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METROLOGY OF THE DIGITAL ECONOMY: SYNERGY OF TECHNOLOGY AND INNOVATION

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Abstract

The creation and development of innovative metrological infrastructure is a priority today. Metrology and metrological support are the types of activities without which it is impossible to introduce innovative technologies. At the same time, the reliability and accuracy of quantitative measurement results of innovative technological solutions is insufficient due to the limitations of the metrological support system for these types of measurements. The constant increase in the level of requirements for metrological support of innovative solutions should be balanced by the introduction of new metrological technologies and methods of regulation and control. Digitalization of metrology is a key trend, which includes the creation of a "metrological cloud", metrology for BigData, metrology for 5G networks, intellectualization and virtualization of measurements. Digitalization of metrological support in the infocommunication industry is becoming relevant for other industries as well. To ensure the uniformity of measurements in the field of innovative technologies, it is necessary to analyze and further develop a system of metrological support for innovative technologies, as well as mechanisms for predicting the need for the development of metrology and metrological support to reduce the time spent on setting up innovative products for production and accelerate the process of mastering innovative technologies. By creating an evidence base that serves as a tool for confirming all the technical characteristics of innovative products and services, metrology and metrological support contribute to the innovative development of the economy.

Keywords: Metrology, metrological support, virtualization

1. Introduction

Metrological support plays a key role in ensuring the success of the business of many companies in various sectors of the economy. The quality of products and services provided directly depends on the metrological support. The more attention a company pays to metrological issues, the less it incurs the costs of eliminating the consequences of selling low-quality products. In quality management, the task of creating competitive products in effective ways is solved by applying the methodology of continuous improvement. This leads to product and process innovation in organizations (Alekseyev et al., 2017). And, as a result, investments in improving the used measuring equipment pay off quite quickly.

Most of the world's leading communication service providers are currently virtualizing their networks, or parts of their networks (Efimushkin et al., 2015). This virtualization significantly affects test and measurement solutions. The achievements of microelectronics, the emergence of productive and cheap microcontrollers, a wide range of sensors, as well as the development of software development tools and innovative technologies, have created the basis for the digitalization of metrology and made it possible to move measuring instruments to a fundamentally new level – in a virtual environment.

2. Problem Statement

Traditional measuring instruments are primarily hardware solutions with some part of the software code. They can also be called hardware and software tools, focusing on the first word. At the same time, the software part of the equipment has, to some extent, auxiliary functions-it provides some post-processing of the measurement results and their display on the display means. This approach has its advantages, since due to the hardware implementation, high measurement accuracy and repeatability of the results are provided. However, if you look at the "hardware" of measuring instruments in a complex, then their use may not be economically profitable for the following reasons:

- limited range of types of measurements;
- difficulties with the integration of measuring equipment into automated measuring systems;
- linking to a specific location;
- redundant functionality (for example, when using measuring instruments equipped with display devices, in the case of obtaining results in automatic mode).

All this can lead to the need to purchase a whole range of measuring instruments instead of a single universal device with flexible capabilities. In addition, "scientific and technological progress requires ensuring the uniformity of measurements, both in individual countries and internationally" (Makarov et al., 2020, p. 490).

3. Research Questions

The research is devoted to the analysis of metrological support of innovative technological solutions, as well as to the creation of innovative metrological infrastructure. The analysis of trends in the

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development of innovative technologies was also carried out. During the research, the issues of digitalization of various industries were considered.

4. Purpose of the Study

The purpose of the study is to obtain results that will allow us to develop recommendations for creating a system of metrological support for innovative technologies. Currently, research and production organizations are equipped with modern measuring instruments designed to solve the problems of assessing the compliance of the parameters of high-tech products at all stages of the life cycle, including to ensure production cooperation. Therefore, such requirements as improving the accuracy, reliability, objectivity and comparability of measurement results used in various fields of activity come to the fore, "first of all, in the areas related to improving the quality of life, the development of new technologies, as well as defense and security" (Shuvalov et al., 2016, p. 191).

5. Research Methods

5.1. Analysis of digitalization trends in various industries

Most modern telecommunications companies strive to minimize their capital costs and operating costs by introducing new innovative technologies to increase the dynamism of production processes, increase network capacity, increase the autonomy of equipment and systems, etc. As networks become virtualized by moving various network functions to the cloud, 5G technology can be used to automate the processing of large amounts of data received from multiple sources in a complex distributed network architecture. This automation and virtualization will allow services to scale and introduce new technologies such as artificial intelligence and machine learning with higher throughput. At the same time, 5G technology is becoming increasingly popular for testing and obtaining measurement results for wireless devices and products that include virtualization and automation.

