

Assuring manufacturing quality in the Industry 4.0 environment

EMN –Meeting October 11th, 2021

Dr. Thomas Engel

Outline

1. **GEMIMEG-II Project**
2. **Sensors and Calibration**
3. **Example: Industrial Products with incorporated Sensors**
4. **Conclusions**

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A Lighthouse Project of the German Ministry for Economic Affairs and Energy





GEMINI

METROLOGY

GLOBAL

Aspiration: **Safe and robustly calibrated metrological systems for the digital transformation**

The Project in a Nutshell

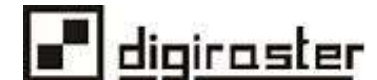
Project start: 01.08.2020
Funding budget: 11,2 M€
Total project budget: 17,9 M€
Project duration: 36 months
Project end: 31.07.2023

Project partners: 13
Industry: 8
NMI: PTB
Applied Research: 1
University: 3

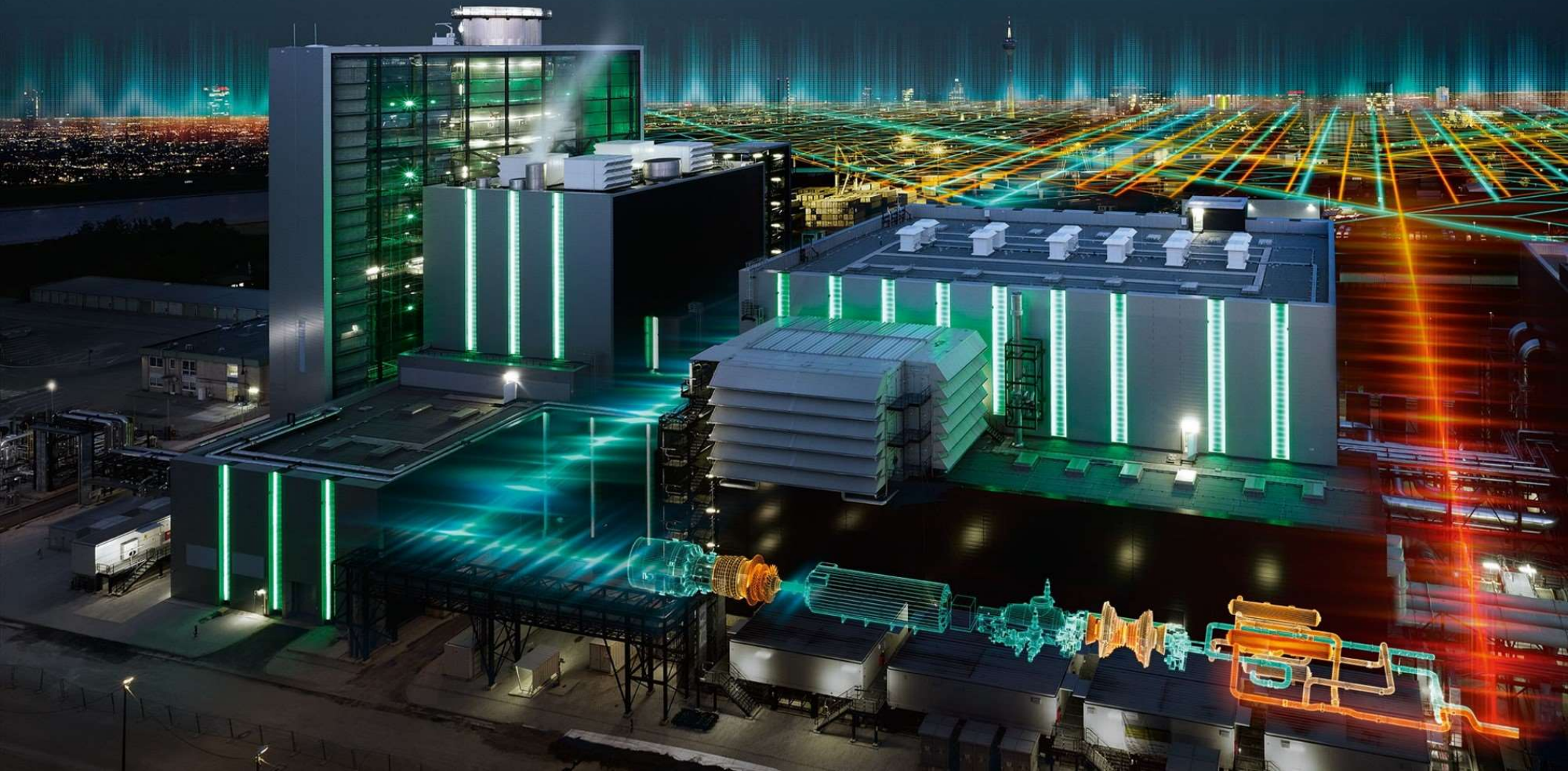
Funded by:



