18TH INTERNATIONAL CONFERENCE ON MANAGEMENT OF LARGE-SCALE SYSTEM DEVELOPMENT (MLSD'2025)

The 18th International Conference on Management of Large-Scale System Development (MLSD'2025) was held on September 24–26, 2025, by the Trapeznikov Institute of Control Sciences, the Russian Academy of Sciences (ICS RAS), with the technical support of the IEEE Russia Section. The event was attended by 350 researchers from over 86 research institutes, universities, and governmental and commercial organizations, including 2 academicians and 2 corresponding members of the RAS, 2 academicians and 4 corresponding members of the Russian Academy of Rocket and Artillery Sciences (RARAS), as well as 86 doctors of sciences and 126 candidates of sciences.

By the established tradition, the first day is reserved for a plenary session to open the conference with all the participants. The MLSD'2025 plenary session became an opportunity to honor the memory of Dr. Sci. (Eng.) *Anatoly D. Tsvirkun*, the inspiration and organizer of the annual MLSD conference series covering a wide range of 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, energy,, 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 and other high-risk installations.

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-scale data arrays.

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

Section 15. Management of the development of large-scale healthcare systems, biomedical systems, and technologies.

Section 16. Managing the development of social systems.

The success of MLSD conferences is evidenced by the regular publication of conference papers in IEEE *Xplore* (Scopus indexing). The proceedings of MLSD'2025 have already been published in IEEE *Xplore*[1] (extended versions of selected English-language papers) and the Institute's website[2] (the full collection of original Russian-language papers).

The figure below illustrates the growth in the number of full text views of MLSD'2022 and MLSD'2024 papers on IEEE *Xplore*, broken down by the 16 conference sections.

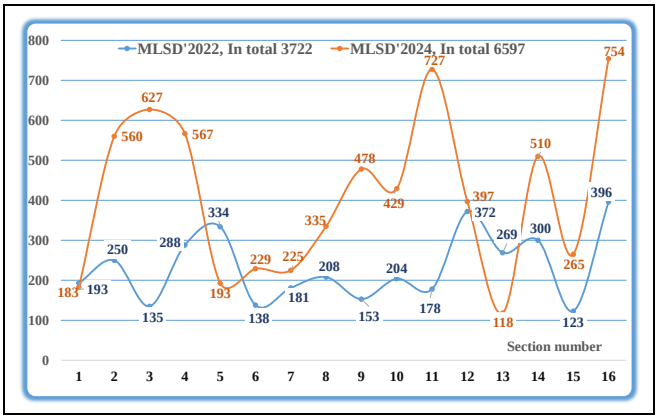
At the same time, the table reveals the problem of low citations for the papers according to IEEE *Xplore* data as of November 1, 2025.

At present, the citations of MLSD papers are insufficient.

On the one hand, it takes time to read the papers, use them as sources, and publish related research. On the other, the vast majority of the papers have not been cited at all. Even the authors did not continue their topics in publications indexed by international databases. This problem is most evident for the papers with the highest number of full text views. For exam-

[1] https://ieeexplore.ieee.org/xpl/conhome/11220592/proceeding

[2] *Trudy 18-oi Mezhdunarodnoi konferentsii "Upravlenie razvitiem krupnomasshtabnykh sistem"* (Proceedings of the 18th International Conference on Management of Large-Scale System Development (MLSD'2025)), Vassilyev, S.N. and Dranko, O.I., Eds., Moscow: Trapeznikov Institute of Control Sciences, 2025. Electronic document (36.2 MB; in Russian.)



The number of full text views of MLSD papers.

The number of citations of MLSD papers

Year	The number of papers published in IEEE *Xplore*	The number of citations (as of November 2025)				
		>10	5–9	3–4	2	1
2024	166	0	0	0	2	13
2023	173	0	0	4	15	40
2022	151	0	4	13	13	36
2021	153	1	5	11	20	25
2020	140	4	11	19	15	23
2019	149	7	10	27	14	29
2018	188	4	28	20	19	31
2017	134	6	14	17	11	27

ple, consider the following six publications with 800–6000 full text views since 2017.

