GEMIMEG-II: Vom Kalibrierzertifikat zur Qualitätsinfrastruktur – Was bringt die Digitalisierung?

DCC-Praxiswerkstatt, BAM
Dr. Thomas Engel

18.Juni 2024, online

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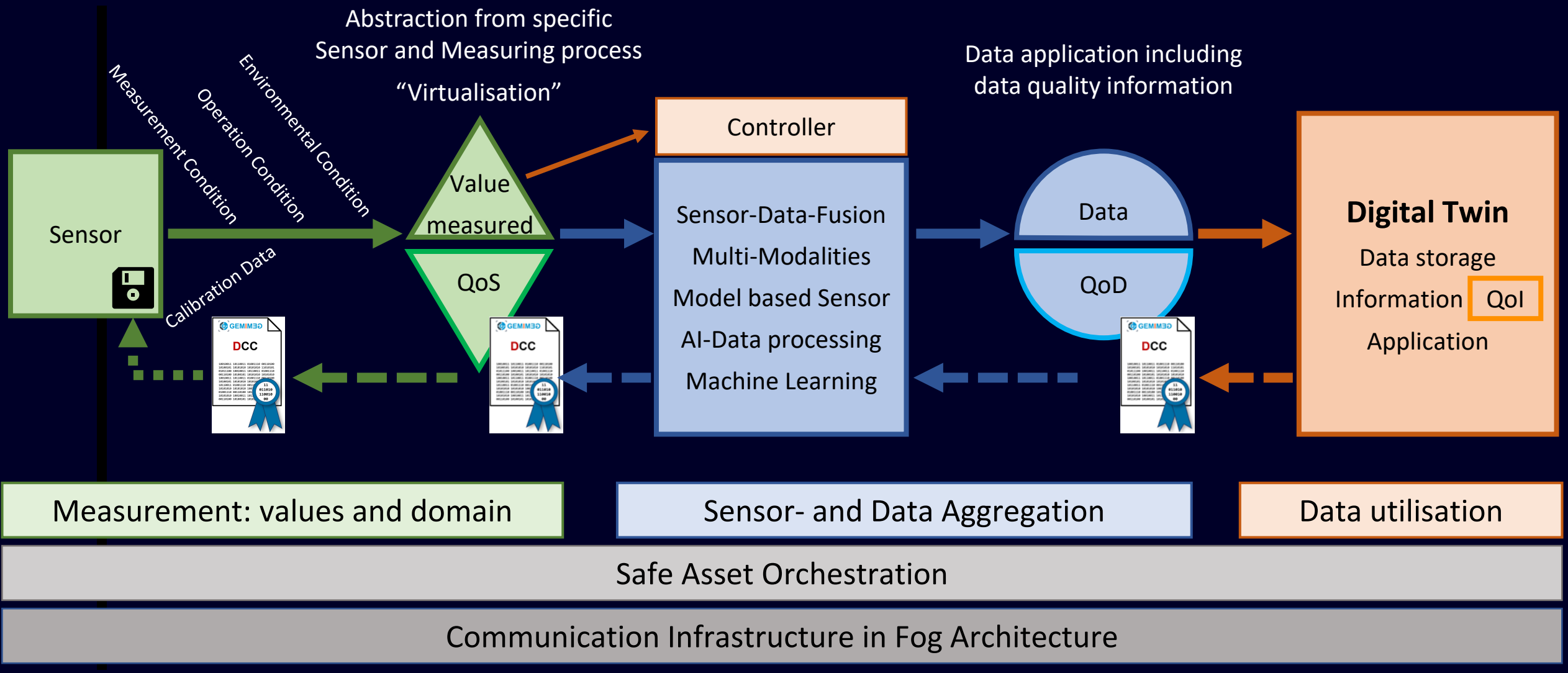
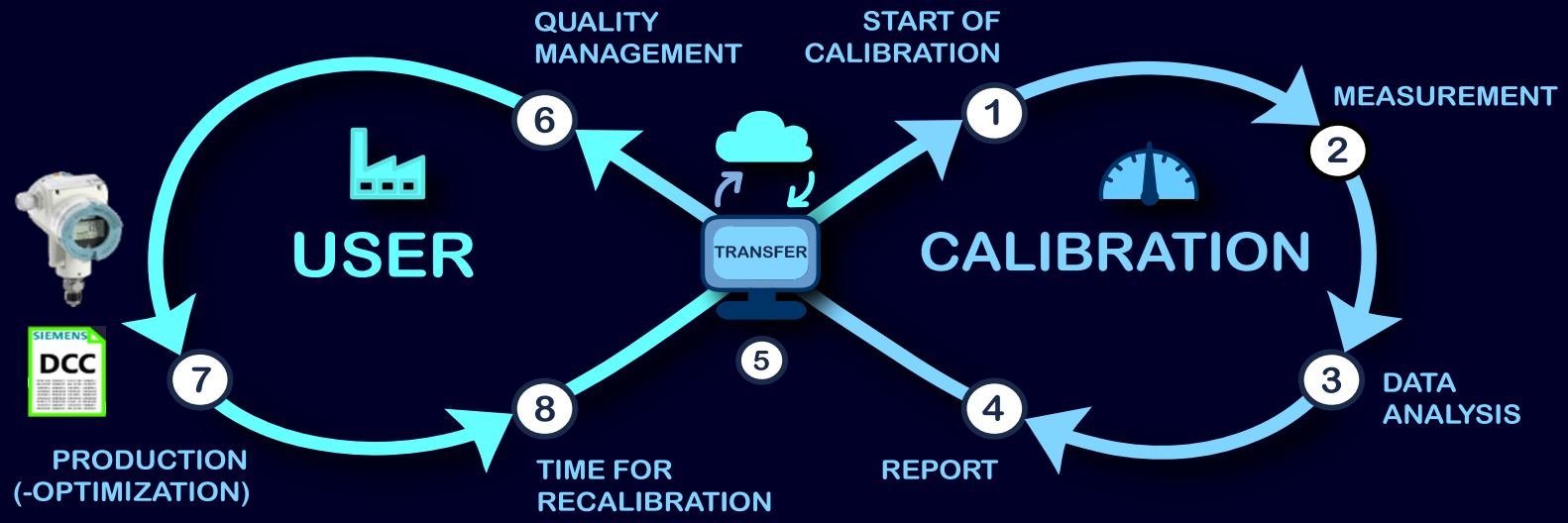
The GEMIMEG - Concept



Calibration Usecases

A) Production process

B) Process equipment with periodic recurring calibrations



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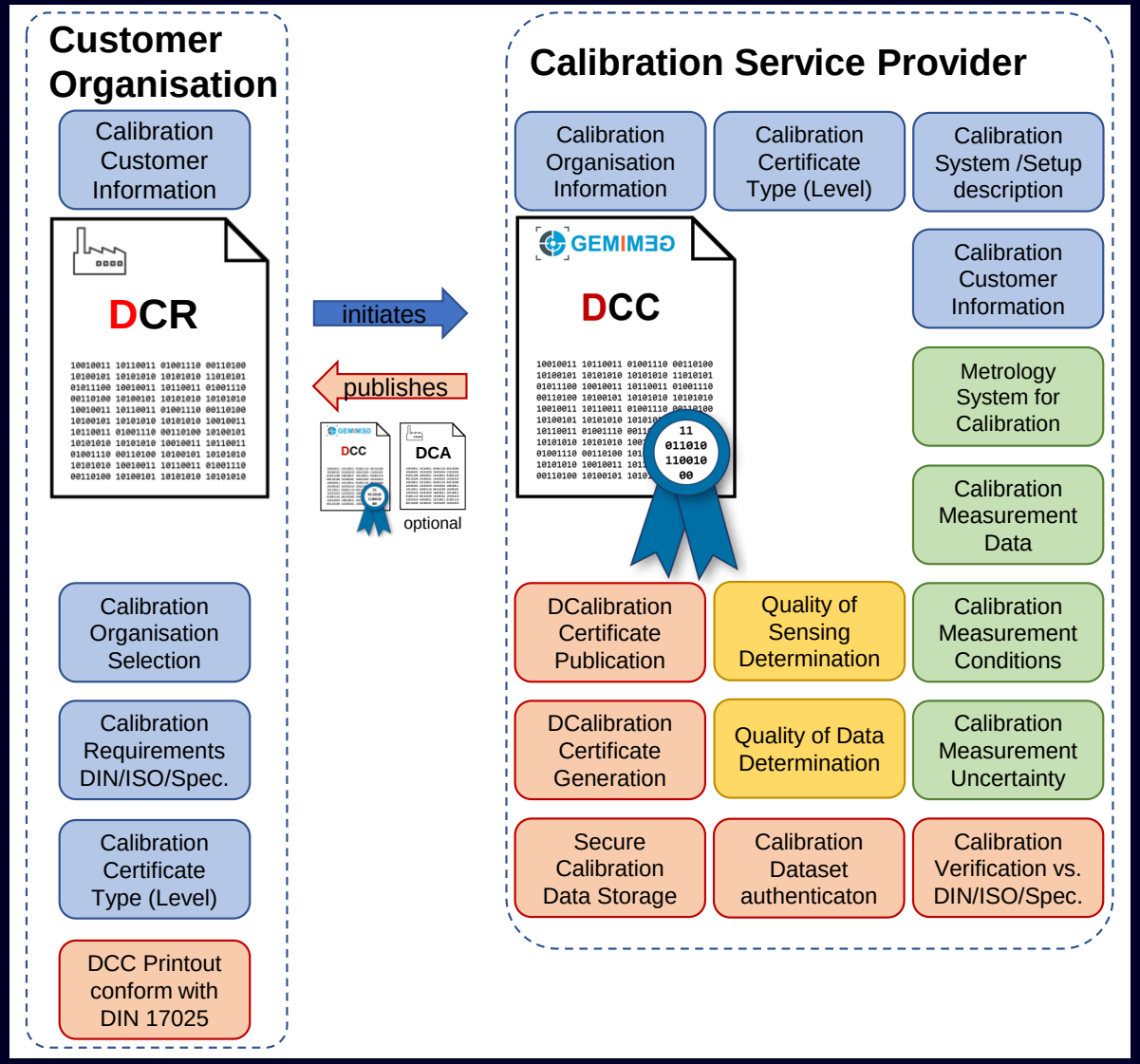
The DCC and its generic components



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 indivicual instruments / artefacts in a „standard“ configuration for repetitive use in subsequent applications (e.g. gauge block set)

Calibration Measurement

Internal operational steps for metrology in respective calibration / verification organisation

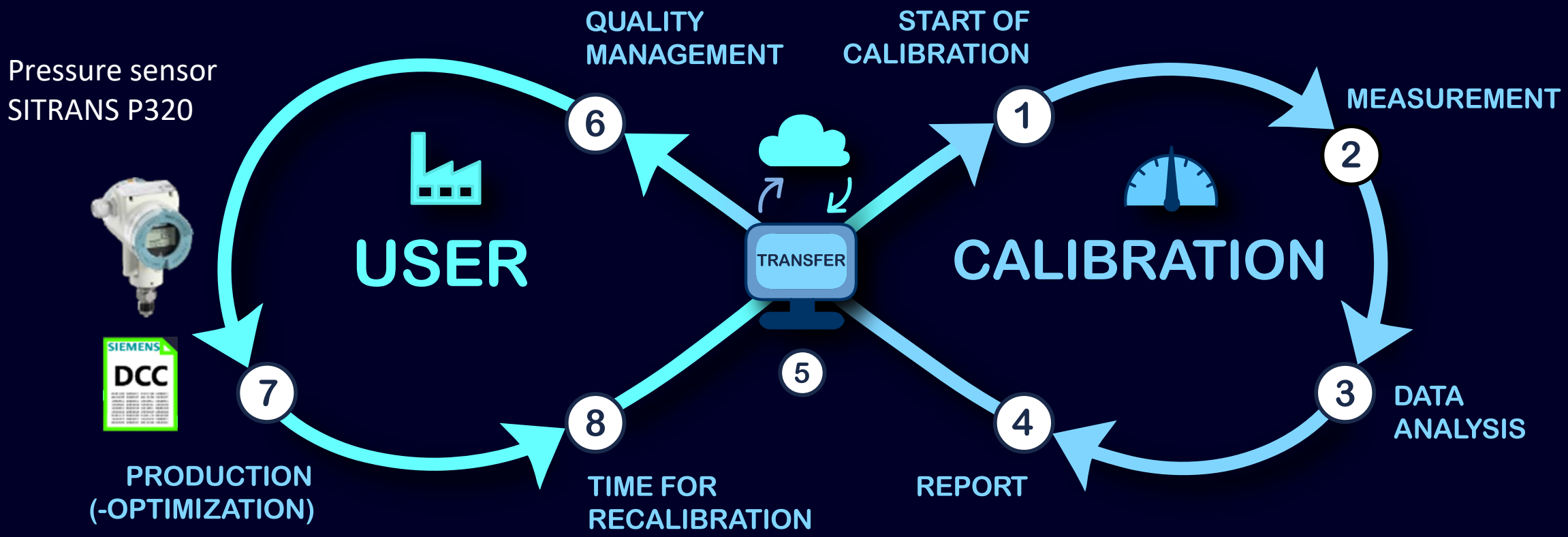
Calibration Documentation

Internal operation steps to fully document and qualify calibration measurement data and to issue DCC certificate – according to requirement for respective type of calibration

