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**PROBLEMATIC ASPECTS OF METROLOGICAL SUPPORT IN  
CONTEXT OF DEVELOPMENT OF DIGITAL ECONOMY**

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**Abstract**

The current problems of introduction of metrology into the digital economy are studied in the article. A review of publications of various authors on the stated topic confirms the great interest paid to this problem in the scientific community. The article analyses the objectives of metrology to ensure the traceability of measurements during the transition to the digital economy. The result of the analysis is the conclusion that in the modern conditions of globalization of the economy, especially in the field of digital communications, when working with global databases, a prerequisite for success is the use of metrology. Entering the international market and maintaining a high level of economic development is often provided by the services of a quality infrastructure, including measurements (metrology). The objective of any state government is to create the necessary conditions for this. In Russia, work on the digitalization of metrology and the modernization of the used measurement mechanisms is continuing.

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## 1. Introduction

Measuring tools penetrate through the modern science and production processes, because in order to fulfill the assigned tasks while ensuring large-scale industrial cooperation, a constant assessment of the compliance of all specified parameters of products and services at all stages of the life cycle is required. And this, in its' turn, requires the unity of measurement processes.

It shall be noted that in recent years, the number of measuring tools has increased exponentially. This fact is the main requirement for the development of digital transformation. Russian metrology sets a key task for the development of new and improvement of existing measurement standards. On the example of Germany, the positive trend in the use of legal metrology can be well traiced: "More than 50% of the tax revenue in the German economy comes from measuring processes carried out by various metrological tools." The National Metrology Institute in Germany is conducting research on the development of an "information cloud" - a kind of prototype of the only digital resource that provides communication between all members of the process.

## 2. Problem Statement

Metrology in its development passes through four planes: organizational, methodological, legislative, technical. The highest degree of progress cannot be achieved without a sufficient level of the rule of law state, without the necessary training of personnel, without standards and international support. The developed methods and means of remote automated verification, created high-precision measuring instruments, implemented devices of reference methods, virtual fields of physical quantities, broadband communications, and the introduction of BigData are an important components of the technical side.

Listing the main tasks that the scientists of the state scientific metrological institutes of Rosstandart are faced for many years and that arising during analysis of domestic metrology, then the following shall be mentioned (Donchenko, 2018; Golikov, 2009):

- creation of an infrastructure for digital calibration certificates (so-called "metrological cloud"), a generalized digital transformation of metrological services.
- development of methods for analysis of many data bases and training using machines for BigData (for metrology analysis of multiple databases);
- measurement of new generation communication systems such as 5G;
- self-calibration and self-adjustment of intelligent measuring tools;
- metrology for simulation and virtual tools.

Not only international cooperation is needed for the digital economy in order to exist and develop, but also the removal of barriers to trade, and the most important condition is availability of one metrological unity.

### 3. Research Questions

Social, economic and industrial changes will occur constantly due to the fact that science does not stand static. In recent times, another wave of transformation of business models has occurred. This wave is caused by the new X digital technologies, such as artificial intelligence, wireless technology, robotics, cyber-physical systems, etc. The introduction of these technologies will increase labour productivity in production. In this case, digital transformation as an obligatory attribute of their development, and it needs metrological support of the entire set of measuring tools and prospective metrology, the basis of which will be the forecast of the measuring demand (Ivanov, 2015). The international competitiveness of an individual company, and even an entire country, will require in the near future not only the development of the latest digital technologies, but also their local use.

### 4. Purpose of the Study

In Russia, in accordance with Article 1 of the Federal Law “On Ensuring the Traceability of Measurements”, the sphere of state regulation of ensuring the traceability of measurements extends to measurements performed in the implementation of many types of activities related to the infrastructure elements of the economy. Currently, there is no high-tech and science-intensive field of activity that does not use the results of high-precision measurements.

The President of the Russian Federation Vladimir Putin signed the Federal Law No. 523-FZ dated 30.12.2020 "On Amendments to the Federal Law" On Standardization in the Russian Federation ". Standards of this law establish the priority of electronic registration of the results of verification. This law also describes the all types of measuring tools. The prescribed registration will become an unconditional legally significant confirmation of the consequences of metrological work. The results of the metrological study will not be taken into account if the information is not transferred to the Federal Information Fund for Ensuring the Uniformity of Measurements. A certificate in hard copy will be issued only if it is requested by the customer, and in this case it will be used as an additional information.

