The European Metrology Cloud

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Abstract. While facing an increasingly globalized market place, the ever-increasing drive for efficiency and rapidly developing consumer demands make the successful digital transformation of Legal Metrology unavoidable. This will include the use of contemporary technologies, such as embedded systems, Internet of Things, Cloud Computing and Big-data. There is a need for legally compatible system architectures, digital services and an appropriate infrastructure to benefit the industry, the notified bodies and the market surveillance authorities, by removing barriers to innovation and reducing costs and time to market for new products which use these technologies. This paper focuses on the development of a digital quality infrastructure; the “*European Metrology Cloud*”, designed to support the processes of conformity assessment and market surveillance and the development of reference architectures and new technology- and data-driven services for this infrastructure, fostering the *digital single market* that the European Commission envisions.

1 Introduction

Developing technologies, such as Cloud Computing and Big Data, facilitate rapid changes that can be seen all over the measurement instrument market. The drivers of the change are an increasingly globalized market place and an ever-increasing drive for efficiency and the rapidly developing consumer demands. Products are being loaded on to ships in India and the corresponding legal transaction takes place in the Netherlands; automatic weighing instruments in Indonesia are monitored and controlled from the UK. The significance of this is that the changes and developments are most likely to continue independently of any Legal Metrology framework. External forces are driving them and the solutions to be developed in this framework must recognize this and must not seek to halt or prevent these changes. Instead, they must regulate the development for the benefit of all stakeholders [1]. Information and communication technologies (ICT) contribute not just to innovation in products, but also to innovation in processes and organizational arrangements. Software and IT-Technology will handle everything needed to allow products to be tracked and counted, while greatly reducing waste. According to the industry, it is high time that the opportunities for Legal Metrology inherent in the “Digital Single Market” [2, 3] start to be exploited [1, 4]. Only if the chance to maintain and even extend the central role of metrological IT is embraced, taking on the task of coordinating and promoting the digital transformation of Legal Metrology, will it be possible for all stakeholders (the Industry, the Notified Bodies and the Market Surveillance Authorities) to derive benefits. Otherwise, the typical inhibitors to innovation will continue to impede innovative technological

concepts from entering the market [1, 4]. To this end we propose to set up a digital quality infrastructure; the “*European Metrology Cloud*”, designed to support the processes of conformity assessment and market surveillance, as well as the development of reference architectures and new technology- and data-driven services for this infrastructure (s. fig. 1). This article will propose the necessary steps which the authors think should be taken to achieve this goal.

Fig. 1. Concept of the European Metrology Cloud

2 The European Perspective

The European Commission has been convinced by several studies that an enormous economic benefit could be gained from a digital single market [2, 3]. Hence, the Commission has issued a Digital Single Market Strategy for Europe to push the most essential aspects. These interwoven European initiatives aim at setting up an

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efficient infrastructure to support, for example, Cloud Computing and Big Data as the bases for Smart Services [4]. Within the Digital Single Market Strategy for Europe, Cloud Computing plays a key role through the *European Cloud Initiative*, the *European Free Flow of Data Initiative*, and through the emerging issues related to ownership, access, portability of data, and switching of cloud service providers [5]. The "*European Cloud Initiative – Building a competitive data and knowledge economy in Europe*" [6] aims to strengthen Europe's position in data-driven innovation, improves its competitiveness and cohesion, and helps create a Digital Single Market in Europe. As part of the package of measures for digitizing Europe's industry, the Commission has outlined a new strategy on Big Data, supporting and accelerating the transition towards a data-driven economy in Europe [7]. According to the EC-Cloud initiative, a data-driven economy will stimulate research and innovation on data-driven technologies, while leading to more business opportunities and an increased availability of knowledge and capital, in particular for SMEs across Europe [7]. The impact of these initiatives is already palpable in areas where innovations are subject to legal control, e.g. to ensure a certain level of quality and market acceptance of products. Such a field, where manufacturers and legal authorities are working closely together to reach mutual objectives, is Legal Metrology [8].