Quality Info Determination

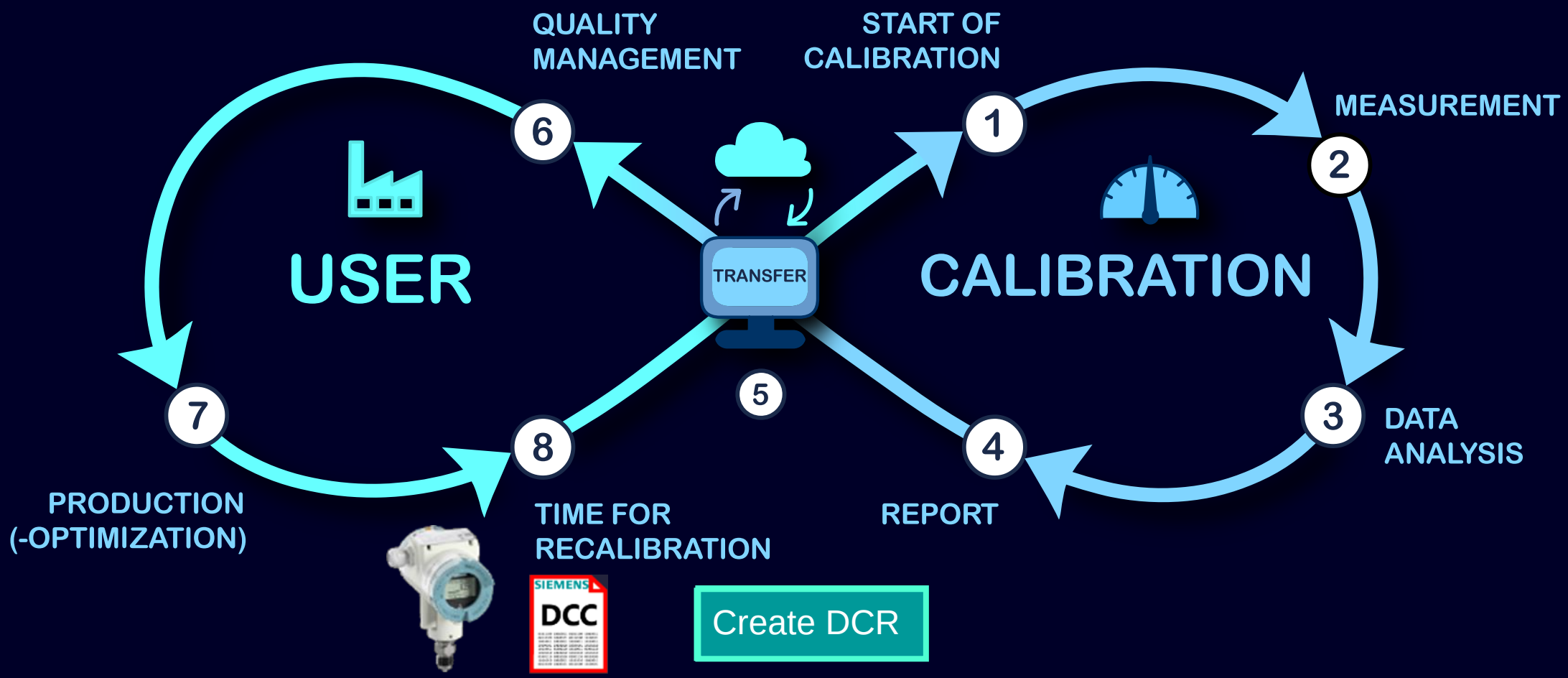
Quality level determination for measurement values data generated by sensor as a physical or model based sensor entity

The role of calibration in a generic production cycle



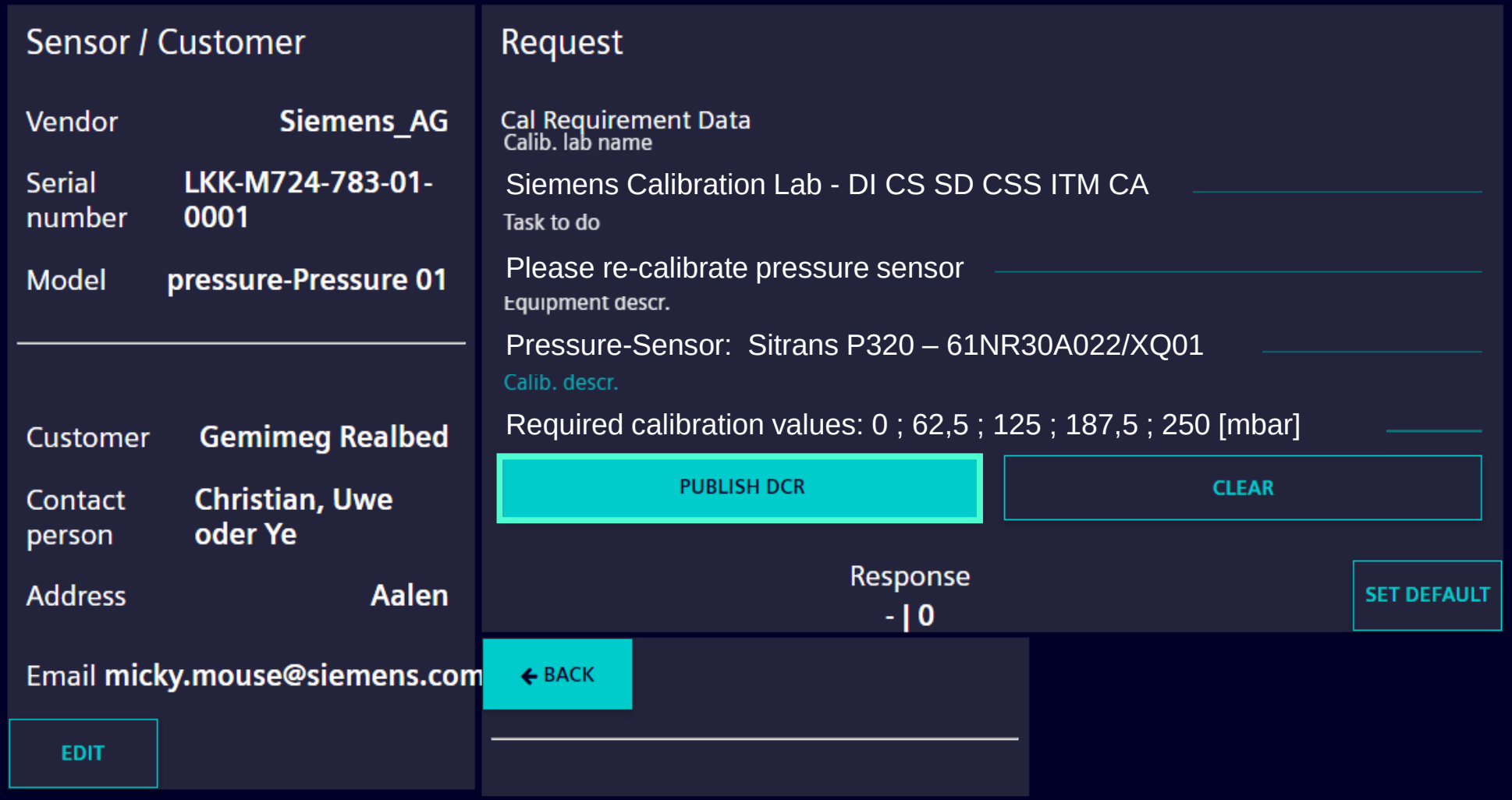
DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer

The role of calibration in a generic production cycle
Recalibration required

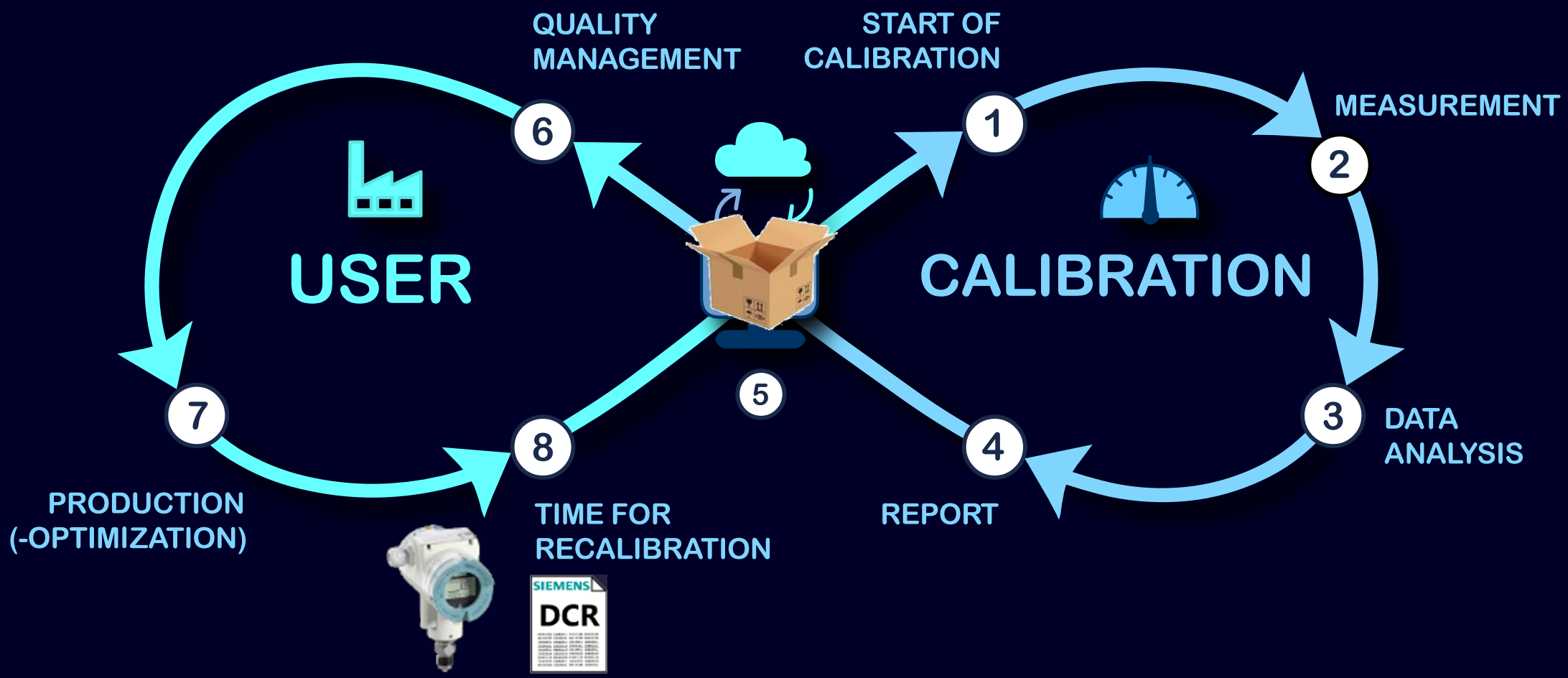


DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer

DCR – Digital Calibration Request



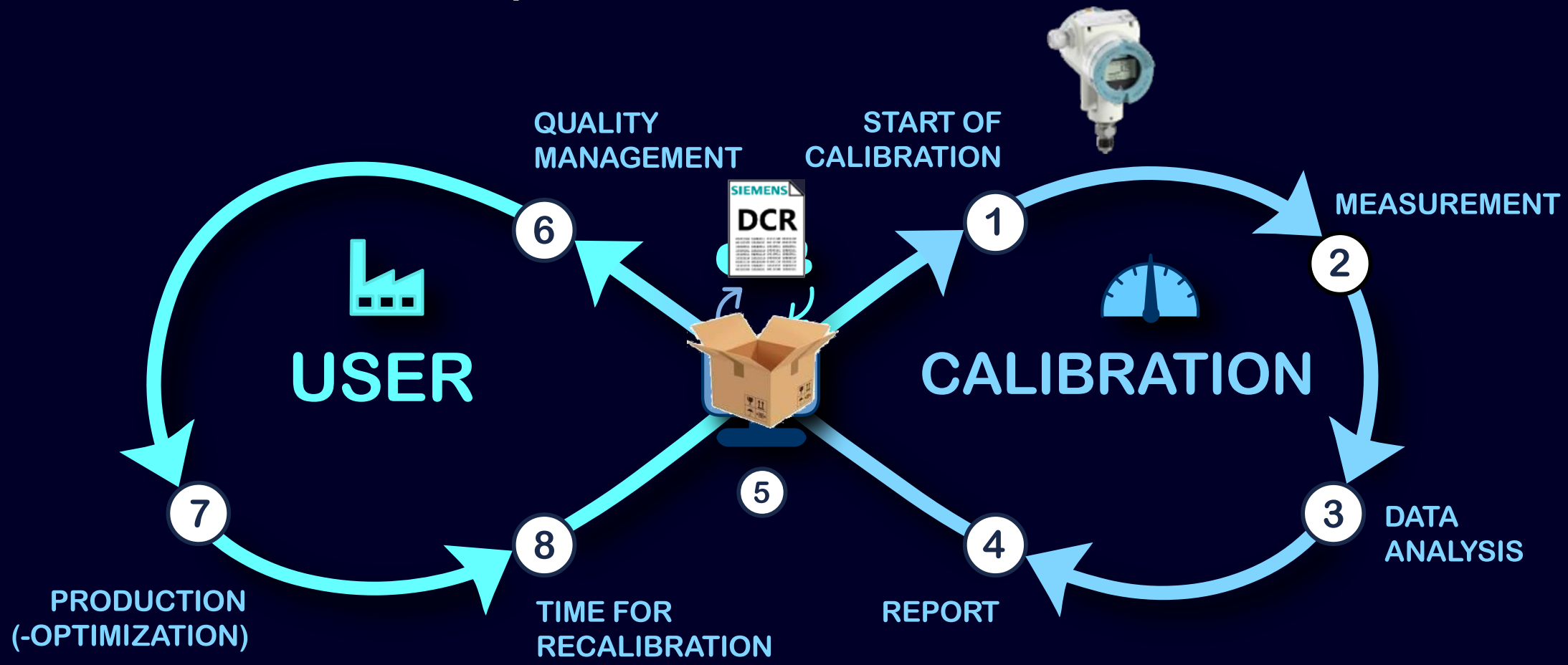
The role of calibration in a generic production cycle
Initiate calibration with service provider



Publish DCR

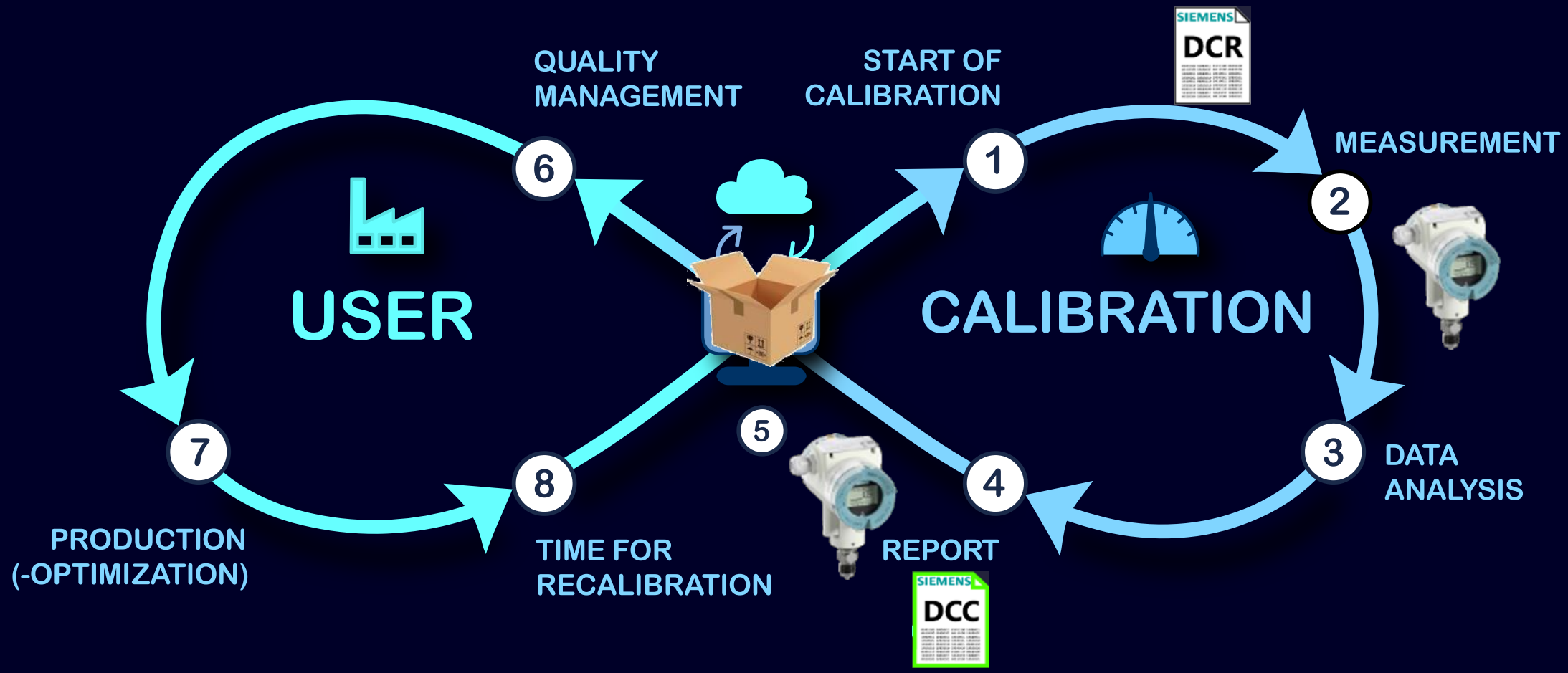
DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer

The role of calibration in a generic production cycle
Initiate calibration with service provider



DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer

The role of calibration in a generic production cycle
Calibrate and generate DCC



DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer

The role of calibration in a generic production cycle
Transfer equipment and DCC to user

QUALITY MANAGEMENT

START OF CALIBRATION

SIEMENS DCC

MEASUREMENT

USER

CALIBRATION

DATA ANALYSIS

PRODUCTION (-OPTIMIZATION)

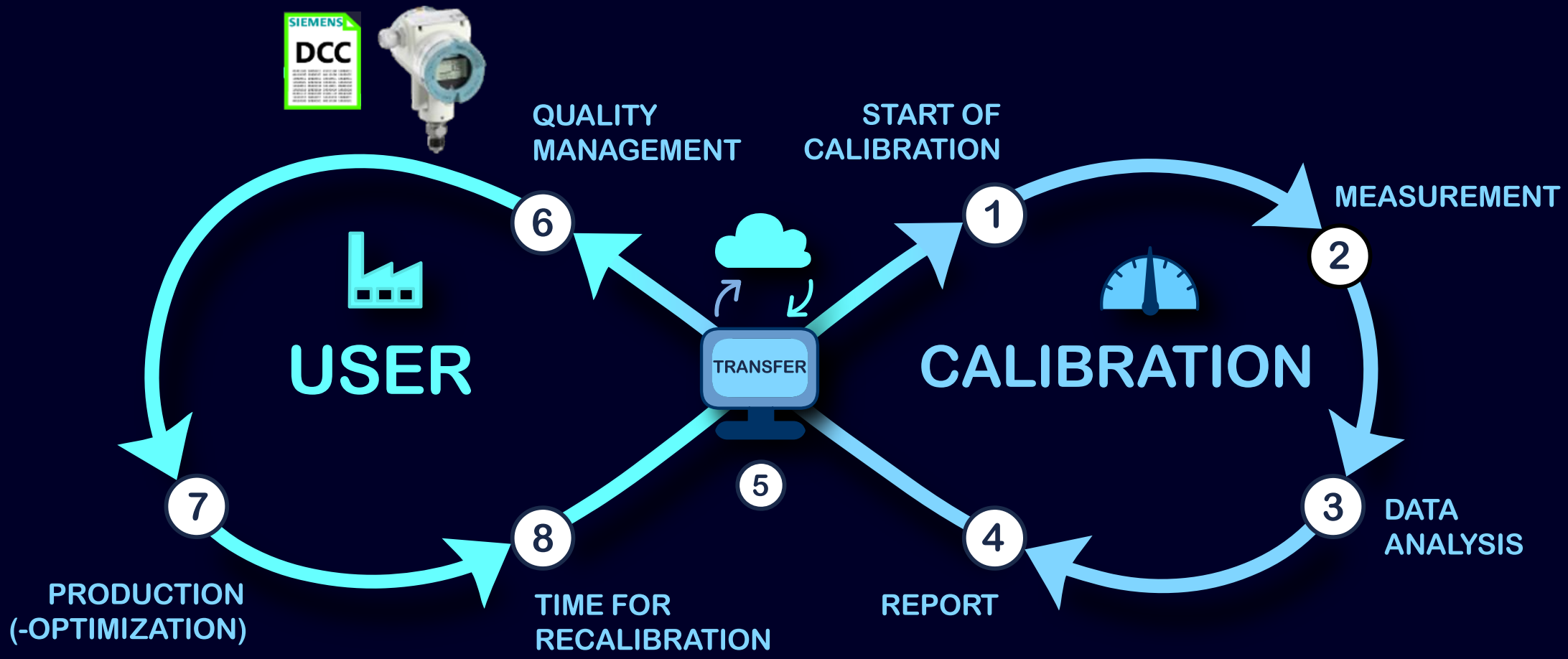
TIME FOR RECALIBRATION

REPORT

1 2 3 4 5 6 7 8

DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer

The role of calibration in a generic production cycle
Transfer equipment and DCC to user



