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## The supersystem of the digital economy: functioning and development based on the principle of self-organizing integration

*E.L. Loginov, Dr. of Sci. (Econ.), Professor of RAS*

e-mail: *evgenloginov@gmail.com*

*T.A. Shkuta*

e-mail: *saa5333@hotmail.com*

*V.L. Loginova*

e-mail: *urmastermind@yandex.ru*

### Abstract

The problems of the formation of a supersystem of the digital economy using the key business model of the joint use of digital assets by economic agents are analyzed on the basis of the convergence of telematic, computing and information services with the final output of a complex of managed digital objects for a new quality of management based on the principle of self-organizing integration. Integration of standardized network infrastructures using cloud principles that involve distributed and remote processing and storage of data on the basis of interaction and consolidation of corporate network environments of different owners (tenants, etc.) of digital assets allows to transform traditional linear hierarchical chains of management transactions into connected, intelligent, scalable, customizable and distributed management networks. The introduction of universal shells of any business processes, starting with the processing of primary data prior to processing in the deep region, using advanced algorithms of multi-agent optimization of the next [after 3G] generation [based on 4G, 5G and further] realized in the framework of electronic micro-, meso- and macro content allows to ensure the stability of the super-system within the limits of the optimal values of the activity of the controlled digital objects due to the increase in the possibilities of observation and control.

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At the present there is no single methodological basis for the formation of a system-structural approach to the increase - on the basis of the digital dominant - of the manageability of the Russian economy with the expansion of the range of optimized indicators of individual digital objects and their aggregated groups [7].

At the same time, in numerous scientific and practical developments, as well as in published publications, special attention is paid to particular issues of improving management efficiency: electronic document management; various means of collecting, transmitting and processing information; implementation of CPM, BPM, EPM, GIS, CPS, IOT, BIG DATA, Smart City, PLM, cyber-physical systems (CPS), building information modeling (BIM) technology, RFID technology, Industry 4.0, industrial intelligence manager (MI), "Web values" (Value Web), etc. Numerous normative documents and patchwork-segment projects of the Electronic Government, implemented in Russia both at the federal and regional levels, also belong here.

In this regard, new business models are urgently needed that form the conditions and mechanisms for ensuring this - it is very important for our country - civilized (including transparent) relations in business and between the state and business that are prospectively structured today as elements digital economy [6].

Perspective is the orientation toward the introduction of technologies of blockages or Internet values [3, 12].

The advantage of implementing the business model of the joint use of digital assets by economic agents based on the convergence of telematic, computing and information services for managing complex sets of digital objects within the digital economy is the qualitatively broader possibilities for collecting, processing, storing and distributing information.

Thus, the overall result of the implementation of a key business model for the sharing of digital assets by economic agents to manage complex economic and organizational sets of digital objects within the digital economy is to improve management effectiveness based on the principle of self-organizing integration.

There is an opportunity to simplify and accelerate the planning, configuration, management, optimization and restoration of the operation parameters of a complex of managed digital objects as elements of a quasi-unified system [2, 10].

From the point of view of ensuring the effective functioning of the architecture of convergence of telematic, computing and information services, the components that make up the invariant kernel of integration of standardized network infrastructures using cloud principles should be included [1, 5]. These principles presuppose distributed and remote processing and storage of data based on the interaction and integration of corporate network environments of different owners (tenants, etc.) of digital assets, integrated from separate quasi-autonomous elements in the network (cloud, swarm) of distributed cloud computing centers within the supersystem of the digital economy.

An invariant kernel for the integration of standardized network infrastructures using cloud principles should include the following elements:

1) The subsystem for monitoring the measured parameters, which provide the formation of the current observable state of the complex of controlled digital objects, incl. situational awareness is provided regarding the interaction and integration of corporate network environments of various owners (tenants, etc.) of digital assets.

2) The subsystem for diagnostics of anomalies of controlled processes, which, based on the data of the monitoring system, will identify the cause of the anomaly and determine the current state of the managed digital objects.

3) The subsystem for analysis of current characteristics, which, based on information received from the subsystem for diagnosing anomalies of controlled processes, evaluates the functionality of stabilizing a complex of managed digital objects in a changed situation, including the possibility of adding or eliminating any number of elements [the centers of cloud computing as computational nodes dynamic computing cluster] from the network (clouds, swarms).