The paper by Dr. Sci. (Eng.) E.E. Dudnikova (ICS RAS) was devoted to the advantages and features of Hyperloop, the revolutionary transport technology involving high-speed vacuum trains inside tubes with reduced internal air pressure [1] (22 citations and 5921 full text views). It presented the technical parameters of the tube and capsule for Hyperloop cargo systems, as well as some estimates for technical and economic indicators, including construction costs and road capacity.

Cand. Sci. (Eng.) *E.L. Kulida* and Dr. Sci. (Eng.) *V.G. Lebedev* (ICS RAS) considered the application of artificial intelligence (AI) methods in aviation [2] (14 citations and 1767 full text views). In particular, current and potential trends in the development of AI technologies for different tasks in civil and military aviation were traced.

In 2018, Cand. Sci. (Eng.) *T.V. Ershova* (Director of the Institute of the Information Society), Cand. Sci. (Phys.–Math.) *Yu.E. Khokhlov* (the Institute of the Information Society) and *S.B. Shaposhnik* (Karelian Research Center RAS) presented the paper "Methodology for Digital Economy Development Assessment as a Tool for Managing the Digital Transformation Processes" [3] (15 citations and 1473 full text views). This methodology includes a system of indicators, measurement tools, and criteria for assessing the current conditions, processes, and results of digital transformation at the national, regional, and industry levels.

The concept of a digital twin in the life cycle management of industrial capital construction projects was developed by *Y. Xu* (Dalian University of Technology), *N.F. Bondaletova*, *V.I. Kovalev* (Russian State Social University), and *A.V. Komrakov* (Moscow State Technical University of Civil Aviation) [4] (9 citations and 1376 full text views). The virtual model proposed by the authors corresponds to a real physical object at all stages of its life cycle, from conception to decommissioning and project closure. This concept allows improving project management during the implementation and operation stages. The analysis provided an intuitive explanation of the basic idea behind a digital twin and identified necessary conditions for its realization, including the Internet of Things and big data processing.

Experts in industrial robotics, Dr. Sci. (Eng.), Prof. *V.M. Chadeev* and Dr. Sci. (Eng.) *N.I. Aristova* (ICS RAS) examined industrial automation as a factor of increasing labor productivity in the country; see the 2017 paper [5] (6 citations and 1017 full text views). This publication considered the theory of automation control, a model invariant to the types of technological operations, and the limits of automation capabilities. The relationship between the cost of a robot and the automation of its component manufacturing was analyzed. A robotic system, the main tool of industrial automation, was treated as a closed self-reproducing system. The invariant theory allows estimating the cost of products in automated manufacturing. The synergetic effect arises as a result of industrial feedback when robots are used to automate the manufacturing of robot components.

A SCADA system for assessing the risks of national critical infrastructure enterprises based on cybersecurity formulas was proposed by *A.D. Kozlov* and *A.K. Noga* (ICS RAS) [6] (1 citation and 815 full text views). The system covers information protection methods and all available security and fidelity measures. Another feature concerns the identification of assets using explicit and implicit (hidden) functions, for which the damage from possible cyberattacks is assessed. The system deals with order scales. An example of a scale for damage and risk values was proposed.

The increased interest in the above papers is due to their high quality and the novelty of scientific directions, approaches, and organization principles of large-scale management. However, the significant gap between the numbers of full text views and citations indicates the need to reorient the MLSD conference to-

ward the improvement of research schools and the presentation of the results of scientific cooperation similar to foresight studies, with mandatory references to additional research and new achievements by colleagues.

