement results.
- Accreditation to ISO 17025 is largely centered on calibration.

How can a DCC be cast as a QIF document?

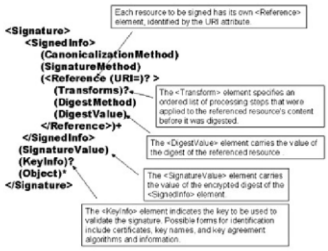
- A calibration procedure prescribes the evaluation of specific metrological characteristics for a type of measurement equipment. This is a QIF measurement plan.
- Calibration results contain the as-found or as-adjusted observations against standard references (e.g., gage blocks). This is a QIF result.
- Measuring devices (e.g., standard references) are QIF resources.
  - The inspecting device information is referenced at the test point measurement level.

XML Signature Syntax and Processing Version 1.1

specifies XML digital signature processing rules and syntax. XML Signatures provide integrity, message authentication, and/or signer authentication services for data of any type, whether located within the XML that includes the signature or elsewhere



XML Signature (slideshare.net)



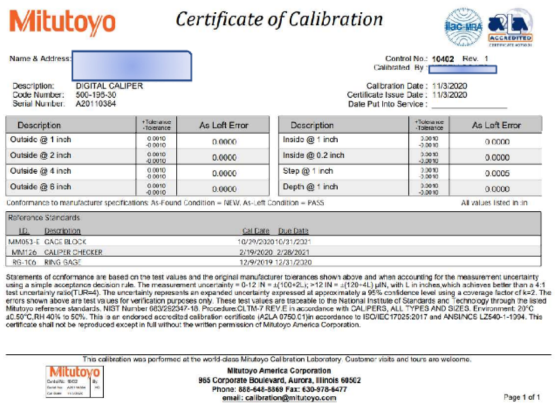
Digital Signature

Signature, Detached
The signature is over content external to the Signature element and can be identified via a URI or transform. Consequently, the signature is "detached" from the content it signs. This definition typically applies to separate data objects, but it also includes the instance where the Signature and data object reside within the same XML document but are sibling elements.

Signature, Enveloping
The signature is over content found within an Object element of the signature itself. The Object (or its content) is identified via a Reference (via a URI fragment identifier or transform).

Signature, Enveloped
The signature is over the XML content that contains the signature as an element. The content provides the root XML document element. Obviously, enveloped signatures must take care not to include their own value in the calculation of the SignatureValue

Example: 0-6”” Caliper



Mitutoyo **Certificate of Calibration**

Name & Address: [redacted]

Control No.: 10402 Rev. 1
Calibrated By: [redacted]

Description: DIGITAL CALIPER
Code Number: 500-196-30
Serial Number: A20110384

Calibration Date: 11/3/2020
Certificate Issue Date: 11/3/2020
Date Put Into Service: ______

Description	+Tolerance -Tolerance	As Left Error	Description	+Tolerance -Tolerance	As Left Error
Outside @ 1 inch	0.0010 -0.0010	0.0000	Inside @ 1 inch	0.0010 -0.0010	0.0000
Outside @ 2 inch	0.0010 -0.0010	0.0000	Inside @ 0.2 inch	0.0010 -0.0010	0.0000
Outside @ 4 inch	0.0010 -0.0010	0.0000	Step @ 1 inch	0.0010 -0.0010	0.0005
Outside @ 6 inch	0.0010 -0.0010	0.0000	Depth @ 1 inch	0.0010 -0.0010	0.0000

Conformance to manufacturer specifications: As-Found Condition = NEW, As-Left Condition = PASS   All values listed in in

Reference Standards

I.D.	Description	Cal Date	Due Date
MM053-E	GAGE BLOCK	10/29/2020	10/31/2021
MM126	CALIPER CHECKER	2/19/2020	2/28/2021
RG-106	RING GAGE	12/9/2019	12/31/2020

Statements of conformance are based on the test values and the original manufacturer tolerances shown above and when accounting for the measurement uncertainty using a simple acceptance decision rule. The measurement uncertainty = 0-12 IN = ±(100+2L); >12 IN = ±(120+4L) µIN, with L in inches,which achieves better than a 4:1 test uncertainty ratio(TUR=4). The uncertainty represents an expanded uncertainty expressed at approximately a 95% confidence level using a coverage factor of k=2. The errors shown above are test values for verification purposes only. These test values are traceable to the National Institute of Standards and Technology through the listed Mitutoyo reference standards. NIST Number 683/292347-18. Procedure:CLTM-7 REV.E in accordance with CALIPERS, ALL TYPES AND SIZES. Environment: 20°C ±0.50°C,RH 40% to 50%. This is an endorsed accredited calibration certificate (A2LA 0750.01)in accordance to ISO/IEC17025:2017 and ANSI/NCS LZ540-1-1994. This certificate shall not be reproduced except in full without the written permission of Mitutoyo America Corporation.

