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PREREQUISITES FOR THE CREATION OF THE UNIVERSAL ALGORITHMIC SPACE OF DIGITAL ECONOMY

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Abstract. Fundamental obstacles to the full globalization of the digital economy are being identified. The reasons of their occurrence are analyzed both at the level of deep properties of information environments in which run economic processes, and at the level of logical bases of computer-networking architectures of the Global Computer Environment (GCE), used now for digitalization of the economy. The ways of elimination of the revealed reasons on the base of the general model of universally programmable and cyber-secure distributed computing are shown. In the growth of this theme the architectural principles of the new class of mass universal network computers with non-microprocessor architecture are offered, which open possibilities of formation in aggregate resources of the current GCE of the universal algorithmic space of the digital economy.

Keywords: digital economy, human informational universality, the algorithmic universality of computers, global computer environment, global information strongly connectedness, the model of distributed computing, computers with non-microprocessor architecture, universal algorithmic space of digital economy.

INTRODUCTION

Social progress is determined by the levels of development of economic relations, structures, systems and processes that are carried out in self-organizing modes through social information space of human brainwork. In the past, the main driving force behind economic processes remained unique intellectual and communicative capabilities of Homo Sapiens in a part of the universal processing of information.

With the advent of mass computers and the global computer environment (GCE), the situation is changing radically. Property of algorithmic universality of computers interrupted the historical monopoly of man for universal processing of information. The aggregate computational, functional, and system-forming potential of the rapidly growing billions of universal computing devices connected by networks opens up prospects of forming for a digital economy the global and universally programmable infrastructure. Such infrastructure has its roots in the depths of the GCE and is capable in the unprecedented conditions of global informational strong connectedness and the growth of streams and volumes of information to ensure a radical increase in the efficiency of the economy.

However, there are fundamental obstacles in this way. The paper presents the results of the analysis of the reasons for their occurrence both at the level of properties of information environments in which economic processes take place and at the level of logical bases of computer-network architectures of the GCE currently used for digitalization of social and economic systems. The ways of eliminating these causes are shown on the basis of the model of seamlessly programmable distributed computing and the new class of universal computers with non-microprocessor architecture, which opens up the possibility of forming the universal algorithmic space of digital economy in the GCE.

DISPROPORTIONS IN THE DEVELOPMENT OF GLOBAL COMPUTER ENVIRONMENT [6-10]

Global digitalization began in the 80s with the mass production of PCs. In the 90s, this process received the net-extension in the global space WWW. Since then, the world produces more than 99% of the information in a globally distributed form in digital forms and accumulates in the network resources of GCE.

The logical basis of the WWW has become the hypertext model. Not possessing the property of functional completeness (algorithmic universality), from the three types of base actions with information - storage, transfer and processing underlying any information processes, it had provided globalization of only two - storage and transfer. Such disproportion made possible the spontaneous forming in the GCE of an unprecedented phenomenon of global informational strongly connectedness ("everything affects on everything and at once"). This phenomenon disrupts the balances of current mechanisms of sustainable development.

In the absence of a general model of globally distributed computing that defines uniform rules for universally programmable processing of information in heterogeneous GCE resources, most of the growing volumes of information remain unprocessed (the crisis of "overproduction of information"). This leads to a spontaneous increase in the number of uncontrollable degrees of freedom in socioeconomic systems, which is one of the main reasons for the growing instability of the world social system.

The property of global informational strongly connectedness has spontaneously arisen in a market economy and rapidly, without prior assessment of the consequences, expands its sphere of influence. This property totally and rigidly formats the information activity of the human environment and social information space of human brainwork, as well as information processes of functioning and development of socio-economic systems.

Revealing and overcoming disproportions is impossible within the framework of existing computer-network architectures based on microprocessors, as well as the existent software technologies and methods of digitalization of the economy based on them.

DEEP PROBLEMS OF DIGITALIZATION

One of the main problems in the development of socio-economic systems are the biological limitations of the throughput capability of persons and of a social information space of them brainwork in a part of the algorithmic processing of information.

Under the conditions of the human monopoly on informational universality, methods and structures of managing social and economic processes at all times were building in anthropocentric architectures. In connection with the advent of computers and the mass expansion of the GCE into various spheres of life, additional opportunities arise that, in their development potential, are able to free the social information space of brainwork from the routine of algorithmic processing of the growing flows and of volumes of information in aims of sustainable development. This requires a transition from the monopoly of anthropocentric management architectures to bicentric architectures of a balanced combination of the advantages of the universality just as human and so computer intellect. Such a transition requires scientific understanding of the similarities and differences in the properties of the universality of man and computers, as well as their projections into the social information space of brainwork and into the area of distributed computing in the GCE.

It should be noted that, despite the growing instability of the world economy and the social system as a whole, such a transition has not yet become a hot topic of science. In the absence of historical precedents, science is not ready for a system-holistic perception of the strongly connected world social system. In the lack of a general, the scientifically based picture of a changing world, the course of development determines the chaos of market competition by means of commercial

promotion of growth in number, complexity, and cost of the "zoo" of heterogeneous technologies, which demand a difficult detection of advantages and verifications of unpredictable consequences.