In this context, note the new organization principle of the MLSD'2025 plenary session, moderated by Dr. Sci. (Eng.) *O.I. Dranko*, Head of Laboratory No. 33 (Large-Scale Systems) at the ICS RAS. He compiled the program of presentations by leading experts around the central theme of MLSD'2025, i.e., the accelerated development of the scientific and technological sovereignty of the Russian economy within the sixth technological paradigm.

Dranko's plenary paper was devoted to substantiating the key role of the fast growth and development of the country's enterprises in managing qualitative and quantitative changes in the proportions between the economic system elements over a definite period [7]. Since 2020, Dranko has been leading the creation of a digital platform for the annual systematic collection of information on all Russian enterprises, focused on the development of methods and models for strategic indicative planning of fast-growing sectors of the economy of the new technological paradigm in modern conditions.

The author presented an original strategy for developing the network economy as an alliance of enterprises that are technological partners in the implementation of innovative development programs and projects, the transformation of old industries, and the development of new ones. According to the main idea of this approach, an enterprise is an element of a large-scale system covering different levels (sectoral, regional, national, and international).

In the plenary paper "Strategic Planning: Reboot," Dr. Sci. (Econ.) *O.O. Smirnova* (the Institute of Scientific Information for Social Sciences (INION) RAS, Center for Interdisciplinary Research) discussed the difficult-to-solve problems of methodological and instrumental support for reorienting the economy toward structural shifts and transition to the rapid growth trend. According to the author's arguments, the key problem lies in the inadequacy of the vertical hierarchical planning system of the Russian market economy. Smirnova's promising alternative is a network structure of strategic planning that supports dynamic adaptation and flexible interrelationships between the economic agents of different scales, industries, and regions.

At the same time, Smirnova drew attention to the following fact in the paper [8]: against the background of thousands of documents, planning programs, masses of network schedules and diagrams, and with the wide possibilities of digitalization and mathematical modeling of planning processes, the main thing—the methodology and tools of state strategic planning—is missing. There are no strategies for achieving a particular result; the goals, resources, and results are explicitly and implicitly duplicated; and the processes of achieving goals are neither transparent nor traceable.

In his plenary paper "From Information Search to Knowledge Management: How LLM Technologies Are Changing the Way of Handling Scientific Information," Dr. Sci. (Phys.–Math.) *K.V. Vorontsov* (Moscow State University, Moscow Institute of Physics and Technology) presented new principles and directions for the application of large language models (LLMs) for processing scientific knowledge.

Technologically, LLMs are distinguished by their vector representation of words, contexts, and meanings [9]. A notable example is the SciRus-tiny model (Moscow State University), which was integrated into the eLibrary.ru publication search system. This model analyzes scientific texts in Russian and English. It was trained on 44 million paper abstracts and citation data and outperformed the SciNCL model in 13 of the 24 SciRepEval benchmark tasks.

One of the central applications of LLMs, discussed in detail by Vorontsov, was Knowledge Workshop, a search and recommendation service. This technology automates the stages of scientific research related to the search, analysis, and processing of large scientific and technical text arrays.

Some features of the service are recommendations for scientific articles when compiling thematic selections; monitoring of new relevant information selections; automation of selection referencing; automatic identification of scientific research trends; assessment of the cognitive complexity of a text and recommendations on the order of reading; systematization and subject classification of scientific and technical information; generation of knowledge maps and other visual representations within the concept of *distant reading*.

The plenary paper by Dr. Sci. (Eng.), Prof., Academician of the RARAS *V.P. Kutakhov* (National Research Center Zhukovsky Institute) was devoted to managing the development of unmanned vehicles under prediction uncertainty. Agreeing with the conceptual statements of the above authors, he highlighted another problem in the strategic management of the development of the new technological paradigm: the creation of intelligent real-time mobile systems that can operate in uncertain and unfamiliar situations, under rapidly changing influence factors, situations, and events, with nonlinear dynamic time-varying processes.