This calibration was performed at the world-class Mitutoyo Calibration Laboratory. Customer visits and tours are welcome.

Mitutoyo America Corporation
965 Corporate Boulevard, Aurora, Illinois 60502
Phone: 888-648-8869 Fax: 630-978-6477
email: calibration@mitutoyo.com

Page 1 of 1

Mitutoyo America Certificate of Calibration mapped as QIF Document

QIF 3.0

- Header
  - Customer contact
  - Gage description
  - Control Number
  - Issue Dates
- Body
  - Test Procedure
  - Test Points
  - Tolerance
  - Results
  - Reference Standards
  - Calibration Dates
  - Fine Print
- Footer
  - Lab information
  - Sticker

- QIF Document
  - Version
    - Time Created
    - Sign offs
  - Pre-Inspection Traceability
    - Customer Organization
    - Inspecting Organization
    - Report Number
  - Measurement Resources
    - Measurement Device
  - Product
    - Description
  - Characteristics
    - Tolerance
    - Nominal
  - Plan
  - Results
    - Measurement Device ID
    - Value
  - Signature

Altova Sample File Demo

Questions?

Digital Metrology Standards Consortium DMSC

Vision
Making the Digital Thread a digital highway by connecting design and quality data in a common framework.

Mission
Building the digital metrology framework that standardizes data for manufacturers. A framework that makes quality data into information to improve and control processes.

- Digital Metrology Standards Consortium QIF & DMIS Standards (qifstandards.org)

Using Schematron to verify DCCs

Presenting author Gamze Söylev-Öktem, PTB, Germany

gamze.soeylev-oektem@ptb.de

Additional author Siegfried Hackel, Justin Jagieniak, Benjamin Gloger, Lutz Doering (all PTB, Germany)

dcc@ptb.de

Abstract

Another major advantage of digitization is the ability to check content for rules and consistency. The matching of the DCC with the DCC schema has proven to be a strategic advantage in this regard, thus ensuring the conformity of the structure of the DCC to the DCC schema.

When checking the content and structure of a DCC, schema checking reaches its limits. At this point, Schematron, a method described in ISO/IEC 19757-3:2020-06, comes into action. Schematron can be used, for example, to check whether the date of the end of calibration is before the date of the start of calibration.

The presentation will first discuss Schematron itself. Then examples will be given to show how Schematron can contribute to the validation of the DCC. The special adaptation of Schematron to GP-DCCs will also be discussed.

Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
National Metrology Institute

Schematron Validation

2^{nd} International DCC Conference

Gamze Söylev-Öktem (PTB)
Benjamin Gloger (PTB)
Justin Jagieniak (PTB)
Dr. Lutz Doering (PTB)
Dir. u. Prof. Dr. Siegfried Hackel (PTB)

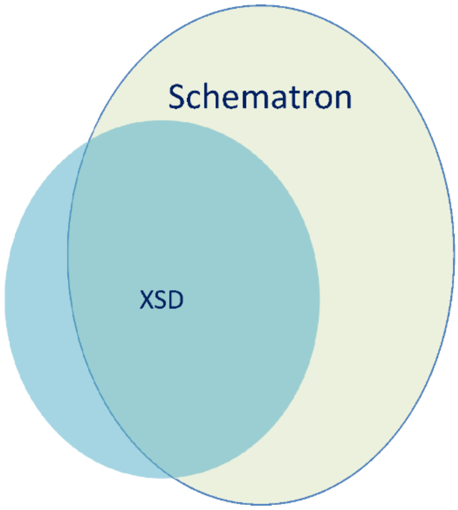
Schematron

- Schematron is a simple and powerful **Structural Schema Language** for making assertions about patterns found in XML documents
- It is not based on grammars but finding tree patterns in the parsed document
- It is an Open Standard

Source: www.schematron.com
Source: EditingSchematron Schemas (oxygenxml.com)

Why Schematron?

- Structural aspects and data types can be defined with XSD, RNG, or DTD schemas
- With Schematron, it is possible to create specific rules and constraints for a specific XML document



Source: schematronTutorial.pdf

The main principles of Schematron

- Designed to be used in conjunction with other validation languages (mainly XML Schemas)
- Uses XPath to specify rules
- Can define co-constraints (a constraint on data based on another item's data)

Source: Beginning XML; Fawcett, Quin, Ayers

What can Schematron be used for?