In this context, the absence of motivated optimism in the forecasts of "development" of both the traditional economy [1] and the digital one [2] is entirely appropriate. An analysis of the ups and downs of the Nasdaq index throughout 20 years in comparison with the fantastic success of the mass production of computer components during this period provides unflattering explanations of the very modest effect of the digitization of the world economy. In [3] it is shown that since 2000 the average annual growth of the index was less than 3% in a year. During this period, the technical progress of computer components had been from hundreds to tens of thousands of percents. As a result, the growth of the index compared with the increase of computer components is hundredths and thousandths of a percent.

Why does the world market in fact "ignore" computer progress and respond to the growing coverage of societies by computer networks not by a new jump in the development of the global economy, but latest crises and increasing instability? Perhaps the main reasons are as follows:

- heterogeneous GCE does not have the system-holistic, functional completeness and cybersecurity properties necessary for controlling the sustainable development of systems in conditions of global strongly connectedness;
- the existing models of globalization social and economic systems do not take into account the objective laws of development of the GCE, which does not allow to effectively use the immense potential of GCE for the holistic solution of strongly connected problems of sustainable development.

The symptoms of the growing incompatibility of computer progress and existing models of digitalization of the economy, noted in the paradox of R. Solow [4], are gaining global proportions. The reasons are not in the weakness or absence of any technology. They are hidden in the self-organization properties of complex systems.

EVOLUTIONARY ROOTS OF ECONOMY

The problems of the digital transformation of the economy are connected with the laws of evolutionary self-organization. In applied to live systems, they are formulated in the Darwinian triad - "heredity, variability, selection." The self-organization of living matter began with the formation of the universal information space of genetic information, which became the basis for the embodiment of the Darwinian triad.

In [5], the particular importance of information in the development of live matter is shown. Organisms and systems of them are considered as biological information machines. The Darwinian triad explains their progress in the course of interaction with the natural environment and with each other, from the implementation of the simplest narrow-profile structures and functions of processing information to complex ones. The genus of Homo Sapiens has become the "top level" of the evolving a great many generations of informational "bio-machines." The distinguishing feature of Homo Sapiens is the acquisition of the unique property of the information universality and the associated social information space of brainwork. It was the first jump to new evolutional levels in the growing of hierarchy of information spaces, and the first information space, which had exited the bounds of the direct action of genetic information.

Structural and functional biodiversity of information functions is fixed at the molecular level of codes of genetic information. Development cycles in the biological contour of genetic inheritance require a change of many generations. The social information space of brainwork bypassing the genetic space has opened up faster channels for the development of information structures and functions. The development of information, freed in the social information space of brainwork from the inertia of the "biophysical" shells, has accelerated by many orders of magnitude [6].

The first product of this evolutionary jump was the information spaces of the simplest labor relations. From them grew

the self-organizing economic space in which the sustainable development of social systems takes place. The technosphere and the information space of technogenesis have also become the product of the evolution of information in the social information space of brainwork. Despite the absence of connection with genetic information, technogenesis, as a product of the development of the social information space of brainwork, "borrows" the attributes of biological evolution. First, the principle of a material embodiment of a variety of complex specialized structures and functions is repeated. Secondly, which is very important, the result of the growing diversity of complex specializations in both cases is the achievement of the universality property. This is the universality of man (in the living embodiment) and the algorithmic universality of computers (in technical implementation).

It is appropriate to assume the hypothesis about the fundamental connection between ascending evolutionary levels in systems of different nature and their general target orientation towards achieving one of a possible property of information universality. The embodiment of the Darwinian triad in universal information environments/spaces requires manipulations not with a material substance "burdened" by the laws of conservation of mass and energy, but with non-material information codes. "Material," energy and time costs of information manipulations are orders of magnitude less than biotechnical ones.

The formation in the GCE of the universal algorithmic space of digital economy opens up the newest evolutionary level of expansion the variety and intellectuality the functions of managing/control sustainable development.

THE MODEL OF DISTRIBUTED COMPUTING AND THE NON-MICROPROCESSOR ARCHITECTURE

The hypertext information space WWW for almost 30 years continues to be the base for the expansion of GCE spheres of influence. In the absence of the general model of universally programmable computing in the heterogeneous GCE, the exponential growth of flows and volumes of weakly formalized information, unsuitable for deep algorithmic processing aimed at managing the sustainable development, becomes the global factor in the destabilization of social and economic systems.

The main obstacle to the formation of the general universal model of distributed computing in the GCE is the extreme heterogeneity of computer and software platforms, forms of data presentation and programs.

Algorithmic digitalization currently uses distributed information processing systems in network architectures Grid, (Cloud + (Fog + (Dew)) and Peer-to-Peer. Such approaches implement various methods of integrating heterogeneous resources of GCE, therefore require solving multivariant integration problems. Their combinatorial complexity is the insurmountable obstacle to the increase in the size of systems. In this case, system-technical complexity and the cost of their implementations are growing too quickly, becoming unacceptable.