Kutakhov considered this problem as part of "Unmanned Aerial Systems," the national project encompassing several federal projects aimed at the comprehensive solution of the following problems: personnel training, infrastructure development for a special certification system for unmanned aerial systems, development of promising technologies, demand stimulation, as well as standardization and serial production of systems and components. This leads to a strategically high-priority problem of developing adaptive learning control based on functional models of unmanned vehicles involved in fast processes and a rapidly changing space of influence factors.

Dr. Sci. (Econ.), Prof. *O.S. Sukharev* (Institute of Economics, the Russian Academy of Sciences) presented his paper "Structural Dynamics of the Russian Economy: Patterns" [10]. It was focused on the problem of finding structural changes for developing technological sovereignty, ensuring sustainable and relatively high economic growth, and settling social development issues. Referring to China's experience in managing internal transformations over the past 30–40 years, the author formulated an economic growth strategy based on several influence factors of economic development: the structure of income distribution, the level of inequality and poverty (the initial state), and current scientific and technological potential.

The plenary papers by O.I. Dranko, O.O. Smirnova, K.V. Vorontsov, V.P. Kutakhov, and O.S. Sukharev, closely related by the topics, were complemented by numerous sectional papers devoted to the management of Russia's innovative development.

Among them, note the paper by Cand Sci. (Phys.–Math.) *O.E. Pyrkina* and Dr. Sci. (Econ.), Prof. *A.Yu. Yudanov* (Financial University under the Government of the Russian Federation), entitled "Optimization of Bank Operations Control and Management with the Model of Incapsulated Knowledge Application" [11]. Encapsulation means replacing a complete understanding of a process with an algorithm of actions sufficient to achieve the result. Such an organizational model belongs to the class of hidden Markov models. The Viterbi algorithm was used to manage and optimize the internal structure. The model can be applied in company management, including fast-growing companies, using encapsulated knowledge.

Active R&D work on the use of AI tools in the analysis of the global and Russian energy sector is being conducted at the Energy Research Institute (ERI) RAS under the leadership of Academician of the RAS *A.A. Makarov*. The current results of this large-scale work were presented at MLSD'2025 in the following papers.

A.A. Galkina, an ERI's senior researcher, noted significant changes in the forecasting of global energy trends; see her paper "Methodological Problems of Long-Term Forecasting of Global Energy Demand" [12]. Scenarios are formed based on the prediction of demographic dynamics, global economic development, and technological development.

Macroeconomic forecasts are now combined with technological forecasts involving technical and economic data. Descriptive forecasts are supplemented by normative ones. The nonlinear conditional dynamic model of energy in the economy, previously used for forecasting, has been transformed into a methodology for forecasting global demand for world energy. It includes comprehensive methods, in particular, analysis of linear and nonlinear series, system and scenario analysis, technical and economic modeling, cluster analysis, etc.

Cand. Sci. (Eng.) *A.E. Tarasov*, an ERI's senior researcher, presented the paper "The Peculiarities of Modeling the Strategy for the Development of the Russian Gas Industry" [13]. He considered in detail variations in global demand for energy resources due to rapid technological changes and complex socio-economic dynamics.

The paper "Modeling of Efficient Scales of Electric Power Storage in the Tasks of Resource Management of Energy System Flexibility" was co-authored by *L.S. Lyushnin*, *M.A. Gorodilov*, *R.O. Alikin*, and Cand Sci. (Econ.) *F.V. Veselov* [14]. The main focus was on commercial dispatching models for balancing the power system amid the growth of renewable energy. The efficiency of electric power storage systems and their impact on the operation modes of power plants and electricity prices were analyzed.

In their paper, *R.O. Alikin*, Cand Sci. (Econ.) *A.A. Khorshev*, and Cand Sci. (Econ.) *F.V. Veselov* described a probabilistic estimation method for the guaranteed capacity of wind power plants (WPPs) to be included in predictive power balances of the power system [15]. Based on parametric model calculations for optimizing the structure of generating capacities, the economic effects for the power system were estimated under different levels of guaranteed WPP capacity.