- Constraint checking
- Naming and design rules checking
- Data exploration
- Data reporting
- ...

Source: www.schematron.com

Elements of Schematron

- There are only 6 basic elements in ISO Schematron
  - assert
  - report
  - rule
  - pattern
  - schema
  - ns

How to use Schematron?

- Using a commercial software:
  - oXygen
    - **<?xml-model href="dcc.sch" type="application/xml" schematypens="http://purl.oclc.org/dsdl/schematron"?>**
  - Liquid Studio

How to use Schematron?

- Using open-source software only :
  - Java
  - Saxon-HE (v10.3) (https://www.saxonica.com/html/download/java.html)
  - SchXslt which is an open source schematron processor (https://github.com/schxslt/schxslt)

How to use Schematron?

- Using open-source software only:
  - **java -jar saxon-he/saxon-he-10.3.jar -s:dcc.sch -xsl:github/schxslt/core/src/main/resources/xslt/2.0/compile-for-svrl.xsl -o:dcc.xsl**
  - **java -jar saxon-he/saxon-he-10.3.jar -s:DCC.xml -xsl:dcc.xsl -o:result.xml**

Thank you very much for listening!

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DCC Helpdesk and DCC Summerschool

Presenting author Thomas Krah, PTB, Germany

thomas.krah@ptb.de

Additional author Siegfried Hackel, Frank Härtig, Thorsten Schrader, Shanna Schönhals, Jan Loewe, Lutz Doering, Benjamin Gloger, Justin Jagieniak, Daniel Hutzschenreuter, Gamze Söylev-Öktem (all PTB, Germany)

dcc@ptb.de

Abstract

Enquiries from the international community have increased steadily. Therefore, the DCC homepage is still being actively worked on. In order to better support the community, the PTB will set up a DCC helpdesk and also process enquiries from the metrological community, if capacities allow. In the lecture, the structure of the DCC helpdesk will be described (1st, 2ndand 3rdlevel support). The development of a knowledge database and the link to the DCC homepage are further goals. The processing of enquiries will be illustrated by way of example.

The plans for the DCC Summer School from 2022-06-13 to 2022-06-24 (twice a week) will be presented. Interested parties can apply for participation in this event soon.

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Braunschweig and Berlin
National Metrology Institute

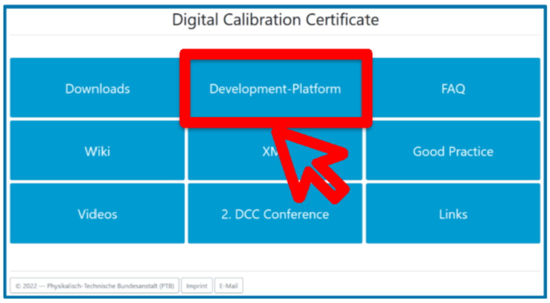
PTB DCC Helpdesk and DCC Summer School

2nd International DCC Conference

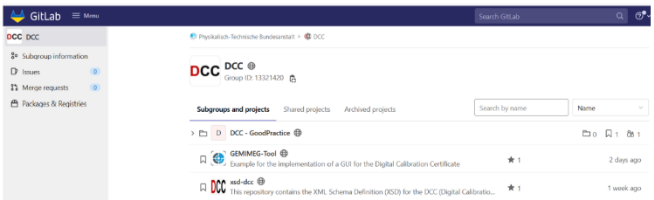
T. Krah, PTB

Where to find information about the DCC?

- Single Point of Entry
  - Address: www.ptb.de/dcc
  - Here every interested person has free access to all available infomation.



- File downloads to start with the DCC:
  - https://gitlab.com/ptb/dcc
  - DCC schema
  - Good Practice examples
  - Gemimeg-Tool



Help and Coordination

Structure of the help desk:

Part 1

- Support structure is currently under construction.
- Planned structure:
  - Support is done via 1st, 2nd, 3rd level support
  - 1st level: FAQ + telephone hotline
  - 2nd level: DCC developer from the single departments
  - 3rd level: developer from the core development team

Structure for coordinational requests:

- Single Point of Entry

Knowledge Base

Part 2

- A knowledge base system similar to other Help Desks is currently also under construction.
- Part of the Service Desk.
- Contains a Q&A data base aside of the FAQ. → Exchange between the systems is ensured.

