



Organisation Internationale de Métrologie Légale  
International Organization of Legal Metrology

# Webinar: Digital Transformation in Legal Metrology

## May 5th, 2021

1:00 p.m. – 3:00 p.m. (CEST)

Supported by:





# Webinar: Digital Transformation in Legal Metrology

	Wednesday, 5th May, 2021	Speaker
13:00 CEST	<b>Welcome and Introduction</b>	Dr Florian Thiel (PTB, WELMEC WG 7), Germany
<b>Part I</b>	<b>Oral Session: Digital Transformation in Legal Metrology</b>	
20 min	<b>Keynote lecture:</b> Digital Transformation of Metrology - The View of the BIPM-OIML Joint Task Group	Hon.-Prof. Dr Roman Schwartz (CIML President)
20 min	Law on Metrology - Barrier or Driver for Digital Transformation in Metrology	Dr Sergey Golubev, (Rosstandart), Russia
20 min	European Metrology Cloud: Establishing the European Metrology Network	Prof. Dr Jan Nordholz, (PTB), Germany
20 min	Blockchain based Applications and Metrology	Dr Wilson de Souza Melo Junior (INMETRO), Brazil
<b>Part II</b>	<b>Q&amp;A Session: Questions from the Audience</b>	
~15:00 CEST	End of the Webinar	



International Organization of Legal Metrology

Organisation Internationale de Métrologie Légale

# Digital Transformation in (Legal) Metrology – The View of the BIPM-OIML Joint Task Group

*Roman Schwartz*  
*President, CIML*

*OIML Webinar, 5 May 2021: Digital Transformation in Legal Metrology*



Working together to promote and advance the global  
comparability of measurements



ABOUT US

COORDINATION

LIAISON

TECHNICAL/SCIENTIFIC

PUBLICATIONS & EVENTS



## The BIPM is...

- the international organization established by the **Metre Convention**, through which Member States act together on matters related to measurement science and measurement standards
- the home of the **International System of Units (SI)** and the **international reference time scale (UTC)**.



## Organisation Internationale de Métrologie Légale



The mission of the OIML is to enable economies to put in place effective legal metrology infrastructures that are mutually compatible and internationally recognized, for all areas for which governments take responsibility, such as those which facilitate trade, establish mutual confidence and harmonize the level of consumer protection worldwide.





# New BIPM-OIML Joint Task Group

Bureau  
International des  
Poids et  
Mesures

**Established:** October 2020, based on respective CIML and CIPM resolutions

**Major aims:**

- To foster enhanced cooperation between BIPM and OIML in order to facilitate both organisations in serving their member states better
- “One single voice for metrology”

**Major strategic objective:**

- To develop and promote a common vision and a common holistic concept of metrology as a key element for the active promotion of the quality infrastructure concept

