



15TH INTERNATIONAL CONFERENCE ON MANAGEMENT OF LARGE-SCALE SYSTEM DEVELOPMENT (MLSD'2022)

The 15th International Conference on Management of Large-Scale System Development (MLSD'2022) was held on September 26–28, 2022. This conference is organized annually by Trapeznikov Institute of Control Sciences, Russian Academy of Sciences (ICS RAS), with the support of the IEEE Russia Section. The conference aims to promote R&D cooperation on various managerial aspects of large-scale system development at sectoral, regional, national, and transnational levels.

Leading scientists from academia, research institutes, universities, and governmental and commercial organizations, professionally involved in the theory and practice of management in the modern era of the information society, are traditional participants of the conference.

Following the publication policy, MLSD conferences broadly present to the scientific community new approaches, principles, and capabilities of cybernetic large-scale management based on mathematical modeling and modern information and communication technologies.

Every year the conference proceedings are published in Russian; since 2017, selected conference papers have been placed in the IEEE *Xplore* digital repository. About 150 MLSD papers annually contribute to the world's scientific collection.

The MLSD'2022 program included 18 plenary and 199 sectional papers of leading experts from 30 cities of Belarus, Kazakhstan, China, the USA, and Russia. Amongst them, 155 papers were extended and published electronically in IEEE *Xplore*.¹

Traditionally, the conference has a plenary session and 16 sections in the following areas.

Section 1. Management problems of large-scale system development, including multinational corporations, state holdings, and state corporations.

Section 2. Methods and tools for managing investment projects and programs.

Section 3. Management of development of a digital economy. Design offices both situational and expected analytical centers, institutes of development of large-scale systems.

Section 4. Simulation and optimization in the problems of development management of large-scale systems.

Section 5. Nonlinear processes and computing methods in the problems of management of large-scale systems.

Section 6. Management of development of banking and financial systems.

Section 7. Management of fuel, power, infrastructure, and other systems.

Section 8. Management of transport systems.

Section 9. Managing the development of aerospace and other large-scale organizational-technical complexes.

Section 10. Managing the development of regional, urban, and municipal systems.

Section 11. Management of objects of nuclear power and other objects of increased danger.

Section 12. Information support and software management systems for large-scale production.

Section 13. Methodology, methods, software, and algorithmic support of intellectual processing of large volumes of information.

Section 14. Monitoring in the management of large-scale systems.

Section 15. Management of large-scale systems advancement in healthcare, medico-biological systems, and technologies.

Section 16. Managing the development of social systems.

MLSD'2022 aimed to cover big data management issues, including big data use in various areas of management, as well as the standardization of methods, models, and tools for big data processing.

The main theme of the conference was theoretical foundations for the strategic management of large-scale system development in the context of national security.

¹ <https://ieeexplore.ieee.org/xpl/conhome/9933724/proceeding>

This range of problems is topical, as was clearly justified by Dr. Sci. (Eng.), Prof. *A.D. Tsvirkun* (ICS RAS) in his plenary paper “Managing the Development of Large-Scale Systems in the New Conditions of Sanctions.” The author defined the essence and content of the modern geopolitical situation as the confrontation of three alternative scenarios of world order evolution (mondialism, unipolarity, and multipolarity of the world, respectively). Mondialism is the elimination of national states and the transition of full power into the hands of transnational corporations. Unipolarity characterizes a world where power and control of resources are concentrated in a chosen territory, and other countries and peoples become its colonies. Multipolarity is the freedom of creation and competition between different civilizations. This context of the modern world order is determinative to understanding sanctions policy.

The paper described TEO-INVEST, a digital platform (software package) to elaborate investment projects for a group of enterprises or enterprises with a complex internal structure. This platform has high potential due to possible integration with Capital Investments, the state information system to monitor the implementation of agreements, reimbursements of investors, and tax deductions. In the future, the Federal Tax Service should become a single complex for attracting private capital to new investment projects and a navigator of state support measures for business.

