Metrology Cloud

WP3: Technology-driven metrological support services

D. Peters
Outline:

- General Objectives
- Partners
- Time Line
- Tasks:
  - 3.1: Supporting Repair and subsequent Verification
  - 3.2: Supporting Software Maintenance / Smart Contracts
  - 3.3: Digital Verification Marking
- Summary
General Objectives

• Transform established procedures in Legal Metrology into the digital domain
• Broader surveillance of meters
• Better planning of the processes and services
• Less down time of the instrument for the user
• Beneficial for market surveillance and verification, notified bodies, manufacturers, and users
• Future maintenance of software in measuring instruments

To develop new technology-driven metrological services: Technological net-based services may include: remote verification and diagnostics, condition monitoring, (predictive) maintenance and verification with the help of the digital representation, i.e. e-market surveillance and e-compliance according to [COM2014/25].
WP3: Partners

Industry:

- Itron
- Gilbarco Veeder-Root
- Espera
- Sartorius
- Bizerba

NMIs:

- PTB
- NPL
- CEM
- LNE
- CMI

Verification Authorities:

Science:

Supported by:

Physikalisch-Technische Bundesanstalt - Braunschweig und Berlin

Nationales Metrologieinstitut
## Work Packages: Responsibility

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## Rough Time Line

### Mai 2018

**WP1: Trustworthy Metrological Core Platform (Nordholz / Neumann)**

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**WP2: Reference Architecture (Oppermann)**

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**WP3: Technology based Metrological Support Services (Peters)**

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**WP4: Data based Metrological Support Services (Esche)**

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Time Line

June 2018

WP1: Trustworthy Metrological Core Platform
WP2: Reference Architecture
WP3: Technology based Metrological Support Services
WP4: Data based Metrological Support Services
WP5: Coordination
WP6: Impact

Convergence

- Platform/QI Demonstrator
- Integration of:
  1. Data bases and Infrastructures
  2. Fundamental Services
  3. Reference Architectures
  4. Prototypes
  5. Existing MI

=> Requirements catalogue

Main Impact:
- Metrological Trust Anchor
- Streamline processes
- Repair / Verify a large number of MI remotely
- Reduce down time
- Harmonize processes
Task 3.1: Support of Repair/Verification

- Pretesting § 37(1) MessEV
- Verification of Parts § 39 (3) MessEV

Types of Requests or Tests to Support Verification:
1. Check protocol, or log files
2. Check system/module integrity,
3. Condition Monitoring / Verification of File Systems
4. Apply Test Data / Test Cases
File-system Checking (Remote Maintenance):

Names:
1: root
2: usr
3: kernel
. 
. 
13: circus

\[ N = \text{rootusrkernel...circus} \]
\[ N_B = 1\ 0\ 0\ 0\ 1\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ \ldots \ 1\ 0\ 0\ 0\ 0 \]

\[ F = \begin{array}{cccccccc}
    a & a & b & b & a & a & b & b \\
\end{array} \]

\[ F_B = \begin{array}{cccccccc}
    0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\
\end{array} \]

\[ L = 7 \quad 8 \]
Task 3.2: Supporting Software Maintenance

Standard Procedure § 40 (3) MessEV, (WELMEC Guide 7.2 Extension D)

1. Update available
2. Conformity of Update and Download Mechanism granted
3. Application/Update granted
4. Ensemble Test
5. Update granted
6. Agreement
7. Update

Manufacturer ➔ Verification Authorities ➔ Notified Body ➔ Samples

User ➔ Instruments in use

Smart Contract

Conditions 1…n ➔ Process ➔ Result
• a **database** in which entries are grouped in blocks
• **blocks** are linked in chronological order
• based on **cryptography** and peer-to-peer (P2P)
• distributed **consensus** systems
• the whole data of the blockchain is stored **redundantly** in each node
• Different approaches like **Proof-of-Work** and **Proof-of-Stake**
Smart contracts are computer programs that can make decisions when certain conditions are met.

Concept was introduced by Szabo in 1996.

Blockchain offers a suitable medium for implementation.

Scripts with the contract details are stored in a specific address of the blockchain.

If the specified external event occurs, a transaction is sent to the address whereupon the terms of the contract are executed accordingly.

A Decentralized Autonomous Organization (DAO) can be defined as a decentralized network of autonomous subjects where both humans and devices can cooperate with each other.

DAO actions are based on rules and processes dictated by smart contracts, as well as ownership relationships that are registered in a blockchain.
Smart Contracts running on Trusted Nodes

Trustworthy Coordinating Platform

- Metrological Administration
- Trust and Security
- Remote Diagnostics
- Digital Representation
- Shared Databases
- Smart Services

Stakeholder Control

Stakeholder → Trusted-Node

**Trusted-Node:**
Trusted Metrological Architecture, e.g. provided by PTB, supervised by MA

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Blockchain Technology

- Blockchain technology is **disruptive** and in its beta stage
- Very **promising**, because **legal metrology** directives and guides formulate many requirements, e.g., parameter integrity for the measuring instrument, durability of measurement result, and possibilities to identify transactions, which can all be fulfilled by a blockchain.
- Examples are an update process, a decentralized audit trail and a PKI system.

**Challenges:**

- Embedded devices should handle the huge amount of data
- Many approaches like **Proof-of-Work** and **Proof-of-Stake** algorithms, or even other technologies, e.g. **DAG-systems, Hashgraphs**
Task 3.3: Digital Verification Marking

• **Compile** the requirements for the support of software maintenance in measuring instruments, combining remove, repair and verification concepts.

• **Evaluate** different concepts for supporting software maintenance with respect to the benefits in Legal Metrology, considering the results of Task 3.1 and Task 3.2.

• **Develop** a prototype of the most beneficial concept for software maintenance in Legal Metrology.

• **Integrate** the concept into the TMC-platform and study its feasibility, industry partners provide technological support.
Summary

Development of a digital representation of the measuring instrument should:
• Contain administrative data, a log file and system model of the instrument
• Collect, evaluate and disseminate data
• Collect and share information of the type of instrument
• Initiates actions if certain conditions are fulfilled

Challenges:
• Digital “support of repair” and “support of verification”
• Exploring the “streamlining of software maintenance” for all stakeholders’ benefit
• Focusing on remote testing module of the logical part
• Initiation of runtime integrity tests
• Test during runtime, like file system test or permanent condition monitoring of the instrument
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