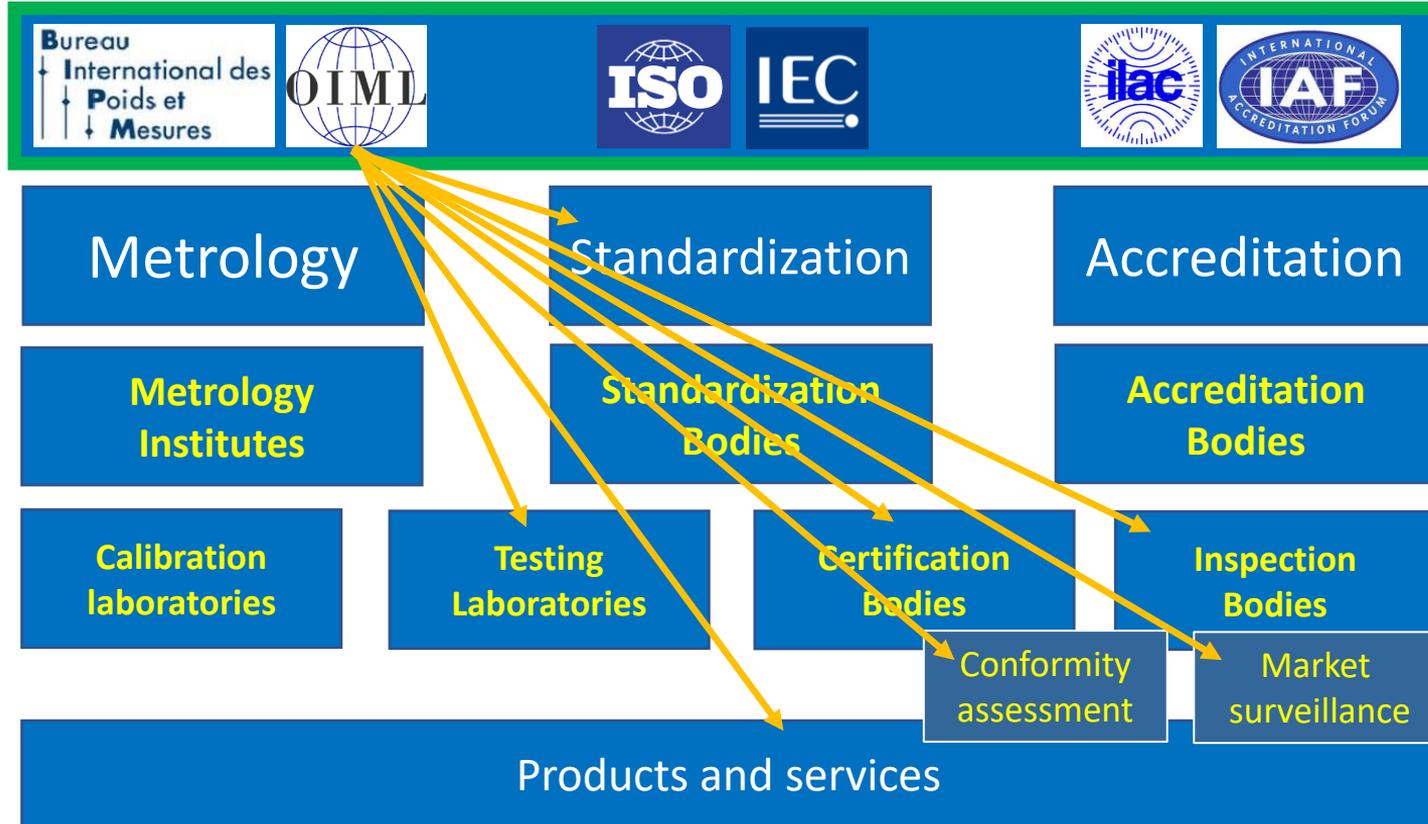
**Action plan includes:**

- Joint promotion / support of the digital transformation of metrology





# Metrology as part of the Quality Infrastructure (QI)





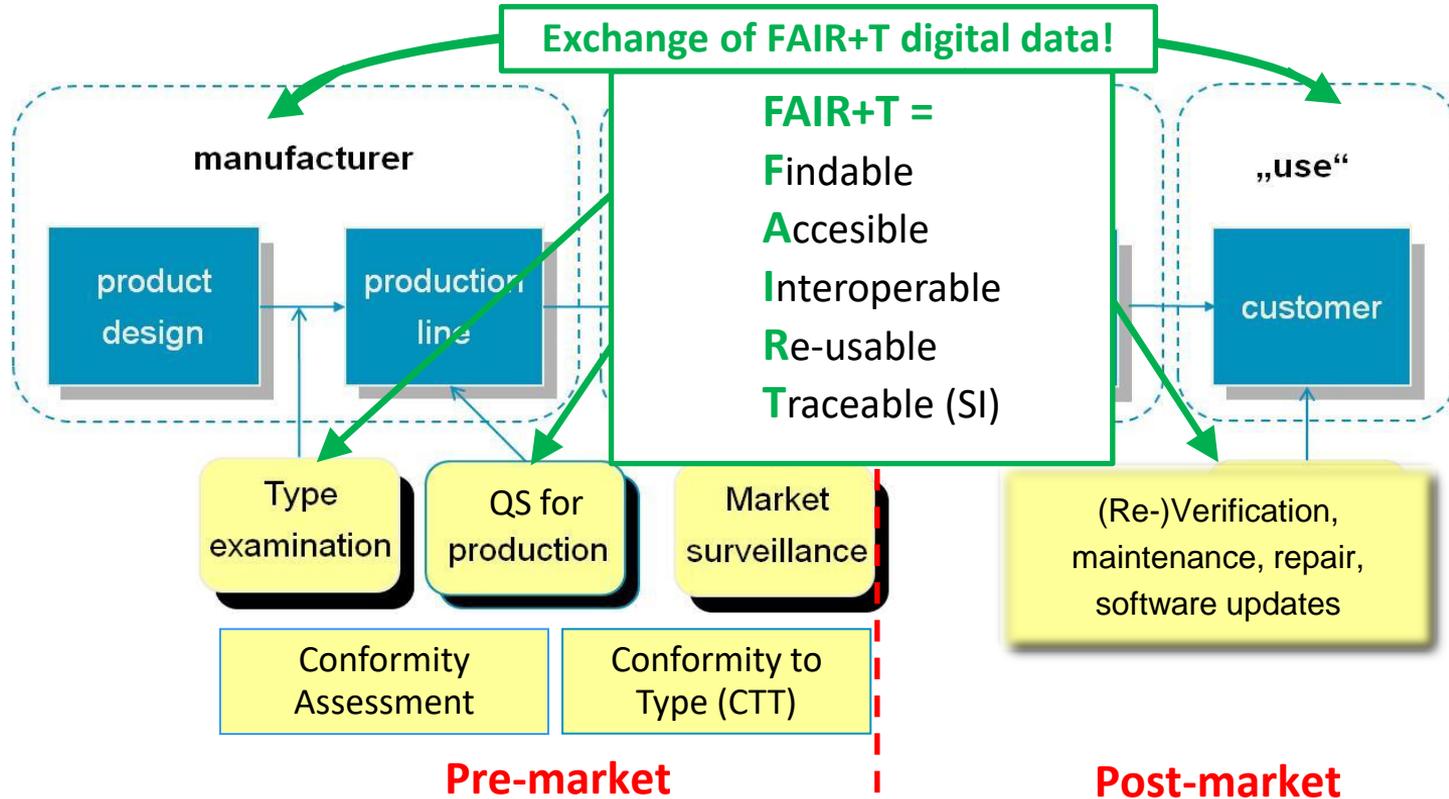
# Digital transformation of metrology

- The **digital transformation of scientific, industrial and legal metrology activities** requires a **HOLISTIC APPROACH** which includes all relevant aspects and activities: (re-)calibration, (re-)testing, (re-)certification, (re-)verification/inspection, market surveillance, accreditation, standardization.
- This requires **GOOD COOPERATION** of **all stakeholders**, i.e. manufacturers/associations, national/regional regulatory and supervising bodies, international organisations in the field of **Quality Infrastructure** (BIPM/OIML, ISO/IEC, ILAC/IAF).



