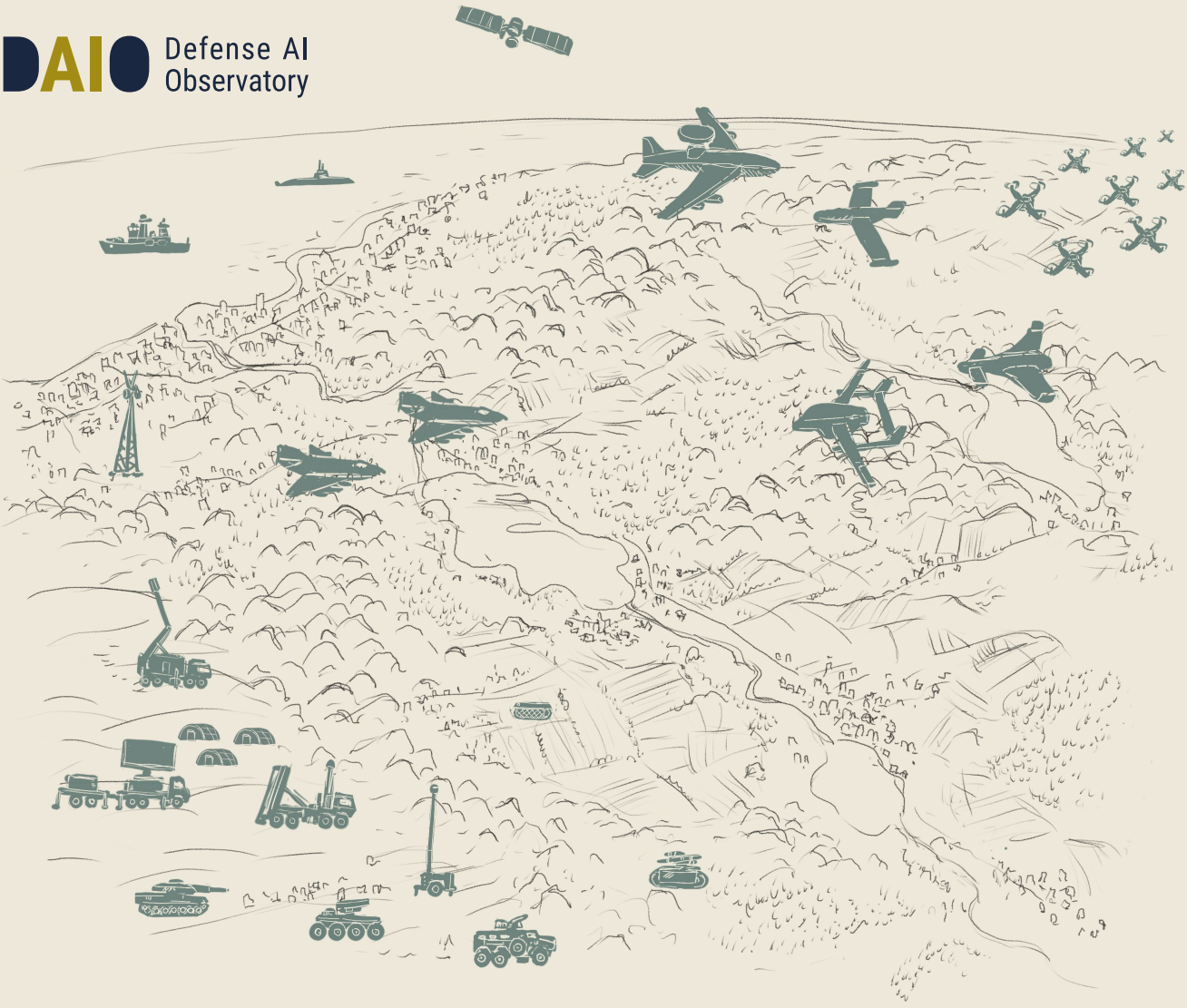
DAIO Defense AI Observatory



High Hopes Amid Hard Realities

Defense AI in Russia

Katarzyna Zysk

DAIO Study 23|11

Ein Projekt im Rahmen von
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Zentrum für Digitalisierungs- und Technologieforschung der Bundeswehr

About the Defense AI Observatory

The Defense AI Observatory (DAIO) at the Helmut Schmidt University in Hamburg monitors and analyzes the use of artificial intelligence by armed forces. DAIO comprises three interrelated work streams:

- Culture, concept development, and organizational transformation in the context of military innovation
- Current and future conflict pictures, conflict dynamics, and operational experience, especially related to the use of emerging technologies
- Defense industrial dynamics with a particular focus on the impact of emerging technologies on the nature and character of techno-industrial ecosystems

DAIO is an integral element of GhostPlay, a capability and technology development project for concept-driven and AI-enhanced defense decision-making in support of fast-paced defense operations. GhostPlay is funded by the Center for Digital and Technology Research of the German Bundeswehr (dtec.bw).

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Acknowledgments
The author would like to thank Heiko Borchert and Joseph Verbovzsky for valuable comments and suggestions. Any errors in fact, analysis, or omission are the sole responsibility of the author.

Design
Almasy Information Design Thinking

Imprint
Katarzyna Zysk, High Hopes Amid Hard Realities. Defense AI in Russia. DAIO Study 23/11 (Hamburg: Defense AI Observatory, 2023).

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ISSN (online): 2749-5337
ISSN (print): 2749-5345

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1 Summary

The Russian political and military leadership is pursuing defense AI with an increasing sense of urgency. Advanced technology has been traditionally considered in Russia a critically important foundation of military effectiveness and strategic advantage. Seen from Moscow, gaining or losing ground in the contest for cutting-edge military technology and more effective weapon systems has far-reaching consequences for national security, defense, sovereignty, economy, and, consequently, for Russia's place in the international hierarchy of power.