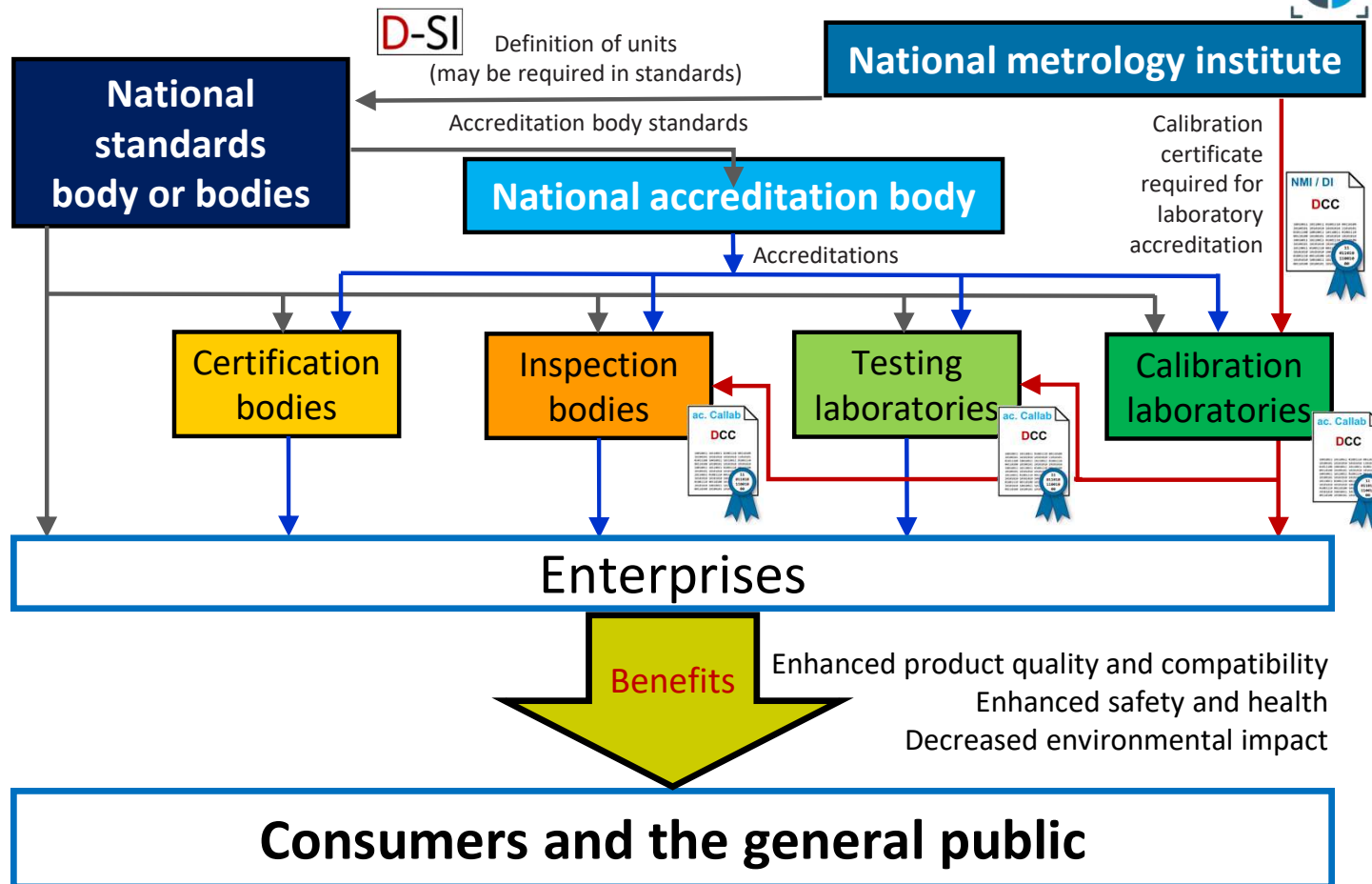
following a decision of the German Bundestag



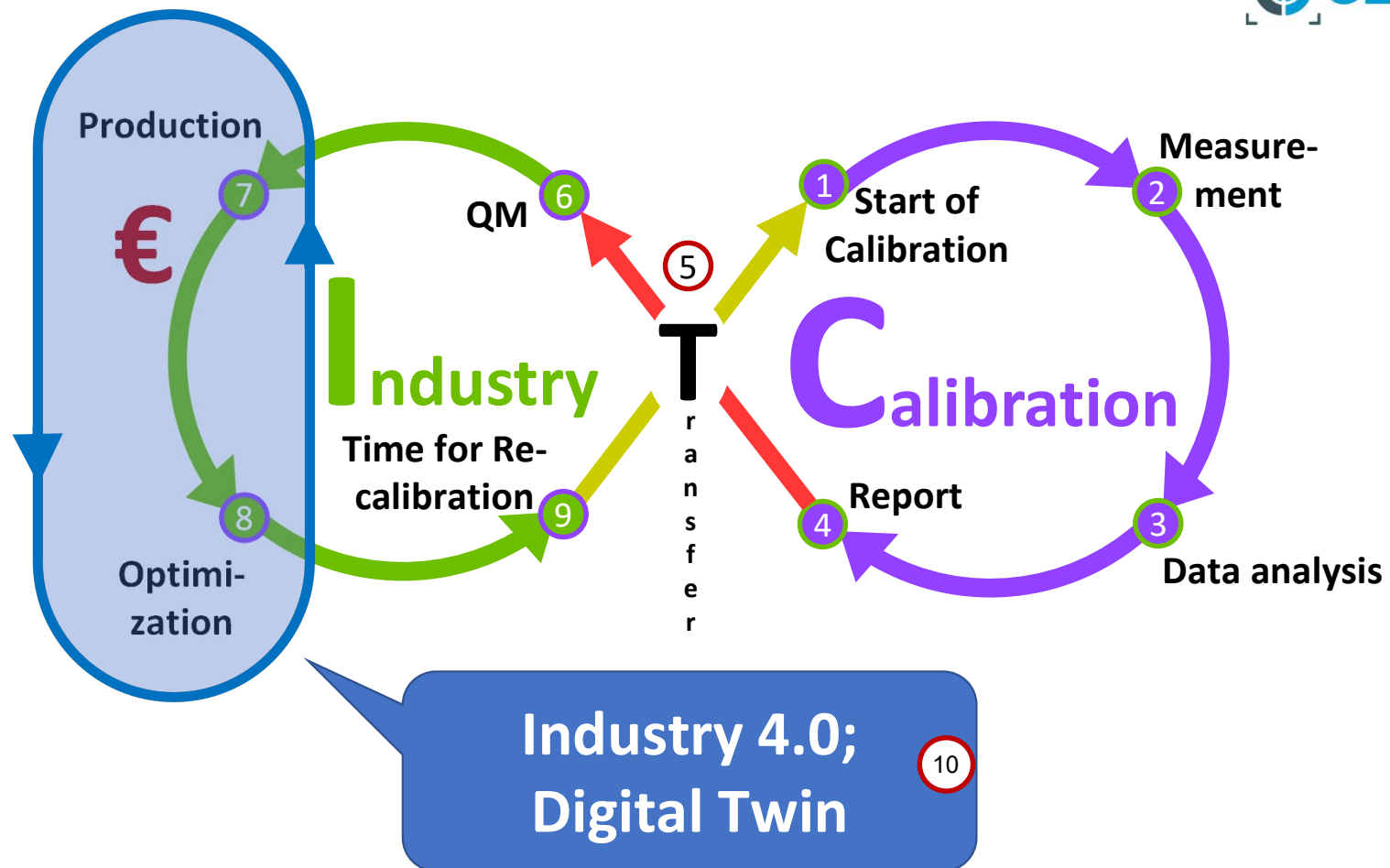
Our world gets digitized everywhere. Why not the calibration ecosystem too? – seamlessly from NMI to local applications