In the plenary paper "Business Models and Methods of Digitalization of the Regional Intellectual Property Management System," Dr. Sci. (Eng.) *V.O. Sirotyuk* (ICS RAS) discussed the goals, principles, and objectives of digitizing an intellectual property management system [16]. Business models and methods were proposed to optimize the structure of a digital patent information fund and build a digital intellectual

property ecosystem. The methods and tools developed were used to create a management body for digital intellectual property in the Eurasian region.

Dr. Sci. (Eng.), Prof. *V.V. Tsyganov* (ICS RAS) devoted his plenary paper to organizational mechanisms for sustainable transport development [17]. According to the author's main message, under the current sanctions, Russia's socio-economic development is impossible without strategic management of the accelerated development of sustainable transport infrastructure in new and promising directions. The main attention was paid to the strategic priority of organizational mechanisms for saving natural resources and reducing harmful emissions. Tsyganov formulated the problem of developing a digital platform to comprehensively model, predict, plan, and allocate resources as well as to incentivize executors involved. To solve this problem, he proposed expanding the environmental protection concept, originally developed for JSC Russian Railways, to road and water transport.

The plenary paper by Dr. Sci. (Eng.), Prof. *I.B. Yadykin* (ICS RAS), entitled "Energy Metrics of Large Dynamic Networks," was devoted to methods for assessing the controllability of linear time-invariant systems based on canonical forms of state equations [18]. The author focused on spectral methods for analyzing energy metrics of stability. He gave priority to spectral and singular decompositions of gramians based on Laplace transform theorems and the Faddeev–Leverrier series. These methods were interpreted through energy measures of state. The direct and inverse controllability gramians can be calculated using a single recursive procedure. Therefore, it becomes possible to formulate a new method for the Laplace transforms in the case of simple and multiple eigenvalues using recursive resolvent decomposition algorithms.

Dr. Sci. (Eng.) *D.A. Gubanov* presented his plenary paper "On the Description of Scientific Objects in the Information System for Scientific Activity Analysis," addressing joint research with Dr. Sci. (Phys.–Math.) *A.G. Chkhartishvili* (ICS RAS) on the automated understanding of the content of large arrays of scientific publications in the field of control theory [19]. He described ISAND, the information system for scientific activity analysis being developed at ICS RAS. The ontological and mathematical modeling principles used for the unified representation and calculation of "distances" between scientific objects (publications, authors, organizations, journals, and conferences) in the thematic space of control theory were discussed. Gubanov also demonstrated the system of automated applications with the following functions: selecting experts and reviewers with the necessary competencies, searching for publications on given topics, analyzing scientific directions and their trends, and others.

In the plenary paper "Finite-Dimensional Dynamics in the Description and Control of Evolutionary Processes in Continuous Media," Dr. Sci. (Phys.–Math.) *A.G. Kushner* (ICS RAS) presented a new method for solving nonlinear evolutionary equations with many spatial variables. The method is based on the use of finite-dimensional dynamics, which involves the construction of auxiliary systems of differential equations with symmetries determined by a finite set of parameters. This method is applicable to systems arising in many areas of physics (filtration, gas flow, wave propagation, etc.). Owing to the capability to find exact solutions of nonlinear evolutionary equations, the method can be useful in the design of new materials within the new technological paradigm.

The plenary paper by Dr. Sci. (Eng.), Prof. *F.I. Ereshko* (Federal Research Center "Computer Science and Control" RAS), entitled "Formalization of Decision Mechanisms Using the Example of a Simulation Game," considered the problem of decision-making in a player interaction model within a two-level organizational system. The author reviewed international and Russian studies of interstate economic and environmental interactions and the formation of a system of balance relations. His original model allows analyzing the activities of companies and assessing the impact of state support on their operation. This model can be used to carry out experiments and develop recommendations for improving the efficiency of companies. In conclusion, Ereshko formulated the basic methodological principles for conducting studies, developing recommendations for actions, and elaborating behavioral strategies for regulatory bodies based on the Pareto principle.