Russia's pursuit of AI is driven by two major forces working in a conjunction: on the one hand, by the hope for a range of capabilities that can help Russia close the capability gap with the West and provide an edge of the battlefield; on the other by fear that AI-enabled technologies may give adversaries critical advantages that will create new vulnerabilities, change the character of warfare, and undermine strategic balance that can pose an existential threat to Russia. Hence, AI development is seen not as a choice, but as a necessity.

The Russian war on Ukraine provides further incentives to pursue AI in defense applications. In addition to proven usefulness on the battlefield, AI-enabled weapon systems and associated emerging and disruptive technologies (EDT) are seen as a way to compensate for the conventional inferiority in an accelerated, nonlinear and possibly exponential, manner.

Hence, the top political leadership, including President Putin, continue pushing for the development of defense AI. In recent years, Russia has produced several strategic policy documents, expanded the organizational ecosystem, adapted legal frameworks and educational programs, and pressed for an extensive civil–military cooperation to accelerate the development. Among priority programs are AI applications in command and control, communications and the speed of decision-making; nuclear and high-precision weapons; unmanned vehicles for a broad spectrum of missions; early warning, air defense, and electronic warfare, offensive cyber and influence operations to shape the psychological domain.

There is, nonetheless, a high degree of uncertainty about Russia's ability to broadly adopt military AI in the short and medium term. Russia continues to struggle with inefficiencies of the state-driven top-down defense innovation model. Long-standing structural problems plaguing the armed forces, as well as the political and economic system at large, such as widespread corruption, repressive bureaucracy and red tape, preferential state funding,

deficient educational foundations, weak intellectual property rights and rule of law undermine the investment climate, competitive research environment, creativity and innovation. In addition, acute problems generated by the pandemic and the Russian war on Ukraine, such as unpredictable funding, brain drain and restricted access to foreign technology and exchange of ideas, aggravate the existing structural issues. They will likely have a lasting impact on the AI development in Russia. Is that enough to dismiss the Russian AI ambitions? Current developments suggest otherwise.

2 Thinking About Defense AI

2.1 Understanding of AI

The Russian political and military leadership attaches an increasing importance to the development of emerging and disruptive technologies (EDT). AI is at the core of the high-tech development, serving as the backbone for most of the Russian military EDT programs.[1]

According to the Russian official definition, AI is "technological solutions capable of mimicking human cognition and performing intellectual tasks similarly to, or better than, humans."[2] More specifically, the Russian military dictionary defines it as a complex of cybernetic devices that replace human intelligence activity; provide the foundation for building an automated control system; is applied for search, recognition and analysis of information; for development of recommendations and decisions; automatic creation and issuing of commands, and as a tool for analyzing a large volume of data.[3] AI is seen as key in decision-making and complex analysis characterized by a high degree of uncertainty and inconsistent data in real-time and under high time pressure.[4]

There is, however, a certain level of confusion about what AI actually is. It derives from the varying degrees of autonomy and intelligence. The Russian discourse on AI distinguishes between "automation" (avtomatizatsiya), i.e., automated, remotely controlled and semi-autonomous weapon systems, and "intellectualization" (intellektualizatsiya), i.e., integrating machine learning and other sub-elements of AI technology.[5]

Automation and weapon systems capable of operating automatically have existed in Russia since the Soviet Era and are therefore more advanced than the process of integrating machine learning and other elements under the AI umbrella.[6] Some examples include the "Perimetr" nuclear C3 system; the P-700 "Granit" anti-ship cruise missile, which featured AI algorithms in an on-board computer;[7] the more precise and complex P-800 Onyx rocket; or the Don-2N radio-electronic facility in Sofrino near Moscow, designed for automatic detection of nuclear warheads and transmission of information to launchers of anti-missile systems, offering options for action.[8] The process of "intellectualization", on the other hand, has critical

1 Zysk, "Defense Innovation and the 4th Industrial Revolution in Russia."
2 "O razvitii iskusstvennogo intellekta v Rossiiskoi Federatsii."
3 "Iskustvennyi intellect."
4 Ibid.
5 Fink, "Russian Thinking on the Role of AI in Future Warfare;" Nadibaidze, "Russian Perceptions of Military AI, and Automation, and Autonomy."
6 Nadibaidze, "Russian Perceptions of Military AI, Automation, and Autonomy."
7 "Pochemu Rossiya massovo vnedryaet iskusstvennyi intellekt v boevye sistemy."
8 Poroskov, "Iskustvennyi intellekt: novoe soderzhanie voennoi moshchi."

elements of adaptability, self-learning, self-improvement, self-programming, and "the ability to make decisions in various and rapidly changing situations, similar to a person."[9]

Advances in AI development may lead weapons systems to move further along the spectrum of autonomy and ultimately replace humans on the battlefield.[10] The Russian government appears to have an ambiguous approach to full autonomy and the ability of weapons to select and apply force to targets without human intervention. In the 2019 national AI strategy, Russia highlights the importance to develop ethical norms to govern the interaction between humans and AI.[11] It recognizes the dangers in using lethal autonomous weapon systems (LAWS). The official stance is that the loss of meaningful human control of LAWS is inadmissible, and the responsibility for and potential unintended consequences of the use of LAWS rests with the operator of the system or "programming."[12]