DCC – Digital Calibration Certificate
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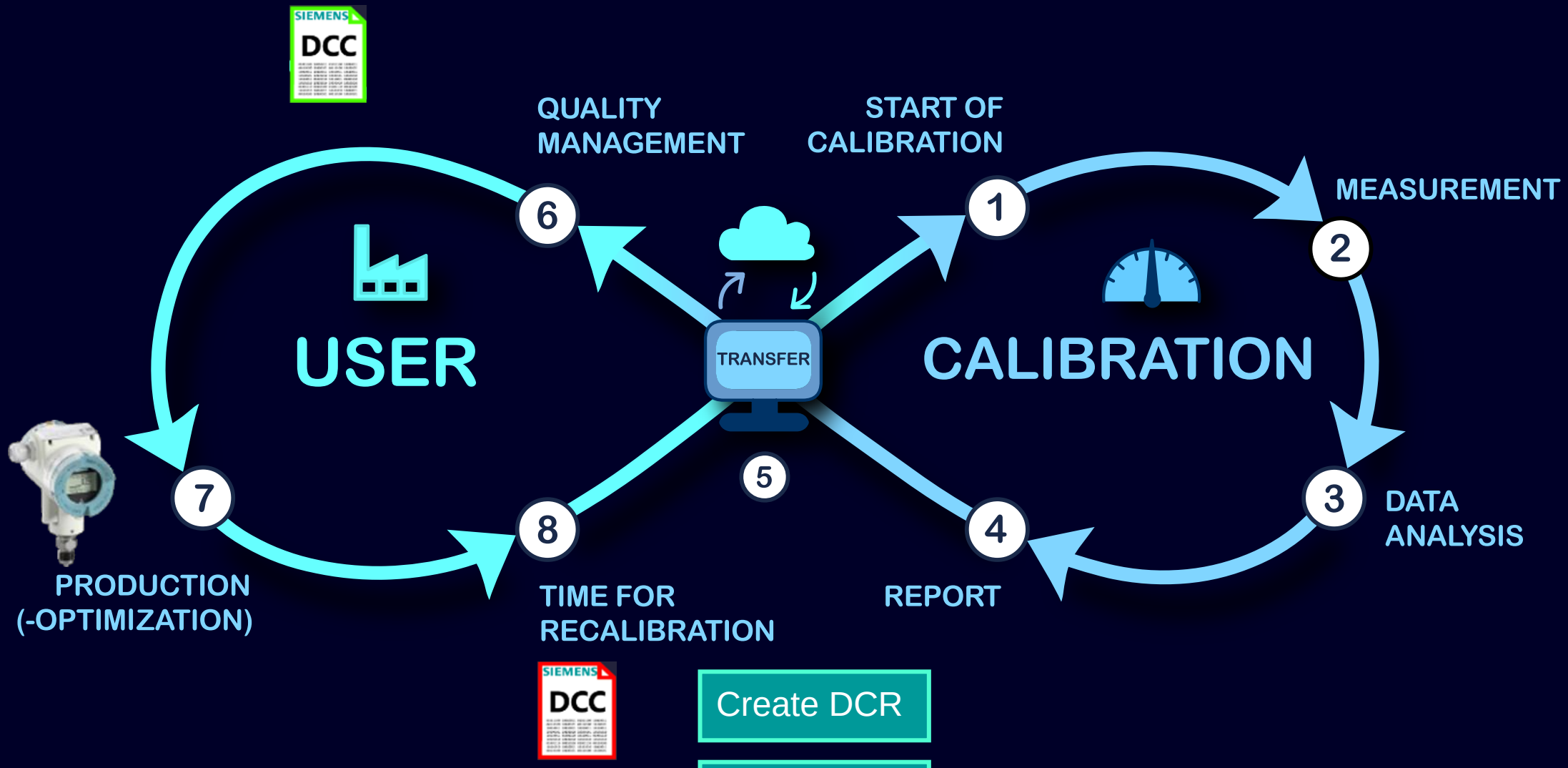
DCA – Digital Calibration Answer

The role of calibration in a generic production cycle
Reinstall equipment and use DCC until expiration



DCC – Digital Calibration Certificate
DCR – Digital Calibration Request
DCA – Digital Calibration Answer

Example: Pressure Sensor with 4 – 20 mA Interface

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Certificate / Zertifikat / Certificat
according to / nach / selon EN 10204, Type 3.1

Inspection certificate / Abnahmeprüfzeugnis / Certificat d

Topic / Thema / Thème :
Quality inspection certificate (Factory calibration) of product SITRANS P (Pressu
Qualitätsprüfzertifikat (Werkskalibrierung) von SITRANS P Geräte (Druckmessun
Certificat d'inspection qualité (calibrage usine) d'appareil SITRANS P (Transmett

Object / Betreff / Objet :

Customer order / Kundenauftrag / Commande client	:
Customer / Kunde / Client	:
Internal order / Internauftrag / Commande interne	:
Product number / Produktnummer / Produit numéro	: 7MF0340
Additional options / Optionen / Options	: C11+C12
Product designation / Produktbenennung / Désignation du produit	: SITRANS
Serial number / Seriennummer / Numéro de série	: N1N9211

Technical data / Technische Daten / Données techniques :

Certificate option code / Bestellte Zertifikatsoption / Option certificat commandée	: C11
Nominal measuring range / Nennmessbereich / Etendue de mesure	: 2,5 ... 250
Max. permissible pressure / Max. Betriebsdruck / Pression admissible max.	: PN 160
Output / Ausgang / Sortie	: HART 4 ..
Selected measuring range / Eingestellter Messbereich / Etendue de mesure paramétrée (Y01)/(Y02)	: -
Displayed unit / Angezeigte Einheit / Unité (Y21)/(Y22)/(Y23)	: bar
Measuring point number TAG N° / Messstellenbeschreibung / Description du point de mesure (Y15)	: -
Mesuring point text / Messstellennachricht / Information du point de mesure (Y16)	: -
HART Address / HART Adresse / Adresse HART (Y17)	: -
PROFIBUS Address / PROFIBUS Adresse / Adresse PROFIBUS (Y25)	: -
Damping setting / Dämpfungseinstellung / Valeur d'atténuation (Y32)	: 2 s
Fieldbus compatibility / Feldbus Kompatibilität / Compatibilité bus de com (Y26)	: -
Saturation limits / Sättigungsgrenzen / Limite de saturation (Y30)	: -
Fault current / Fehlerstrom / Courant de défault (Y31)	: -

Standards / Normen / Normes : EN 10204-3.1 + IEC 62828-2

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Certificate / Zertifikat / Certificat
according to / nach / selon EN 10204, Type 3.1

Inspection certificate / Abnahmeprüfzeugnis / Certificat de réception

Results / Ergebnisse / Résultats :

Input		Output (mA)		Deviation (%)		Hysteresis (%)
%	Pressure (mbar)	Up	Down	Up	Down	
0	0,000	3,9995	3,9997	-0,0028	-0,0017	0,0011
25	62,500	8,0004	8,0006	0,0025		
50	125,000	11,9994	11,9999	-0,0036		
75	187,500	15,9984	15,9993	-0,0099		
100	250,000	20,0005	-	0,0034		

Summary of the results / Ergebniszusammenfassung / Conclusion sur les tests :
- The measures values are within the defined limits / Die gemessenen Werte liegen innerhalb der
mesure se trouvent dans les tolérances définies
- Compressive strength test passed / Druckfestigkeitsprüfung bestanden / Test on surpression cor
- The high voltage test is passed / Die Hochspannungsprüfung wurde bestanden / Le test de haut

Responsible for the tests / Verantwortlich für die Tests / Responsable des tests
Department / Dienststelle / Département
DI PA MF-H MI-PV PRO-1
Date des tests
//

Comments / Kommentare / Commentaires :

The supply / service described was inspected in accordance with the order and declared as true.
Die bezeichnete Lieferung / Leistung wurde entsprechend der Bestellung geprüft und für einwandfrei befunden.
La livraison / service ci-dessus a été, après vérification, déclaré conforme à la demande.

Department / Dienststelle / Département	Function / Funktion / Fonction	Name / Nom	Date
DI PA MF-H MI-PV QM	Quality Manager Products PI-PV Qualitätbeauftragter Produkte PI-PV Chargé de mission qualité Produits PI-PV		

Results / Ergebnisse / Résultats :

Input		Output (mA)		Deviation (%)		Hysteresis (%)
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0	0,000	3,9995	3,9997	-0,0028	-0,0017	0,0011
25	62,500	8,0004	8,0006	0,0025	0,0035	0,0009
50	125,000	11,9994	11,9999	-0,0036	-0,0007	0,0029
75	187,500	15,9984	15,9993	-0,0099	-0,0043	0,0056
100	250,000	20,0005	-	0,0034	-	-

Inherent Process and Customer Value:
Higher Repeatablity and Reproducibility
by more precise process control at NO additional cost → lower waste, higher yield

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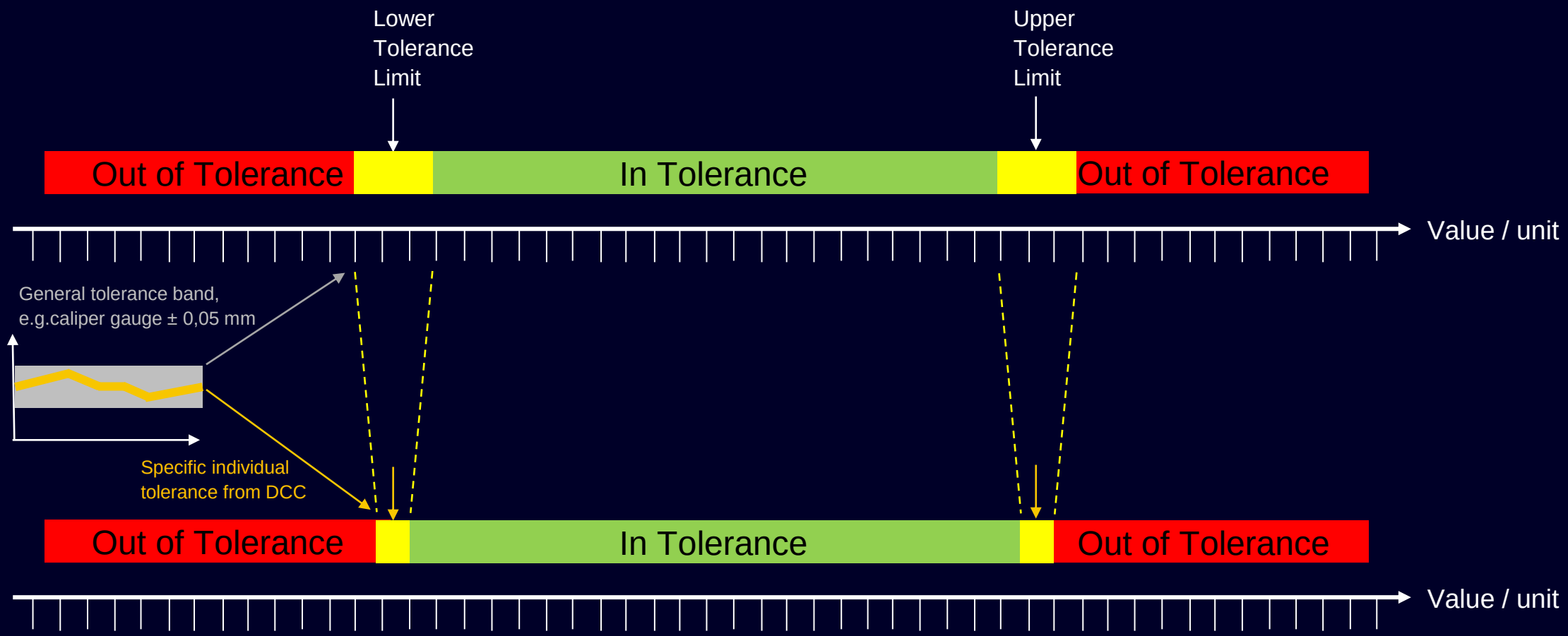
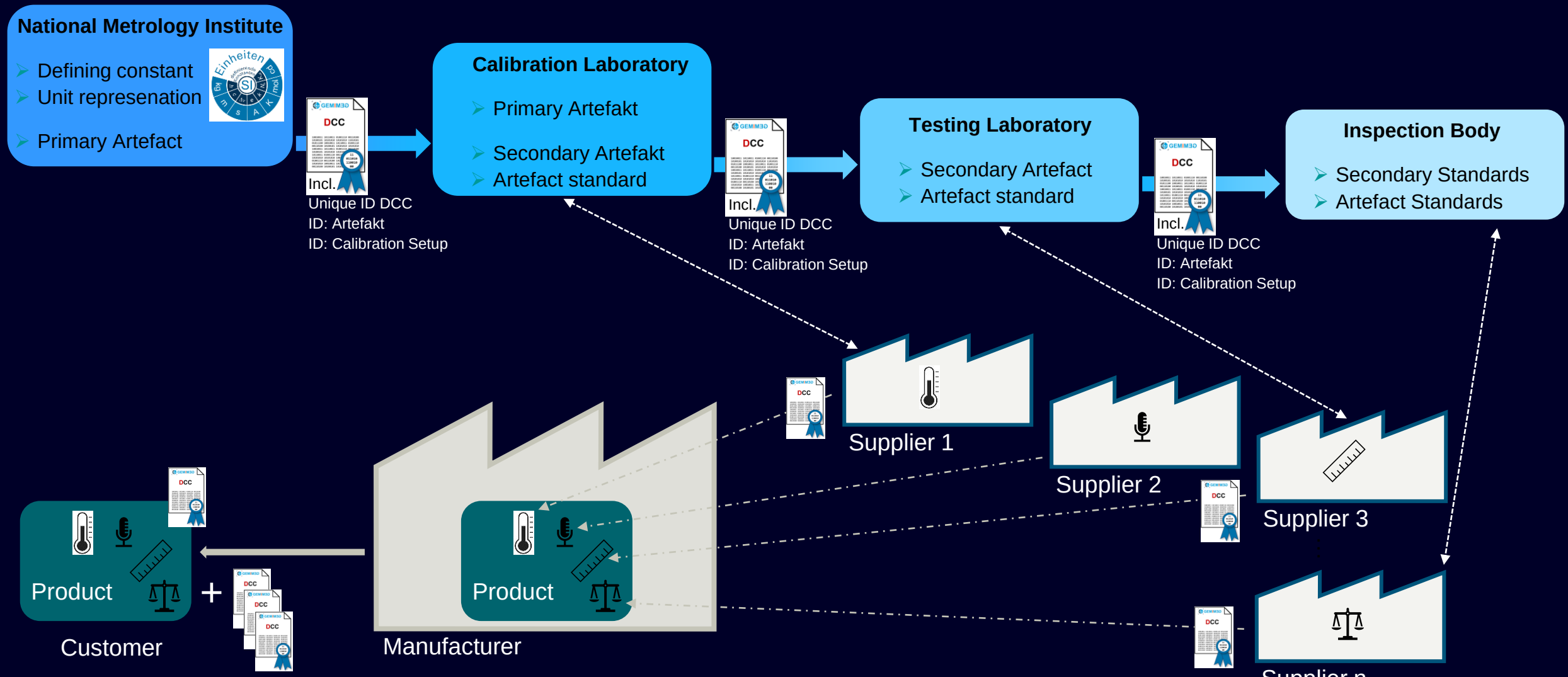
Benefits from Digital Calibration Certificate
DCC enables process yield in production processes