Help and Coordination

Contact Hotline:

Help desk: www.ptb.de/dcc
E-mail: dcc@ptb.de
Phone.: to be announced

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

Support developing DCCs

Offerings:

- Consultancy for organisations (DKD, DAkkS, EMNs, …).
- Executing projects in collaboration with partners.
- Development of Good Practice examples.
- …

Summer School

- Date: Group 1: 2022-06-13 to 2022-06-17
  Group 2: 2022-06-20 to 2022-06-24
- Scope:
  - Topics: Fundamentals of the DCC, Good Practice examples, …
  - Getting started with the DCC
  - Hands-On work with DCC (active participation required)
- How to get involved?
  - Application required
  - Application should be addressed to dcc@ptb.de
- Prerequisits:
  - Proven IT knowledge (web programming, C++, Java, …)
  - Knowledge of calibration processes (performed calibrations, preparation of calibration certificates, …)
- Funding:
  - In collaboration with department *9.3 International Cooperation* funding possibilities will be checked individually (contact: digitalisation@ptb.de).

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Status: 03/22

Final Discussion and Further Steps

Presenting author Siegfried Hackel, PTB, Germany

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Abstract

A summary of the conference will be given. Furthermore, an outlook into the near future based on the results of the DCC conference will be shown. The third international DCC conference will be announced.

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Nationales Metrologieinstitut

Final Discussion and Further Steps

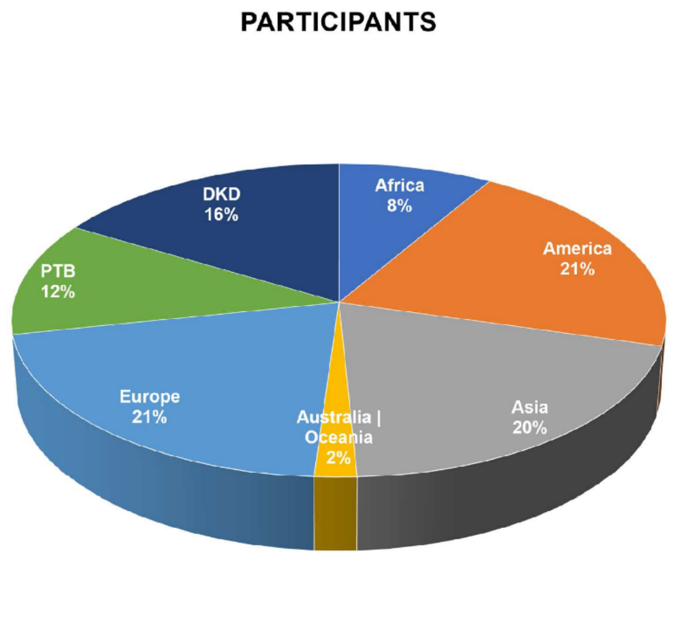
Siegfried Hackel

02

Statistics

Continent	Participants
Africa	59
America	145
Asia	137
Australia | Oceania	13
Europe	143
PTB	82
DKD	114
Sum	**693**

At the End: 708



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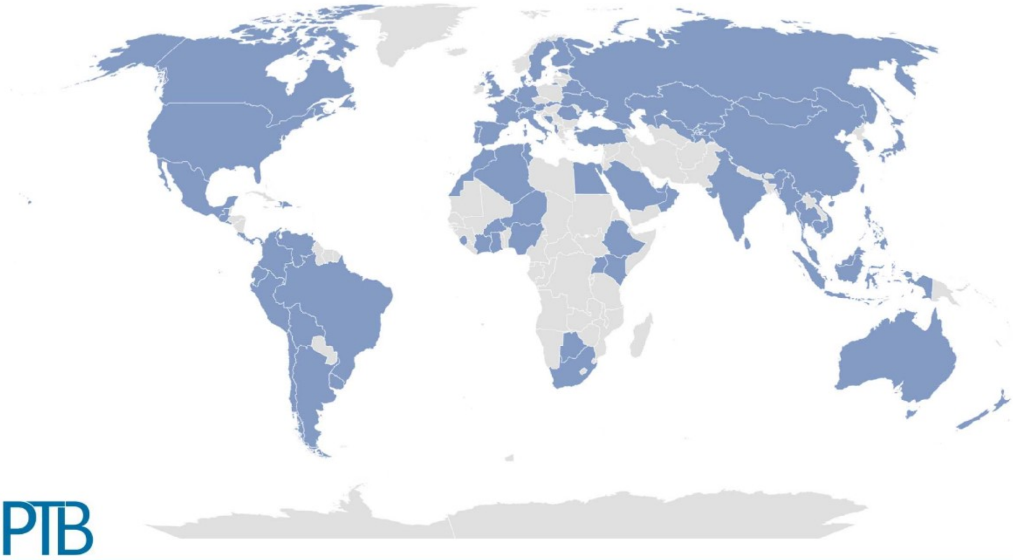
03