However, Russia simultaneously argues that it will be very difficult to develop criteria for what the "meaningfulness" means without politicizing the issue.[13] The Russian government systematically opposes agreeing to legally binding international instruments that would prohibit the use and development of LAWS.[14] One notable reason behind it is that restrictions could slow down the pace of Russian AI development, thus pushing Moscow behind in the technological race.[15] In July 2022, the Russian official representation to the UN argued that there is also a number of benefits of LAWS: they can be more efficient than a human operator as they do not have the human weaknesses. Hence, they can reduce errors deriving from human mental or physical states (e.g., moral and religious attitudes, revenge, panic, exasperation, prejudice, or fear). Moreover, highly automated technologies can also increase accuracy and thus reduce strikes against civilians and civilian facilities.[16] While the latter argument sounds shallow in the light of the systematic Russian targeting of civilians in Ukraine, the Russian authorities seem to be certain about the advantages of LAWS. In the 2019 national AI strategy, Russia highlighted the importance of developing ethical norms to govern the interaction between

9 Fink, "Russian Thinking on the Role of AI in Future Warfare".
10 "Iskustvennyi intellekt".
11 "O razvitii iskusstvennogo intellekta v Rossiiskoi Federatsii".
12 Letter of Andrey Belousov, Ambassador Permanent Representative of the Russian Federation to the UN Office and other international organisations in Geneva to Flavio S. Damico, Chair of the Group of Governmental Experts on Emerging Technologies in the Area of Lethal Autonomous Weapon systems (GGE on LAWS).
13 "Examination of various dimensions of emerging technologies in the area of lethal autonomous weapons systems, in the context of the objectives and purposes of the Convention. Submitted by the Russian Federation."
14 Nadibaidze, "Great power identity in Russia's position on autonomous weapons systems;" Hoffberger-Pippan/Vohs/Köhler, Autonomous Weapons Systems; "Potentsial'nye vozmozhnosti i ogranicheniya voennogo primeneniya smertonosnykh avtonomnykh sistem vooruzhenii, predstavleno Rossiiskoi Federatsiei".
15 "O razvitii iskusstvennogo intellekta v Rossiiskoi Federatsii."
16 Letter of Andrey Belousov, Ambassador Permanent Representative of the Russian Federation to the UN Office and other international organisations in Geneva to Flavio S. Damico, Chair of the Group of Governmental Experts on Emerging Technologies in the Area of Lethal Autonomous Weapon systems (GGE on LAWS),

humans and AI.[17] Two years later, the national code of ethics for AI was approved. Notably, these are recommendations designed for the use of AI systems in the civilian sector only, and not for military purposes.[18] Under the current regime, AI development appears unlikely to be significantly affected by ethical limitations.

2.2 Driving Forces Behind the Pursuit of AI

Russia's pursuit of AI is driven by two major forces working in a conjunction: hope for a range of strategic advantages, and fear that adversaries may get ahead and acquire AI-enhanced capabilities. On the one hand, Russia looks at AI optimistically as a possible game changer for both the armed forces and the national economy, with the potential to boost Russia's international standing. On the other hand, Russia's pursuit of AI is driven by a pessimistic expectation that AI-enabled technologies may create new security threats and vulnerabilities that adversaries could exploit and thus win a conflict even before its eruption.[19] The development is seen as consequential for the future character of warfare and dynamics of crisis escalation; it can undermine strategic balance and pose an existential threat to Russia.[20] As Putin has put it, AI will determine Russia's security, sovereignty, and place in the world.[21] Pursuing AI is therefore not a matter of choice, but of necessity.

The Russian authorities see AI as a source of potentially vast opportunities, which can narrow the capability gap with the West. They acknowledge that due to limited resources, competing with the US and NATO symmetrically would take a long time.[22] Conversely, breakthrough technologies can provide military advantages in a relatively short period of time.[23] In 2021, Putin argued that AI may give Russia a qualitative breakthrough in enhancing combat features of key weapon systems, such as hypersonics, lasers and robotics.[24]

The Russian invasion of Ukraine has further added to the sense of urgency to accelerate the development of AI-enabled capabilities. Their use on the battlefield in Ukraine, in form of drones for various missions, face recognition for identifying Russian forces, or offensive cyber operations has contributed to define improvements for Russian Unmanned Aerial Vehicles (UAVs) an "urgent task" for the

17 "O razvitii iskusstvennogo intellekta v Rossiiskoi Federatsii".
18 Novyi, "Rossiya budet kontrolirovat' sozdanie 'sverhrazuma.'"
19 "'Whoever leads in AI will rule the world';" Cheberko, "Pochemu v Rossii ne poluchilsya analog DARPA."
20 Lieutenant General A.V. Sergeantov, A.V. Major General Smolovyi, Colnel Terent'iev, "Transformatsiya soderzhaniya voiny: kontury voennykh konfliktov budushchego."
21 Putin, "Speech at Artificial Intelligence Journey 2022."
22 Zysk, "Defense Innovation and the 4th Industrial Revolution in Russia."
23 Ibid.
24 "Putin otsenil rol' iskusstvennogo intellekta v proizvodstve vooruzheniya;" "Putin otsenil rol' iskusstvennogo intellekta v vooruzhenii."

military-industrial complex in 2023.[25] Putin argued that the most effective weapon systems are those that operate with high speed and almost automatically. With reference to the use of UAVs in Ukraine, he stressed the need to create a wide range of AI-enabled UVs for missions such as reconnaissance, target acquisition and strike, as well as ways to use them, including swarming and integration into one reconnaissance network. The objective is to have information provided by drones available to every soldier in the near future.[26]

The Russian authorities have not provided details about the exact lessons Russia has learned to date from the warfighting in Ukraine. However, the investment choices, further explored in chapter 5, indicate a number of priorities, further corroborated in the official rhetoric. They include command and control (C2), communications, and the speed of decision-making at all levels; high-precision weapons, nuclear weapons; UVs for surveillance, reconnaissance, situational awareness, search and rescue, target acquisition, strike, air defenses, early warning, electronic warfare, space based systems; logistics, manufacture; offensive cyber, and influence operations to shape the psychological domain.