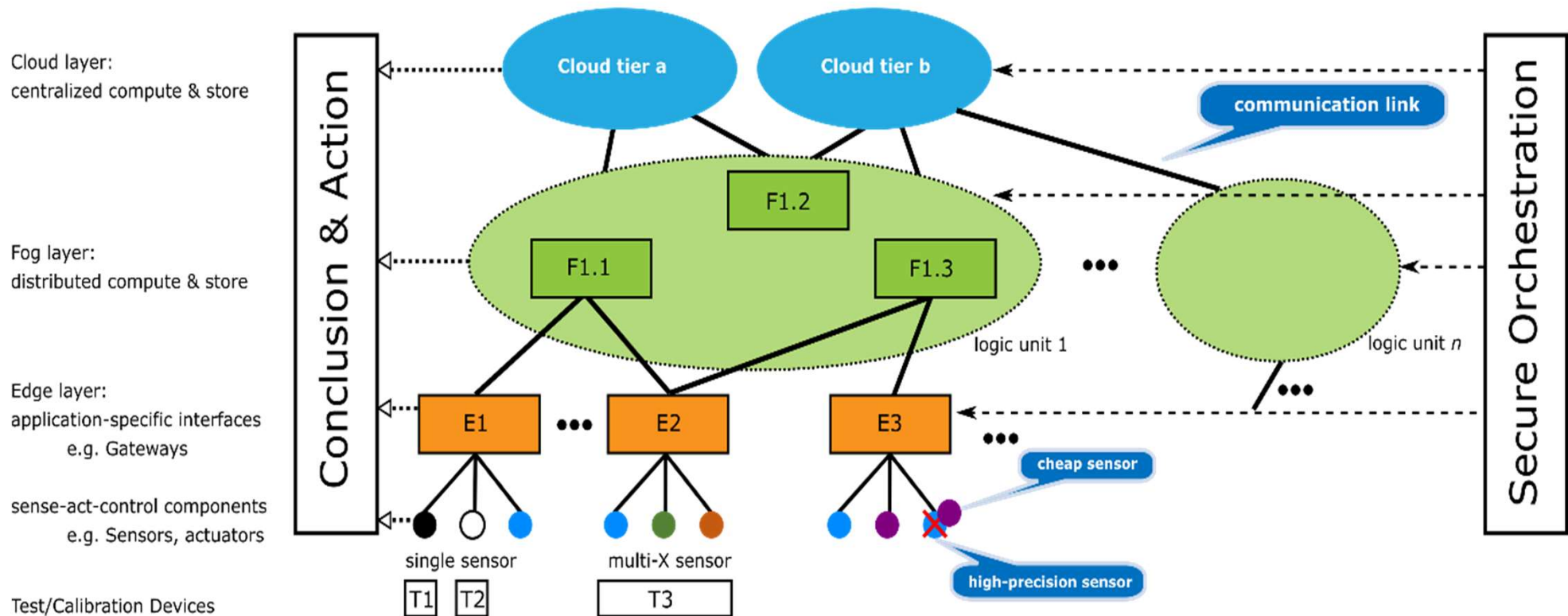
National Quality Infrastructure



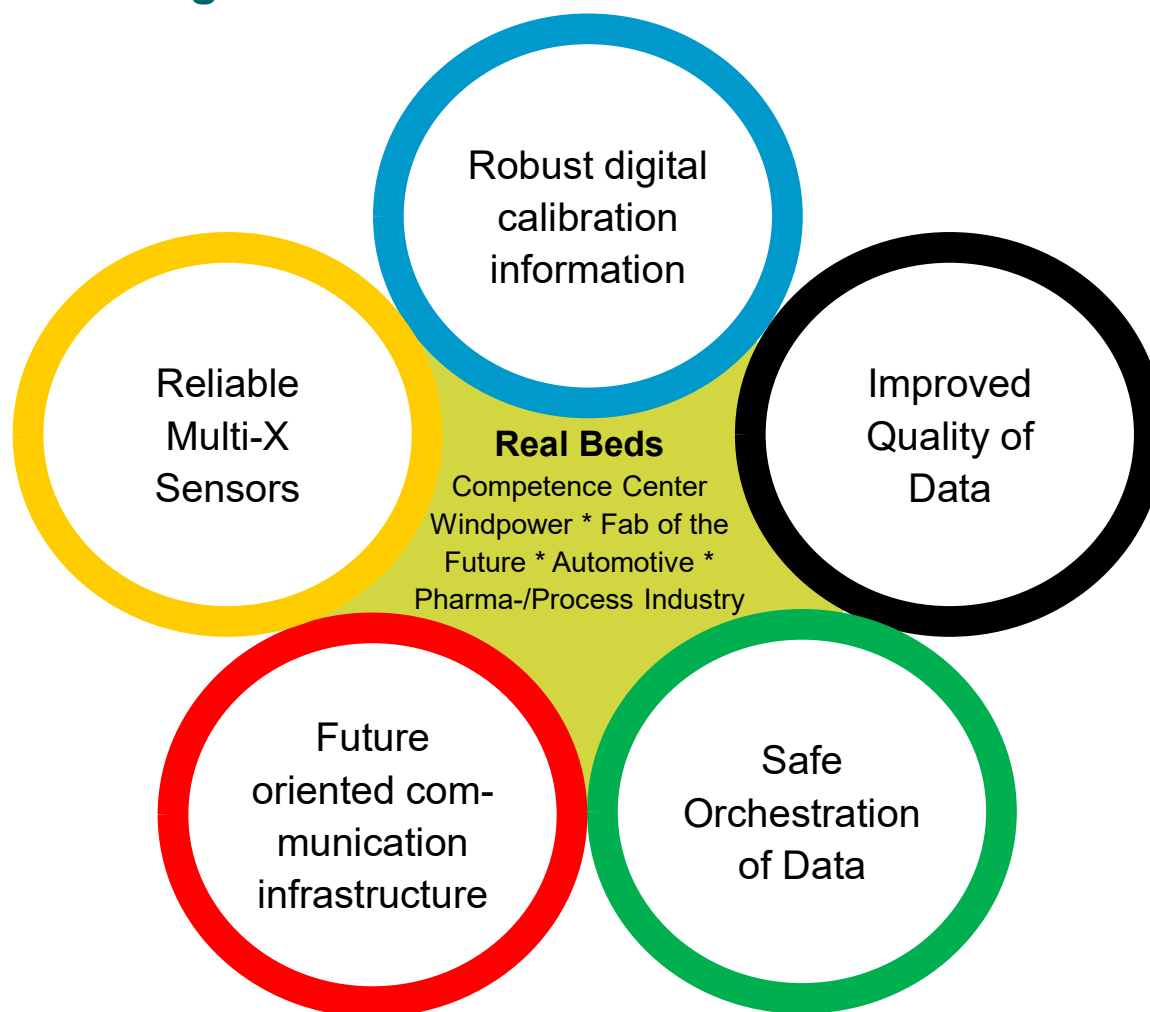
Typical Production Cycle



Architecture of a Massive Sensor Network



Our Research Agenda

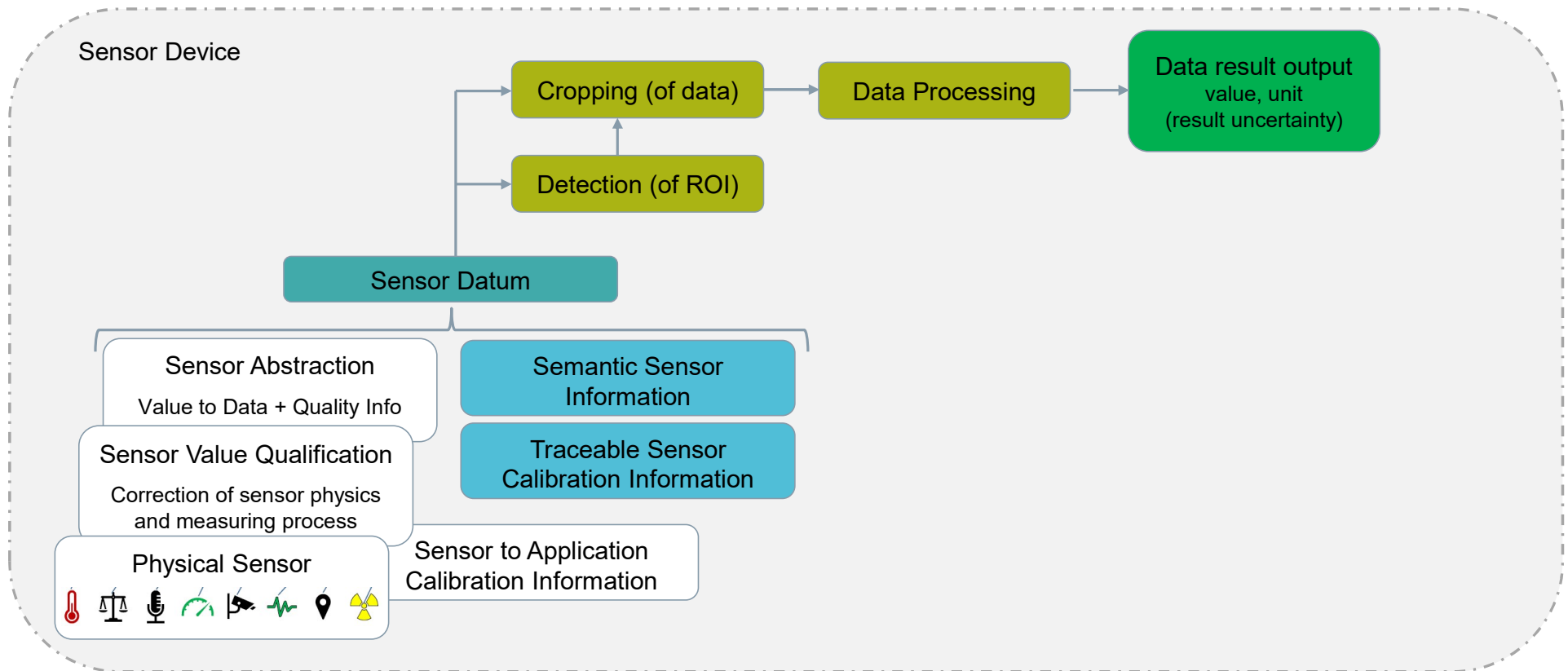


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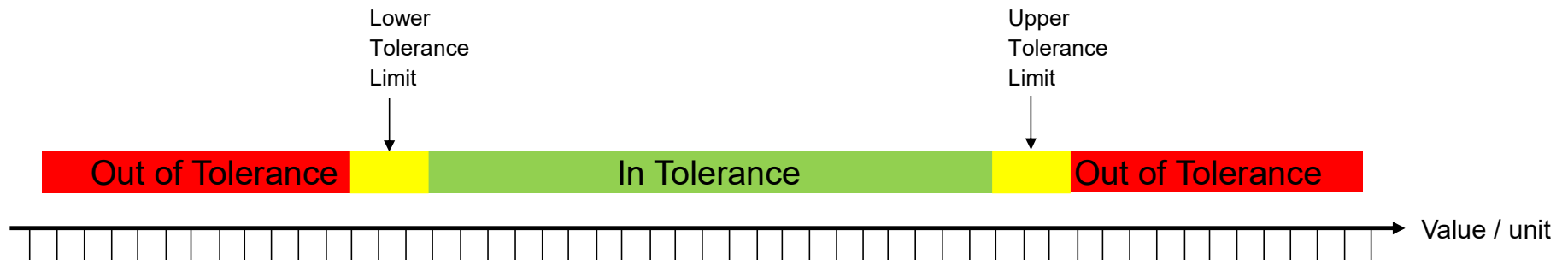
GEMIMEG

Perception: Sensor Data to Output Data

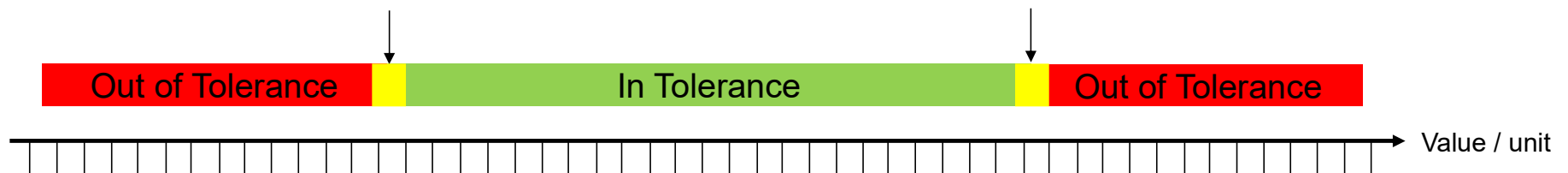




GEMIMEG Benefits



Precise and secure information about metrology system can help to shrink tolerance budgets:



Higher yield and higher productivity are the direct result and this will improve production cost structures!
Seamless process integration is the key, to avoid errors from data transfer.

Quality of X: QoX

X: Sensing, Data, Information, ...



A measurement result typically consists of:

(corrected) Measured Value + Measurement Unit + Measurement Uncertainty + Statistical Information

Example: Length measurement

8.412 μm (10^{-6} m) $\pm 10 \mu\text{m}$ 3σ
(GUM)

In addition, there can be much more quality related information for the measurement process itself or the data aggregation and evaluation or the information gained from the data, like e.g.