Seizing the chances of digitalization could resolve existing obstacles for innovation within the quality infrastructure set up by Legal Metrology and foster Legal Metrology's digital transformation. This will be beneficial for all collaborators in this area, while make Legal Metrology fit for the digital age. In the following, the required actions to reach this aim are identified and justified.

2.1. Inhibitors to Innovation in Legal Metrology

Manufacturers often consider regulations as an "inhibitor to innovation", due to the following reasons: Regulations are considered to increase the time to market. The costs for the requested IT security are not considered to be justified. A technology gap between manufacturers, the Notified Bodies and/or the Market Surveillance Authorities can be identified, i.e. the authorities are not acting on "eye level" with the manufacturers (or vice versa). It is felt that the authorities refuse innovative solutions and "bend" them to squeeze them into known concepts. Also, it is claimed that Notified Bodies require too much security or, on the contrary, do not require a sufficient security level. Additionally, the manufacturers complain that there are no actual harmonized processes in Europe, i.e. they feel that there is no coherency in conformity assessment and verification of measurement instruments in the field and no unified quality standard exists in the European single market.

3 Digital Transformation of Legal Metrology

The urgent needs of the manufacturers and the technological possibilities provide the guiding objectives that the European approach described here will address, whilst guaranteeing transparency appropriate for conformity assessment and market surveillance in an increasingly globalized economy [1, 4]. The authors propose a European virtual quality infrastructure, based on the possibilities that "measuring instruments of the future" will offer, incorporating the potentials of the existing distributed infrastructures and databases, and aiming at improving the coordination in Europe by technology- and data-driven Legal Metrology services.

The overall objectives of this proposal are the development of a quality infrastructure for data and reference architectures for new technology- and data-driven services for Legal Metrology, to foster the aims of the European Commission to establish a digital single market [2, 3]. This considers the needs of all stakeholder groups in Legal Metrology: Industry, Notified Bodies and Market Surveillance Authorities (see Fig. 1).

To achieve this, the following actions are proposed:

3.1. Join Infrastructures and Databases

To reduce the administrative burdens for businesses [3], and to expedite and harmonize the administrative process of conformity assessment and market surveillance, a digital quality infrastructure for European Legal Metrology needs to be developed that aggregates existing IT infrastructures and databases of the partners (Industry, Notified Bodies and Market Surveillance) towards a Legal Metrology Grid. For the interoperable interconnection of infrastructures and databases a secure and trustworthy "core"-platform needs to be established in every member state. A blueprint for the member states' platforms will be developed which serves as a communication and service platform rather than a data dumping environment (see Fig. 2).

Fig. 2. Concept of the trustworthy core platform for the member states.

3.2. Reference Architectures

The industry and the notified bodies alike have voiced the need for the provision of broadly applicable

reference architectures for new, complex technologies such as Cyber-Physical Systems, the internet of things (IoT) components, Cloud Computing or Big-Data processing (see Fig. 3). These architectures will be the key elements of the future European digital quality infrastructure, fulfilling the “essential requirements” of European legislation on Legal Metrology and offering adequate security and easy verification of such technologies for market surveillance and verification authorities.

Fig. 3. Technology Stack of future metrological IoT-systems and the architectural needs to be fulfilled by the reference architectures for each level.

3.3. Streamlined and New Metrological Services

Based on the latter steps, new technology- and data-driven metrological services could be developed. Net-based services may include remote verification and diagnostics, condition monitoring, (predictive) maintenance and verification, i.e. e-market surveillance and e-compliance as suggested by the European Commission [3]. To realize these services, the concept of the “digital twin” known from the Industrial Internet may be used. An administrative shell containing descriptive information of the individual measuring instrument may be hosted within digital quality infrastructure and accessed by all authorized parties.

The hundreds of millions of measuring instruments used in the EU single market create enormous data volumes over their life-cycle in separated data bases. Smart merging of these sources will create a metrological data lake from which new data-based services (smart services) could be derived [2] for the stakeholders to simplify the existing regulated processes.