An important factor fueling the Russian pursuit of AI is the longstanding expectation that a large-scale military modernization can have a transformative effect on the entire national economy in the short and the long term.[27] As such, AI is considered critical for a success in the global strategic competition.[28]

The expectations are high indeed. Putin claims that the introduction of AI could generate additional global GDP growth of 1.2% annually, i.e. twice the impact that the global growth of information technology had on the economy in the beginning of the 21st century.[29] Echoing him, the CEO of Russia's largest state-owned Sberbank and a major figure behind Russian AI development, German Gref, argued in 2022 that the introduction of AI leads to a five to sevenfold rise in indicators such as speed, quality, personalization, and economic efficiency. Correspondingly, it can result in additional increase in the country's GDP by 1% already in 2025.[30]

It is unclear whether this assessment has taken into account the damage made by the direct and indirect impact of the Russian war in Ukraine, including sanctions. Still, the Russian hopes for the AI-generated economic transformation have influenced the model of defense innovation aimed at creating links between the

25 Putin, "Speech at the annual meeting of the Board of the Ministry of Defense of the Russian Federation."
26 Ibid.
27 "Oreshkin: iskusstvennyi intellekt pomozhet povysit' proizvoditel'nost' truda;" "Gref schitaet, chto razvitie iskusstvennogo intellekta sposobno sil'no izmenit' Rossiyu;" Zysk, "Defense Innovation and the 4th Industrial Revolution in Russia."
28 Putin, "Speech at Artificial Intelligence Journey 2022."
29 "Oreshkin: iskusstvennyi intellekt pomozhet povysit' proizvoditel'nost' truda".
30 Putin, "Speech at Artificial Intelligence Journey 2022."

military and the civilian sectors. As such, it emulates the innovation pathway taken by other militaries, notably the US, and hoping for a similar success. There is no evidence, however, that the Russian authorities have considered that the radically different political, economic, and legal systems create diametrically different conditions for defense innovation.

3 Developing Defense AI

Russia's growing interest in advancing defense AI has been reflected in a series of strategic documents, concepts and policy papers. Many of the documents remain classified and this report does not aim to provide an exhaustive list. However, the examples below shed light on Russia's main focus areas and the extent of the development.

Among central strategic documents are concepts aimed to accelerate the development of combat robots, for instance the "Concept of development and combat use of robotic complexes for the period until 2025"[31] and the "Concept of the use of robotic systems for military purposes for the period 2030," both adopted in 2014.[32] Subsequently, Russia developed in 2016 the "Strategy for scientific-technological development of the Russian Federation," which defines as a priority the "transition to advanced digital, intelligent production technologies, robotic systems, new materials and design methods, the creation of systems for Big Data processing, machine learning and artificial intelligence."[33]

As noted above, the defense AI development in Russia remains closely connected to national economic development, as expressed in strategic policy documents, including a batch released in 2018. Subsequently, Russia created a series of national projects, such as the "Digital Economy," which includes the development program "Artificial Intelligence" for the period 2021–2024.[34] To facilitate the development, innovation and investment climate, the Russian government has been working on removing regulatory obstacles in administration, healthcare, transport, medicine, education, construction communications, agriculture, fuel and energy, and other sectors.[35] In addition, Russia launched the federal project "Digital Technologies," which focuses more broadly on advanced technologies such as robotics, quantum computing, virtual reality, blockchain, wireless communications and others.[36]

The growing interest of the Russian authorities in AI has also been expressed in form of conferences hosted by the MoD, aimed to facilitate contact between stakeholders across sectors. Notably, the 2018 conference brought together key Russian civilian and military actors, including the Ministry of Education and Science, the Russian Academy of Sciences, other government organizations and

31 "Minoborony RF utverdilo plan boevogo primeneniya robotov do 2025 goda."
32 "Na voenno-nauchnoi konferentsii po robototekhnike vpervye pokazhut unikal'nye razrabotki voennogo naznacheniya."
33 "O Strategii nauchno-tekhnologicheskogo razvitiya Rossiiskoi Federatsii."
34 Markotkin, Chernenko, "Developing Artificial Intelligence in Russia: Objectives and Reality"; "Programma standartizatsii AI kak dokument strategicheskogo planirovaniya na 2021 – 2024 gg 'Iskusstvennyi intellekt'"; "Predstavleny 36 proektov natsional'nykh standartov v oblasti II".
35 Markotkin/Chernenko, "Developing Artificial Intelligence in Russia: Objectives and Reality;" "Programma standartizatsii AI kak dokument strategicheskogo planirovaniya na 2021 – 2024 gg 'Iskusstvennyi intellekt'."
36 Petrella/Miller/Cooper, "Russia's Artificial Intelligence Strategy: The Role of State-Owned Firms."

industry.[37] The participants underscored the critical role of AI and argued that the leading role of states in contemporary information society is largely determined by the level of development of information technologies, primarily technologies for "intellectual analysis" and support for decision-making at various levels of government. The conference proposed ten recommendations, several of which were later realized, including the objective to:

- create AI and Big Data consortium combining efforts of leading Russian scientific, educational and industrial organizations;
- establish a fund for analytical algorithms and programs to ensure high-quality expertise on automated systems;
- create a state system for training AI specialists;
- create an AI laboratory at the "ERA" technopark for testing promising software and hardware solutions;
- establish National Center for Artificial Intelligence to provide assistance in creating a scientific reserve, AI infrastructure, and pathways for implementing promising AI technologies;
- monitor medium and long-term AI development trends, also abroad;
- organize wargames with a wide range of scenarios aimed to determine the impact of AI on the changing character of military operations at various levels;
- maintain the discussion, including at annual AI conferences.[38]

The Russian government has ordered state-owned companies to draft "roadmaps" for developing key technology (e.g. quantum computing, 5G implementation). Sberbank's German Gref was responsible for AI roadmap, which was completed in October 2019.[39] The document has identified sub-technologies and timing of transition between stages of research, development and commercialization, as well as examples of target use-cases. In addition, it points out major obstacles and barriers to the development, and measures to overcome them.[40]

Likewise, Sberbank was instrumental in preparing the draft of Russia's first national AI strategy that was finalized and signed by Putin in October 2019. The "National Strategy for the Development of Artificial Intelligence for the period until 2030" defines strategic goals in investments, research and development (R&D), infrastructure, educational and training programs, legal frameworks, recruitment of talent to the military and security services, and attempts to streamline actions to advance the development across various sectors.[41]

37 "Konferentsiya 'Iskusstvennyi intellekt: problemy i puti ikh resheniya – 2018'"; "Shoigu prizval voennykh i grazhdanskikh uchenykh obedinit'sya dlya raboty nad iskusstvennym intellektom."
38 "Konferentsiya 'Iskusstvennyi intellekt: problemy i puti ikh resheniya – 2018'".
39 "Dorozhnaya karta razvitiya 'skvoznoi' tsifrovoi tekhnologii neirotekhnologii i iskusstviennyi intellekt."
40 Ibid.; Petrella/Miller/Cooper, "Russia's Artificial Intelligence Strategy: The Role of State-Owned Firms."
41 "O razvitii iskusstvennogo intellekta v Rossiiskoi Federatsii."

One of the main objectives of the strategy is to significantly improve the development of AI in Russia by 2024. While the document recognizes that Russia lags behind the front-runners in AI development, the United States and China, it also argues that Russia has a significant potential to become one of the global leaders in AI development and use.[42] The strategy aims to increase the number of state and private entities involved in technological innovation by 50 per cent. The objective is to create a high-performance export-oriented sector equipped with modern technologies in major industries, not least in manufacturing and agriculture.[43]

During the high-level "AI Journey Conference" in Moscow in November 2022, Putin pointed at several measures the Russian authorities plan to take to accelerate AI development: design new federal projects on robotics to move forward the work on industrial robots; create AI development maturity index to evaluate practical results of AI implementation by Russian industries in various regions; and develop sovereign cloud technologies. The ambition is to introduce AI technologies to every national development project and every state program, as well as in investment programs of Russian companies.[44]

The war in Ukraine and the Western sanctions that followed suit since 2014 have exacerbated the problem of Russia's dependence on foreign components such as micro-electronics, software, and other high technology products. It has pushed the development of domestic AI solutions to the top of the agenda. In July 2022, the government adopted a concept for the development and use of weapons systems using AI technologies, though the document appears to be classified.[45] To accelerate a large-scale implementation of domestic AI technology, the Ministry of Economy approved the roadmap "Development of the high-tech direction 'Artificial Intelligence' for the period up to 2030" in December 2022. A similar objective was behind Deputy Prime Minister Dmitry Chernyshenko's agreement signed on 16 January 2023 with 30 parties engaged in the implementation of projects within the framework of the AI roadmap.[46] To encourage businesses to introduce innovations, starting from January 2023, those buying and deploying Russian-made solutions, including AI-enabled systems, can take advantage of tax incentives and direct additional funds for technological upgrades.[47]

In addition to launching a program to support the development of domestic import substitutes, Russia has also found some components in China after the

42 Ibid.;" Petrella/Miller/Cooper, "Russia's Artificial Intelligence Strategy: The Role of State-Owned Firms".
43 Markotkin/Chernenko, "Developing Artificial Intelligence in Russia: Objectives and Reality".
44 Putin, "Speech at Artificial Intelligence Journey 2022."
45 "Speech by Deputy Head of the Russian Delegation to the UN, K.V. Vorontsov during the discussion on "Conventional Arms" in the First Committee of the 77th session of the UN General Assembly."
46 "Iskusstvennyi intellekt poshel na ubyl."
47 Putin, "Speech at Artificial Intelligence Journey 2022."

sanctions imposed in the wake of the annexation of Crimea in 2014.[48] The more extensive package of sanctions imposed in 2022, together with a massive withdrawal of Western companies, have made the situation more precarious. While Russia is searching for technological partnerships in various parts of the world, including among the ASEAN members,[49] the Sino-Russian technological collaboration remains one the most important relationships. AI-related research collaboration between these two countries has systematically expanded since 2016 and includes robotics, biotech, telecommunications, cyberspace, machine tools, microelectronics, as well as uses of outer space.[50] In 2020, the cooperation was further developed as a part of a two-year initiative for scientific, technological, and innovation cooperation.[51] Still, the scope has remained relatively limited, and China has been taking on an increasingly dominant role. The COVID-19 pandemic, moreover, has redirected the attention primarily to the field of health and biotechnology. The Western sanctions and US export controls restricting China's access to foreign technology has imposed limits on the benefits of Russia's technological cooperation with China.[52]

48 "Skorbnaya zhivuchest;" see also Gressel, "The sanctions straitjacket on Russia's defense sector."
49 "Great potential for Russia – Vietnam AI cooperation."
50 Konaev/Imbrie/Fedasiuk/Weinstein/Sedova/Dunham, "Headline or Trend Line? Evaluating Chinese-Russian Collaboration in AI"; Lee, "China-Russia cooperation in advanced technologies: The future global balance of power and the limits of 'unlimited' partnership;" Petrella/Miller/Cooper, "Russia's Artificial Intelligence Strategy: The Role of State-Owned Firms."
51 Konaev, Imbrie, Fedasiuk, Weinstein, Sedova, Dunham, Headline or Trend Line? Evaluating Chinese-Russian Collaboration in AI; Bendett/Kania, "A new Sino-Russian high-tech partnership. Authoritarian innovation in an era of great-power rivalry."
52 Ibid.

