Analysis of barriers to the development of Industrial Internet of Things technology and ways to overcome them

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Abstract. As is known, in 2019 the national program “Digital Economy of the Russian Federation” was launched. In the first phase, nine roadmaps were developed, of which six were approved by the Prime Minister. Participation in the development of these roadmaps provides a fresh perspective on some particular problems. The authors reveal some details of the approach to the implementation of the "Industrial Internet of Things" direction. Some specific differences of the industrial Internet from the regular Internet are discussed using examples. Some conclusions are drawn about the directions for further research in this area.

1. Introduction
This paper provides an additional look at the problems of creating new end-to-end technologies using the example of the Industrial Internet of Things (IIoT) technology [1, 2]. It is advisable to pay attention to the barriers to the creation of these technologies. The roadmaps talk about development, but, apparently, in most cases it would be more correct to talk about their creation. This is fully true for the industrial Internet of Things.

2. Statement of the problem
The Internet of Things is the solution to all real, not virtual, problems using Internet technologies. The Industrial Internet of Things means the same when applied not to everyday tasks, but to industrial production. The difference between the industrial Internet of things and the usual one is approximately the same as the difference between an industrial computer and a personal computer, which is intended only for office work. This understanding is not always available even at the highest levels of the organization of these works. This article discusses some specific examples and provides recommendations for the development of these technologies.

For example, let us compare how research and development work should differ from experimental design and serial production of innovative products.

Research works prove the theorem on the possibility of creating at least one sample of a new type of device. In this case, individual elements of the product can be created in any way, including the technology of their creation may be unknown to the creators of a common device, for example, it can
be ready-made assemblies from another technical device. For example, to create a laser device for cutting donor tissue using a semiconductor laser at the Institute of Laser Physics SB RAS [3], the mechanical parts of the plotter were used, but due to the additional laser system for accurate measurement of the position of the writing head and due to feedback, the position of the writing unit was controlled much more accurately than a traditional plotter. Also, instead of the writing unit, a semiconductor laser was installed with a power control circuit and an interferometer for measuring distance. Thus, a device was created that can accurately measure the profile of donor tissue, using software, this allows you to create a three-dimensional map of this profile. Next, the software calculates the optimal cutting of this tissue for cutting out the elements of the heart valve. After that, the laser head cuts the donor tissue, cutting out all the necessary elements of the artificial heart valve. Such a development does not allow launching mass production, but demonstrates that the idea is workable, and that its effective solution is in principle possible.

Research and development requires the availability of technical documentation that ensures the production of all components of the product, or, if the products are purchased, agreements are required on the appropriate supply of these components or an indication of the possibility of purchasing them for the entire period of production of the new product. Research and development is the creation of a technology for the production of these products. Until the completion of the R&D, no product is created for sale, this phase also consists solely of costs. This development can end with the production of several units of the product, which must be investigated to control the quality of the created technology.

Pilot production is a stage of verification of the created technology, at which products are already produced in small quantities. Even if there is no profit from the output, then, in any case, it can be sold - so think most of those who are engaged in research work. But this is wrong. Products resulting from pilot production should be used to investigate their reliability.

Serial production is a stage when all products are produced using a single technology, therefore their quality is determined by the quality of technology. The modern approach is based on such a high degree of production automation that it completely excludes the human factor, therefore, firstly, the products coming off the automatic production line are usually much cheaper and much more reliable than the products of the pilot batch, and even more so since product obtained as a result of research work.

Taking into account this difference between different stages, we will consider the stages of creating technologies for the industrial Internet of things.

3. The difference between IoT and IIoT

Most of the authors writing about the Internet of Things on the Internet are specialists in economics, business organization, or even writers specializing in science fiction. The idea is being introduced that it is enough just to entrust the solution of all tasks to computers, and they will be solved by orders of magnitude more accurately, better, faster, more reliably. These writers are inspired by the results of using traditional Internet technologies for a variety of tasks. They see new opportunities in increasing the range of tasks solved with the help of Internet technologies, but they often lose sight of the need to create fundamentally new Internet technologies, industrial rather than household ones.

Let's define what distinguishes the regular Internet from the industrial one. For this purpose, let's draw an analogy between a personal computer and an industrial one.