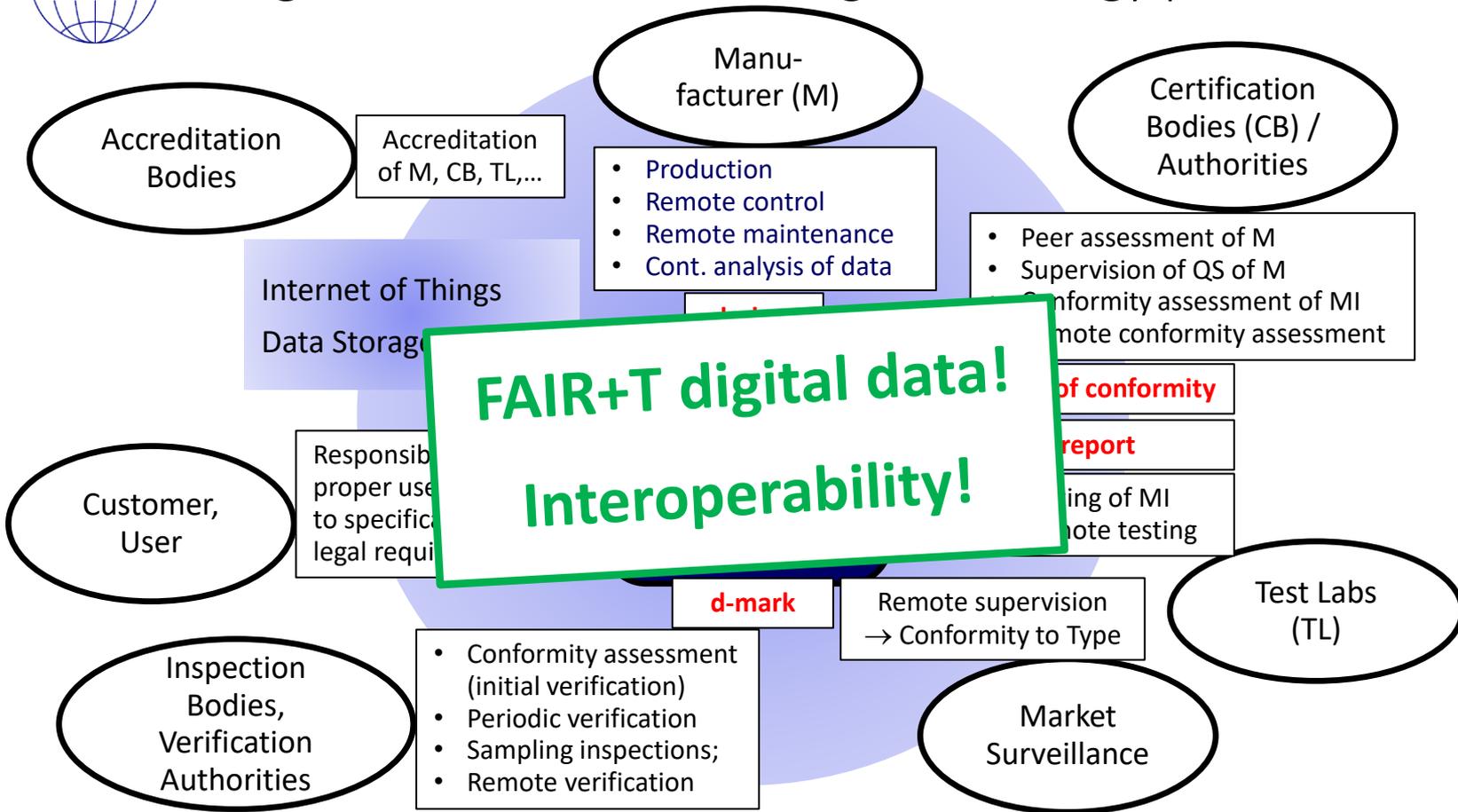


# Challenge for legal metrology: Digital transformation of the various processes during the life cycle of a product





# Digital transformation of legal metrology processes





# Digital representation in metrology processes



- Contain all relevant information for **conformity assessment, verification, market surveillance** in a **machine-readable way**
- Know the relevant **standards and regulations**, and provide **machine-readable information** about it
- Contain all relevant information for **customers** to gain **trust and confidence** in the products and quality measures
- Provide **machine-readable interfaces** for users and manufacturers to enable „smart quality assurance“
- Combine **machine-readable documents and certificates**, enable automation of digital QI processes
- Are **secured and validated** to provide access to information only to eligible parties (e.g. by use of blockchain technology)





# Example: Digital Certificate of Conformity in Metrology (D-CoCM)

- Part of the **digital representation** of a measuring instrument
- Will contain **type evaluation certificates, certificates of supervised manufacturers' QS for the production, and other relevant documents**
- Will provide the legally prescribed information as **machine-readable data** (e.g. digital plate, digital test report, digital verification mark, etc.) to enable stakeholders to perform **ALL** legally prescribed actions
- Requires a **holistic approach** to address the needs of **ALL** stakeholders involved during the life cycle of an instrument
- Is intended to be realised using **FAIR+T digital data, based on the SI**



Digital representation
<b>D-CoCM</b>
↳ D-plate
↳ D-test report
↳ D-mark
...





# Towards a joint “Statement of Intent”

## The BIPM/CIPM-OIML/CIML Joint Task Group...

- Recognizes the importance of the **International System of Units (SI)**, which underpins all measurements in industry, trade, legal metrology, and science;
- Recognizes the necessity for a **digital transformation of industrial, legal and scientific metrology** activities and processes in close cooperation with all stakeholders in the field of quality infrastructure (QI);
- Supports that **digital representations of physical devices** should rely on robust, unambiguous and machine-actionable data, which are **based on the SI and on FAIR+T principles**, to facilitate efficient processes in industry, economy, society, modern research and development globally;
- Supports a respective **joint “Statement of Intent”** to be elaborated and signed by all stakeholders in the field of QI;
- Invites representatives of **other organizations** to join this initiative towards a digital QI framework based on the SI and FAIR+T principles.



Thank you for your attention!

感谢您的关注

Danke für Ihre Aufmerksamkeit!

관심을 가져 주셔서 감사합니다.

Спасибо за внимание!



شكرا لاهتمامكم



**Physikalisch-Technische Bundesanstalt**  
**Braunschweig und Berlin**

Hon. Prof. Dr. Roman Schwartz

CIML President

[president@oiml.org](mailto:president@oiml.org)





# Law on Metrology - Barrier or Driver for Digital Transformation in Metrology

Dr. Sergey Golubev

Russian Federation

2021



# The concept of digital transformation in legal metrology

Digital infrastructure for participants to work on their legal metrology tasks

Legislation

Legal significance of all tasks executed on the technical platform

Technical platform

Data about standards, measurement instruments, reference materials and other technical objects in legal metrology

Keynote:

*All data on a digital platform must be coherent. For example, data about measurement instrument, needs data about all instruments for its calibration to exist on a platform.*



# Digital transformation in legal metrology

Practical tasks:

- Develop technical platform
- Motivate participants to work on the platform
- Legal significance of the data on the platform

Keynote:

*Digital transformation should simplify participants tasks, but not add additional steps.*



# Legal metrology tasks for digital transformation

- Verification of measurement instruments
- Calibration of verification instruments (MIs which are used in verification procedures)
- Type approval procedure
- Certifying of reference materials
- ... other 15 processes

Keynote:

*Digital confirmation of all these results means, that information from digital platform is legally significant. Data protection and digital signatures for all participants are necessary.*

# Digital transformation

## Legislation

- ✓ Law on metrology
- ✓ 18 government and ministries acts for law realization
- ✓ Technical acts and guidelines

## Technical platform

Outsourcing or NMI ??

Digital infrastructure

Keynote:

*These two threads are strongly interrelated. Coordination between them are very important*



## Two key decisions

- Simultaneous or step-by-step executing
- Permission to work outside digital infrastructure

Keynote:

*An easier-to-implement solutions can greatly increase the time for the digital transformation*

# Digital transformation timescale. Coordination

## Legislation

- ✓ 2017 (Mid) The first draft for a new law
- ✓ 2017-2018 Discussions with professional society and experts
- ✓ 2018 Discussions with federal bodies and in Government
- ✓ 2019 Official movements
- ✓ 2019 27.12.2019 Signed by President
- ✓ 2020 Developing 18 documents for law realization
- ✓ 2020 24.09.2020 Came into force

## Technical platform

- ✓ 2016-2017 Development by outsource company
- ✓ 2017-2018 Using of the developed platform by Rosstandart
- ✓ 2018 (Mid) Decision to continue developing by NMI
- ✓ 2018-2019 Customizing the platform for actual tasks
- ✓ 2019 Successful integration the platform by Rosstandart
- ✓ 2020 30.01.2020 deployment the platform for all users
- ✓ 2020 24.09.2020 Became the only one possibility to work in legal metrology area
- ✓ 2020-... Improving the platform

# https://fgis.gost.ru/fundmetrology/registry

ФГИС "АРШИН" Войти

- Нормативные правовые акты Российской Федерации
- Нормативные документы
- Информационные базы данных
- Информация и данные ГСССД
- Международные документы
- Международные договоры
- Аттестованные методики (методы) измерений
- Единый перечень измерений, относящихся к сфере государственного регулирования
- Эталоны единиц величин
- Утвержденные типы стандартных образцов
- Утвержденные типы средств измерений
- Сведения о результатах

**ЕДИНЫЙ ПЕРЕЧЕНЬ ИЗМЕРЕНИЙ, ОТНОСЯЩИХСЯ К СФЕРЕ ГОСУДАРСТВЕННОГО РЕГУЛИРОВАНИЯ**

1

Число записей: 1

*Единый перечень измерений, относящихся к сфере государственного регулирования*

Посмотреть

**ГОСУДАРСТВЕННЫЕ ПЕРВИЧНЫЕ ЭТАЛОНЫ РОССИЙСКОЙ ФЕДЕРАЦИИ**

160

Число записей: 160

*Государственные первичные эталоны Российской Федерации*

Посмотреть

**ЭТАЛОНЫ ЕДИНИЦ ВЕЛИЧИН**

113 770

Число записей: 113 770

*Эталоны единиц величин*

Посмотреть

**МЕЖДУНАРОДНЫЕ СЛИЧЕНИЯ**

437

Число записей: 437

*Международные сличения*

Посмотреть

**УТВЕРЖДЕННЫЕ ТИПЫ СТАНДАРТНЫХ ОБРАЗЦОВ**

9 108

Число записей: 9 108

*Утвержденные типы стандартных образцов*

Посмотреть

**УТВЕРЖДЕННЫЕ ТИПЫ СРЕДСТВ ИЗМЕРЕНИЙ**

96 066

Число записей: 96 066

*Утвержденные типы средств измерений*

Посмотреть

**СВЕДЕНИЯ О РЕЗУЛЬТАТАХ ПОВЕРКИ СРЕДСТВ ИЗМЕРЕНИЙ**

*Сведения о результатах поверки средств измерений*

Посмотреть

**РЕЗУЛЬТАТЫ ПОВЕРОК СИ**

2021 2020 2019 2018 2017 2016 2015 2014 2013 2012 2011 2010 до 2010

Поиск...