4 Organizing Defense AI

As a part of the large-scale modernization program launched in 2008, Russia has gradually expanded its AI R&D ecosystem, which has grown increasingly dense in recent years. The Russian defense innovation strategy relies on a hybrid model. Dominated by the traditional top-down state-led approach and heavy reliance on state funding, it comes with important modifications: it involves the civilian sector, where AI and many other new technologies are being researched and developed.

The objective is to generate synergies between the sectors, thus increase the state's access to resources, talent, experience to facilitate and accelerate the development.[53] Furthermore, the long-standing expectation is that defense innovation will provide an impetus for the whole economy.[54] As put by Deputy Head for Scientific and Educational Activities at the military technopark ERA, Andrei Morozov, high-tech military technology is often dual-use and can benefit the civilian sector.[55] Likewise, the Head of the Department for the Development of Artificial Intelligence Technologies in the Russian MoD, Vasilii Yelistratov has argued that while the MoD adapts civilian technologies for the army, the army also provides technology transfer in the opposite direction. The transfer has become even more important in the face of sanctions: the hope is that the domestic defense industry will be able to provide solutions Russia can no longer get from abroad.[56]

Over the years, the Russian authorities have created a large number and variety of cooperation platforms between the military and security services on the one hand, and the academic, industrial, commercial and some private actors on the other. According to information provided by the "Zvezda" media group run by the Russian MoD, as of 2022, more than 150 domestic industrial enterprises, research and educational organizations were involved in various joint military-civilian networks and collaborative platforms working on AI for weapons systems and combat operations.[57] Overall, the MoD, in cooperation with the Russian Academy of Sciences, financial institutions, leading research centers and universities, has created and operates an R&D ecosystem that interacts with more than 1,200 entities from 25 Russian regions.[58]

Among the key institutions that have AI at the center of their R&D priorities are the so-called "radical innovation centers", "technopolises," or "technoparks." They aim to bring theory and practice closer together by combining scientists and ex-

53 Zysk, "Defense Innovation and the 4th Industrial Revolution in Russia."
54 Putin, "Presidential Address to the Federal Assembly," 2012; Putin, "Presidential Address to the Federal Assembly," 2013.
55 Zakvasin, ""Iskusstvennyi intellekt — sredstvo, a ne samotsel': v tekhnopolise 'Yera' rasskazali o rabote unikal'nogo klastera."
56 "Vasilii Elistratov: 'Nasha zadacha – sokhranit' zhizni lyudei s pomoshchyu intellektual'nykh mashin."
57 Poroskov, "Iskustvennyi intellekt: novoe soderzhanie voennoi moshchi."
58 "Struktura i realizatsiya innovatsionnoi deyatel'nosti."

perts from different, and usually separated, environments. The aim is to accelerate the process from the invention of an idea to its full implementation.[59]

The Advanced Research Foundation (FPI) created in 2012, focuses on developing new and potentially disruptive dual-use technologies. Among the main programs are unmanned vehicles (e.g., the Marker unmanned ground vehicle – UGV, the Udar unmanned tank); autonomous systems and automated decision-making; superconductors (Liman); additive technology of polymetallic products (Matritsa); autonomous deep-submergence vehicle (Vityaz'-D); and ultra-thin materials for improving individual camouflage and protection (Tavolga).[60]

One of the most prominent Russian military AI R&D centers is the ERA technopolis. Inaugurated in 2018, it focuses on information technology. ERA is tasked with creating EDTs for the needs of the Russian armed forces. As put by Deputy Head of ERA for Scientific and Educational Activities, Morozov, AI crosscuts almost all of ERA's research and development activities. AI development is more of a means rather than an end in itself.[61] In September 2019, a dedicated AI laboratory was established at ERA.[62]

ERA's prioritized R&D fields have expanded over the years and include robotics, information security, small spacecrafts, energy sufficiency, pattern recognition, nanotechnology, nanomaterials, information and telecommunication systems, information technology and computer science, hydrometeorological and geophysical support, hydroacoustic object detection systems, geographic information platforms for military use, radiolocation and targeting for high-precision weapons, automated control & IT, as well as "weapons based on new physical principles", i.e. directed energy, radiological, genetic and electromagnetic weapons.[63]

There are three clusters of activities at ERA: research, education, and production. The latter is represented by the Kulibin Research and Production Center, in addition to the Lomonosov Microelectronics Design Center. Kublin is designed for experimental and small-scale accelerated production of prototypes of weapons, military and special equipment from design samples created at ERA and by its partners. The main centers include metal processing, development and testing of

59 Zysk, "Military R&D, innovation and breakthrough technologies;" "Yeffektivnost' nauchnogo poiska prizvana podnyat' pravovaya osnova deyatel'nosti voennogo innovatsionnogo tekhnopolisa YeRA;" "Voennyi Innovatsionnyi Tekhnopolis ‚yeRA' sozdan v sootvetstvii s ukazom Prezidenta Rossiiskoi Federatsii ot 25 iyunya 2018 № 364;" Goncharov, "Osobennosti organizatsii innovatsionnoi deyatel'nosti v Minoborony Rossii."