3.4. European Centre of Excellence

Establishing a European center of excellence for metrological information technology to be constituted by experts from all stakeholder groups is the final step. These experts will take on relevant technological and legal issues surrounding new technologies and coordinate metrological services in Europe (e.g. by subcontracting). The main objectives of this center will be to strengthen the cooperation within Europe and maintain and advance the developed metrological infrastructure.

Finally, the developing digital infrastructure will contribute its findings to the key European and International Standards Developing Organizations in Legal Metrology (the European Cooperation in Legal Metrology (WELMEC) and the International Organization of Legal Metrology (OIML)). The entire concept described here is designed to keep informed the standardization committees about its progress, parallel to its evolution. In this way, both committees - WELMEC WG 7 and OIML TC5/SC2 - will be actively involved and will be able to recommend further steps or investigations, to make the results even more beneficial for all partners.

4 Impact

The envisioned short-term impact of this project is the aggregation of existing data infrastructures of all stakeholders and the creation of a realistic concept for a pan-European IT infrastructure for Legal Metrology. The goal in doing so is to overcome the known obstacles in Legal Metrology described in Subsection 2.1, including the lack of a trustworthy core platform (see Fig.2).

The core-platform is designed to fulfil functions such as the confidential transfer of information between authorized partner organizations and systems. This will realize an initial quality infrastructure for data to prove the feasibility of the approach and to allow other infrastructures to join easily. Concurrently, reference architectures will be made available for the highest-priority technologies, such as IoT devices, Cloud Computing and testbeds for ecosystems that are needed for intelligent meters. Based on these reference architectures, metrological IT services will be made available, such as remote verification and maintenance of measuring instruments (to name only a few of many possible services). Data obtained from the administrative shell of each individual measuring instrument in service (and of all instruments of the same type) throughout its life cycle will be used to provide smart, data-based metrological services to stakeholders with the aim of optimizing administrative processes. These architectures and services lay the basis for the advancement of the quality infrastructure created within this project.

Furthermore, the European center of excellence will be established, where any stakeholder involved in Legal Metrology can receive advice and support on IT-related questions and processes. This center will also provide services for conformity assessment of advanced technologies. After an initial three-year phase, the concept for a pan-European IT infrastructure will be expanded by incorporating further existing infrastructures and, where possible, amended to include new opportunities presented by the developed reference architectures and the technology- and data-based metrological services. The developed concepts will be transferred to the standardization and harmonization committees of WELMEC and OIML (WELMEC WG 7 and OIML TC5/SC2), who in turn will establish them as

technological standards. By doing so, beneficial concepts and findings will be made available internationally.

4.1. Impact at the European Level

The European center of excellence for metrological information technology will provide forensic support by analyzing complex incidences in the market, provide support for the evaluation of contemporary security risks within Legal Metrology and therewith provide a unified quality level across Europe. For improved impact, research activities for contemporary technological IT challenges, such as Cloud-Computing Services, software defined networks, network function virtualization, security issues or Big Data for measuring instruments will be coordinated on a European level at this center. The European industry may use the results of the research as support when new measuring instruments and measuring systems are to be designed.

5 Conclusion

Technologies such as embedded systems, the internet of things (IoT), cyber-physical systems, cloud computing and big-data concepts have evolved significantly over the past ten years. These technologies have converged to form completely new fields such as the industrial internet and smart services. The resultant technology – and data-based opportunities, if exploited, could benefit all stakeholders in Legal Metrology – for example, by reducing costs, removing typical barriers to innovation and expediting the time to market for new products.

The concept proposed here focuses on establishing a data infrastructure for European metrology using a trustworthy “core”-platform in the member states; this “European Metrology Cloud” is designed to support the processes of conformity assessment and market surveillance. The concept also focuses on developing new technology- and data-based metrological services for this infrastructure to promote manufacturer innovations and support harmonization in Europe.

In this way, the European Metrology Cloud directly addresses the main inhibitors to innovation, brings together all European partners, supports capacity building in Europe and fosters the digital single market the European Commission envisions.

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