1 - 20 из 26001814  на страницу « Предыдущая 1 2 3 ... Следующая »

Организация-поверитель	Регистрационный номер типа СИ	Наименование типа СИ	Тип СИ	Модификация СИ	Заводской номер/Буквенно-цифровое обозначение	Дата поверки	Действительна до	Номер свидетельства/Номер извещения
ООО "ТЕСТЭЙР"	54561-13	Измерители цифровые многофункциональные	VT200, AMI300	Измеритель цифровой многофункциональный модели VT200	1207 4182	03.05.2021	02.05.2022	С-ВЯУ/03-05-2021/61087357
ООО "ГАЗПРОМ ДОБЫЧА ШЕЛЬФ ЮЖНО-	32808-11	Газоанализаторы	СГОЭС	СГОЭС-пропан	32102	03.05.2021	02.05.2022	С-ГШЮ/03-05-2021/61087707

## Number of different objects on the platform

➤ Number of verification instruments (standards)	113 845
➤ Verification authorities	1 815
➤ Verifications (2020)	43 890 176
➤ Verifications (2021)	26 001 764
➤ Verifications (2010-2021)	379 699 840



## Participants of the digital infrastructure

- Federal agency for Technical regulation and metrology
- National accreditation system
- Verification authorities
- Manufactures and users of measurement instruments

# Key benefits of the digital infrastructure in legal metrology

## National metrology body

- ✓ Most complete and up-to-date data about verifications and measurement instruments
- ✓ Most complete data about traceability for MI and verification instruments
- ✓ Environment for risk-based approach in metrological supervision and supervision over verification authorities

## Verification authorities

- ✓ Real-time posting and appearing of the verification results -> client orientation
- ✓ The risk of fake certificates disappears
- ✓ The price of mistakes will be reduced

## Manufactures and users of measurement instruments

- ✓ There is no need to monitor the verification intervals – you will be informed in before
- ✓ Find most appropriate verification body



## Conclusions

- Changing the legislation can be a motivator for the transformation of the professional community in the shortest possible time
- The digital infrastructure for legal metrology can be created and implemented in 3-4 years period
- The infrastructure will bring great economic benefits to its conscious participants



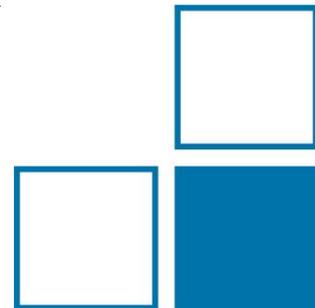
Thank you for  
your attention



# European Metrology Cloud

Establishing the European Metrology Network

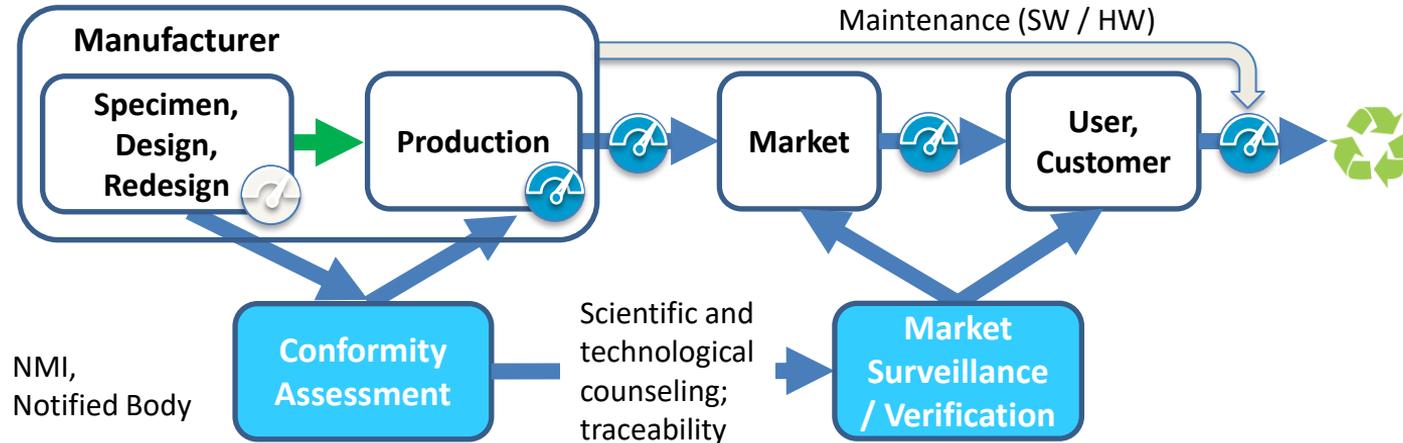
Prof. Dr.-Ing. Jan Nordholz



European Regulations set up a Quality Infrastructure:



## European Regulations set up a Quality Infrastructure:



PTB ~ 600 certificates / yr (2014/32/EU)

