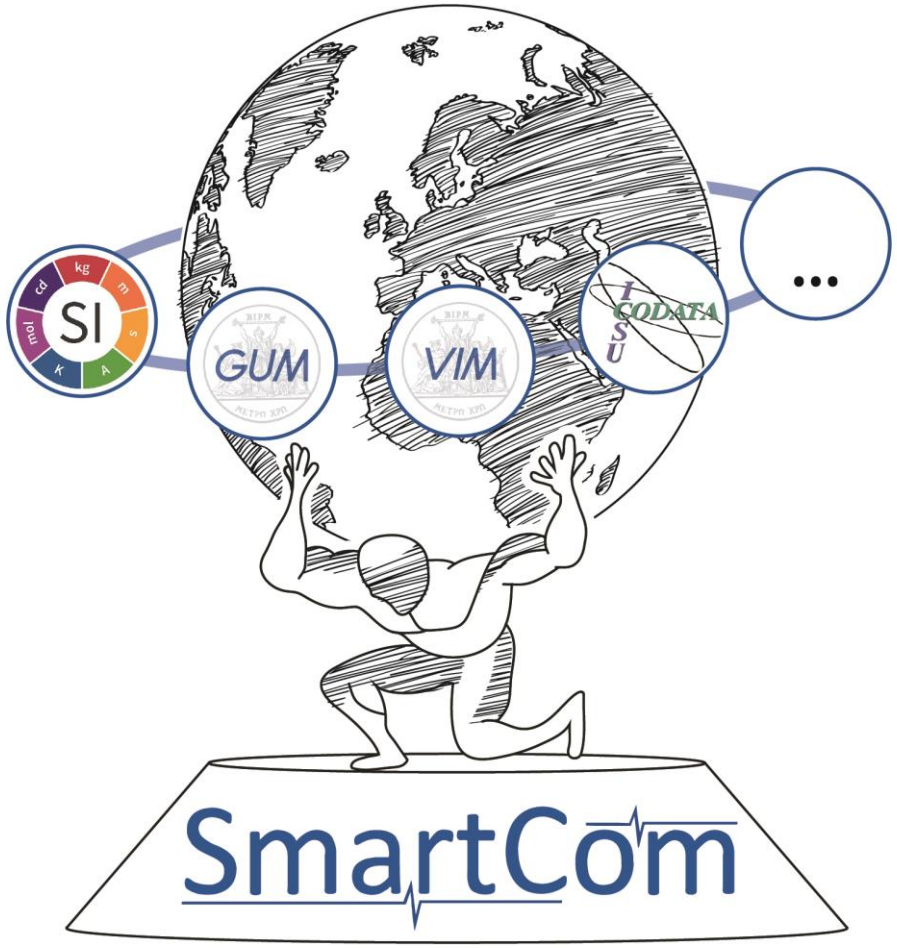


The Digital Calibration Certificate

SmartCom

M4DT – Online Session III

29-Sep-21

Wiebke Heeren

Introduction: EMPIR SmartCom

Communication and validation of smart data in IoT-networks

Smart-Sensor
Smart-Home/(Ind. 4.0)
Smart-City





Unambiguous, universal
safe (cryptographic secured)
long term (machine)readable/
interpretable



validation
Server



digital information formatted
for further/ advanced data
consolidation and analytics