The federal state information system "ARSHIN" operates in conjunction with the Federal Information Fund for Ensuring the Uniformity of Measurements. This system gives access to Russian regulatory legal acts, international documents, the list of measuring instruments in state regulation (Digital transformation in Russia: 2020 results and development prospects, 2021; Filippo, 2018; Panshin, 2016). The measurement methods that have passed certification, standards recognized by the state, various samples of standard procedures, the results of the verification of measuring instruments can be studied.

In the future, it is possible to work out the FSIS "ARSHIN" for synchronous work with the systems of other ministries and departments. For example, with the GIS of Housing and Communal Services of the Ministry of Construction of Russia in order to distribute a notification to the owners of metering devices that the validity of the check has expired and to avoid the need to transfer information to the company management. As well as with the Federal State Statistics Service of the Federal State Accreditation Agency in order to conduct direct monitoring over the status of the organization and provide the information about organization reference base. And in the future, to facilitate the use of resources, it is planned to merge it with the Portal of State Services and to create a separate mobile application.

The advanced development of the system for ensuring the traceability of measurements as one of the most high-tech spheres of the economy shall have a stimulating effect on the development of its other elements and help Russia achieve a high level of economic and social development, corresponding to the status of the major global power of the XXI century.

## 5. Research Methods

The needs of society and the economy, requiring the development of measuring technology, compliance with primary standards, can be traced while studying the strategies of national programs for the development of the production sector, reports of the International Bureau of Weights and Measures.

Upon receiving the data, it is possible to indicate the subsections of the measuring technology. Their sustainable development makes it possible to provide an increased level of the management system for all production operations and life cycles of the products manufacturing, followed by its metrological study.

The integration of a number of breakthrough technologies, such as virtual simulation, robotics, databases, the Internet of things, artificial intelligence, cloud and edge computing technology, predictive analytic, involves the digitalization of metrology.

The technology of "digital twins", the ability to analyse big data for making automated decisions, assessing various scenarios, using digital platforms for remote access, reducing the cost of technological solutions are the primary steps for the widespread entering of digital technologies into metrology (Digital transformation of metrology - five objectives of Rosstandart (Digital trends of 2018: the biggest research of the Internet, social networks and electronic commerce, 2021; Federal Agency on Technical Regulating and Metrology, 2021).

For digital transformation and advanced development of metrology, it is necessary:

- analysis of the real needs for information contained in the field of metrology shall be conducted. It is necessary to take into account the requirements for the content of the material, for what period of time these reports will be available. And the most important is to ensure that the economic side is clearly and competently calculated (all financing options, the amount of necessary financial resources for providing this information);
- already existing classifiers, metrology catalogs shall be updated. Without this procedure it is impossible to assess the likelihood of using the database and register;
- all the regulatory and methodological aspects of the supply process of informatization in the field of metrology shall be studied;
- modernization of instructions for measurement, calibration, verification based on the experience of scientific achievements in the field of measurement technologies shall be carried out;
- develop methods for remote calibration and verification and test them in practice;
- work on conformity of all measuring instruments shall be carried out;
- boundaries and capabilities of the Federal Information Fund shall be expanded while maintaining the uniformity of measurement procedures in the processing and presentation of information.

Rosstandart is actively working to ensure the digital transformation of Russian metrology. For example, there is an occurred "single window" service for those who use the services of the CSM through the digital service "Kto poverit" (Who will verify). Rosstandart conducts an exchange of companies' databases for vehicles (Auto.ru and Autoteka) that are used by buyers to control vehicles by VIN number. Information systems such as "Beresta", FSIS "Arshin" and "Kontur" have been developed and implemented.

The transition to digital availability of an extensive measuring park is the first action. Then work on the digitalization of metrology itself shall be carried out. The modernization of the used measurement mechanisms will become inevitable. New realities will also dictate changes in the rules of metrological procedures, and as a result, new standards that will regulate the metrological procedure will be developed and implemented widely. The science of "metrology" will take a course towards the convenience and simplicity of carrying out metrological services, reducing the prime and overall costs of metrological procedures (G20 DETF, 2016; Skilton, 2015). However, the concentration of metrological services in modern realities will only expand. It is dictated by the latest metrological technologies and various standards of control and regulation. This is the primary task for Rosstandart in the near future.

## 6. Findings

Digitalization of metrology will affect the following aspects:

1. Support and regulation. There are a number of regulatory issues that still need to be addressed. The regulation of high-tech industries today is largely dependent on specialized communities, which in one way or another determine the standards. At the same time, today no regulator in the world has all the necessary experience to develop the relevant standards and approve them alone. Within the framework of the policy in the field of the digital economy in Russia, it is planned to actively use the regime of "regulatory sandboxes", which can allow companies whose profile is the development of financial proposals, services, products, to conduct tests for their approbation without violations of the law. An example of the latest developments in the field of financial products is biometric banking authentication, insurance technologies (in particular a sensor that takes into account the owner's car driving model during calculation of the insurance premium).