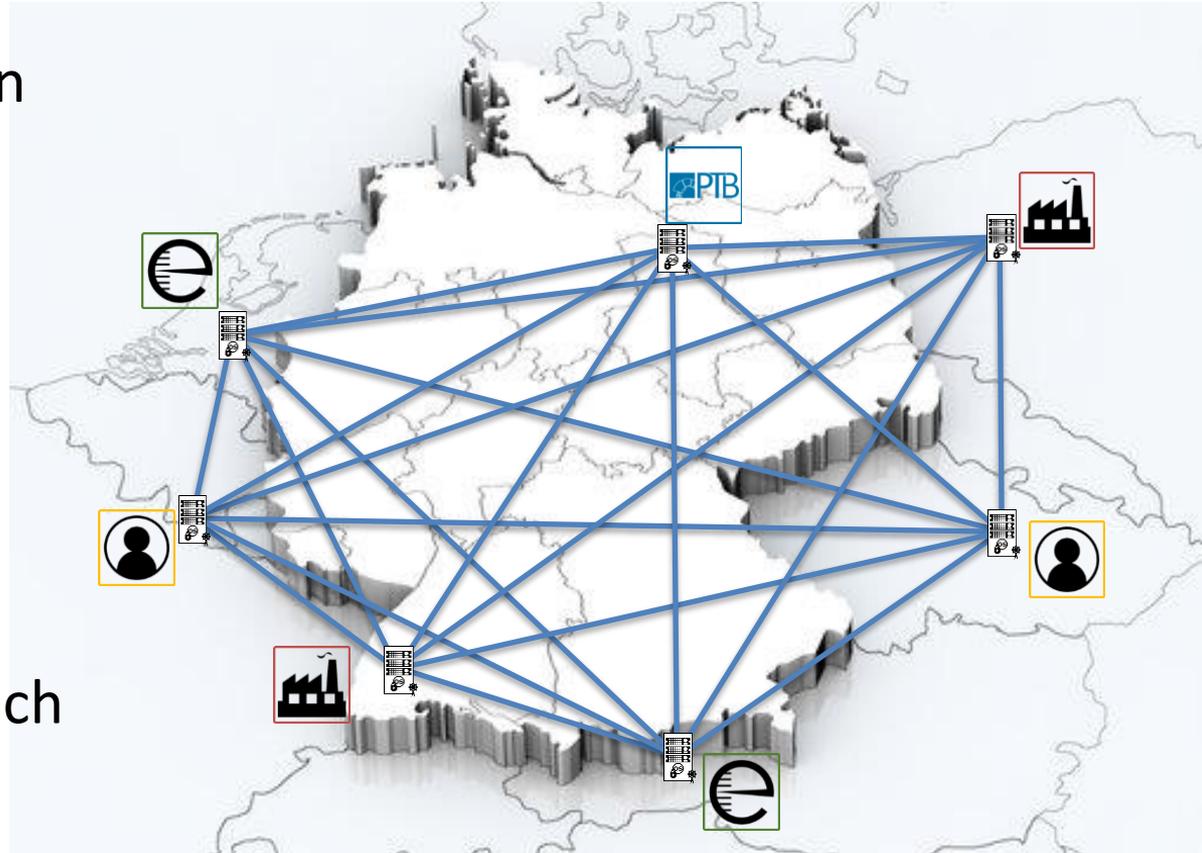
Germany ~ 1 mil. verifications / yr

### In the future:

- increased need for data interconnectivity
- trend towards IoT- and distributed measuring devices

# The European Metrology Network

- Secure Authentication
- Immutable Logging
- Data Harmonization
- Distributed System
- Minimal Data Approach



- Single Point of Contact for Metrological Data Interchange
- Safe & Secure Process Flow Control via Smart Contracts
- Complete Data Sovereignty: no data replication, no caching
- Shared Identity Management for Devices and Users via Federate PKI
- Extensibility towards related fields, e. g. Industrial Metrology
- (Future) GAIA-X Compatibility

# PTB Partners and Cooperations

## External Partners

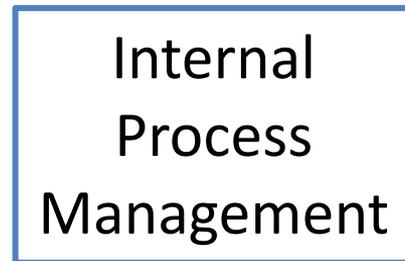
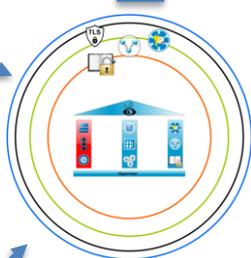


Arbeit an geeichten Waagen  
für hybride Wiegeleistungen  
an Nutzfahrzeugen

## Internal Partners



# SARTORIUS



# Video

- Single Digital Platform for Legal Metrology
  - significant acceleration of processes
  - no discontinuities → improved data consistency
  - applicable across Europe due to harmonized regulations
- Extensibility towards other use cases
  - industrial metrology: digital calibration certificate (DCC)
  - storage/retrieval of EU Declaration of Conformity
  - compatibility with GAIA-X
    - data interchange between Metrology Cloud and cloud services offered by third parties

# Questions?



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[www.ptb.de](http://www.ptb.de)

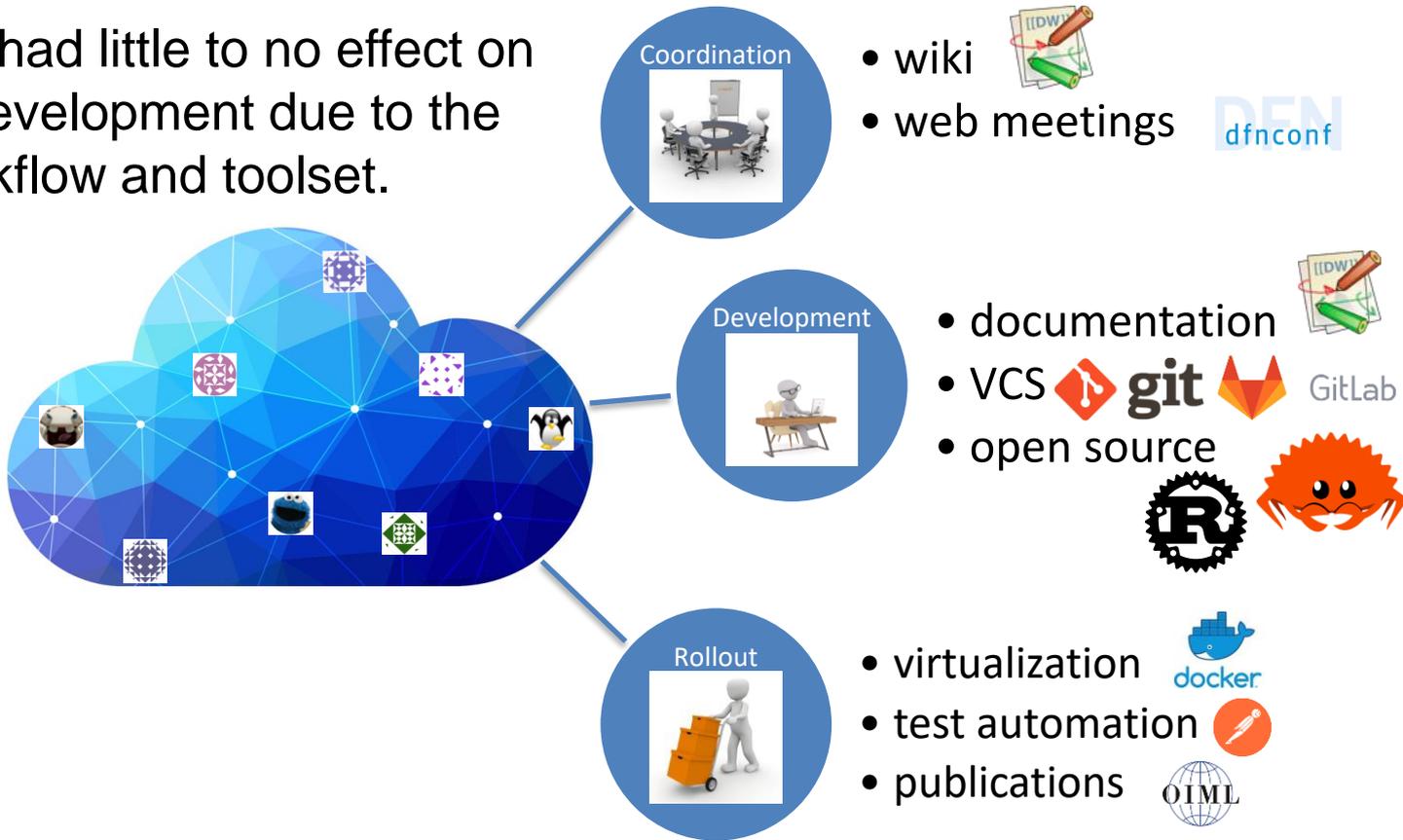


- Maximilian Dohlus
- Jasper Gräflich
- Alexander Kammeyer
- Jörg Neumann
- Martin Nischwitz
- Jan Wetzlich
- Artem Yurchenko



# PTB Working on the EMC

Covid-19 had little to no effect on the MC development due to the team workflow and toolset.