A personal computer is used to facilitate the work of an office worker, it allows you to speed up the creation of texts, the calculation of mathematical relationships, the modeling of simple tasks, the calculation of statistical models, and so on. Since personal computers, due to their extreme efficiency, became widespread, many researchers began to use personal computers for professional control purposes, that is, as control machines. However, personal computers were not originally designed for these purposes, so they must be seriously reprogrammed, and in some cases hardware modifications are necessary. One of the main problems is the condition for the inheritance of all the capabilities of the previous series by new computers, compatibility with them, both software and hardware. This forces us to use far from optimal algorithms for computer actions. If an industrial computer in multitasking mode completely obeys the priorities set by the user, then a personal computer operates according to its own
rules, which are far from optimal when solving problems of managing production processes or scientific research. A professional computer is focused primarily on working with devices that it controls, a personal computer is focused on working with a user, for it the perception of a task from a person and the most convenient presentation of information for a person is a priority. When receiving tasks for irreversible actions, the personal computer asks again whether this action is exactly required, meaning the possibility of an erroneous command. In an industrial computer, the possibility of an erroneous command must be excluded in principle. An industrial computer must operate according to a different logic, it must have fundamentally different interface capabilities, a different speed, a different memory size, it needs many ADC and DAC channels with high speed, bit depth, rigidly connected with the machine time, and the machine time must be strictly synchronized with a unified system of precise time. A personal computer is considered secure enough if it has anti-virus programs and is powered by an uninterruptible power supply. For an industrial computer, these measures are not enough: it should, in principle, be invulnerable to viruses, and uninterruptible power supply should work not only for a time sufficient to save the created files and close running programs, but to continue all functions without disrupting the rhythm of work.

The industrial Internet should differ in approximately the same way from the usual one, that is, it should be different in everything. Thus, the creation of the industrial Internet of things technology is the creation of a new software and hardware environment and new communication networks.

Traffic volumes of such networks are estimated at up to 1 PB (petabyte) per day.

Very often, authors of articles and even developers of development programs confuse the use of the Internet for industrial purposes and the creation of special Internet technologies for industry. The Internet has long been used for industrial and especially for commercial purposes, with its help you can order and pay for many services and goods, but this is the usual Internet of things, not the industrial Internet of things. Unfortunately, officials from the management of these programs often forget about this. We met the opinion that the funds of the Program should be spent as soon as possible on the creation of a smart housing and communal service, that is, a system of smart meters for the consumption of water, heat, electricity and gas, as well as a system for automatic calculation of rent. Perhaps such an investment can pay off most quickly, but this has nothing to do with the industrial Internet.

4. The main problems

Standardization is one of the biggest challenges. The creation of a whole variety of mutually incompatible technical solutions should not be allowed. The compatibility of technical solutions would greatly simplify the implementation of this technology. But history shows that compatibility is achieved in two cases: firstly, if a standard has been created, the observance of which is necessary for all participants, and secondly, if there is a production leader, whose technical solutions are the standard for everyone who intends to join the market for these products ... As a rule, standards are developed with a great delay after many developers have already created a variety of hardware. It is certainly reasonable to follow the leader's wake, but such an approach cannot be state policy. At the same time, the Russian Federation is facing extensive sanctions actions that have already begun to affect the cyber space. Some technical opposition explains the need to create a GLONASS system as opposed to the already existing GPS system. Similarly, the United States has launched several parallel projects to create rocket engines as opposed to Russian engines. Therefore, the creation of a Russian standard for the industrial Internet of things, apparently, may be quite reasonable. If possible, you should use the available world developments to achieve maximum compatibility with foreign technical solutions. However, it may turn out that it is not so necessary to obey ready-made foreign solutions in this case. The answer to this question should be given by a consultation of specialists.

In our opinion, the main problem in solving all problems in this direction is the lack of a systematic approach to their solution. The nominated and selected experts are most concerned with how to get the largest possible share of funding, rather than how to avoid misallocation of funding. This is also manifested in the fact that instead of a single plan for creating technologies, a matrix of projects is created, into which not elementary technologies but projects fit into.
Also, one of the mistakes is the requirements for individual projects, according to which the results should be obtained as early as possible, that is, within one calendar year. If the creation of fundamentally new technologies is required, then the results should not be required for some holiday dates. The timing of obtaining results should depend on the complexity of technologies, on the necessary components for their creation, on the availability of relevant technical knowledge at the disposal of developers (including world-class technology).

5. Smart sensors
Currently, smart sensors are understood to be those sensors that are most convenient to use, since they give a ready-made measurement result, that is, they are optimized for user-researchers. The requirements from a person to the sensors that he is going to use are radically different from the requirements of the control system. The technical device requires the highest speed, highest reliability, a digital output is also desirable, but in its absence, this problem is solved with the help of high-speed ADCs. Consequently, the development of the industrial Internet requires the development of sets of different sensors.

In some cases, sensors should not provide the highest accuracy, but the greatest amount of complex information, such as video cameras with image recognition. One of the key solutions can be distributed computing, in which sensors equipped with intelligence carry out primary information processing. Distributed computing can dramatically improve performance.

In general, it seems that for the industrial Internet one should move away from centralized data processing, preferring decentralized and distributed processing. The principle of operation of such systems is based on the complete interchangeability of individual processors by their functions, as is done when implementing swarm algorithms.

6. Conclusion
This paper cannot address all the problems of the industrial Internet development, but it does discuss some aspects that, in our opinion, were outside the sphere of roadmap developers. In particular, it is a mistake to equate the use of existing Internet technologies for industrial purposes with the creation of industrial Internet technologies. Industrial Internet technologies imply the creation of technologies for remote highly reliable and high-speed industrial production management by methods and technologies that are, in fact, close to Internet technologies, but at a fundamentally new technical level. This is not a simple quantitative increase; it is a qualitatively different technology.

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