4) The subsystem for evaluating the current plan for the management of telematics, computing and information services, which analyzes the impact of the deterioration of the functional characteristics of control systems on the attainability of the current goal and, if the plan is unsuitable, issues an appropriate warning.

5) An intelligent agent that replans or corrects the algorithms of telematic, computing and information systems by using not just logical algorithms, but more sophisticated intellectual algorithms for neural-fuzzy control.

The application part should include the following main modules:

- a real-time monitoring system for elements and processes in a converged information and computing platform for managing a complex of cloud computing centers as computational nodes that make up a dynamic computing cluster;

- a system for modeling, recognizing and analyzing the global and current situation and supporting decision-making and in normal modes;

- a system for predicting the development of time-related violations in the real-time and the spread of violations on interacting subsystems in a converged information-computing platform for managing a complex of cloud computing centers as computational nodes that make up a dynamic computing cluster;

- intelligent real-time agent for adjusting the management of the interaction of the centers of cloud computing and optimizing solutions based on planning devices for the operational management of digital objects;

- interface for issuing recommendations to digital objects to stabilize the management process in a critical situation;

- a real-time solver for issuing recommendations to digital objects: issuing recommendations for the application of control actions in this current situation;
- a subsystem for mapping the current situation in a converged information and computing platform with support for a dynamic pool of compute nodes that make up a dynamic computing cluster;
- user interfaces in a converged information and computing platform for the use of cloud computing services.

It is expected that the use of artificial intelligence elements allows the transformation of traditional linear hierarchical chains of managerial transactions into connected, intelligent, scalable, customizable and distributed management networks fundamentally based on access to [digital assets (electronic content) accumulated in all subject areas [8, 9]. In this case, the use of elements of artificial intelligence will ensure the stability of the super-system within the limits of the permissible parameters of the functioning of digital objects due to an increase in the possibilities of monitoring and control [4, 13].

At the same time, each module of the cloud computing center can be not only a source and a recipient of information, but a relay router, and a regional cluster of cloud computing centers becomes a computing node as the basis for a convergent information computing platform while forming a network interaction driver for other computational nodes that make up the dynamic computing megacluster.

The integration of information systems of different clusters within the framework of a complex of managed digital objects ensures the implementation of a key business model for the joint use of digital assets by economic agents when creating in the economy the opportunities for all solvent users willing to use programs and computing services from "clouds" [centers of cloud computing] self-organizing integration of a complex of managed digital objects and support in each of them standard the set of information, computer, etc. services.

On the basis of monitoring, access to the identification of economic activity of a complex of managed digital objects creating increased risks [11] is realized. Here, the behavior of participants in digital economic interaction makes it possible to distinguish the organizational strategy of a complex of managed digital objects that create heightened risks and their characteristics (chronotype, participants, role structure, etc.) [14, 15].

Structural relationships determine the identifiable links of operational-regime situations dynamically localized as temporary, resource or any other matrix that formalizes the information portrait of the process of maintaining the regimes of self-organizing integration of a complex of managed digital objects using structured blocks of content of distributed databases consisting of different data, versions or structured options, typical or atypical.

Affiliation ties determine the affiliation of information packets distributed over computational nodes as elements of a dynamic computing cluster, including structured information materials for building stable operational and communication links of a complex of managed digital objects with a common organizational information platform and a coordinated information exchange management system.

The core of the coordinated information exchange management system should be a convergent information and computing platform, which simultaneously forms the driver for the network interaction of the computational nodes that make up the dynamic computing cluster. Such a system should combine information, telematic and computing services for the development of information systems for managing a complex of managed digital objects as elements of a quasi-unified system.

The possibilities of network-centric integration of data with respect to the content of distributed databases provide communication between each other in a cloud of distributed cloud computing centers, from processing primary data to processing in the deep region, using advanced multi-agent optimization algorithms for the next [after 3G] generation [based on 4G, 5G and further], realized in the framework of electronic micro-, meso- and macro content on horizontal, vertical and network principles.

The possibility of forming a temporary, resource or operational-regime matrix of the studied process of self-organizing integration within the studied segment of the digital economy is created, which can be based both on a separate event (the result of an economic operation) and on aggregation and comparison of dissimilar economic events and network flows of such operations.