**Webinar - Digital Transformation in Legal Metrology**



# **Blockchain-based Applications and Metrology**

**How this technology will impact  
the digital transformation**

**Wilson S. Melo Jr., PhD  
Inmetro -Brazilian National Institute of  
Metrology, Quality, and Technology  
wsjunior@inmetro.gov.br**

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May 5th 2021

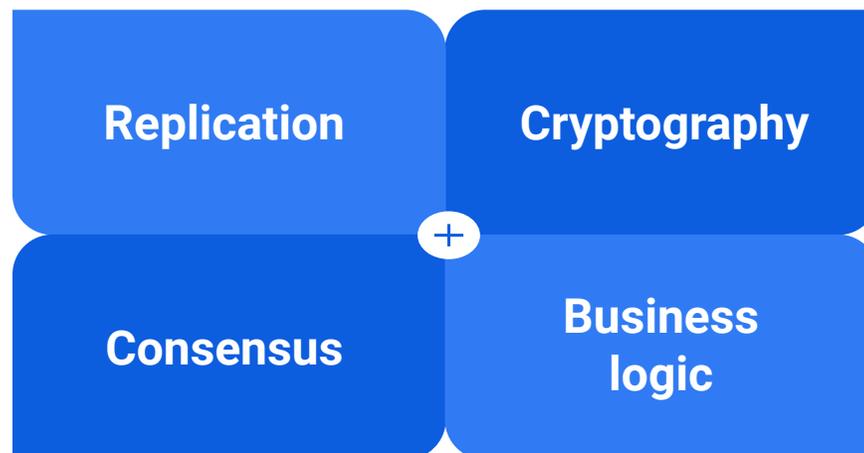
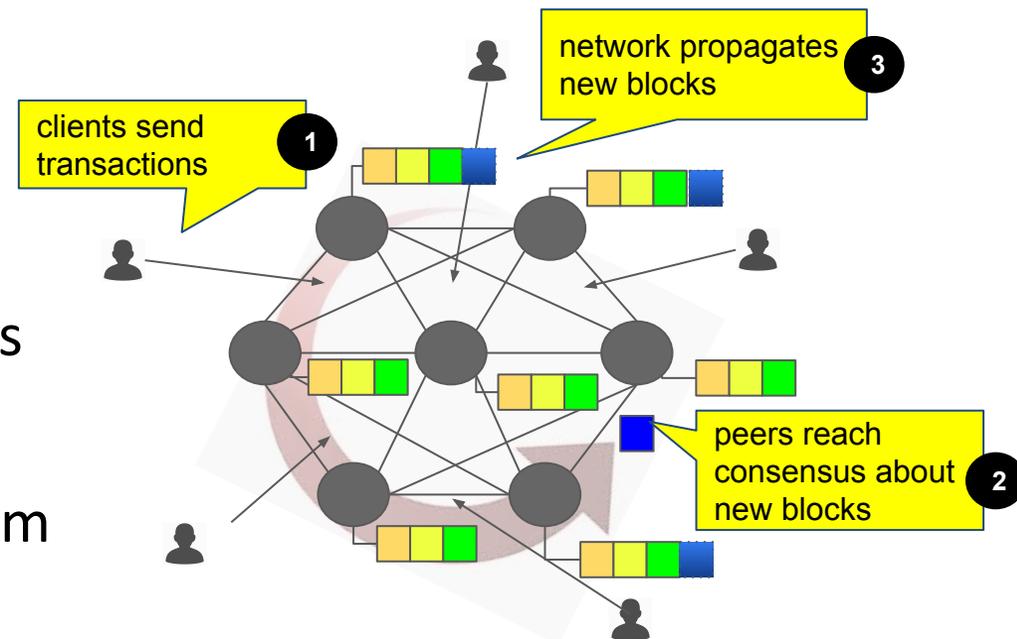
## In the next 20 minutes...

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- Blockchain elementary concepts
- Why blockchains are important
  - Immutable storage, workflow automation;
  - Security properties that protect data and software.
- Applications in Metrology
  - Case studies involving distributed measuring systems, blockchain-based PKI for smart meters, field surveillance of fuel dispensers.
- Main challenges
  - Performance, information privacy, the consensus among stakeholders.
- The Inter-NMI blockchain network

# What are blockchains and how they work?

- Basically, they provide trust among independent parties that do not need to trust each other:
  - An immutable append-only data structure, which uses a chain of blocks cryptographically linked;
  - Automation of workflows by using smart contracts - in practice, a platform of distributed services;
  - Strong properties regarding security.
- It has called the attention of different players in areas like finances, industry, business, government...
- Metrology is also an area that can take advantage of blockchains!



# Blockchains and the digital transformation

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- Digital transformation involves several technologies
  - Industry 4.0 and its nine pillars: Big data, cloud computing, robot automation, horizontal and vertical integration, IoT, additive manufacturing, augmented reality, simulation, and cybersecurity.
- Blockchain encompasses many of these technologies
  - It integrates different peers in a distributed **cloud**-based environment;
  - It stores data in a reliable repository, supporting **Big Data** applications;
  - It uses smart contracts to automate workflows, enabling **horizontal and vertical integration** among different systems;
  - It provides strong security properties, enhancing **cybersecurity**;
  - In the context of Legal Metrology, smart meters can constitute blockchain oracles, a link to integrate **IoT devices** and blockchains.