Vision of the project

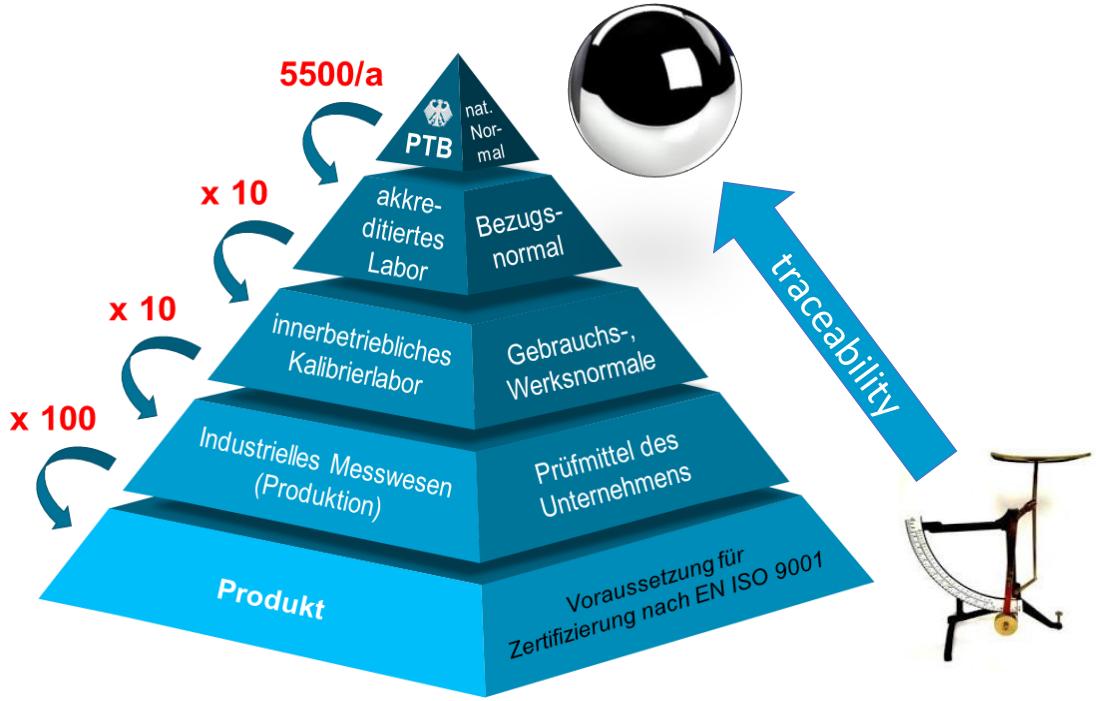
Develop and establish the basis for an unambiguous, universal, safe and uniform communication of metrological data in the Internet of Things (IoT) and Industry 4.0

Today: focus on **digital calibration certificates (DCC)**

The need for DCCs I

Calibrations have an essential role in quality management

- The **SI system** provides the framework for comparable measurements
- Comparability is based on traceability to the SI system
  - Traceability can only be ensured by an unbroken chain of calibrations
- Calibration information is documented in calibration certificates