The complex under consideration creates a unique opportunity to increase the effectiveness of organizational mechanisms in principle, with the implementation of a key business model for the joint use of digital assets by economic agents, with the opportunity for everyone who wants to use programs and computing services from the "cloud" [centers of cloud computing], to support the user's own efforts to create, deployment, management and collapsing of applications in the corporate cloud with their integration into management processes and procedures of interaction and association corporate network environments of different owners (tenants etc.) digital assets. The analysis allows to detect the interrelationships of a complex of managed digital objects in the integration of standardized network infrastructures using cloud principles that involve distributed and remote processing and storage of data based on the interaction and integration of corporate network environments of different owners (tenants, etc.) of digital assets, quasi-autonomous elements in a network (cloud, swarm) of distributed cloud computing centers and from optimization.

As a result, there is a distributed-network formation of a set of measures to maintain optimal regimes for self-organizing integration of a complex of controlled digital objects with a constant step-by-step comparison with the required normative model for the development of complex organizational and economic systems within the digital economy by self-deploying distributed cloud centers in the economy of the cloud Computing as the basic elements of a converged information platform.

To ensure the stability of the digital economy's supersystem within the optimal values of the activity of managed digital objects in the process of self-organizing integration, an intellectual interconnection of key elements is proposed, using a multidimensional interpretation of the systematics of links and operational-regime control transactions.

The new technology provides a dynamic study of the semantics of the analysis of explicit and latent relationships in databases containing the necessary information on operational-regime situations. Automated monitoring and control is performed to determine the basic characteristics of the system-dynamic analysis of electronic content of control transactions while maintaining the self-organizing integration of a complex of managed digital objects, with the formation of any studied process of self-organizing integration based on the analysis results-a temporary, resource or operational-regime matrix.

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### **Суперсистема цифровой экономики: функционирование и развитие на основе принципа самоорганизующейся интеграции**

*Е.Л. Логинов, д.э.н., профессор РАН*  
e-mail: *evgenloginov@gmail.com*

*Т.А. Шкута*  
e-mail: *saa5333@hotmail.com*

*В.Е. Логинова*  
e-mail: *urmastermind@yandex.ru*

#### **Аннотация**

Проанализированы проблемы формирования суперсистемы цифровой экономики с использованием ключевой бизнес-модели совместного использования экономическими агентами цифровых активов на основе конвергенции телематических, вычислительных и информационных сервисов с итоговым выходом комплекса управляемых цифровых объектов на новое качество управления на основе принципа самоорганизующейся интеграции. Интеграция стандартизированных сетевых инфраструктур с применением облачных принципов, предполагающих распределенную и удаленную обработку и хранение данных на основе взаимодействия и объединения корпоративных сетевых сред различных владельцев (арендаторов и т.п.) цифровых активов, позволяет осуществить превращение традиционных линейно-иерархических цепей управленческих транзакций в подключенные, интеллектуальные, масштабируемые, настраиваемые и распределенные управленческие сети. Внедрение универсальных оболочек любых бизнес-процессов начиная с обработки первичных данных до обработки в глубинной области с применением передовых алгоритмов многоагентной оптимизации следующего [после 3G] поколения [на основе 4G, 5G и далее], реализуемых в рамках электронного микро-, мезо- и макроконента позволяет обеспечить устойчивость суперсистемы в границах оптимальных значений деятельности управляемых цифровых объектов вследствие увеличения возможностей наблюдения и управления.

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**Ключевые слова:** *искусственный интеллект, цифровая экономика, организационно-экономические системы, телематические, вычислительные и информационные сервисы, самоорганизующаяся интеграция*

**Об авторах**

*Логинов Евгений Леонидович*, доктор экономических наук, профессор РАН, эксперт РАН, заместитель директора по научной работе, Институт проблем рынка РАН, профессор Департамента мировой экономики и мировых финансов Финансового университета при Правительстве Российской Федерации, Москва.

*Шкута Татьяна Александровна*, ведущий специалист, банк «ВТБ-Германия», Москва.

*Логинова Валерия Евгеньевна*, младший научный сотрудник, Институт проблем рынка РАН, Москва.

**About authors**

*Evgeny Leonidovich Loginov*, Doctor of Economics, Professor of the RAS, Expert of the RAS, twice winner of the Government Prize in Science and Technology of Russia, Deputy Director of the Market Economy Institute of RAS, Professor of the Department of World Economy and World Finance at the Financial University under the Government of the Russian Federation, Moscow.

*Shkuta Tatyana Alexandrovna*, Leading Specialist, VTB-Germany Bank, Moscow.

*Loginova Valeria Evgenievna*, Junior Researcher, Market Economy Institute of RAS, Moscow.