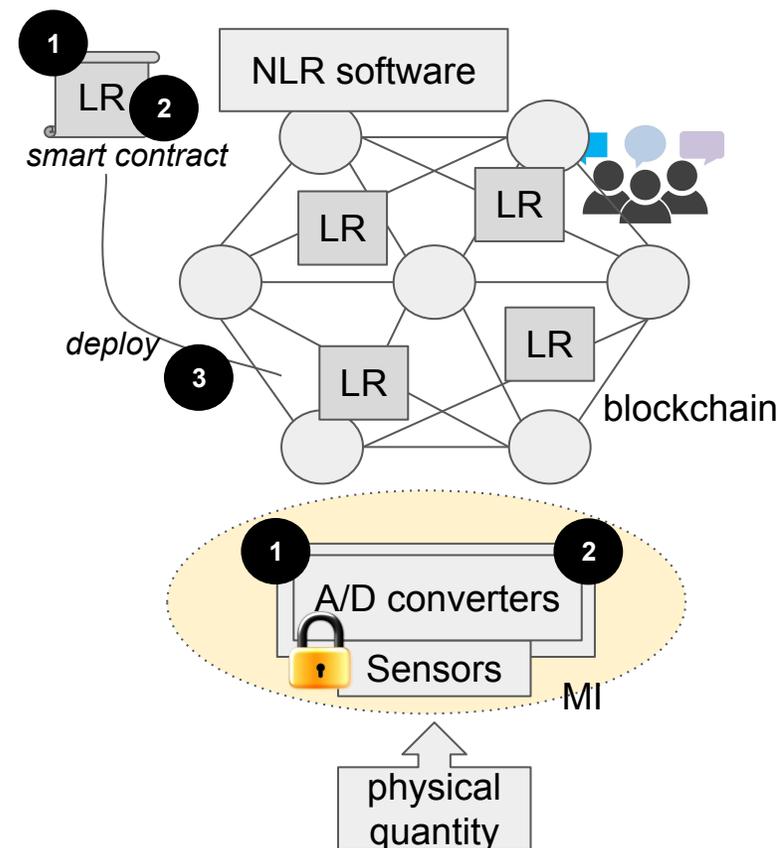
# Blockchain-based applications and Legal Metrology

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- Elementary applications are trivial...
  - Immutable data storage - critical measurements, calibration parameters, product attestation, and certification.
- But we also have motivation for more complex applications
  - Distributed measuring systems with legally relevant (LR) software running as smart contracts can be more secure and easier for evaluating;
  - Public-Key Infrastructure (PKI) for smart meters;
  - Field surveillance of measuring instruments using smart contracts;
  - New business models in Metrology (e.g., meters as blockchains' oracles)
- The European Metrology Cloud Project shall also include blockchains (Thiel and Wetzlich, 2019):
  - A permissioned blockchain that supports smart contracts and incorporates mechanisms to assure the privacy of sensitive data;
  - Intended use: decentralized IDs Administration and immutable logbook.

# Examples of blockchain-based applications: Case #1

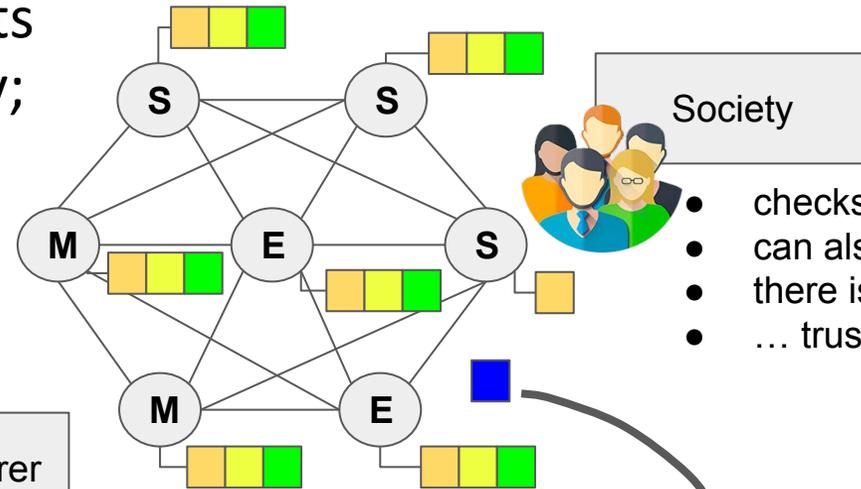
- Distributed measuring systems
  - Sensors send raw data from physical quantities directly to the blockchain.
  - Smart contracts perform measurement running LR software and processes.
  - We increase LR software protection
    - Software becomes immutable since its hash is written in the ledger.
  - We reduce costs with MI legal control regarding software inspection
    - Type approval (activities 1 and 2);
    - Market/field surveillance (activity 3).
  
- Publications:
  - [IEEE-I2MTC Conference, 2019](#)
  - [IEEE-Transactions I&M, 2020](#)



# Examples of blockchain-based applications: Case #2

- Public Key Infrastructure (PKI) for smart meters:

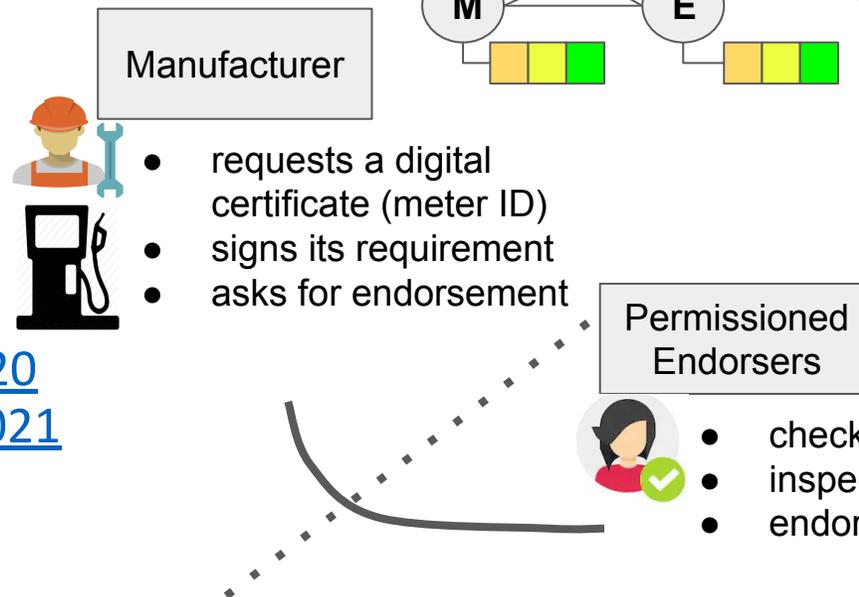
- The blockchain stores and attests public keys from smart meters;
- Meters sign their measurements using the respective private key;
- There is no cost with digital certificates;
- The solution does not depend on a trust third party (TTP).



- checks the blockchain
- can also take part on it
- there is no collusion...
- ... trusts the smart meter

- Publications:

- [IEEE-MetroInd, 2020](#)
- [Sensors Journal, 2021](#)