The disadvantages of such approaches are size restrictions, narrow specialization, high system-technical complexity and cost of operation, conservatism. In principle, they cannot ensure the full-scale use of the algorithmic potential of the aggregate resources GCE for solving the whole variety of strongly connected problems of the digital economy.

In [7-9], the new approach to the organization of distributed computing was proposed, which allows eliminating the root causes of the continuous reproduction of the heterogeneity of the GCE. This approach is based on the general model of the universally and seamlessly programmable distributed computing, built [7] by the mathematical generalization of the classical model of universal computers by J. von Neumann. On this basis, proposed principles for creating the new class of mass universal computers with non-microprocessor architecture [8]. By "zeroing out" the reasons of the heterogeneity and combinatorial complexity of integrating GCE resources, this architecture ensures the seamless and cyber-secure spreading of property the universal programmability

from internal resources of computers to an arbitrarily large number of computers connected by networks. This opens the ways to the formation (with minimum expenses) in the aggregate GCE resources of universal, mathematically homogeneous, seamlessly programmable and cyber-secure algorithmic space of distributed computing and network-centric control for solving of the variety of digital economy tasks [10]

ABOUT THE UNIVERSAL ALGORITHMIC SPACE OF DIGITAL ECONOMY

In the absence in GCE of the unified universal algorithmic space, technologies for building narrow-profile systems, such as Blockchain, Big Data, Deep Learning, etc., are used to solve problems of the digital economy. They oriented on the high-cost integration of heterogeneous GCE resources (see above). It fundamentally limits system-forming capabilities in growing of scale such solutions. Initially every of such approaches is not algorithmically universal and system-holistic. They are used to solve particular classes of digital economy's problems.

The practice of decades of GCE growth shows [1-4] that numerous generations of narrow-profile, systemically fragmented technologies for digitization of the economy do not provide the expected system-wide effect (paradox of R. Solow [4]).

The conception of multilevel evolutionary processes assumes that the transition to qualitatively higher levels of development occurs through the development of many generations of narrow-profile solutions after the appearance of elements with the universality property. The universality provides the basis for the following information space, in which there is a jump in the acceleration of evolutionary processes.

In the context of the interdependent development of the GCE and digital economy, this new space will be the universal algorithmic space with the additional property of cyber-trusteeship given to it. This feature is now partially implemented by Blockchain software technologies in an extremely heterogeneous GCE, composed of billions of computers with microprocessor architectures. Such architectures with their cumbersome baggage of highly complex system software, are becoming increasingly vulnerable to unauthorized interference. Such software implementations cannot be considered as a full-scale solution of digital economy problems.

The proposed model of universal distributed computing, which can be implemented in mass network computers with non-microprocessor architecture [7-9], opens up possibilities for forming universal, mathematically homogeneous, seamlessly programmable and cyber-secure algorithmic space of digital economy in the aggregate resources of the GCE [10]. In such algorithmic space computers with the non-microprocessor architecture at the hardware level ensures efficient and secure execution of the system functions of control by distributed computing with an account of the growing demands for reliability, cyber-security, and cyber-trusteeship.

Within the framework of the new system-forming qualities of the proposed digital economy space, the possibility of creating the universal digital platform for fiat money systems opens up.

This will allow government structures to create a system-holistic alternative to the growing anarchy of crypto-currencies. The universal digital platform may become the key foundation for the full-scale integration of the all variety of narrow-profile systems of the digital economy, as well as viable branches of the traditional economy.

CONCLUSION

The problems of the formation of the universal algorithmic space of digital economy have deep roots in the objective laws of multi-level evolutionary self-organization of complex systems. With exhausting of the system-forming potential of the current level space, which supports the processes of self-organization, a jump into the information space of the next level with new principles and rules of self-organization is performed. The paper shows the general nature of the evolutionary-jumplike development of socioeconomic systems. In this work,

for the first time the internal laws of the development of the GCE, which occurs total influence on social and economic systems, are taken into account. The implementation of the universal algorithmic space of digital economy in GCE is the jump to the new level of systemic self-organization.

The subject of further research is an in-depth analysis of the patterns of formation and development of the digital economy and the system-holistic interpretation of the Darwinian triad in its multi-level ascent along the vertical of the considered information spaces of the implementation of processes self-organization.

In the absence of an understanding of the fundamental laws of the development of the GCE, the threats of losing control over super-powerful informational factors of the destructive impact on the world social system are rapidly growing. This is the dark side of the systemically unbalanced growth of the diversity of technologies and the unprecedented challenge to modern science, which does not possess the methods and means of full-scale system-holistic integrating the knowledge produced.

To respond to new challenges, it is a necessary embodiment in the GCE a universal noospheric space of knowledge formation and their holistic integration for the development of sustainable development technologies. The implementation in GCE the universal algorithmic space of the digital economy is the next step in that direction.

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