QoS	QoD	QoI
Signal strength/level	Data fusion: residual error level	Accuracy of information derived
Signal/Noise ratio (SNR)	Data fusion: axis data uncertainty	Machine/system status, DT
Battery status of sensor	Software / model based sensor	Remaining Battery Life
Motion blurring	Sensor network data, modalities	AI: Classification quality / %
Sensor motion/Doppler effects	Redundancy/Diversity of Data	Anomaly detected

Quality of X

X: Sensing, Data, Information, ...

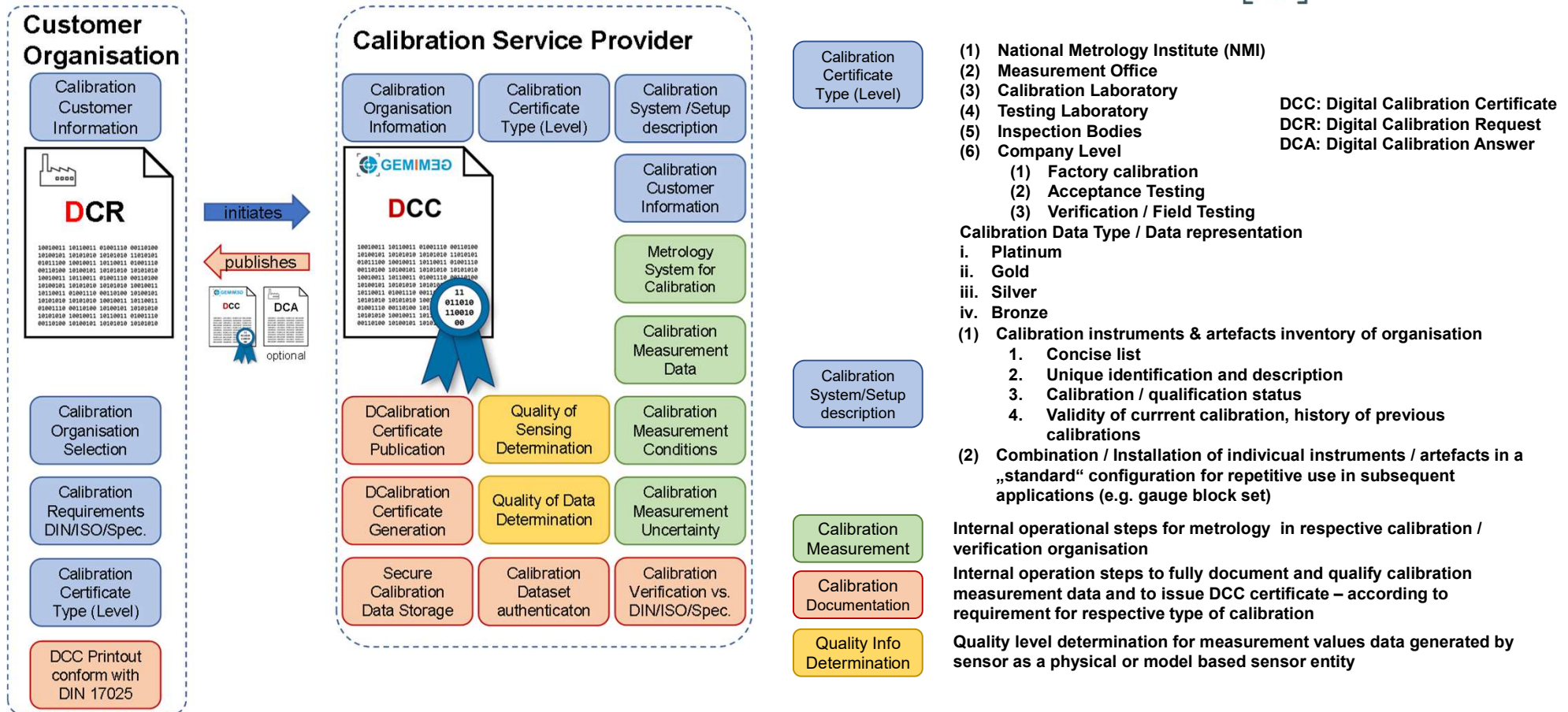


Suggested functional elements for a concise QoX description:

Sensor System Type	Type of physical sensor or software/model based sensor
Quality Indicator	Sensor System parameter to be characterized internal parameter: e.g. operational, functional external parameter: e.g. environmental
Indicator Description Definition	Detailed/explicit determination scheme, traceable, version controlled formula for calculation incl. input parameters allowed range of values, value type
Indicator Metric	Scale for Indicator (absolute + unit, relative, %, dB, ...)
Indicator interpretation:	Status interpretation (good, acceptable, bad, info only – low trust level, ...)
...	

A first suggestion for semantics can be found in:
Vedurmudi, A. P.; Neumann, J.; Gruber M.; Eichstädt, S.; *Semantic Description of Quality of Data in Sensor Networks*,
Submitted for publication to Sensors