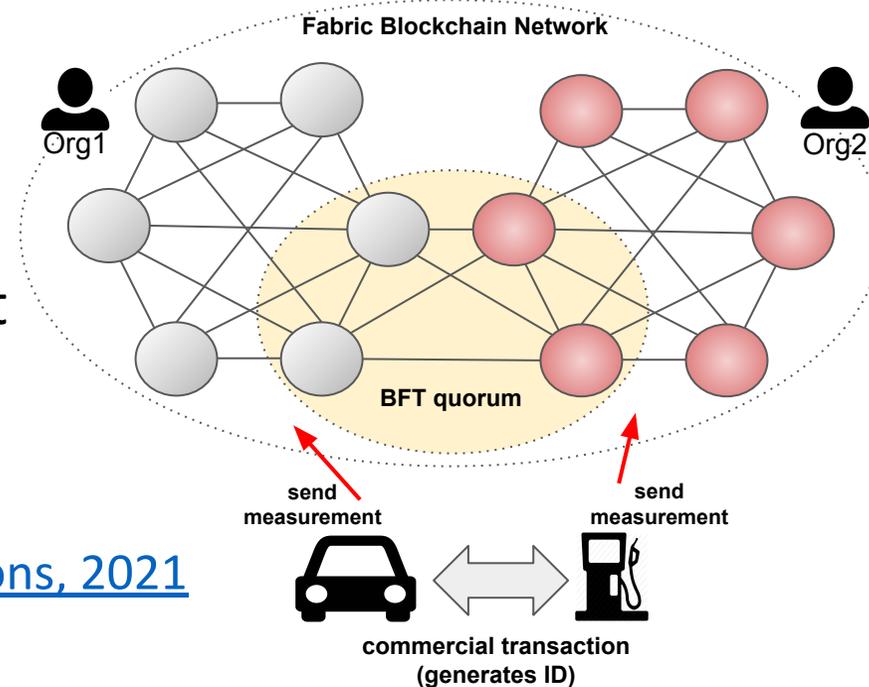
- requests a digital certificate (meter ID)
- signs its requirement
- asks for endorsement

Permissioned Endorsers

- checks information
- inspects the smart meter
- endorses transactions

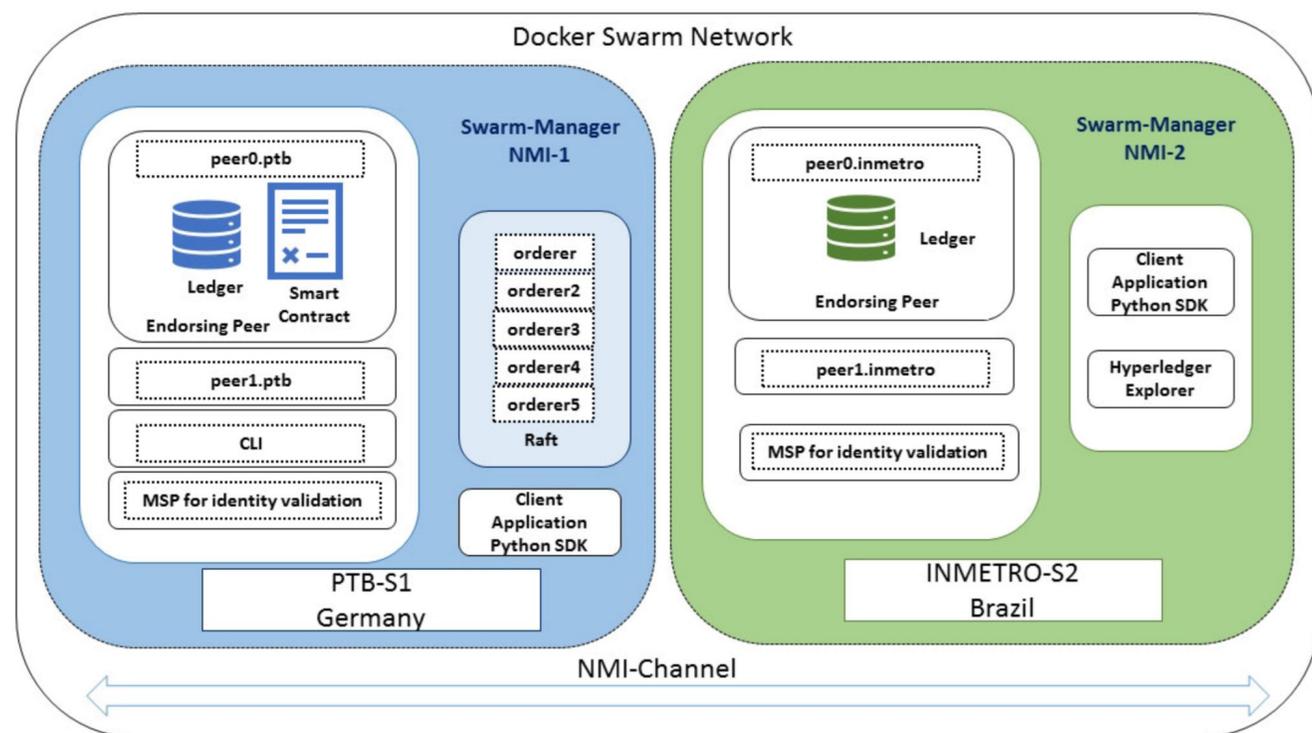
# Examples of blockchain-based applications: Case #3

- Field surveillance of fuel dispensers
  - Vehicles' embedded sensors can monitor fuel dispensers' correct behavior;
    - One can use IoT devices (e.g., OBD interfaces) that are already available;
  - Vehicles write measurements into the blockchain;
  - Smart contracts perform data analysis (prevention against collusion)
    - Our approach is based on the Law of Large Number.
  - Independent organizations interested in fighting against frauds support the blockchain network
    - They do that by providing peers voluntarily.
  - Our implementation uses Byzantine-fault tolerant consensus ([BFT-SMaRt](#)).
- Publications:
  - [Journal of Network and Computer Applications, 2021](#)



# Proposal of an Inter-NMI blockchain network

- Since 2019, Inmetro and PTB are working together to specify a blockchain architecture to support applications in Metrology
  - A blockchain network held by NMIs and interested research institutions.
- So far, we have four publications, proposals involving strategies for privacy, and the blockchain-based PKI prototype.
- Involved technologies:
  - Hyperledger Fabric;
  - Virtualization using docker containers;
  - Smart contracts write in Golang;
  - Client applications write in Python 3;
  - Code and setups are available in [Github](#).



# Young technologies always include challenges...

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- Performance is probably the main bottleneck
  - Researchers are looking for a manner to make blockchains scalable;
  - Meanwhile, we need to think about blockchains for “small” datasets.
- There are several concerns about the privacy of sensitive data
  - The blockchains philosophy is based on information sharing;
  - PTB is developing important studies regarding the application of homomorphic and functional encryption.
- Platforms are in a maturing process
  - It does not make any sense to create a blockchain from scratch,
    - We need to adopt a standard platform (e.g., Ethereum, Hyperledger Fabric);
  - Platforms are still changing, so applications need to deal with this.

# Conclusions

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- Blockchains is a technology with huge potential
  - Some researchers compare it to the Internet 20 years ago.
- Blockchains-based applications can accelerate digital transformation in Metrology, addressing several aspects related to information reliability, systems integration, and workflows automation.
- An inter-NMI blockchain network can constitute an important initiative to propagate these concepts among metrologists.
  - A common base for developing research ideas;
  - A tool of synergy among different NMIs and their common demands.

# Acknowledgment

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Our achievements are result from a great team work!

- Inmetro
  - Wilson Melo, Raphael Machado, Paulo Nascimento, Lucila Bento, Lucas Severiano, Carlos Oliveira, Ramon Rodrigues, and Luiz Rust Carmo.
- PTB
  - Daniel Peters, Mahbuba Moni, Artem Yurchenko, and Florian Thiel.
- Federal University of Rio de Janeiro
  - André Vieira, and Claudio Farias.
- LaSIGE - University of Lisbon
  - Alysson Bessani



LASIGE



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