The complexity of the current geopolitical situation was also addressed by Dr. Sci. (Eng.), Prof. *V.V. Tsyganov* (ICS RAS). In the plenary paper “Methods and Models for Adapting the Russian Transport Infrastructure under Sanctions,” he systemically analyzed the destructive effects of anti-Russian sanctions on Russia’s transport sector. Obviously, the Western countries and their allies in Asia are attempting a global blockade of the Russian Federation in trade and transport spheres. Due to unprecedented sanctions, the economic situation in the country is very difficult. From the author’s point of view, the socio-economic development of Russia under sanctions is impossible without an advanced geographical transformation of the national transport infrastructure. Turning logistics from the West to the East is a transport development strategy for improving social stability and defensive potential. As discovered, this strategy is complicated to develop: in practice, it required a new “theory of large transport systems” and a complex set of transport infrastructure management models under sanctions. The proposed digital platform includes a dynamic real-time model of government operation in

uncertain conditions and five functional blocks (management of transport infrastructure development for socio-economic systems; selection and expertise of transport infrastructure development projects; training and restructuring of transport infrastructure; formation of transport corridors; ensuring security). In conclusion, Tsyganov dwelled on some issues of implementing the prototype of such a set of models in the projects of new transport infrastructure to improve living standards as well as the economic efficiency and security of the Russian Federation.

Academician of RAS *S.P. Filippov* and the co-authors, Cand. Sci. (Econ.) *F.V. Veselov* and Drs. Sci. (Eng.) *A.V. Keiko* and *T.G. Pankrushina* (Energy Research Institute RAS) presented the plenary paper “Information and Model Support for Decarbonization Management in the Russia Energy Sector.” It was devoted to the key direction in the transformation of the modern economy. The authors considered the production structure of the country’s energy economy as an objective source of greenhouse gas emissions, acting as the center of strategies and measures of decarbonization programs and the low-carbon restructuring of the strategic planning system. The *National Climate and Energy Plans* (NCEP) of EU countries were analyzed. As applied to Russian reality, the matter concerns the close integration of the three most important documents: the Energy Strategy, the Forecast of the Scientific and Technological Development of the Fuel and Energy Sectors, and the Forecast of the Long-Term Socio-economic Development of the country. In the new conditions, only this approach can become an effective tool for managing decarbonization in almost all spheres of the economy with fossil fuels (the harmonization of the pace of technological re-equipment and the commensurability of required costs and achieved environmental effects along all fuel and energy resource production and consumption chains). For the practical implementation of such a strategy, the paper proposed SCANNER, a digital platform (a modeling and information package) to study the fundamental interconnections of the Russian fuel and energy complex with the global energy system (at the level of Russian energy resources exports) and the national economy (considering sectoral production capabilities of the fuel and energy complex and solvent domestic demand).

The plenary paper “The Interaction of Federal District Economies of the Russian Federation (Coalition Analysis Results)” by Corresponding Member of RAS *V.I. Suslov* and co-authors *Yu.S. Ershov* (Institute of Economics and Industrial Engineering, SB RAS, Novosibirsk) and Cand. Sci. (Econ.) *N.M. Ibragimov*



(Novosibirsk State University) was devoted to regional economic integrity. In terms of strategic planning, this paper logically agrees with the directions of energy and transport development mentioned above. The research was based on applied calculations on the interregional multisector optimization model for 40 sectors and 8 federal districts of Russia for the year 2030. The proposed digital platform involves calculations by the coalition analysis methodology (assessing the autonomous development capabilities of all possible coalitions of federal districts). The coalition analysis rested on input-output tables and the theory of cooperative games; the semi-dynamic version of the interregional multisector optimization model with the non-linear setting (8 federal districts and 40 types of economic activity) was used for implementation. According to the calculations, the rupture of ties between regions and their ties with the outer world caused changes in almost all regional development indicators: the final product, gross output, investment, and employment. The authors presented several negative impacts of the potential rupture on various regional characteristics. As demonstrated by the calculations, the national economy has a high degree of interregional integration and involvement in the global economy. The greatest effect is expected from the coalition interaction of the eastern regions: they “work” for the all-Russian market, provide exports (oil and gas, non-ferrous metals, timber), and have a positive balance of commodity exchanges and a smaller share in the total final consumption (as compared to the share in the total GRP).