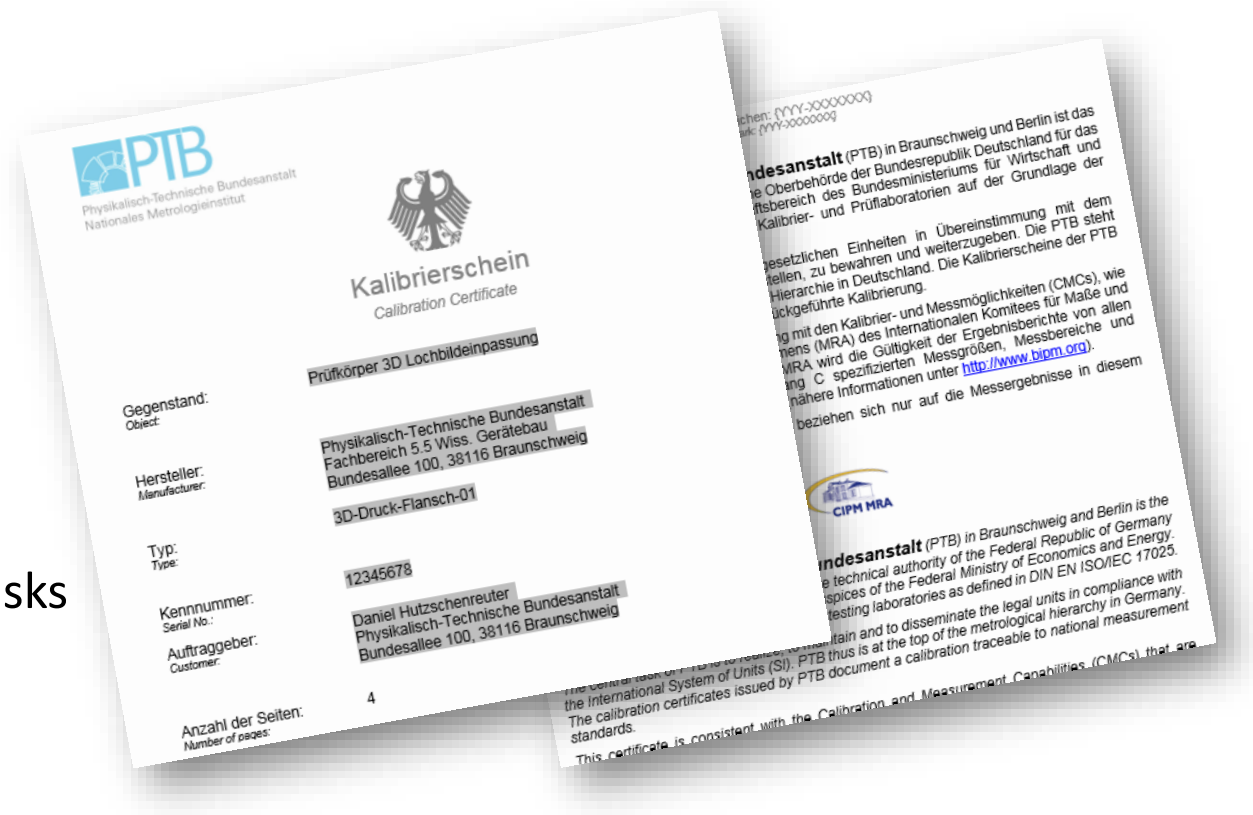


→ A great amount of calibration certificates p/a with an essential role in quality management

The need for DCCs II

The handling of current calibration certificates requires manual work

- Calibration certificates are commonly still **paper** documents or PDF files
  - ⚠ These formats lack machine-readability
- Transcribing data from a certificate needs to be done **manually**
  - ⚠ Vulnerability to human errors that cause risks
  - ⚠ Inefficiency in terms of time and costs

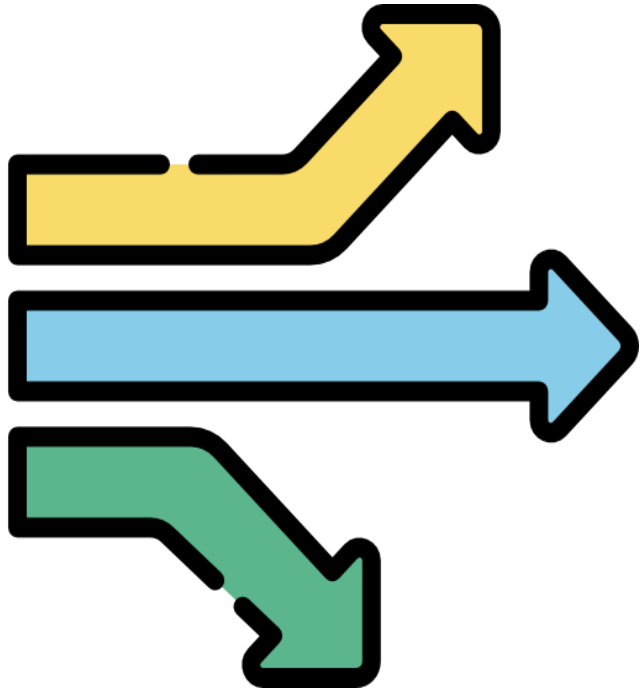


The need for DCCs III

Digitisation of calibration information provides significant benefit

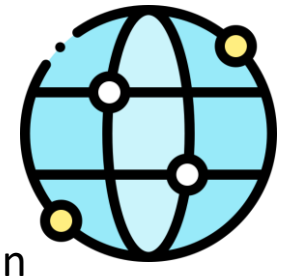
ANALOGUE CERTIFICATE

- Paper document or a PDF file – only human readable
- Requires human interpretation – slow processes and data integrity issues
- Paper documents must be archived for long term storage