The number of connected IoT devices in various industries, such as transportation, medical equipment, and home appliances, will continue to grow. This trend is simultaneously causing a growing need to test and verify devices with measurement functions and other equipment to ensure their proper operation. Continuous monitoring and IoT technologies collect and analyze data in real time, which contributes to improving processes, increasing efficiency and security.

5G technology is not only "the accelerator and the main trend in the development of mobile telecommunications for the next decade" (Tikhvinsky, 2018, p. 48), but also takes on the role of a base for the introduction of new innovations in autonomous cars, industrial and commercial vehicles and factory equipment, where it is necessary to quickly receive, analyze and process significant amounts of data. With very complex electronics and higher computing power in production, there is a growing demand for complex modeling, testing, and measurement tasks.

IoT devices often require high measurement accuracy and the ability to collect large amounts of data. Testing and measurement in this case is becoming increasingly important to ensure reliability, performance, and quality.

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In data centers (data centers), there is a growing demand for electronic test and measurement equipment to solve problems related to network operation and operability, real-time analytics, and troubleshooting. As bandwidth requirements increase, new standards and higher data rates may lead to the need for high-speed digital test equipment.

In addition, because 5G data centers are used to provide higher data rates with lower latency than previous cellular standards, data center equipment uses more powerful Ethernet transceivers and interfaces that require a different level of testing, measurement and monitoring.

The continuous growth of data traffic often leads to the transition from large data centers to modular, which usually requires testing and monitoring of the data center at the component level. In this case, "testing and tracking errors in the program code becomes less complex, due to the fact that there is no difference between running the application locally and running the application on the server″ (Evseev & Zenyuk, 2018, p. 31). This in turn is leading to edge computing, where most of the functions important to end users are computed closer to the consumer rather than sent to the cloud. The resulting latency reduction enables real-time network analysis, analytics and troubleshooting on the end-user device.

5.2. Virtualized environments

Network Function Virtualization (NFV) was launched in 2016 (Shalaginov, 2017). Large companies such as Deutsche Telekom, Telefonica, China Mobile and AT&T have brought their solutions to market. But the operators ran into problems in terms of testing and measurements. For example, virtualized environments have more variables than physical environments. Each of these variables affects the system and the measurement result. For metrological purposes, it is necessary to set as many variables as possible, changing only a few parameters from one test to the next. In this way, the test equipment can match the changes made by the system under test to the results provided by the test tool. The smarter the tool, the better it can handle the complexity of the system under test.

Most of the modern virtualized testing tools on the market come in the form of virtual machines that can work with various types of hypervisors. Moving to containers is expected, where the vendor supplies the container with the test agent rather than the entire virtual machine.

Currently, the infocommunication industry is at a turning point, when physical network functions still remain, but at the same time new virtual functions are being introduced. Both functionalities require end-to-end management, which is provided through physical and virtual elements. This fact creates significant difficulties and problems. In addition, carriers need to be able to manage their hybrid networks as they scale.

6. Findings

The deployment of virtualization has made network monitoring and management more complex due to the dynamic nature of virtualization. Virtualization results in the network being disaggregated into a much larger number of components than make up virtual services, including physical machines, compute nodes, virtual machines, and virtual networks. In addition, the components of a virtual service can change

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dynamically, which makes it difficult to ensure that the service works, as well as to track the parts that make up the virtual service at any given time.

As an alternative to hardware and software measurement tools (MT), there are software and hardware measurement tools (SHMT), in which the main emphasis is placed on the intellectual component, that is, on the software solution. These measuring instruments are devoid of some of the above disadvantages. However, at the moment they cannot compete with traditional MT in terms of accuracy and repeatability of measurements.

As a rule, the basis of software C is a universal computing platform, which is equipped with a rich range of external interfaces. The measurements themselves are performed by standard sensors connected to it. The main processing is carried out already at the level of the microprocessor.

One of the varieties of SHMT is virtual measuring instruments (VMI), which were "legalized" by the State standard back in 2013 (State Standard 8.818-2013, 2013). According to the mentioned document, the VMI is a "measurement tool implemented on the basis of a universal computer and additional software and hardware tools, in which the composition and operation of software and hardware tools can be changed by the user, and standard user interfaces are used to control the measurement process and/or display their results."

With the arrival of "container" technologies for the deployment of software for virtual measuring instruments, additional areas of application open up (Efimushkin & Sazonov, 2020).

Advantages of software (virtual) MT:

- no binding to specific hardware platforms;
- relatively easy to distribute and update software;
- the ability to easily integrate into measurement systems;
- the ability to install on relatively cheap computing tools by eliminating physical controls (toggle switches, knobs, switches) and means of output of results;
- the ability to use mobile devices (smartphones, tablets, etc.) as a means to control the device and display the results.