60 "Fond perspektivnykh issledovanii. Proekty;" "FPI ne sostyazaetsya s amerikanskim DARPA, zayavil zamgendirektora;" "FPI: Rossiya mozhet voiti v pyaterku liderov po kvantovym vychisleniyam"; "'Udar' na avtopilote."

61 Zakvasin, "'Iskusstvennyi intellekt — sredstvo, a ne samotsel': v tekhnopolise 'Yera' rasskazali o rabote unikal'nogo klastera."

62 Sosnitskii, "Innovatsii otsenivaet praktika: Tekhnopolis YeRA stal yeffektivnoi ploshchadkoi konstruktivnogo issledovatel'skogo dialoga."

63 Zysk, "Is Russia a threat in emerging and disruptive technologies?;" "V voennom innovatsionnom tekhnopolise ‚Yera' nachal rabotat' Nauchno-proizvodstvennyi tsentr 'Kulibin';" "Nauchno-proizvodstvennyi tsentr 'Kulibin'."

new types of batteries and small spacecrafts. The mini-factory has special workshops that have, among other means, 3D printing with plastic, photopolymer, metal, ceramics, as well as carbon processing at its disposition.[64]

ERA has an extensive network of civilian cooperation partners that involve engineering centers, financial development institutions, and leading Russian universities and research institutes, such as the renowned Kurchatov Institute and Rosatom's research and production complex 'Dedal'.[65]

The Russian MoD also operates a number of other scientific testing centers focused on AI, autonomy and robotics for the needs of the armed forces and the defense industry, such as The Main Research and Development Center for Testing Robotics[66] and the 46th Central Research Institute.[67] AI R&D is also taking place in the Russian defense industry that hosts laboratories working on AI applications in weapon systems, smart munitions, unmanned vehicles and systems countering drones, advanced radio-communication systems, machine learning of deep neural networks, VR technologies, face recognition, Big Data, and others. Rostec United State Corporation, and a large number of its subsidiaries (e.g., Kalashnikov, Kamaz, Ruselectronics) are among the most prominent ones. [68]

The extensive Russian defense R&D innovation infrastructure is coordinated by the MoD's Main Directorate of Innovative Development (GUIR), created in February 2013.[69] Its objective is to organize the development, support scientific and technical programs that aim to foster conditions favorable to innovation. In 2020, the cooperation network involved more than 1,200 entities, including industrial parks, engineering centers, various technological development platforms, financial development institutions and leading universities and research institutes.[70] Furthermore, GUIR monitors new technologies in Russia and abroad, not least those that could pose a threat to national security.[71]

64 Ibid.; Zakvasin, "'Iskusstvennyi intellekt — sredstvo, a ne samotsel': v tekhnopolise 'Yera' rasskazali o rabote unikal'nogo klastera."
65 "Shoigu prizval voennykh i grazhdanskikh uchenykh obedinit'sya dlya raboty nad iskusstvennym intellektom;" Zysk, "Military R&D, innovation and breakthrough technologies."
66 "Sergei Popov o sovremennom sostoyanii robototekhniki v vooruzhennykh silakh;" "Spetsialisty GNIIC robototekhniki Minoborony RF sosredotochili usiliya na razrabotke i sozdanii sistem tekhnicheskogo zreniya."
67 "46 Tsentral'nyi nauchno-issledovatel'skii institut Ministerstva oborony Rossiiskoi Federatsii."
68 "Rostec Will Start Exporting Face Recognition Technology to the Armed Forces;" Poroskov, "Iskustvennyi intellekt: novoe soderzhanie voennoi moshchi;" "Rostekh: Rossiya uzhe imeet narabotki po samoobuchayushchemusya oruzhiyu s iskusstvennym intellektom;" Rutkovskaya Polina, "V Rossii razrabotali boepripasy s iskusstvennym intellektom."
69 Former Main Directorate of Research and Technological Support of Advanced Technologies (Innovative Research) (GUNID), "Glavnoe upravlenie innovatsionnogo razvitiya Ministerstva oborony Rossiiskoi Federatsii;" "Glavnomu upravleniyu nauchno-issledovatel'skoi deyatel'nosti Minoborony Rossii – 8 let."
70 Goncharov, "Osobennosti organizatsii innovatsionnoi deyatel'nosti v Minoborony Rossii."
71 "Vyderzhka iz polozheniya o glavnom upravlenii nauchno-issledovatel'skoi deyatel'nosti i tekhnologicheskogo soprovozhdeniya peredovykh tekhnologii (innovatsionnykh issledovanii) Ministerstva oborony Rossiiskoi Federatsii."