DIGITAL CERTIFICATE

- Based on XML file format – **machine readable** and still human readable as an option
- **Increased efficiency** and security via automated communications and processes
- Readable and storable in **digital storage systems**, e.g., databases and potentially in the device itself

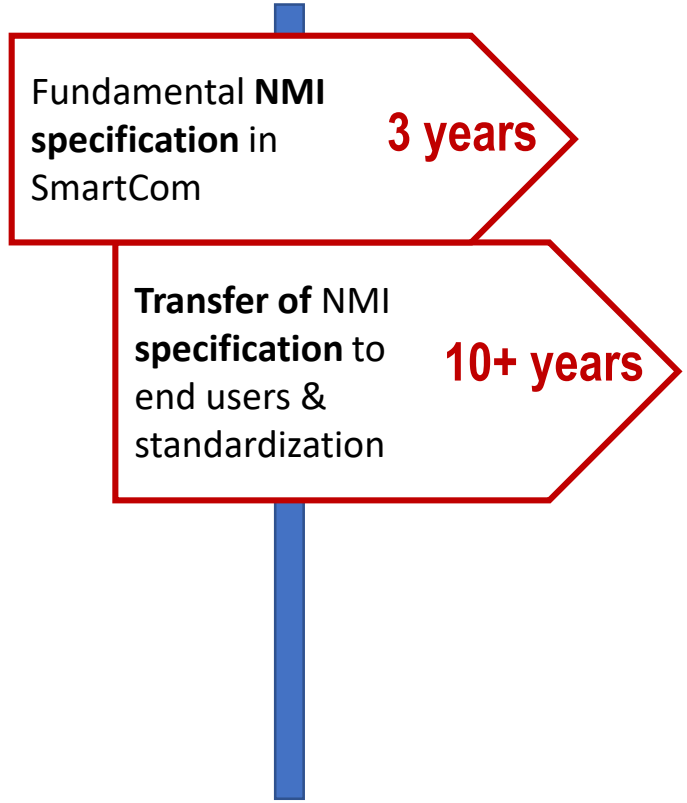


Goal and challenges around DCC



Digital Calibration Certificate (DCC) considering technical and legal requirements

- **Consensus:**
  - uniform structure/hierarchy
  - uniform exchange format (XML)
- **Technical solutions:**
  - cryptographic signatures/seals
  - data security, encryption
  - authentication (identification of interaction)
- **Legal requirements:**
  - legal validity/ documentation of validity period
  - Withdrawal of calibration certificates



Universal requirements

Identification of first basic set of parameters for DCC – survey among SmartCom partners

… regarding content and structure

Parameter	Description	yes/no/conditional						
		Partner 1	Partner 2	Partner 3	Partner 4	Partner 5	Partner 6	Partner XY
usedSoftware								
name	Name of software used for creating an editing the DCC	n		n	n	n		n
release	Release status of used software	n		n	n	n		n
coreData								
uniqueID	Unique identification of calibration certificate	y	y	y	y	y		y
beginPerformance	Date at which calibration activities started	y	y	n	n	n	n	y
item								
name	Unambiguous name/ label of calibration item	y	y	y	y	y	y	y
description	Detailed description of calibration item	y	y	n	c	y		c

Universal requirements

… regarding content and structure

EASY

Parameter	Description	yes/no/conditional						
		Partner 1	Partner 2	Partner 3	Partner 4	Partner 5	Partner 6	Partner XY
usedSoftware								
name	Name of software used for creating an editing the DCC	n		n	n	n		n
release	Release status of used software	n		n	n	n		n
coreData								
uniqueID	Unique identification of calibration certificate	y	y	y	y	y		y
beginPerformance	Date at which calibration activities started	y	y	n	n	n	n	y
item								
name	Unambiguous name/ label of calibration item	y	y	y	y	y	y	y
description	Detailed description of calibration item	y	y	n	c	y		c