However, it should be noted that software measurement tools also require special attention from the point of view of information security. The ease of updating the software, the possibility of network distribution of "measuring" functions, require protection against unauthorized interference in a metrologically significant part of the software (State Standard 8.883-2015, 2015). Alternatively, it is possible to use digital signatures and automatic software integrity monitoring before launching the corresponding functions. A separate issue is ensuring the immutability of the measurement results, which are stored in electronic form. There may be several options. For example, using the same digital signature or using hash functions to control the integrity and immutability. You can also encrypt the data.

It should be noted that it is not yet possible to completely abandon traditional means. This is especially true in areas where ultra-high accuracy or speed of measurement is required. But progress does not stand still with the possible emergence of computing platforms with integrated reference sources in the near future. Some companies, especially telecommunications companies, may soon transfer their MT to the virtual world.

7. Conclusion

Metrological solutions for virtualized networks differ significantly from traditional hardware solutions. They require various components that must be developed for virtualized environments. The whole concept of software-defined network virtualization and network features is to make services and applications available on demand, and scale without compromising quality, performance, or user experience. But it is thanks to virtualization that you can provide end-to-end measurements for all key components: networks, services, and subscribers. In addition, metrological solution providers do not just focus on testing virtual networks, but virtualize their solutions to reduce costs, increase efficiency, and expand functionality on the software side that is not available in hardware solutions. Metrological solution providers must maintain a wide range of network configurations as efficiently as possible, ensuring consistent quality and reliability. It is assumed that virtual testing will provide the same efficiency and reliability as hardware testing; the goal is to achieve the same level of results in software testing that was available in hardware testing. Since network function virtualization aims to automatically scale and self-repair the network, integrating metrological functions into the network management infrastructure will be critical, leading to innovative changes in testing functions.

References

Alekseyev, A. L., Blatova, T. A., Makarov, V. V., & Shuval-Sergeeva, N. S. (2017). Kachestvo i innovacii: integraciya upravleniya [Quality and innovation: management integration]. *Issues of radio electronics, 1*, 85-89.

Efimushkin, V. A., & Sazonov, A. S. (2020). Ispol'zovanie tekhnologii kontejnernoj virtualizacii v sovremennyh izmeritel'nyh sistemah [The use of container virtualization technology in modern measurement systems]. *Proceedings of the TSNIIS*. St. Petersburg Branch, *1*(9), 7-23.

Efimushkin, V. A., Ledovskikh, T. V., Korabelnikov, D. M., & Yazykov, D. N. (2015). Obzor reshenij SDN/NFV zarubezhnyh proizvoditelej [Overview of SDN/NFV solutions from foreign manufacturers]. *T-Comm-Telecommunications and Transport*, *9*(8), 5-13.

Evseev, P. G., & Zenyuk, K. A. (2018). Kontejnernaya virtualizaciya. preimushchestva i nedostatki [Container virtualization. advantages and disadvantages]. *In Technocongress*, 30-32.

Makarov, V. V., Blatova, T. A., Fedorov, A. V., & Budagov, A. S. (2020). Metrology In Ensuring the Quality Of Products And Services In Digital Economy. *In European Proceedings of Social and Behavioural Sciences EpSBS*, 490-498. https://doi.org/10.15405/epsbs.2020.10.03.55

Shalaginov, A. (2017). NFV: sostoyanie i perspektivy [NFV: status and prospects]. *The First Mile*, *3*, 58-66. [in Rus.] https://doi.org/10.22184/2070-8963.2017.64.3.58.66

Shuvalov, G. V., Minin, O. V., Minin, I. V., Zonova, A. D., & Romasko, S. V. (2016). Klyuchevye aspekty Strategii obespecheniya edinstva izmerenij v Rossijskoj Federacii do 2025 goda. [Key aspects of the Strategy for ensuring the uniformity of measurements in the Russian Federation until 2025]. *Interexpo Geo-Siberia*, *5*(1), 191-199.

State Standard 8.818-2013. (2013). *State system for ensuring the uniformity of measurements. Virtual measuring instruments and virtual measuring systems. General principles.* https://docs.cntd.ru/document/1200104267

State Standard 8.883-2015. (2015). *State system for ensuring the uniformity of measurements. Software of measuring instruments. Algorithms of processing, storage, protection and transmission of measuring information. Evaluation procedure*. https://docs.cntd.ru/document/1200121090 [in Rus.]

Tikhvinsky, V. O. (2018). Tekhnologii 5G–bazis mobil'noj infrastruktury cifrovoj ekonomiki. [5G technologies are the basis of the mobile infrastructure of the digital economy]. *Telecommunications*, *3*, 48.