Note the paper “Scenario Analysis of Problems in the Security Management of Complex Socio-Economic Systems” by Corresponding Member of RAS *V.L. Schultz* (Center for Security Studies RAS), Dr. Sci. (Eng.), Prof. *V.V. Kul’ba*, and Cands. Sci. (Eng.) *I.V. Chernov* and *A.B. Shelkov* (ICS RAS). It considered the problem of increasing the efficiency of security management through the formal target forecasting of the behavior of the controlled object and its environment. The authors summarized the experience accumulated in improving the security management of socio-economic systems based on the scenario approach, including theoretical problems and applications. The digital platform proposed in the paper is represented by a software-analytical complex. Methodologically, the complex is based on a mathematical model of signed, weighted signed, and functional signed digraphs. This model extends the classical graph model with additional components. In particular, each vertex is assigned its parameter; each arc is assigned either a sign, or a weight, or a function (i.e.,

an arc transformation functional is introduced). In a practical interpretation, the parameters of graph vertices are the key indicators or factors describing the state and dynamics of the situation, and the graph structure reflects the cause-and-effect relations between them. A totality of vertex parameter values in the graph model describes a particular state of the situation at a given time. A change in these values generates an impulse (a transition of the system from one state to another). Management of situation development is modeled by changing the structure and impulses applied to certain graph vertices. The authors performed scenario studies of the problems of regional security, information security, public security, and technogenic security in the Russian Federation.

An important life support condition in an unstable environment was considered by Dr. Sci. (Eng.), Prof. *V.N. Burkov*, Dr. Sci. (Eng.), Prof. *A.Yu. Zalozhnev*, and *A.D. Kostyreva* (ICS RAS) in their paper “Consumer Market Stabilization Modeling” (Section 16). The authors presented a macro description of the operation of an economic system. The main variables in the model are the free price index, money savings of the population, commodity stocks of consumer goods in monetary terms, and the regulated price index. The value of money acts as an auxiliary variable. This economic and mathematical model is described by a system of ordinary differential equations. In the model, all production is aggregated into one sector with the gross output divided into consumption goods and all other products (fixed and current assets, non-productive goods not representing consumer demand items). The paper introduced approaches to the development of anti-inflationary economic policy and considered economic policies to stabilize the consumer market. As shown, four major stabilization policies can be chosen within the model. Also, the modeling results and their qualitative assessment were given. The model neglects budget revenues and their balancedness. To study consumer market stabilization, it suffices to represent the budget only by government expenditures for a certain period (the wages in the non-productive sphere, social security payments, and social insurance payments).

On the background of modern globalization and the informatization of public life, information wars and confrontations in social networks become harsh tools for violating social stability. In this regard, R&D works focused on mechanisms to counter information attacks, recognize initiators, block transmitted messages, and launch a reverse information wave are crucial for national security. At the plenary session, this subject was considered by Dr. Sci. (Eng.) *D.A.*

Gubanov and Dr. Sci. (Phys.–Math.) A.G. Chkhartishvili (ICS RAS) in the paper “Forming Opinions in Social Networks: The Confrontation of Several Information Sources.” The authors studied a model in which agents’ opinions (or preferences) are unobservable and the observed actions do not fully reflect their opinions. For such a model, the following problems of information control and confrontation were stated and solved: the state of agents is subjected to mass influence (e.g., through controlled media) to obtain network actions beneficial for the Principal. The Principal’s strategy is choosing the degree of information influence. Analytical solutions were obtained in the case of a conditionally “atomized” network (in which the agents do not trust each other).

An important area of the country’s development under sanctions was addressed by Cand. Sci. (Eng.) M.V. Smirnov (Financial University under the Government of the Russian Federation) in the paper “Methods and Models of Decision-Making to Achieve Russia’s Technological Sovereignty” (Section 6). The author posed the topical problem of choosing priority parameters in the process of decision-making to achieve Russia’s technological sovereignty. Based on matrix convolution and prioritization, he proposed an approach to organizing a binary tree of financial and economic parameters involved in the integral assessment of managerial decisions and their results.