Statistics
Participants



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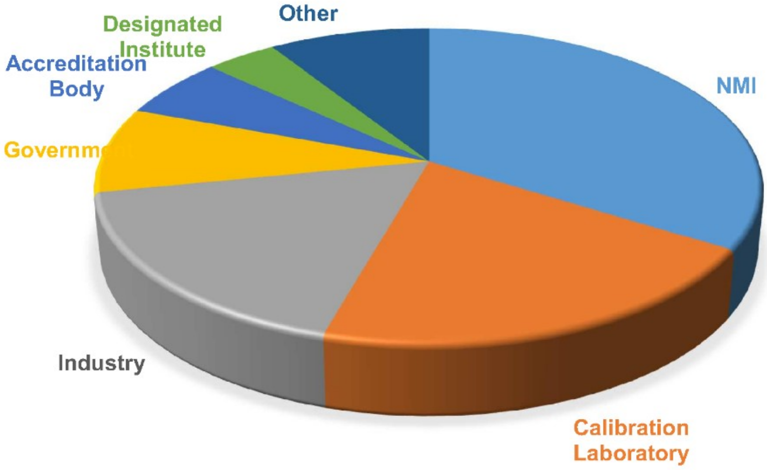
04

Statistics
PARTICIPANTS



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05

The Conference itself

- Welcome
  - ✓ CIPM-Strategy for Digitalization
    - It is good that the necessity has been recognised and that accelerated processes are to be established.
    - Quick decision for Digital SI and uniform DCC mandatory
- Implementation strategies
  - ✓ USA: Impressive investments
  - ✓ Intensify coordination and discussions

06

The Conference itself

- Necessity of Good Practice (GP)
  - ✓ Common realisation is there that GP is important for lifting the treasure of machine interpretability
- Call for an international NGO
  - ✓ Determination of GP and (sub-) schemes
  - ✓ Storage of agreed GP and sub-schemata
  - ✓ Transitional solution at PTB
- Use of the data from the DCC
  - ✓ 2022-03-01 14:30: Simple Python example has shown this

07

The Conference itself

- Quantity | Value | Unit
  - ✓ Topic in two presentations
  - ✓ CIPM has this in focus and is working on a proposal
  - ✓ DCC can easily implement this
- Adapting norms and standards to the fourth industrial revolution
  - ✓ Great need to improve

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08

The Conference itself

- DCC-Syntax 4.0
  - ✓ DX, DCC, DCR, DCA, DTC, DRM
    - Call for active cooperation by email to

      “”abbreviation”” @ptb.de
  - ✓ Envelope
    - A lively discussion shows that new possibilities can optimise processes.

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09

The Conference itself

- List of requirements of accreditation bodies for the DCC
  - ✓ Reference to lecture by DAkkS
  - ✓ Discussion is neccessary
- IT-Security
  - ✓ his topic will continue to accompany us

10

The Conference itself

- xsdMETAS and DCC
  - ✓ 2022-03-01 12:45: Implementation of Digital Calibration Certificate at NIMT
  - ✓ Lecture commitment from METAS at 3rd International DCC Conference

von·Daniel·Hutzschenreuter·an·alle:····3:10·PM¶
No·Federico,·this·is·not·waht·I·sayed·:-)¶
von·Federico·Grasso·Toro·METAS·an·alle:····3:11·PM¶
hey·daniel.·my·mistake!·I·understood·it·wrongly!¶
von·Siegfried·Hackel·PTB·an·alle:····3:12·PM¶
:-)))¶

11

Look to the Future

- Third International DCC Conference
  - **Save the Date: 2023-02-27 to 2023-03-03 (online)**

12

Look to the Future

- Online-Proceedings
  - ✓ We will publish an online conference volume (DOI)
  - ✓ The request to the speakers for publication is in progress
  - ✓ You will be informed when the proceedings are published
- https://www.ptb.de/dcc
  - ✓ All information can be found here

Thanks a lot!

Héctor Laiz
Frank Härtig
Chairpersons
Benjamin Gloger
Christian Keilholz
Gamze Söylev-Öktem
Jan Loewe
Justin Jagieniak
Kai Mienert
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Moritz Jordan
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2022-03-03

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As of: March 2022

Federal Ministry
for Economic Affairs
and Climate Action

The Physikalisch-Technische Bundesanstalt, the National Metrology Institute of Germany, is a scientific and technical higher federal authority falling within the competence of the Federal Ministry for Economic Affairs and Climate Action.