Universal requirements

NOT TOO EASY

… regarding content and structure

Parameter	Description	yes/no/conditional						
		Partner 1	Partner 2	Partner 3	Partner 4	Partner 5	Partner 6	Partner XY
usedSoftware								
name	Name of software used for creating an editing the DCC	n		n	n	n		n
release	Release status of used software	n		n	n	n		n
coreData								
uniqueID	Unique identification of calibration certificate	y	y	y	y	y		y
beginPerformance	Date at which calibration activities started	y	y	n	n	n	n	y
item								
name	Unambiguous name/ label of calibration item	y	y	y	y	y	y	y
description	Detailed description of calibration item	y	y	n	c	y		c

Universal requirements

… regarding content and structure

NEW

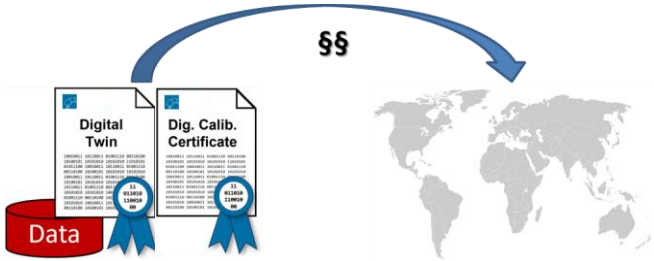
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uniqueID	Unique identification of calibration certificate	y	y	y	y	y		y
beginPerformance	Date at which calibration activities started	y	y	n	n	n	n	y
item								
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description	Detailed description of calibration item	y	y	n	c	y		c

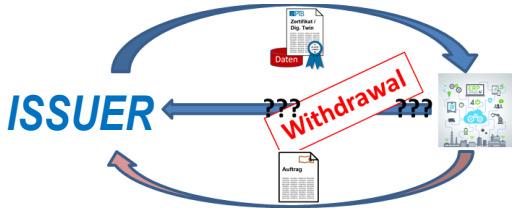
Basic framework

… regarding secure transfer



- (long-term) preservation of readability, integrity and authenticity
- stable data format
- electronic signatures
- allow for mutual recognition across borders
- comply with privacy policy
- interoperability
- preservation of controllability of data
- allow for verification/ validation of data
- ensure usability
- allow for withdrawal
- …





DCC structure - Layout

Fundamental DCC-layout

1. Administrative shell (mainly mandatory)

2. Calibration results (partly regulated)

3. Individual information (not regulated)

4. Optional Attachment:
   „Human readable document“ (e. g. PDF)





+ Framework conditions
+ legal requirements

DCC structure – XML based approach

Administrative data



PTB Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

Kalibrierschein
Calibration Certificate

Gegenstand: *Object:*	1 Gewichtstück zu 10 g *1 weight of 10 g*
Hersteller: *Manufacturer:*	Hersteller Herstellerstraße 42 12345 Herstellerort
Kennnummer: *Serial No.:*	1040917
Auftraggeber: *Applicant:*	Physikalisch-Technische Bundesanstalt Arbeitsgruppe 1.15 Bundesallee 100 38116 Braunschweig
Anzahl der Seiten: *Number of pages:*	4
Geschäftszeichen: *Reference No.:*	1.81-17.019
Kalibrierzeichen: *Calibration mark:*	PTB - 11044 17
Datum der Kalibrierung: *Date of calibration:*	20.09.2017

Im Auftrag
On behalf of PTB

Braunschweig, 13.10.2017

Siegel
Seal

Im Auftrag
On behalf of PTB

Vorname1 Name1

Vorname2 Name2

DCC structure – XML based approach

Administrative data



Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

Kalibrierschein
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Im Auftrag *On behalf of PTB* — Braunschweig, 13.10.2017 — Im Auftrag *On behalf of PTB*

