# Conceptual Design of Complex Integrated Systems

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***Abstract*-The article describes the problems of digital transformation of the Republic of Belarus. The ways of solving the problem are proposed. A new approach to the design and development of complex information systems is proposed – the design of complex integrated systems. The basic properties of complex integrated systems are determined**

***Keywords*- System design, complex systems, digital transformation, system of systems, interoperability, integration**

## I. INTODUCTION

Currently, it is difficult to overestimate the importance of digitalization of key processes in any state. Digital technologies make it possible tooptimize many management processes in the economy, healthcare, education, and industry. The development of the modern economy is largely based on the processes of digital transformation. Until 2020, digitalization was an evolutionary process, but the COVID-19 pandemic radically changed the role and perceptionof digitalization in the state and society and accelerated its pace. Digital technologies are now essential for work, learning, entertainment, communication, shopping, and access to everything from health services to culture. One of the important conditions for successful implementation of the digital transformation strategy is the development of new approaches to the design and development of information systems. As such an approach, it is proposed to use the design of complex integrated systems [1], [2].

### *A.Digital transformation of the Republic of Belarus*

Despite the undoubted successes in the development of the information and communication infrastructure of the Republic of Belarus, the creation of individual elements of e-government, it is premature to talk about significant progress in the digitalization of the public sector of Belarus for a number of reasons:

- Many platforms and systems were originally developed to solve specific tasks and did not provide for the possibility and necessity of integration, as well as integration into the chain of industry, country and supranational platforms. Often the developed solutions were not integrated with each other.
- Digitalization in our country has developed chaotically and sometimes uncontrollably from the point of view of embedding in a single strategy of digital transformation of the country.
- Currently, there are practically no industry platforms into which digital platforms of enterprises can be integrated.
- Many institutions and departments use proprietary software to digitalize key processes. Often, when using such software, enterprises have to adapt their business processes to the functionality imposed by the manufacturer, and not vice versa.
- Comprehensive information security is not fully ensured. This problem includes both the development of software and hardware solutions and security in the information space.

The digital transformation of the economy and society of Belarus should contribute to the achievement of the following goals:

- Ensuring the digital sovereignty of the country
- Creating conditions for the introduction of innovative solutions in the sphere of economy and society, as well as for the integration processes of both internal and external country digital platforms
- Implementation of the import substitution strategy in the field of digitalization of key processes of the economy and society.
- Creation of complex information security systems.
- Creating conditions and guidelines for young people.

One of the significant factors of ensuring the sovereignty of the state in cyberspace is the desire for independence (sovereignty) ICT or more broadly digital sovereignty. Securing digital sovereignty is becoming increasingly difficult in a globalized world. At the same time, there is currently no clear definition of the digital sovereignty of the state. The author Ashmanov I.S. defines digital sovereignty as the right of a state to determine its information policy independently, manage infrastructure, resources, ensure information security, etc. From the point of view of staffing digital sovereignty, this process involves high-quality personnel rotation (the arrival of

responsible specialists in the relevant ministries who are thoroughly versed in the processes of digitalization and IT industries), the creation of educational programs at universities that train multidisciplinary specialists – at the junction of IT technologies and public administration, public policy, innovative economy, the creation of new jobs in the country, providing the state with useful innovations in the field of artificial intelligence, e-government, the Internet of things, electronic services, new weapons systems, etc. From a technological point of view, digital sovereignty is determined by the presence of a sovereign complex of integrated and complementary digital services and platforms in all key spheres of the life of the state and society, including its own hardware base, technological solutions in the field of content delivery, as well as national digital platforms (social networks, cloud storage, messengers, information storage services, etc.).Thus, the digital sovereignty of a country is closely linked to the ability to independently form an information policy, manage information flows, ensure information security, and ensure the storage and processing of digital data regardless of external influence. Achieving these goals requires increased expertise in the digital sphere. The rules of behavior in the virtual space are being actively discussed now. Probably, partly because of the insufficient expert level, the world community as a whole, and ours in particular, have not made much progress on this issue. Currently, no State has been able to fully achieve digital sovereignty. For example, China, which has one of the most technologically advanced and developed economies in the world, is heavily dependent on a number of Western technologies (microchips, processors, etc.). The USA is a world leader in creating ICT solutions. At the same time, a number of high-tech industries have been transferred to other states.

### *B. Conditions for the introduction of innovative solutions in the sphere of economy and society*

Currently, many countries, including the Republic of Belarus, are striving to create conditions for the introduction of digital innovative solutions in the sphere of economy and society. As a rule, these issues are regulated by various fundamental documents such as the Digital Development Strategy, various state digitalization programs, etc. In the Republic of Belarus, the issues of innovative development are reflected in the Resolution of the Council of Ministers of the Republic of Belarus No. 66 dated February 2, 2021 on the approval of the State Program "Digital Development of Belarus for 2021- 2025". This state program was adopted in order to ensure the introduction of information and communication and advanced production technologies in the branches of the national economy and the sphere of life of society. The program provides for the implementation of measures for the introduction of digital innovative solutions in the sphere of economy and society. But for the successful implementation of innovative solutions in the sphere of economy and society, the following conditions must be met:

- Development and implementation of new approaches, methodologies in the field of design, development, standardization and implementation of industry and digital platforms.
- Training of elite specialists in the field of development and implementation of innovative solutions in the sphere of economy and society.