Precise and secure information about metrology system shrinks tolerance budgets !

Usecase: System Integration of industrial products and industrial production systems



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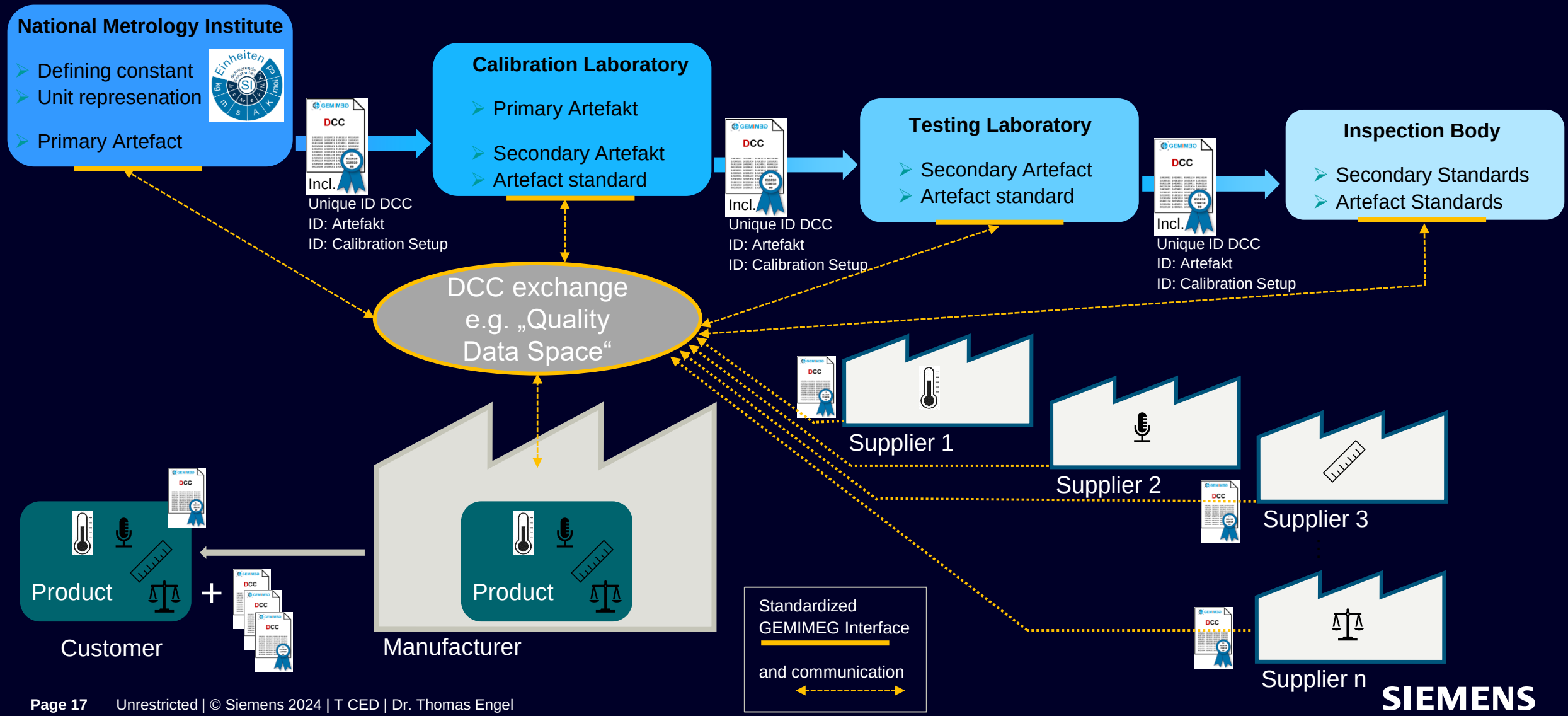
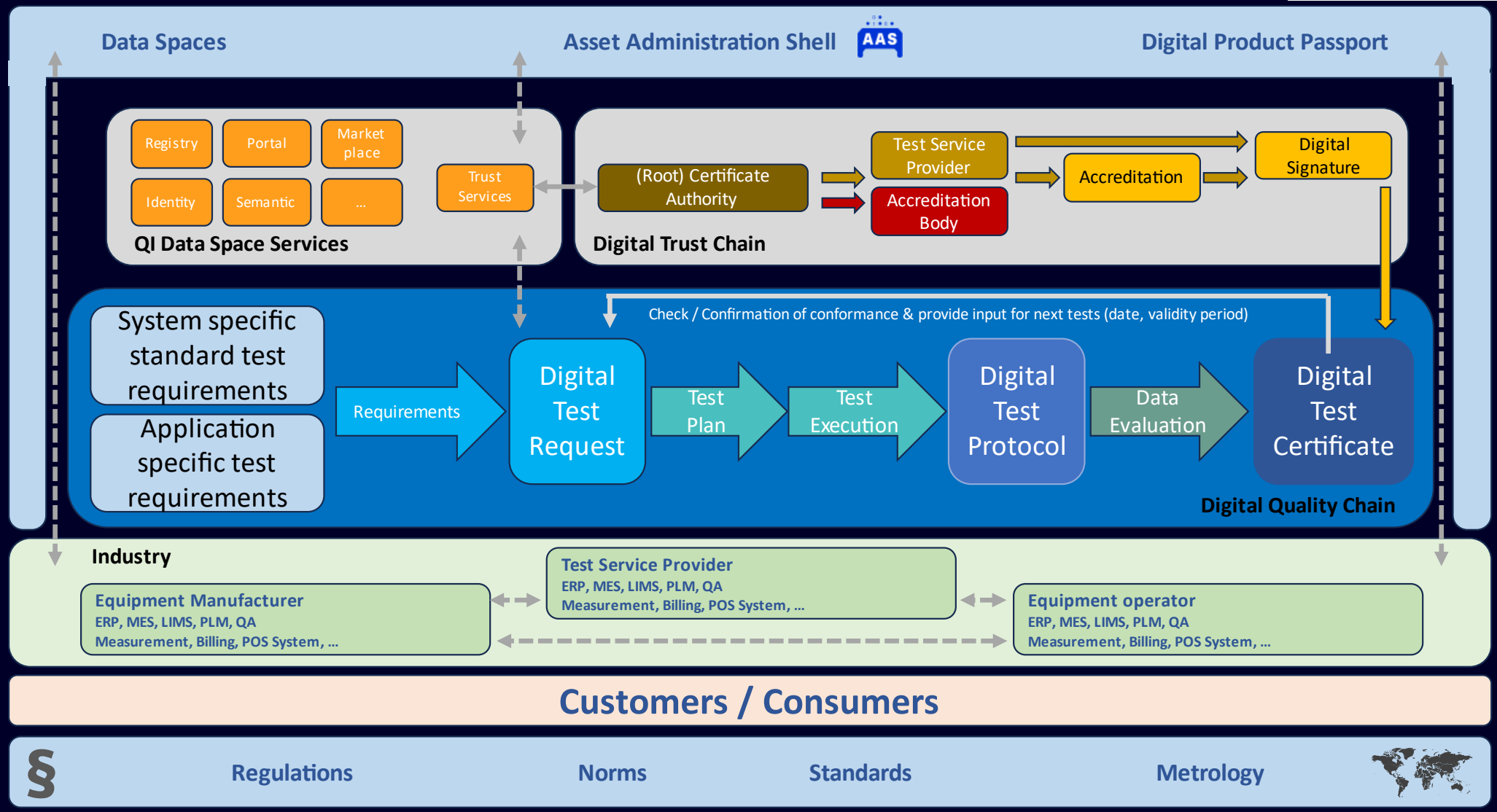
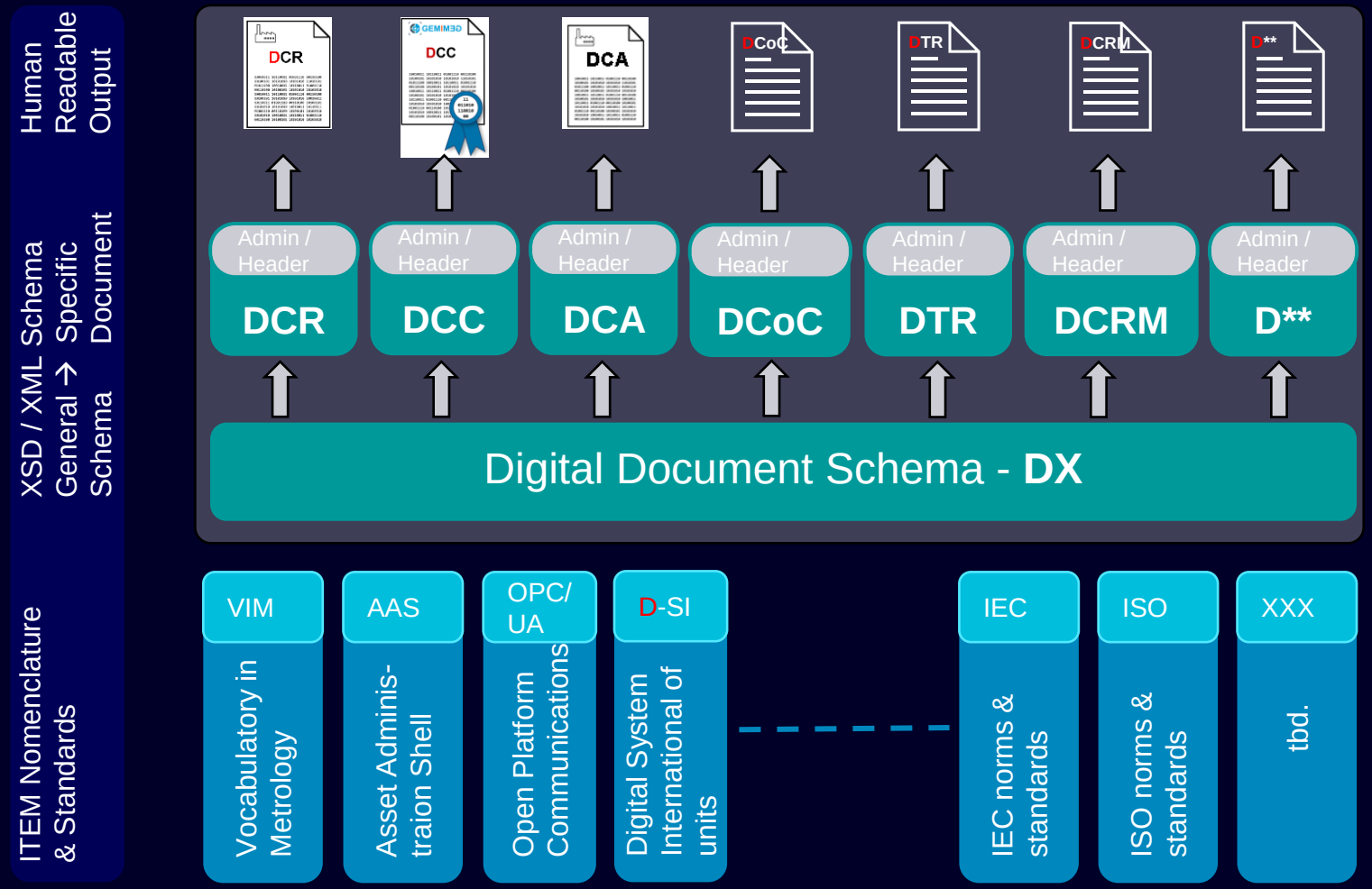