Siegel *Seal*

Vorname1 Name1 — Vorname2 Name2

```
<?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/v2.3.0/dcc.xsd"
        xmlns:dcc="https://ptb.de/dcc"
        xmlns:si="https://ptb.de/si"
        schemaVersion="2.3.0">
    <dcc:administrativeData>
        <dcc:dccSoftware>[...]</dcc:dccSoftware>
        <dcc:coreData>[...]</dcc:coreData>
        <dcc:items>[...]</dcc:items>
        <dcc:calibrationLaboratory>[...]</dcc:calibrationLaboratory>
        <dcc:respPersons>[...]</dcc:respPersons>
        <dcc:customer>[...]</dcc:customer>
        <dcc:statements>[...]</dcc:statements>
    </dcc:administrativeData>
```

DCC structure – Details II

Measurement data



Messergebnisse
Measurement results

Masse
Mass

Nennwert *nominal value*	Kennzeichnung *marking*	Masse *mass*	Unsicherheit *uncertainty* $k = 2$
10 g	18L	10 g + 0,003 mg	0,004 mg

DCC structure – Details II

Measurement data



Messergebnisse
Measurement results

Masse
Mass

Nennwert *nominal value*	Kennzeichnung *marking*	Masse *mass*	Unsicherheit *uncertainty* $k = 2$
10 g	18L	10 g + 0,003 mg	0,004 mg

```
<dcc:measurementResults>
    [...]
    <dcc:result>
        <dcc:name>
            <dcc:content lang="de">Masse</dcc:content>
            <dcc:content lang="en">mass</dcc:content>
        </dcc:name>
        <dcc:data id="Mass">
            <dcc:list>
                <dcc:quantity>
                    <dcc:name>
                        <dcc:content lang="de">Nennwert</dcc:content>
                        <dcc:content lang="en">nominal value</dcc:content>
                    </dcc:name>
                    <dcc:noQuantity>
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                <dcc:quantity>
                    <dcc:name>
                <dcc:content lang="de">Kennzeichnung</dcc:content>
                        <dcc:content lang="en">marking</dcc:content>
                    </dcc:name>
                    <dcc:noQuantity>
                        <dcc:content>18L</dcc:content>
                    </dcc:noQuantity>
                </dcc:quantity>
                <dcc:quantity>
                    <dcc:name>
                        <dcc:content lang="de">Masse</dcc:content>
                        <dcc:content lang="en">mass</dcc:content>
                    </dcc:name>
                    <si:real>
                        <si:value>10.000003E-3</si:value>
                        <si:unit>\kilogram</si:unit>
                        <si:expandedUnc>
                            <si:uncertainty>0.000004E-3</si:uncertainty>
                            <si:coverageFactor>2</si:coverageFactor>
                            <si:coverageProbability>0.95
                                </si:coverageProbability>
                        </si:expandedUnc>
                    </si:real>
                </dcc:quantity>
            </dcc:list>
        </dcc:data>
    </dcc:result>
    [...]
</dcc:measurementResults>
```

“How to“ DCC

management →



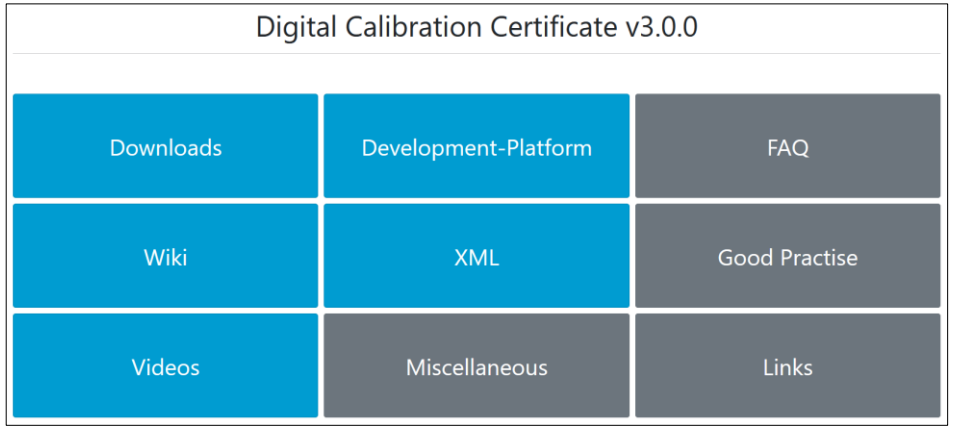
- Guiding a larger change process
  - Integration in enterprise’s existing structures/ processes