The paper “Model of Dynamics the Inflation Macro Indicators Taking into Account External Influences” by Cand. Sci. (Phys.–Math.) V.B. Gusev (ICS RAS) analyzed macroeconomic indicators of Russia’s economy (the consumer price index, the ruble exchange rate, and the dynamics of the annual GDP in the medium term). The model involves expert hypotheses, patterns, and statistical data. The so-called phenomenological approach was used: the properties of the economy’s observed response to external influences were formalized, and the resulting model was verified.

The paper “Single-Factor Stress Testing of the System-Forming Enterprises” by Dr. Sci. (Eng.) O.I. Dranko, Corresponding Member of RAS A.F. Rezhnikov (ICS RAS), Dr. Sci. (Eng.) A.S. Bogomolov (Institute for Precision Mechanics and Control Problems RAS, Saratov), and Cand. Sci. (Econ.) M.M. Dvoryashina (ICS RAS) was focused on the control of recession risks for real-sector enterprises. The authors presented the results of calculations of the single-factor stress tests (the critical reduction in revenue) for a list of system-forming organizations. According to the calculations, many Russian organizations have a good margin of safety for 2022.

Cybersecurity of the technosphere plays a significant role in the national security system. The main problems and approaches in this field were considered in the plenary paper “Risk Assessment and Cybersecurity of Nuclear Power Plants” by Cand. Sci. (Phys.–Math.) V.G. Promyslov, E.A. Abdulova, Cands. Sci. (Eng.) E.F. Jharko and A.Yu. Iskhakov, Dr. Sci. (Eng.), Prof. R.V. Meshcheryakov, Dr. Sci. (Eng.) A.G. Poletykin, Cand. Sci. (Phys.–Math.) K.V. Semenov (ICS RAS) and N.N. Akimov, P.A. Golubev, and I.Yu. Lepekhin (Sedakov Research Institute of Measuring Systems, Branch of All-Russian Research Institute of Experimental Physics, Nizhny Novgorod). The paper considered cybersecurity risk assessment for automated process control systems (APCSs) of critical facilities. The internal and external contexts of risk assessment were discussed for APCSs of nuclear power plants (NPPs). Two methodologies were proposed: the ones for the R&D life cycle stage and the operation stage of APCSs. The authors formulated the main tasks of ensuring the cybersecurity of APCSs of NPPs and outlined the principles of security architecture. The connection between the classical principle of defense-in-depth, applicable for nuclear safety, and its projection to information security in APCSs of NPPs was described. As justified by the authors, the main goal of cyber protection in APCSs of NPPs is to prevent violation of nuclear safety standards. Due to this feature, there is a strong connection between the classifications of APCSs of NPPs by nuclear security and cybersecurity.

Methodological grounds for developing digital decision support platforms were presented in the paper “Hierarchical Structures in Strategic Planning and Control” by Dr. Sci. (Eng.), Prof. F.I. Ereshko (Federal Research Center “Computer Science and Control” RAS). The author proposed mathematical models of controlled systems with a hierarchical organization.

The papers mentioned above are only a small part of the conference contributions, methodologically verified and implemented in the form of services, analytical applications, and software systems. They provide a toolkit for analytics and the choice of management strategies for the development of large-scale systems in complex macroeconomic and geopolitical conditions.

Thus, the main result of MLSD’2022 was proposals on implementing a digital strategic planning platform for transport, energy, economic, and social systems and investment processes under foreign sanctions.

The results obtained allow optimizing the choice of state-supported enterprises by the criterion of pre-



serving the basic socio-economic processes in complex macroeconomic conditions and under high uncertainty. One example is choosing the set of enterprises supported to maintain the vitality of industries in economic mobilization conditions and under emerging constraints (sanctions, epidemics, etc.).

The modern growing challenges and threats to Russia's economy require urgent and adequate preventive measures based on the risk-oriented approach to economic management. According to the Russian and foreign experience, the risk-oriented approach should be applied in a broad sense: as a mechanism of forming financial resources to cover losses and minimize risks and as a mechanism of forming a wide range of financial measures and coordinated actions in addressing strategic development objectives of Russia's economy.

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