The Future: GEMIMEG-X ? (Project proposal submitted to BMWK, under evaluation)



The Digital Calibration Document „Ecosystem“
A generic view…



Concept:
One common DX-Schema with Semantics
(as XSD / XML-Schema as parent schema)

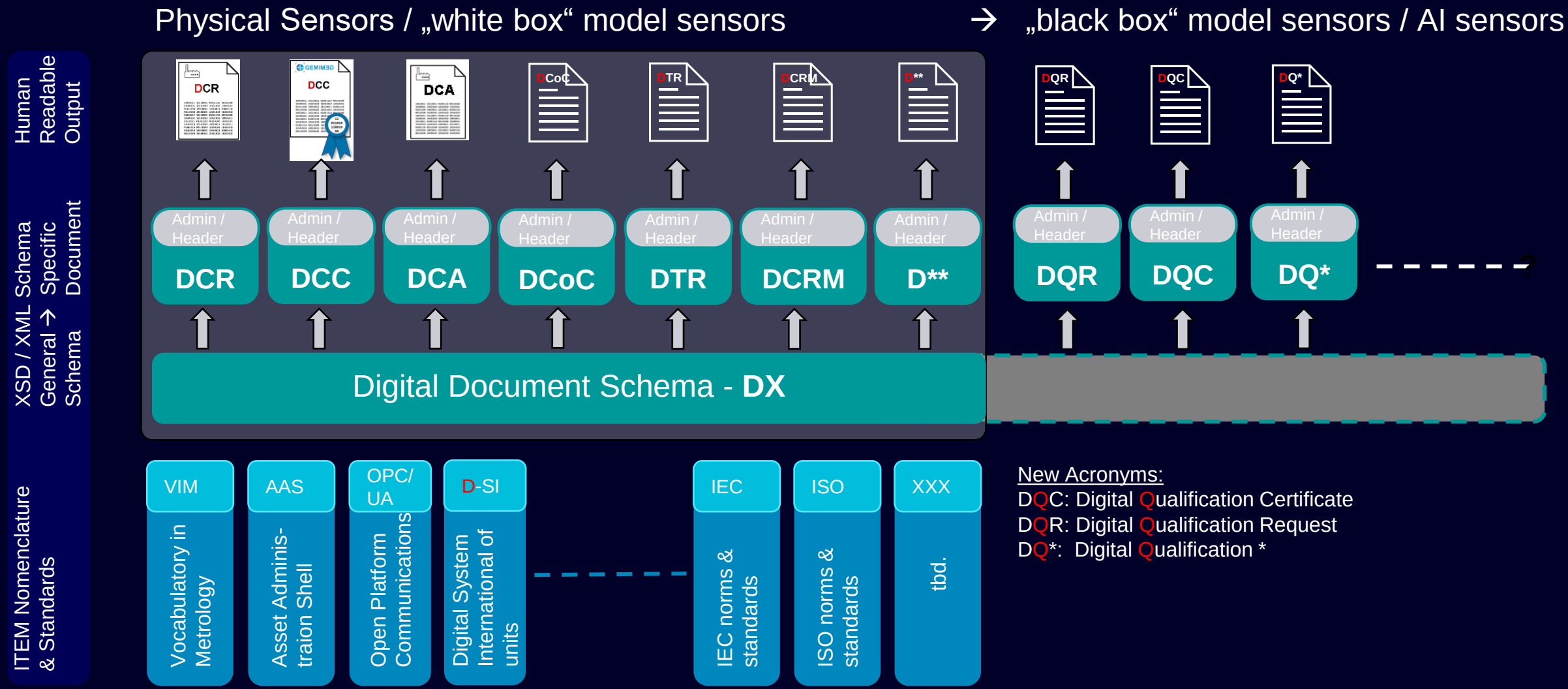
Multiple different sub-schemata of DX as children / branches for

- DCR Digital Calibration Request
- DCC Digital Calibration Certificate [1]
  DCA Digital Calibration Answer
- DCoC Digital Certificate of Conformity [1]
- DTR Digital Test Report
- DCRM Digital Certificate for Reference Material [1]
- D** … and many more digital documents

[1] governed by ISO 17xxx standards

HRO: Multi-language available → automatic conversion / generation from (signed/qualified) D**.XML file

The Digital Calibration Document „Ecosystem“
A generic view…



Building Blocks for a Digital Quality Document

Semantic Model

- Terms
- Definitions

(plus Ontology)

\+ Multi-lingual Translations

Implementation

- XSD Schema

Potentially others:

- JSON Schema
- …

Digital Quality Document

- DCC.xxx
- DCoC.xxx
- DTR.xxx
- DCRM.xxx
- …

(xxx: xml, json, ...)

Tools

- GEMIMEG Tool*
- Schema Validation*
- PyDCC **
- …

* PTB ** Open Source

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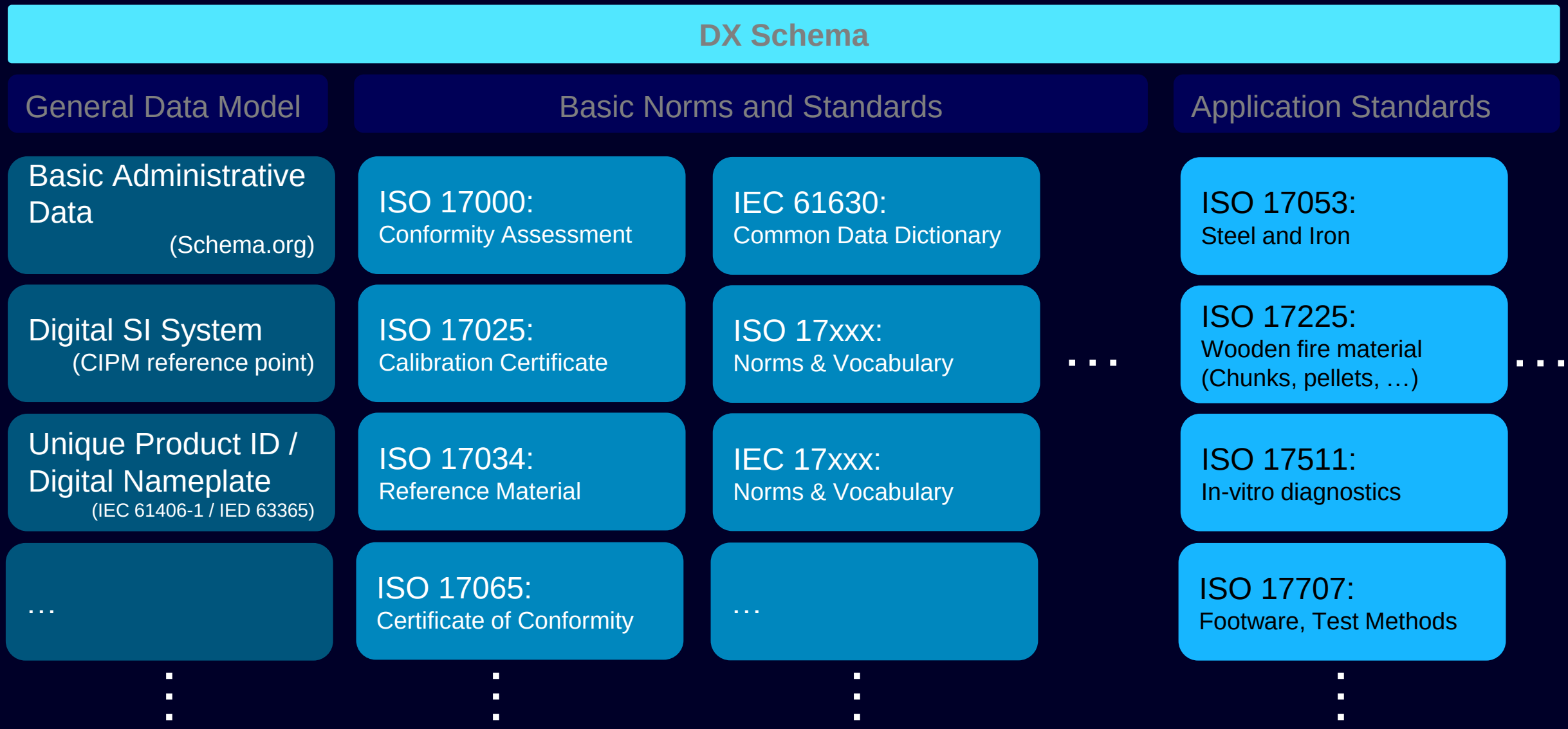
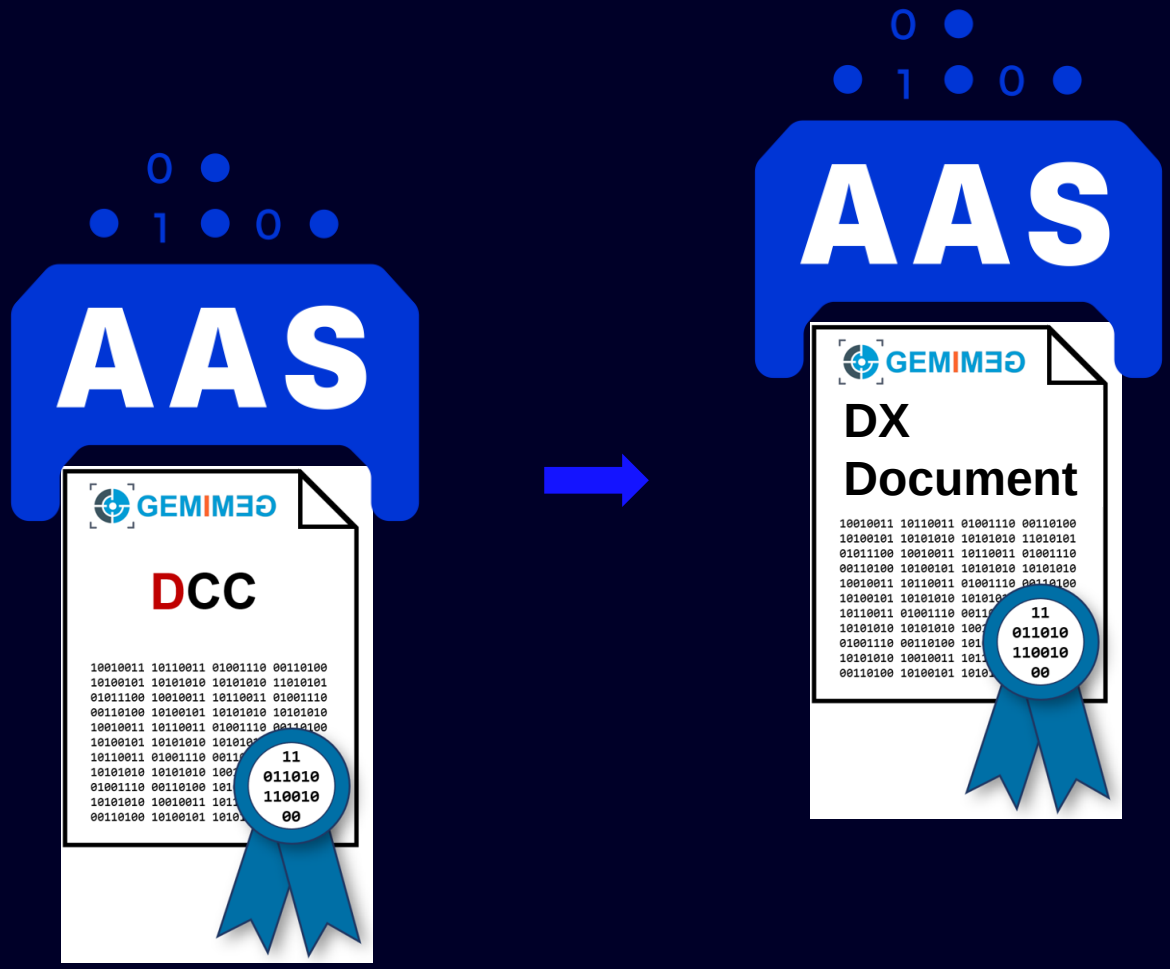
Suggestion for modular structure of Semantic Model for DX-Schema