In the plenary paper "Software for Upper-Level Systems of NPP APCS: Protection and Configuration Management," Cand Sci. (Phys.–Math.) *V.G. Promyslov* presented joint R&D work with Dr. Sci. (Eng.) *A.G. Poletykin*, Cands. Sci. (Eng.) *A.A. Baibulatov*, *M.E. Byvaikov*, *E.F. Jharko*, and Cand. Sci. (Phys.–Math.) *K.V. Semenkov* (ICS RAS).

The paper was devoted to the development of the upper-level system, which has been carried out at ICS RAS for over 20 years. During that period, the upper-level systems were developed and implemented for the Bushehr Nuclear Power Plant (NPP) in Iran and power units 1 and 2 of the Kudankulam NPP in India. Such upper-level systems are a response to the fundamental incompleteness and limitations of classical solutions, including ERP systems (which automate financial and

management processes but are inefficient in production control due to their orientation to supervision) and SCADA systems (which provide extensive data on production processes). As a result, the upper-level system becomes a production and control loop for automating routine processes and, at the same time, a transparent supervision mechanism that increases the efficiency and profitability of production.

One approach to building the upper-level system as an integrated enterprise management system is to organize a continuous reconfiguration mode for the application software of the NPP's automated process control system (APCS). Promyslov provided brief information about the application software, revealed the main ideas of the reconfiguration methodology, and presented the characteristics of the data preparation system for automated reconfiguration.

In his paper "Methods of Regulating the Activities of Export Companies and Food Security of the Country," Dr. Sci. (Eng.) *V.K. Akinfiev* (ICS RAS) considered the following critical situation arising in an open market economy [21]. Exporting companies can independently determine the outputs and sales markets of their food products; if global market prices, minus the costs of entering that market, are higher than domestic market ones, then profitable exports can increase the latter prices and cause inflationary processes in the country. Minimizing such risks by introducing export restrictions is an important task of state food security management. The author's approach to modeling and analyzing such situations considers the interactions between market participants and coordinates the interests of independent producers and the state. The mechanisms for regulating the grain market in the Russian Federation were analyzed, and a mathematical formulation of the problem and its solution methods were provided. This approach may be useful for developing adaptive strategies for the country's entry into foreign markets.

Dr. Sci. (Eng.) *V.G. Varnavskii* (ICS RAS) presented the plenary paper "Assessment of Import Dependency across the Russian Sectors of Economy Using OECD Inter-Country Input-Output Tables" [22]. It was devoted to structural shifts in import dependency in various sectors of the country's economy for 2014 and 2020. The approach of this study is based on constructing a model of Russia's intersectoral balances (input–output tables) with imports highlighted in the matrices of intermediate and final products, calculating the dependency of each sector's intermediate and final products on imports, and identifying the sectors with the highest and lowest levels of import dependency. According to the model calculations, after 2014, most sectors of the Russian economy shifted toward reducing their import dependency. Of the 26 main sectors, a reduction in the share of imports in intermediate and final consumption was observed in 14 and 16 sectors, respectively. The most successful sectors were agriculture and fisheries, extractive industries, pharmaceuticals, telecommunications, information technology and services, education, healthcare, and social services.

In his closing remarks, O.I. Dranko—the moderator and organizer of the plenary session—thanked all participants for their active discussion of the presentations by the leading speakers, questions, critical comments, and suggestions. MLSD'2025 was a successful continuation of the previous conferences [23, 24]. As noted by Dranko, the MLSD'2025 plenary session provided a unique opportunity for a multifaceted discussion of current issues in indicative strategic planning for the development of the Russian economy.

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