2. Reference standards. Any manufacturing process begins with measurement accuracy, and the requirements for accuracy become more rigid. Big data measurements are one of the most important directions in the development of metrology as an essential condition for the creation of high-tech products. The field of measuring technology and metrology, as one of the structural components of the entire modern economy, is inevitably involved in the ongoing changes. On the one hand, advances in technologies for generating, transmitting, processing and storing digital information open up new opportunities for developers of measuring equipment and metrologists, and on the other hand, the introduction and development of "smart systems" and digital models requires the development of fundamentally new approaches to ensuring metrological reliability of instruments and standardization of measurement techniques.

3. Unified information environment. The most important task of improvement of the information basis for ensuring the uniformity of measurements is to create a unified information environment with free access to information databases. This will make metrology more open, stimulating the adaptation of open access and collaboration practices through new digital tools, and will significantly reduce the time and material costs for information accessing, collecting and processing.

4. Intelligent measuring instruments. According to Russian metrologists, one of the results of digital transformation will be equipping of all measuring instruments with sensors and providing them with means of connection to telecommunication networks in order to transfer information to a single information base. It means a significant increase in the number of "smart" measuring instruments and measuring systems. As soon as a measuring device equipped with a computer, or even a sensor, is connected to the communication network, the measurement result can be immediately used by all users around the world. An intelligent sensor is an adaptive sensor with a metrological self-monitoring function, which has a digital output and provides the transfer of primary measurement information and information about metrological serviceability status through the interface. It is also considered that metrological diagnostic self-control is the most promising, it monitors deviations of the diagnostic parameter characterizing the critical component of the error from the reference value of this parameter (Morozova et al., 2020; Vasilev et al., 2020).

5. Digital models. Digital models are a combination of a computer, universal hardware I/O signals and software that determines the configuration and operation of virtual measuring instruments. For the widespread introduction of digital models, it will be necessary to create a state system that provides: testing of digital models; maintaining a register of digital models; certification of personnel and accreditation of organizations for the right to use digital models for forecasting and managing real objects and processes.

6. To ensure the traceability of measurement results, it will be necessary to create new standards of units of quantities, reference measurement techniques, new approaches to ensure the traceability of measurement results of virtual measuring tools.

7. Remote verification and calibration of measuring instruments. Reducing the costs for staff business-travel, delivery of measuring instruments, expensive equipment and reference standards are certainly attractive factors. They contribute to the promotion of the idea of remote verification /calibration. Verification /calibration in this case is carried out from anywhere and in any laboratory that has the necessary equipment, using remote connection and instrument control. The scenario is executed without the possibility of deviation from the methodology, which means that the principle of traceability of measurements is implemented.

8. Training of workers to digital skills. Now the work of a metrologist, under the influence of digitalization and automation, is turning from manual labour into a operator labour. It is largely determined by both knowledge of how measurements are made and knowledge of programming skills.

9. The international cooperation. International cooperation for the development of the digital economy shall consist not only in the removal of metrological trade barriers, but in the formation of a single metrological space. So, to improve navigation systems like GPS, GLONASS and GALILEO, it is necessary to further improve the accuracy of atomic clocks and create means of their comparison all over the world. Entering the global market and providing the economy are always supported by the services of a quality

infrastructure that includes measurements (Akhmetshin et al., 2018). The World Trade Organization pays great attention to standards and mechanisms for ensuring the traceability of measurements. In addition, metrology is at the forefront in the conditions of coronavirus pandemic. Russian experts are interested in a dialogue with European colleagues on ensuring the traceability of measurements in the process of digital transformation of the economy, since digitalization in Europe is already quite developed.

## 7. Conclusion

Thus, the transition to digital technologies helps to strengthen the competitiveness of the national economy. The directions of development of metrological support in the digital economy are becoming the subject of active discussion at the world's leading venues. The success of the development of "digital metrology" directly depends on how it meets the new requirements.

The main challenges in formation of the digital economy are to maintain quality of measurements and trust to their results. With regard to the quality of measurement, it is about the provision of services with high accuracy of measurements using modern means and methods, the development of new standards and methods for analyzing new data, ensuring the confidence of consumers of these services. As for the role of metrology in supporting the industrial sector, it shall be understood that in the modern conditions of globalization of the economy, during work in the field of digital communications with big data, it is impossible to work without metrology, while the cost of metrological support shall decrease with a simultaneous increasing of the quality of such services. This is a key task that Russia will work on in the near future.

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