Asset Administration Shell
Submodel: Digital Quality Documents

Subproject to develop
AAS Submodell for **Digital Calibration Certificate**
May 2023 – October 2023
Project Lead: Dr. Sebastian Käbisch (Siemens AG)

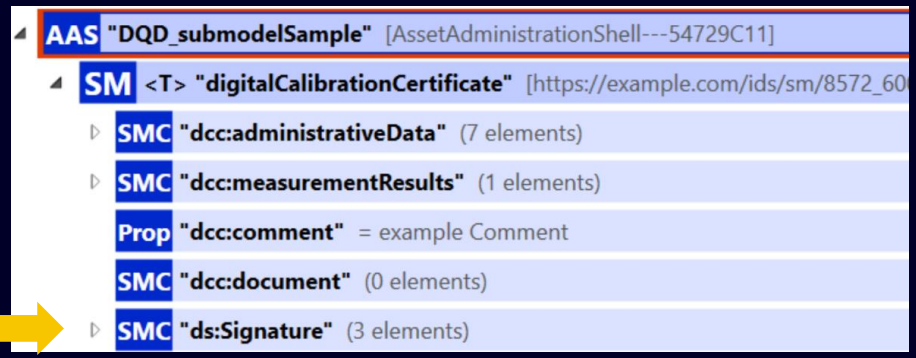
AAS Submodell:
Digital Quality Documents
to support the **DX document schema**



Asset Administration Shell
Submodel: Digital Quality Documents

Digital Quality Documents characterize the *performance of a system / product* over its *entire life span* via the following documents by recurring tests over time:

- Calibration (DCC)
- Conformity asessment (DCoC)
- Legal metrology (DCC, DCoC)
- Test reports (DTR)
  - Acceptance tests
  - Field Tests
  - Check lists for system function / completeness



Signed document for
Originality and Authenticity

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From machine readable XML to human readable PDF

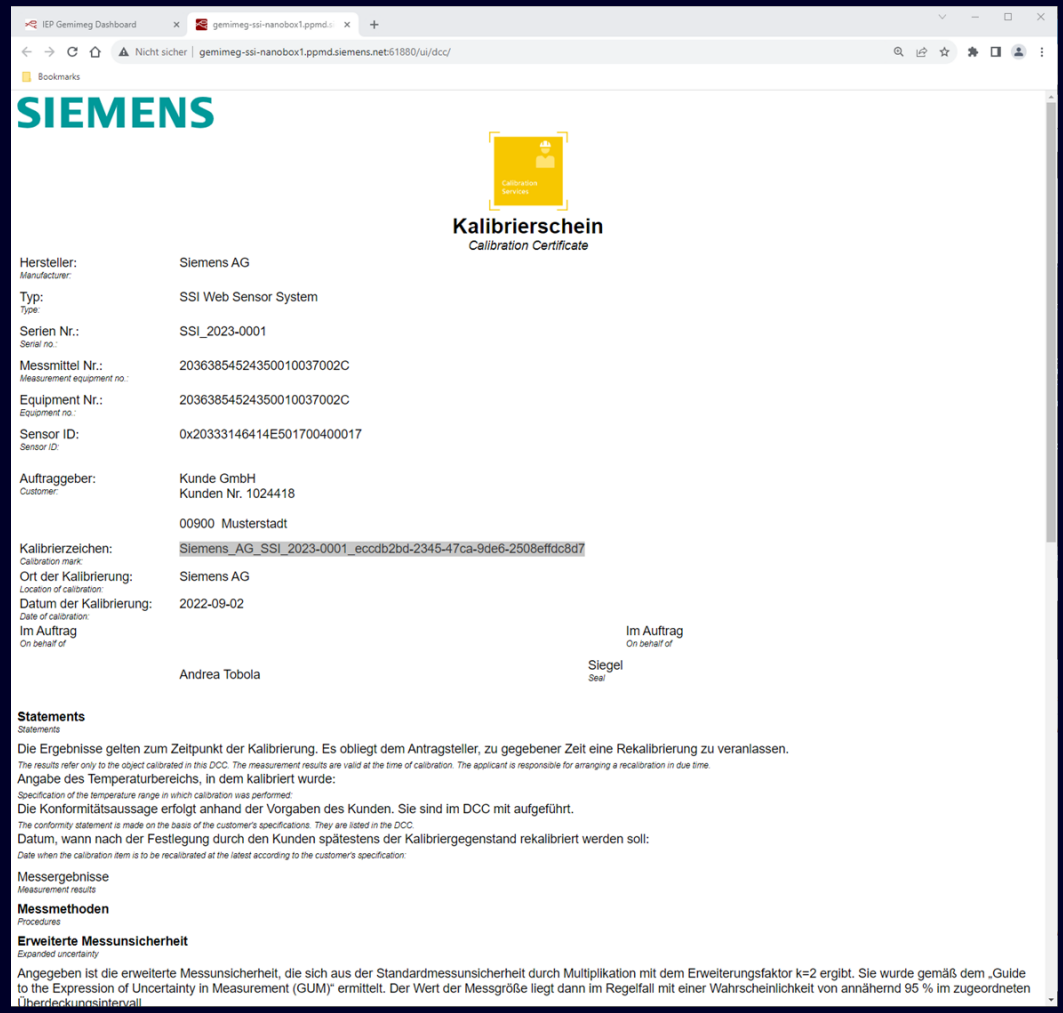
Pressure-DCC.xml

C: > D > Benutzer > GEMIMEG > _internal > 2023-02-19-GEMIMEG-IOT > Live-Demo > Pressure-DCC.xml

```xml
<?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" xsi:schemaLocation="https://ptb.de/dcc https://ptb.de/dcc/v3.1.1/dcc.xsd" schemaVersion="3.1.1">

    <dcc:administrativeData>
        <dcc:dccSoftware>
            <dcc:software>
                <dcc:name>
                    <dcc:content>ssi_dcc_generator.py</dcc:content>
                </dcc:name>
                <dcc:release>0.1</dcc:release>
            </dcc:software>
        </dcc:dccSoftware>
        <dcc:coreData>
            <dcc:countryCodeISO3166_1>DE</dcc:countryCodeISO3166_1>
            <dcc:usedLangCodeISO639_1>de</dcc:usedLangCodeISO639_1>
            <dcc:usedLangCodeISO639_1>en</dcc:usedLangCodeISO639_1>
            <dcc:mandatoryLangCodeISO639_1>de</dcc:mandatoryLangCodeISO639_1>
            <dcc:uniqueIdentifier>Siemens_AG_LKK-M724-783-01-0001_94f82edf-ce57-429a-ae71-6b2337cdb844</dcc:uniqueIdentifier>
            <dcc:identifications>
                <dcc:identification>
                    <dcc:issuer>calibrationLaboratory</dcc:issuer>
                    <dcc:value>Siemens AG, Building M311, Schuckertstr. 2, 91058 Erlangen</dcc:value>
                    <dcc:name>
                        <dcc:content lang="de">Auftrags Nr.</dcc:content>
                        <dcc:content lang="en">Order no.</dcc:content>
                    </dcc:name>
                </dcc:identification>
            </dcc:identifications>
            <dcc:beginPerformanceDate>2022-09-02</dcc:beginPerformanceDate>
            <dcc:endPerformanceDate>2022-09-02</dcc:endPerformanceDate>
            <dcc:performanceLocation>Siemens AG, Building M311, Schuckertstr. 2, 91058 Erlangen</dcc:performanceLocation>
        </dcc:coreData>
        <dcc:items>
            <dcc:item>
                <dcc:name>
```

XML representation of the Digital Calibration Certificate (DCC)



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Kalibrierschein
Calibration Certificate

Hersteller: *Manufacturer:*	Siemens AG
Typ: *Type:*	SSI Web Sensor System
Serien Nr.: *Serial no.:*	SSI_2023-0001
Messmittel Nr.: *Measurement equipment no.:*	20363854524350010037002C
Equipment Nr.: *Equipment no.:*	20363854524350010037002C
Sensor ID: *Sensor ID:*	0x20333146414E501700400017
Auftraggeber: *Customer:*	Kunde GmbH Kunden Nr. 1024418 00900 Musterstadt
Kalibrierzeichen: *Calibration mark:*	Siemens_AG_SSI_2023-0001_eccdb2bd-2345-47ca-9de6-2508effdc8d7
Ort der Kalibrierung: *Location of calibration:*	Siemens AG
Datum der Kalibrierung: *Date of calibration:*	2022-09-02

Im Auftrag *On behalf of*

Andrea Tobola

Im Auftrag *On behalf of*

Siegel *Seal*

Statements
Statements

Die Ergebnisse gelten zum Zeitpunkt der Kalibrierung. Es obliegt dem Antragsteller, zu gegebener Zeit eine Rekalibrierung zu veranlassen.
The results refer only to the object calibrated in this DCC. The measurement results are valid at the time of calibration. The applicant is responsible for arranging a recalibration in due time.

Angabe des Temperaturbereichs, in dem kalibriert wurde:
Specification of the temperature range in which calibration was performed:
Die Konformitätsaussage erfolgt anhand der Vorgaben des Kunden. Sie sind im DCC mit aufgeführt.
The conformity statement is made on the basis of the customer's specifications. They are listed in the DCC.