technical →



- Basic knowledge of XML
  - https://www.w3schools.com/xml/
- Creation not yet automated
  - Use application such as Notepad++ or Visual Studio Code

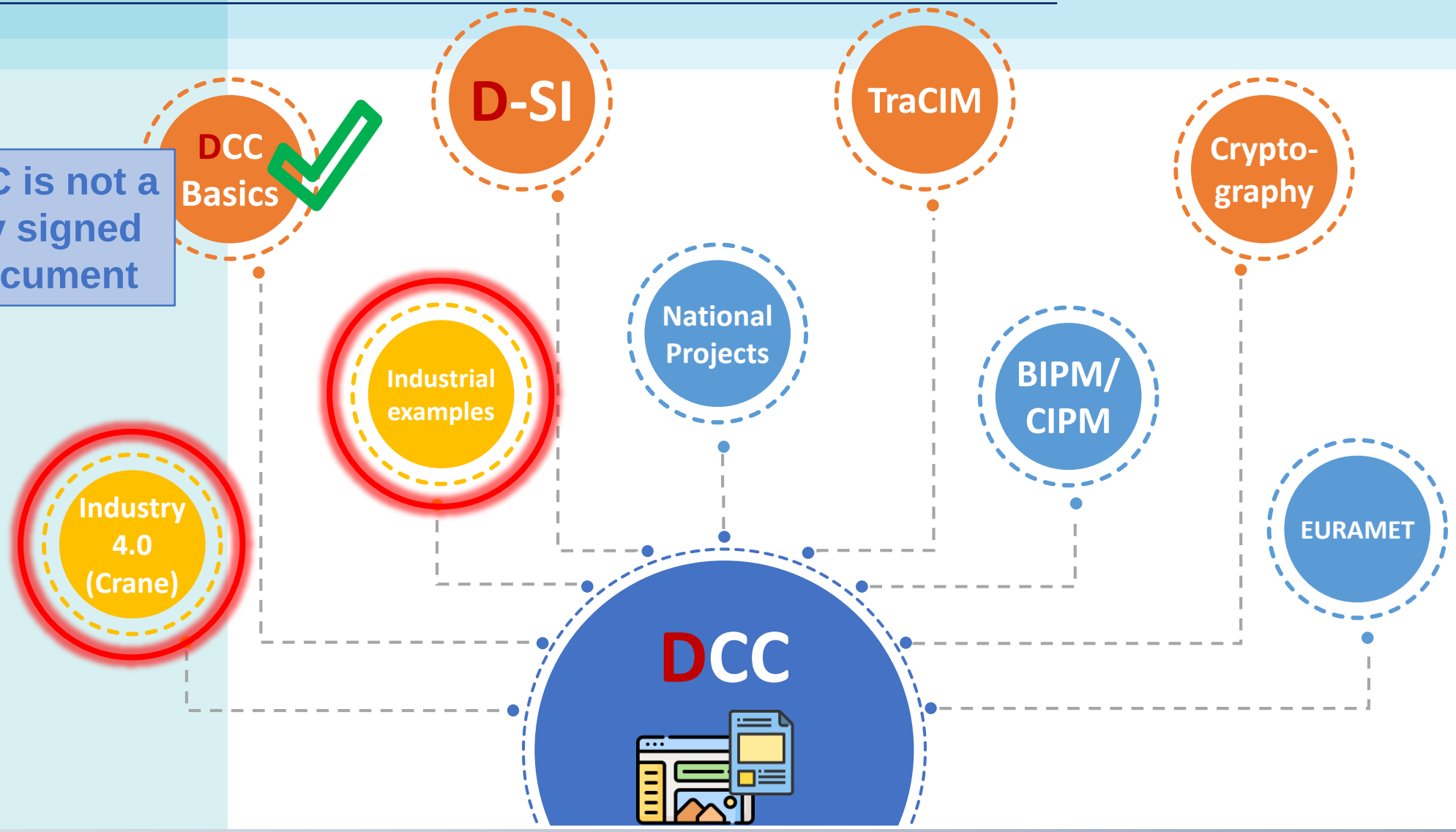
https://www.ptb.de/dcc →





DCC – Showcases

→ A DCC is not a digitally signed PDF document



Acknowledgements

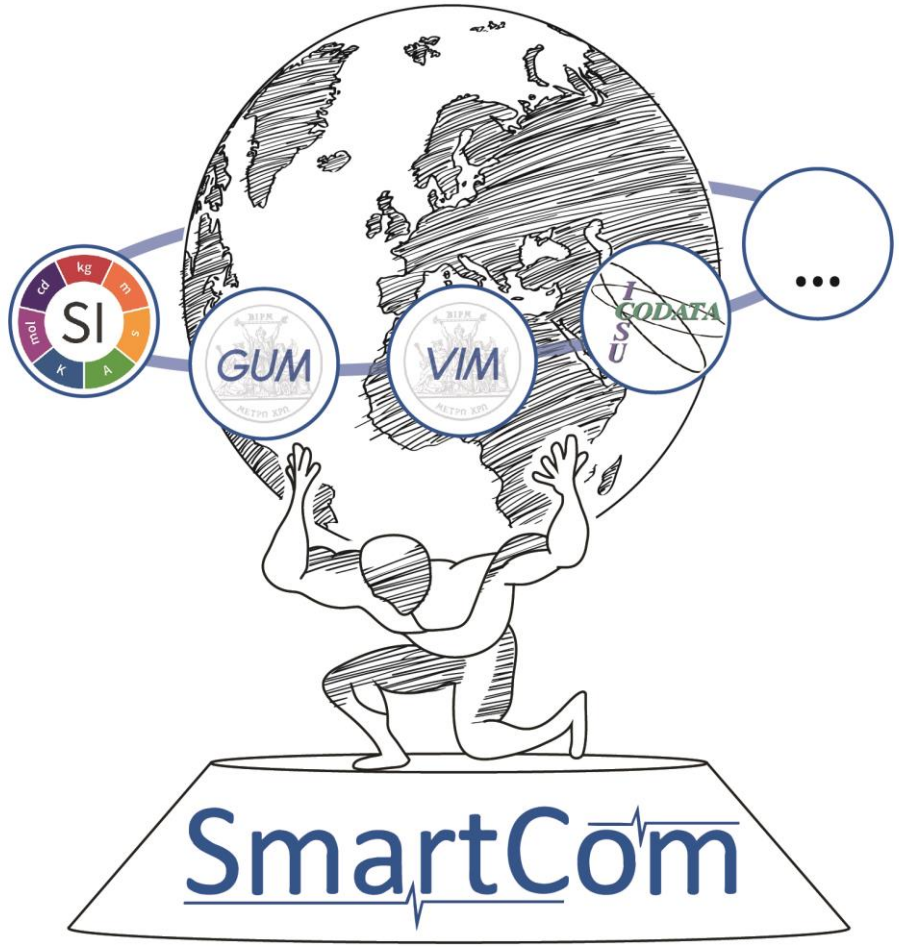
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Thank you for your attention!

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Bundesallee 100
38116 Braunschweig

Wiebke Heeren
Phone: 0531 592-1206
E-Mail: wiebke.heeren@ptb.de
www.ptb.de

Contact: smartcom@ptb.de



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