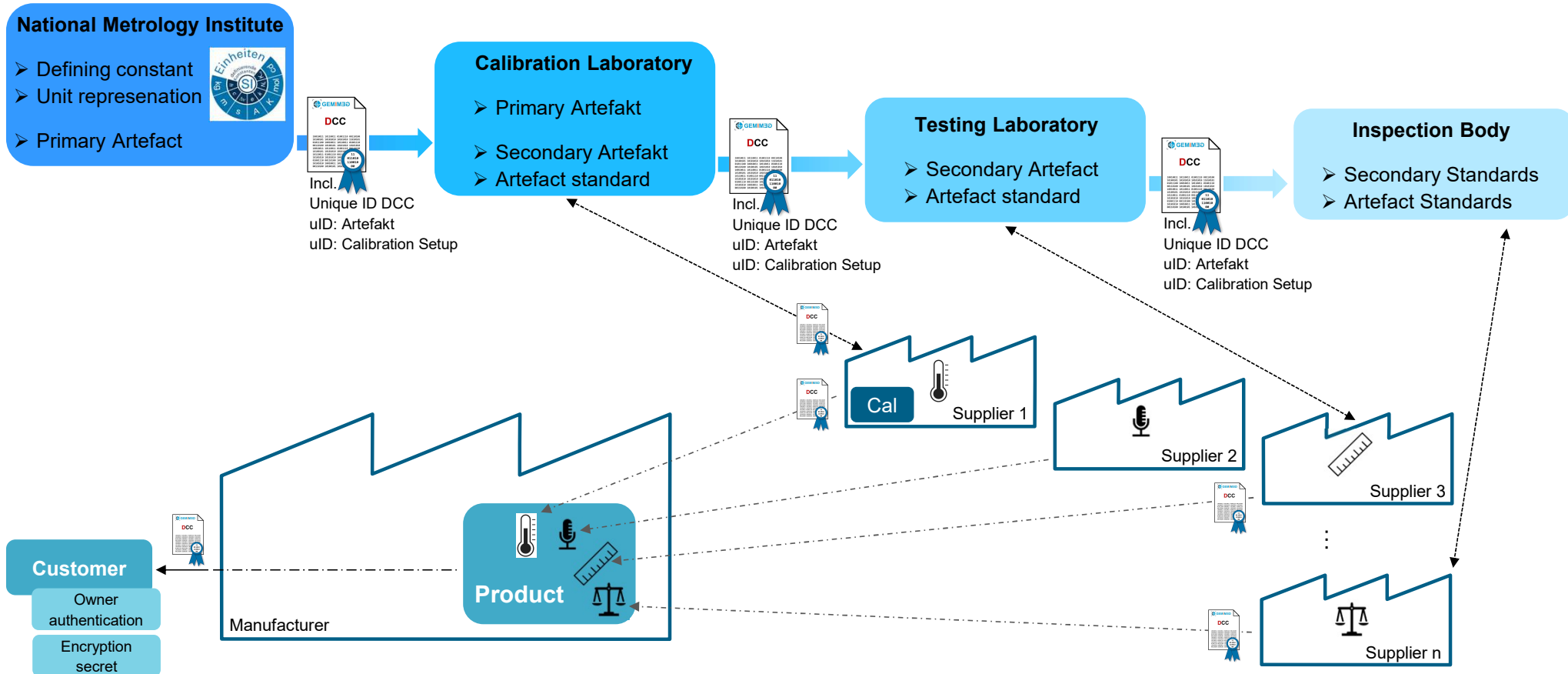
TP 2.3 – Improved Quality of Data



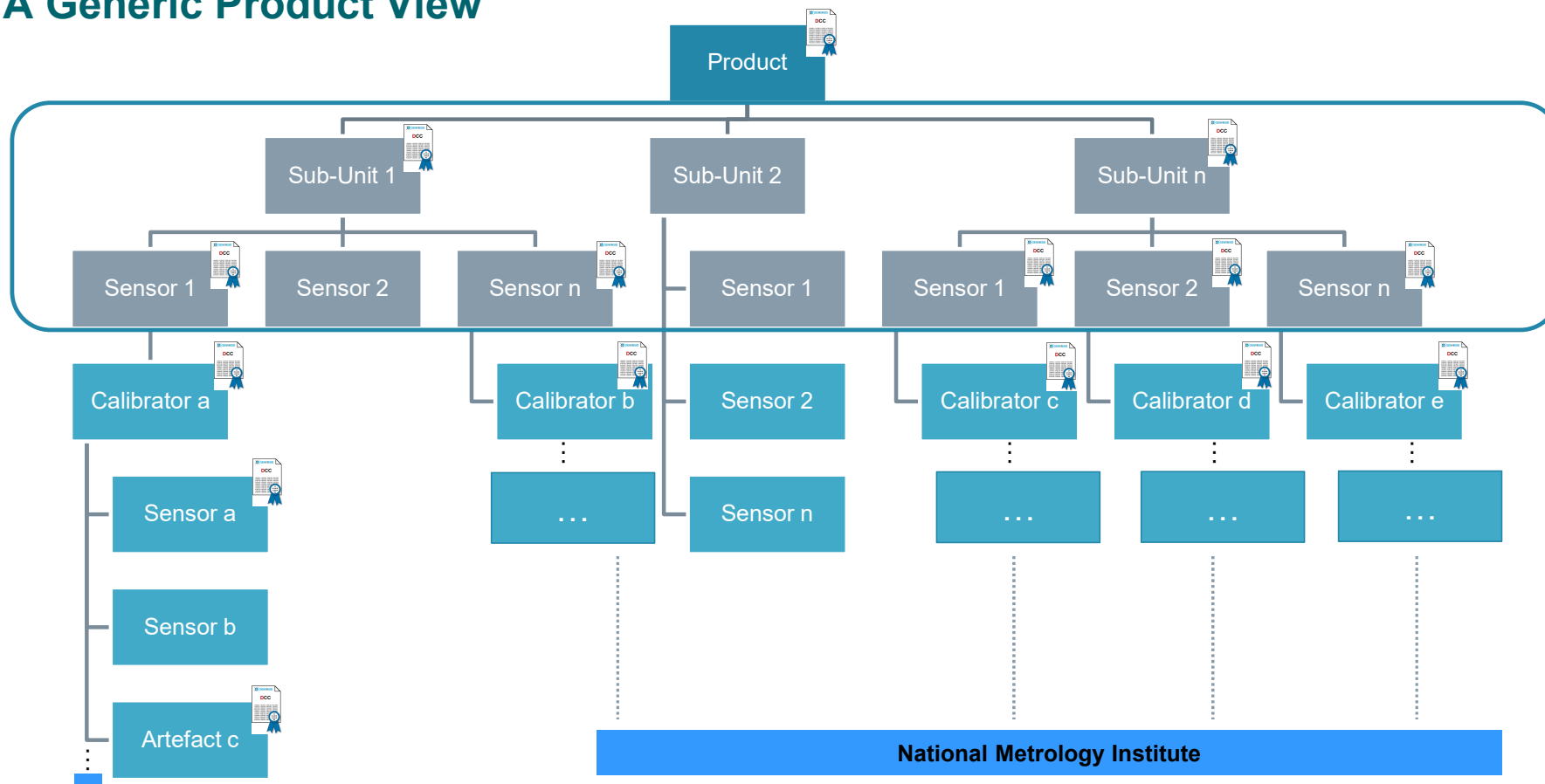
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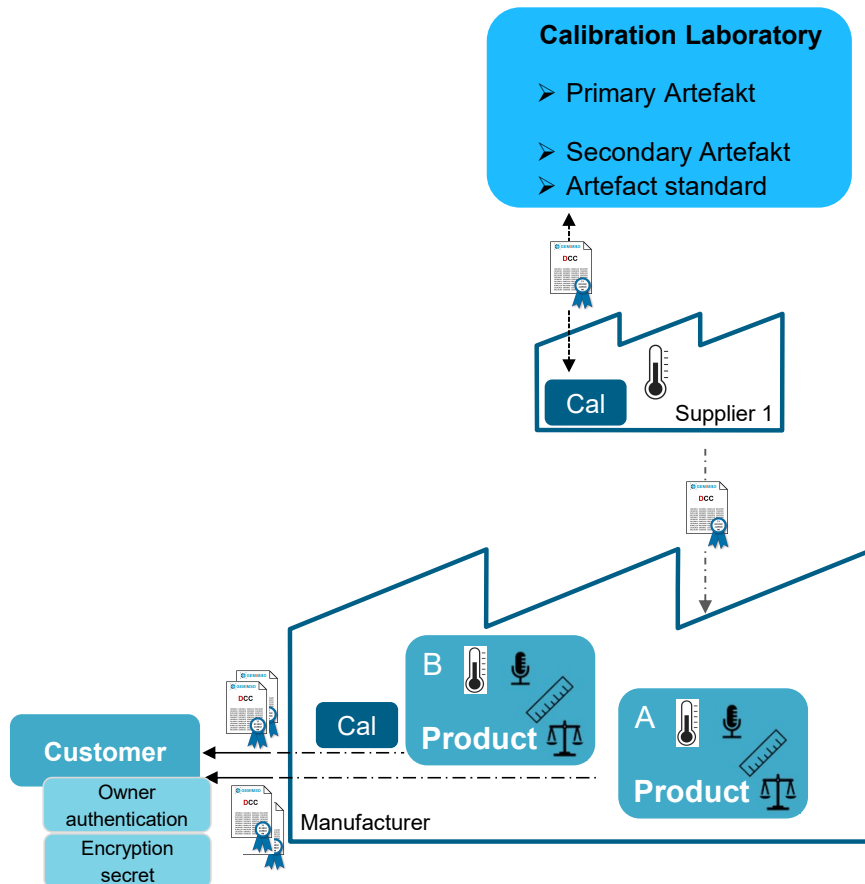
Hierarchical System in Quality Infrastructure