Datum, wann nach der Festlegung durch den Kunden spätestens der Kalibriergegenstand rekalibriert werden soll:
Date when the calibration item is to be recalibrated at the latest according to the customer's specification:

Messergebnisse
Measurement results

Messmethoden
Procedures

Erweiterte Messunsicherheit
Expanded uncertainty

Angegeben ist die erweiterte Messunsicherheit, die sich aus der Standardmessunsicherheit durch Multiplikation mit dem Erweiterungsfaktor k=2 ergibt. Sie wurde gemäß dem „Guide to the Expression of Uncertainty in Measurement (GUM)" ermittelt. Der Wert der Messgröße liegt dann im Regelfall mit einer Wahrscheinlichkeit von annähernd 95 % im zugeordneten Überdeckungsintervall

Generated German PDF-Document

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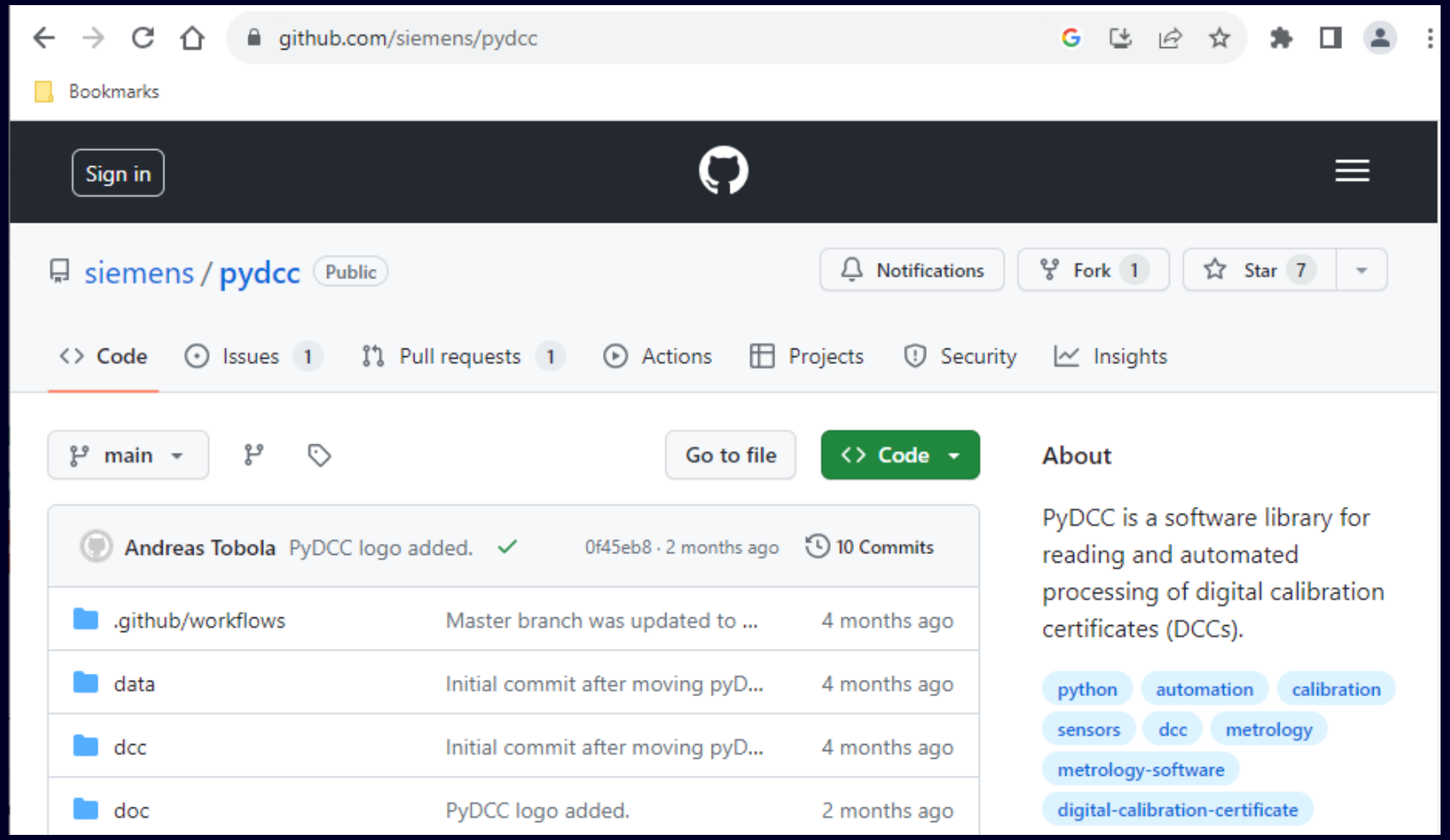
PyDCC – Python library processing digital calibration certificates (DCCs)

https://github.com/siemens/pydcc – Open Source SW



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Summary: Benefits from DCC in a Stakeholder perspective

Sensor owner

Asset Administration
- Full Automation
- Correct Data
- Full Traceability

DCR standardize calibration requirements

Consistency in DCC information content

Calibration Tracking
- Due date
- Intervals
- Perfomance

Resilience

Calibration Service

Standard calibration requirements in DCR
- Data Handling
- Adminstrative Data
- Order Clarification

DCC based on DCR
* DCR is „DCC template“

Full process automation

Secure data provisioning in platform / data space: DCR / DCC / revocation

Industry 4.0 compliant

New digital Businesses

Sensor User

Full process automation
- Instant data availability
- Reduced error margin
- Accurate data improve process yield

Consitent DCC data
- Across calibration service providers

Secure data availablity in platform / data space: DCR / DCC / revocation

Sensor data lifetime / type evaluation – recal. interval

Industry 4.0 compliant

Regulatory / Auditor

Full data traceability
- Instant data availability
- DCR / DCC / DCA
- Calibration laboratory accreditation
- Transparent process quality chain with all stakeholders in a quality process

Automated (Pre-)Auditing

Secure data availablity in platform / data space:
- DCR / DCC / revocation
- Independent audit trail

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Fragebogen an Labore zu den erwarteten Effizienzgewinnen

Nur gelb ausfüllen (Durchschnittskalibrierung aller Typen)							
Name Kalibrierlabor / Org-Name							
AnsprechpartnerIn							
Stückzahl pro Jahr	2500						
Stundensatz	95 €						
	Zeit in min				Kosten in €		
	heute	DCR & DCC	Einsparung		heute	DCR & DCC	Einsparung
Angebotslegung	6,1	1,1	-5,0		10 €	2 €	- 8 €
Angebotsklärung			0,0		- €	- €	- €
Eingangsprüfung	5,0	3,0	-2,0		8 €	5 €	- 3 €
Erfassung Kalibrierauftrag und Daten	5,0	3,0	-2,0		8 €	5 €	- 3 €
Kalibrierung asFound	5,0	5,0	0,0		8 €	8 €	- €
Kalibrierung asLeft	5,0	5,0	0,0		8 €	8 €	- €
Erzeugung Kalibrierschein	4,0	2,5	-1,5		6 €	4 €	- 2 €
Bewertung Kalibrierung	5,0	3,0	-2,0		8 €	5 €	- 3 €
Versand	5,0	5,0	0,0		8 €	8 €	- €
Sonstiger Aufwand	0,0	0,0	0,0		- €	- €	- €
	40,1	**27,6**	**12,5**		**63 €**	**44 €**	**- 20 €**
	heute	DCR & DCC					
Vorgänge mit Klärungsaufwand	3%	1%	Anteil an Vorgängen, wo ein erhöhter Klärungsaufwand in Angebotsphase notwendig ist				
Klärungsaufwand in min	120	120	Typpischer Zeitaufwand für Angebotsklärung im Einzelfall. Verrechnet sich dann anteilig in Tabelle oben als Angebotsklärung.				
Einsparung		**- 49.479 €**	pro Jahr				
	oder						
Zusätzliche freie Kapazität		**779**	Stück pro Jahr				

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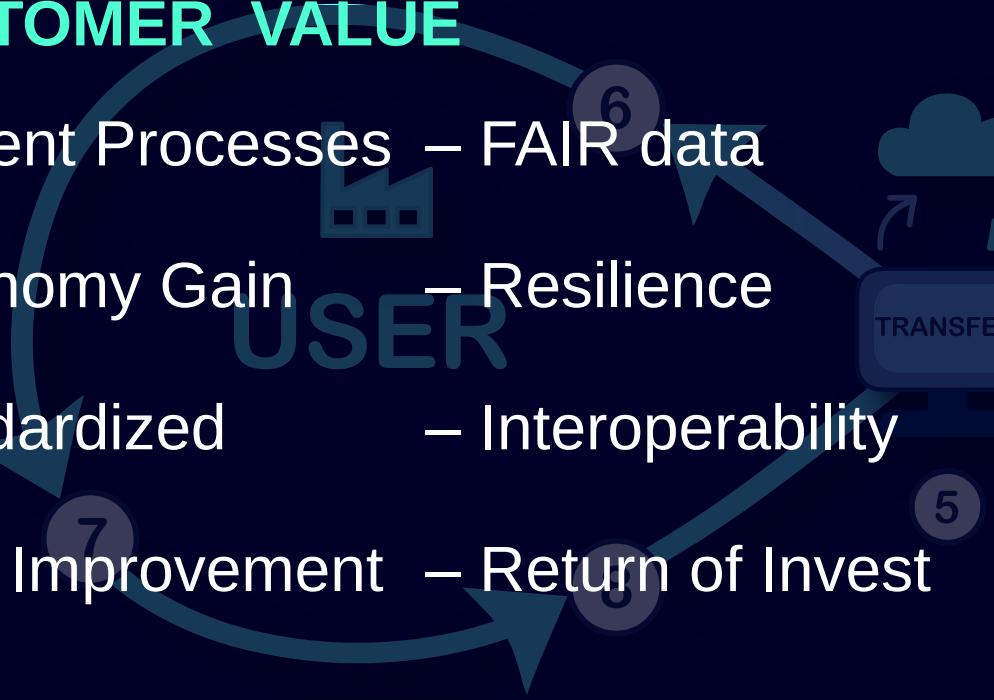
The value behind the GEMIMEG concept for industrial processes



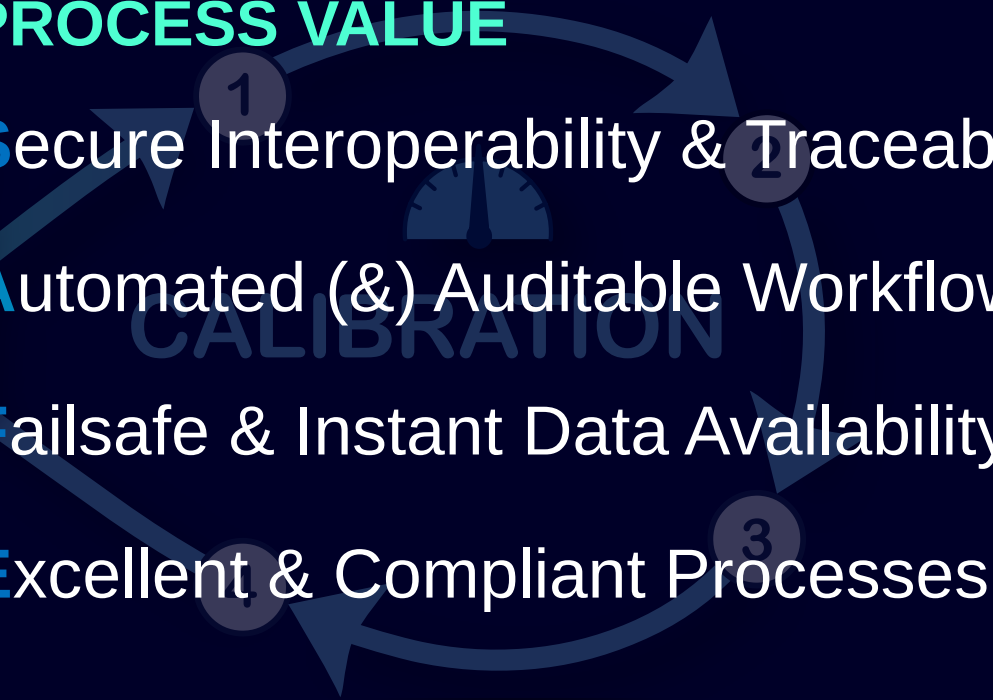
CUSTOMER VALUE

Efficient Processes – FAIR data

Autonomy Gain – Resilience

Standardized – Interoperability

Yield Improvement – Return of Invest



PROCESS VALUE

Secure Interoperability & Traceability

Automated (&) Auditable Workflows

Failsafe & Instant Data Availability

Excellent & Compliant Processes

→ Sustainable, circular processes!

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Contact

Published by Siemens AG
Dr. Thomas Engel
Principal Key Expert Research Scientist
T CED
Otto-Hahn-Ring 6
81739 München
Germany
Phone +49 172 24 21 401
E-mail engelthomas@siemens.com

More content:

GEMIMEG-II — How metrology can go digital…
https://iopscience.iop.org/article/10.1088/1361-6501/ace468/meta

PyDCC
https://github.com/siemens/pydcc/

Contributions to previous international DCC conferences

Presentation and paper @ IMEKO 2024 end of August

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