The analysis of successful examples in the field of digital transformation of the state shows that one of the important conditions for the introduction of innovative solutions in the sphere of economy and society was the development of unified country approaches to the design, development and implementation of innovative solutions. When developing such solutions, it is advisable to use the experience of leading countries, the existing level of digitalization of the country, as well as the conditions and features of the development of the economy and society of the Republic of Belarus.

### *C. Approaches to system design*

The rapid development of global networks in the late 90s - early 00s, primarily the Internet, created the prerequisites for a sharp increase in the needs for various information systems, in fact, the process of their creation began to be massive. This was due to the massive introduction of computer technology in various spheres of government and society, the development of data transmission networks. At the initial stage, digitization of existing documents and automation of individual processes took place. One of the first directions of automation of business processes was the development of information systems for managing individual processes of enterprises, such as automation of accounting, personnel accounting, material values, etc. As information technologies were introduced into production and business processes, the complexity of information systems and services grew. For this reason, approaches to the design and development of information systems have changed. The theoretical model of culture is a kind of coordinate system, a system of key concepts that real. Classical approaches no longer allowed the effective development and implementation of complex systems. New design approaches were required that could take into account the complexity of systems, the possibility of scaling, integration with other systems. A separate scientific and methodological discipline, system engineering, is devoted to the issues of designing complex systems. As the complexity of information systems and services grew, not only approaches to system design evolved, but also processes in the digital sphere. In general, it is possible to identify the main processes of digitalization, which were formed as digital technologies penetrated into various spheres of the economy and society:

- Automation. Currently, there are many definitions of this process: from general conceptual definitions to descriptions of specific processes of an enterprise or organization. For example, in [3], the automation process is defined as "a direction of scientific and technological progress that uses self-regulating technical means and mathematical methods in order to free a person from participating in the processes of obtaining, converting, transmitting and using energy, materials, products or information, or significantly reducing the degree of this participation or the complexity of the operations performed." According to GOST [4], automation is the introduction of automatic means for the implementation of processes; a system of measures aimed at increasing human productivity by replacing part of this labor with the work of machines. It is based on the use of modern computer technology and scientific methods. In [5], automation is described as the first stage on the way to digital transformation, when human labor is replaced by machine labor. Summarizing the considered approaches to the definition of the automation process, it can be concluded that automation is a business or production process that is digitized, while there is no optimization or change in the business or production processes themselves.
- Computerization. The widespread introduction of computer technology is closely connected with the process of computerization. According to GOST [4], computerization is the process of automating any processes in any field of human activity through the use of computers. In [6], it is defined that computerization is the widespread introduction of computers into various spheres of human activity (for example, for the management of technology, transport, energy, etc. production processes). In the encyclopedia [7], computerization is described as a process of expanded introduction of electronic computing technology into all spheres of human activity. Based on the results of the analysis of the presented definitions, it can be concluded that computerization is the process of mass introduction of personal computers for the purpose of full–scale use of automation in production or business processes.
- Informatization. Many authors associate the next stage of development and implementation of digital technologies in the state and society with the process of informatization. At the same time, there are various definitions of this process in the literature. Thus, in [8] informatization is described as an organizational, socio-economic, scientific and technical process that provides conditions for the formation and use of information resources and the implementation of information relations. The Law of the Republic of Belarus "On Information, Informatization and Information Protection" [9] provides the following definition: informatization is an organizational, socio–economic, scientific and technical process that provides conditions for the formation and use of information resources and the implementation of information relations. According to [10], informatization is an organizational, socioeconomic, scientific and technical process of creating favorable conditions for meeting information needs, realizing the rights and freedoms of subjects of the information sphere, which is based on the mass application of information systems and technologies in all types of activities of individuals and legal entities. The author [11] gives the following definition: informatization is an unprecedented increase in the speed and quantity of production and dissemination of information, as well as the increased role of information processes, systems and networks using ICT in society. Based on the results of the analysis and generalization, it is possible to define informatization as a scientific and technical process for the creation and implementation of information systems and services in various fields of activity, characterized by the massive penetration of information technologies into all spheres of theeconomy and society.
- Digital transformation. Currently, many institutions, departments, companies, and industries have developed a digital transformation strategy. However, there are many definitions of this process in the literature. As a rule, definitions of digital transformation are based on the size of the object of digital transformation (institution, industry, country). Thus, in [8], the authors define digital transformation as a manifestation of qualitative, revolutionary changes, consisting not only in individual digital transformations, but in a fundamental change in the structure of the economy, in the transfer of value-added centers to the sphere of building digital resources and endto-end digital processes. The following definition is given in [12]: digital transformation is the process of introduction of digital technologies by an organization, accompanied by optimization of the control system of the main technological processes. Digital transformation is designed to accelerate sales and business growth or increase the efficiency of organizations that are not purely commercial (for example, universities and other educational institutions). In [13], the authors conclude that digital transformation is simultaneously aimed at improving existing business processes and creating competitive advantages by changing and creating new business processes within the enterprise. Based on the results of the analysis, we will determine that digital transformation is a process of integrated