Hierarchical System in Quality Infrastructure – A Generic Product View



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.

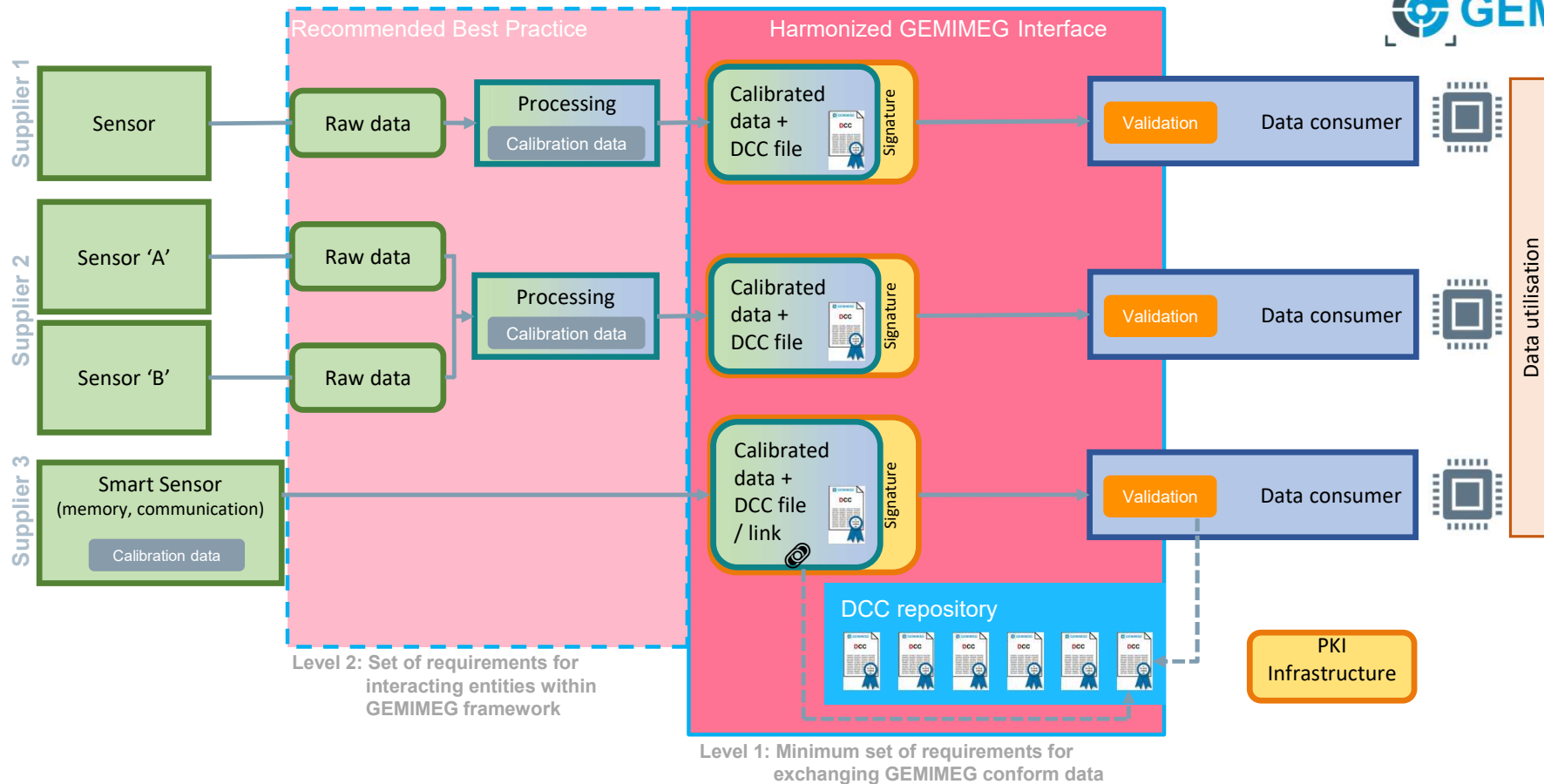
Final product A not calibrated: Manufacturer forwards supplier DCC to customer, i.e. token, encryption secret, challenge

Final product B to be calibrated:

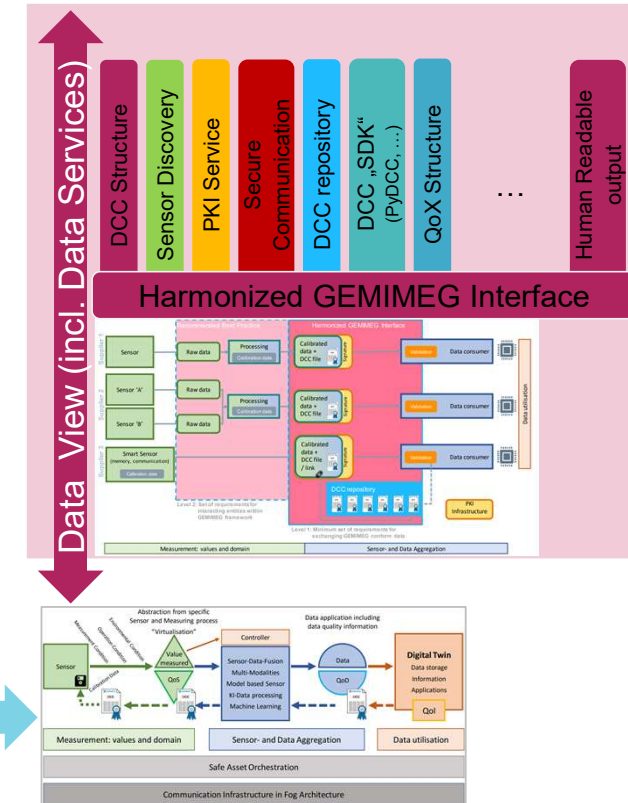
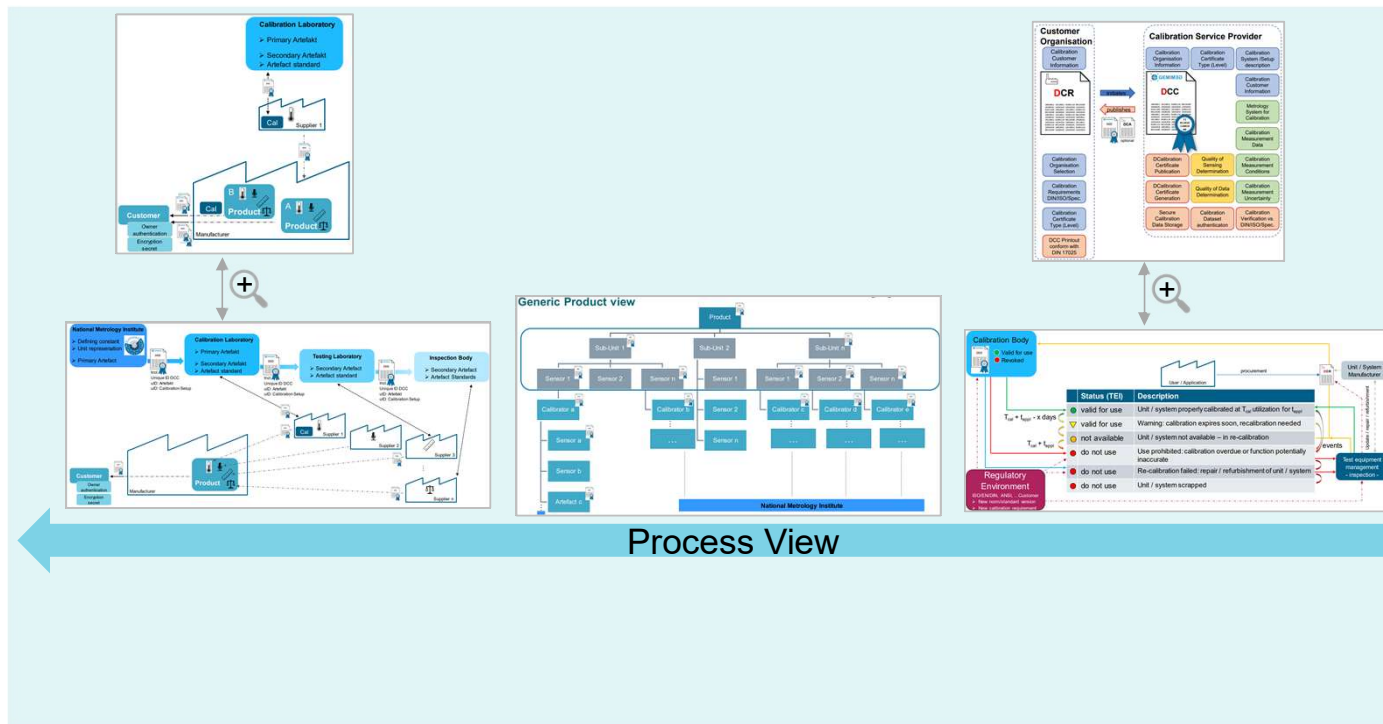
Manufacturer generates DCC for product and delivers to Customer e.g.:

- 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
- IV. plus additional supplier DCC, e.g. for accessories

Data Augmented with Digital Calibration Certificate



Process and Data Flow Overview



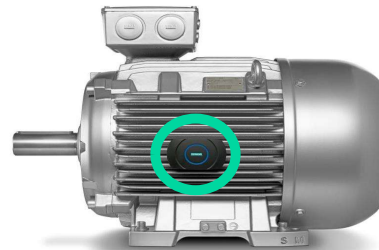
Potential applications for GEMIMEG solution

- Siemens Digital Industries – Process Control

Gas Chromatograph
+ calibration gas with DCC



- Simotics Connect – Brownfield automation
Condition monitoring sensors
e.g. T, p, hum %, vibration/shock, ...
U, I, phase shift, ...



Potential applications for GEMIMEG solution

- Siemens Digital Industries – Siwarex



Legal metrology and calibration
for weighing products



Dosing/filling/bagging scales and check weighers

High accuracy blending and batching as well as high-speed bagging and filling are typical requirements for a lot of industries. The corresponding SIWAREX electronics provide extensive features and functions to fulfill all requirements.

- SIWAREX WP351: weighing module for SIMATIC ET 200SP
- SIWAREX WP251: weighing module for SIMATIC S7-1200
- SIWAREX FTA: weighing module for SIMATIC S7-300/400



Conclusions

- To leverage the full potential of digitalisation in Metrology, we should follow the
F indable
A ccessible
I nterpretable
R eusable
data principles – plus full traceability
- We should bundle our resources to build up a strong and versatile digital metrology framework based on international conventions D-SI, DCC, ...
 - with well defined structures, semantics and ontologies and
 - non competitive software modules of the framework being available as open source
- ideally maintained by a neutral metrology organisation
- Associated partners/supporters for the GEMIMEG-II Project are highly welcome and appreciated

GEMIMEG-II – a growing community of associated Partners



SED Flow Control GmbH
Center of Competence Pharma and Biotech



**Trusted & traceable metrology
is *the* key enabler for IIOT for
all critical applications
– when trustworthiness matters!**

I Kontakt

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Project Info:

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or

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