The Russian MoD's role in practical application of AI was, however, deemed insufficient. In order to strengthen its position as an engine for AI implementation, a special department dedicated to the development of AI technologies was created in 2021.[72] The head of the department, Vasilii Yelistratov, highlighted the need to keep a database of relevant AI technologies that will be assessed and recommended for the defense sector to work on.[73] Projects that will pass the examination are to be tested at the ERA technopolis.[74]

Commercial, predominantly state-owned companies also play a crucial role in developing AI. Under the lead of German Gref and Sberbank, several major Russian companies leading AI development in their respective fields (VKontakte, Yandex, Mail.ru Group, MTS, Gazprom Neft, and The Russian Direct Investment Fund), formed in November 2019 "AI Russia Alliance." Its stated objective is to "facilitate and accelerate the development of AI in Russia for education, research and practical applications, and to foster a competitive market for AI solutions."[75]

The Russian AI R&D infrastructure, moreover, includes academic institutions that host AI centers and laboratories, such as the Neural Networks and Deep Learning Lab at the Moscow Institute of Physics and Technology, the Higher School of Economics, the Ivannikov Institute for System Programming of the Russian Academy of Sciences, the Skolkovo Institute of Science and Technology, the Zhukovskii Institute, the National Center for Cognitive Technologies at the Information Technologies, Mechanics and Optics University in Saint Petersburg, the National Research Nuclear University, and the ITMO University.[76]

Furthermore, Russia created in September 2022 the National Center for the Development of Artificial Intelligence affiliated with the government. Its objective is to provide help with implementation of the national AI strategy and activities under the federal project "Artificial Intelligence." The Russian media reported that nearly 9.5 thousand organizations from 15 sectors of the Russian economy participated in the creation of the center.[77] It aims to to provide expert support and coordinate implementation of AI, monitor key indicators of AI development, provide a platform for selecting prospective AI solutions for business, science and government, and assist in the implementation of important infrastructure programs.[78]

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72 "V Minoborony RF sozdali upravlenie po rabote s iskusstvennym intellektom;" "Russia's top brass to set up Artificial Intelligence Department."
73 "Shoigu: sistemu upravleniya i svyazi VS RF usovershenstvuyut s primeneniem tekhnologii II."
74 Kashemirov, "Na forume 'Armiya' obsudili budushchee iskusstvennogo intellekta."
75 "AI'yans v sfere iskusstvennogo intellekta."
76 "Unique iPavlov Intelligent Platforms;" "Tsentr Tekhnologii Iskusstvennogo Intellekta NIC imeni N.E. Zhukovskogo (CTII);" "AI Is for Active Involvement... of Russian Students in Artificial Intelligence Research"; "Kak razvivaetsya iskusstvennyi intellekt v Rossii."
77 "V Rossii nachal rabotat' gosudarstvennyi tsentr razvitiya II".
78 "Natsional'nyi tsentr razvitiya iskusstvennogo intellekta pri Pravitel'stve Rossiiskoi Federatsii (NCRII);" "Natsional'nyi tsentr razvitiya iskusstvennogo intellekta nachal rabotu v Rossii;" Poroskov, "Iskustvennyi intellekt: novoe soderzhanie voennoi moshchi."

5 Funding Defense AI

Information about the scope of the Russian funding for defense AI is not publicly available. Financial details behind military EDT programs are sensitive and usually classified. Moreover, AI technology is not as much a product in itself, as it is a foundation for almost all of the Russian military EDT programs, which makes the appraisal of the funding specifically for AI difficult. In addition, the Russian innovation environment is extensive and intersects various financing sources and cooperation platforms, also involving other sectors, which further adds to the complexity.[79]

Still, general economic and financial trends can give an idea about the conditions for the Russian defense R&D environment and the relation between declared ambitions and economic realities. Moreover, it is helpful to look at AI funding in the civilian sector, not least because its active involvement is a part of the broader effort to implement the national AI strategy.

The AI development in Russia is predominantly funded by the state. On the one hand, having support of the top political and military leadership has been key to overriding the traditional institutional conservatism in the military organization, increase its responsiveness to policy change and openness to innovation.[80] At the same time, relying on preferential state funding constrains competition, risk-taking and limits incentives for innovation. Crucial decisions about the AI R&D, such as selecting projects to be pursued and funded, are more likely to be taken using political criteria, rather than choosing the most competitive ideas.[81] Combined with heavy governmental bureaucratic control, red tape, widespread corruption, in addition to poor intellectual property rights, these factors stifle innovation. Moreover, the economic crisis and an unfavorable business environment, including stagnation and periods of stagnation and recession since 2014, have had a negative impact on the development of EDTs in Russia and has put R&D funding under further pressure.

For instance, the annual budget of the Advanced Research Foundation (FPI) was RUB 3.8 billion (approx. €90 mill) in 2013. In 2014, it was reduced to RUB 3.3 billion (approx. €80 mill). While it was supposed to increase in 2015–2016 to RUB 4.5 billion annually (approx. €110 mill), it was actually reduced by 10 per cent.[82] The budget was supposed to stay at the same level during 2017–2018, but it decreased from RUB3.8 billion to RUB3.4 billion. Ambitions to boost the FPI spending significantly in the following years were not matched with financing.[83] Notably, the Russian investments for EDT are only a small part of the billions of dollars

79 Zakvasin, "'Iskusstvennyi intellekt — sredstvo, a ne samotsel': v tekhnopolise 'Yera' rasskazali o rabote unikal'nogo klastera."
80 Zysk, "Managing Military Change in Russia."
81 Ibid.
82 "Byudzhet Fonda perspektivnykh issledovaniii na 2018 godu ostanetsya prezhnim."
83 Ibid.; Nikol'skii, Bocharova, "Novoye litso voennykh innovatsii."

invested in EDT development in the US and China.[84] For comparison, the US allocated around USD3.8 billion (approx. €3.57 billion) to the Defense Advanced Research Projects Agency (DARPA) in 2022.[85]

In addition, the COVID-19 pandemic and sanctions have had a significant negative impact on the financing of AI in Russia. In August 2020, the Russian media reported that the budget for the federal project "Artificial Intelligence", which is to support the implementation of the national AI strategy, was cut from RUB124.8 billion for a four-year period (approx. €1.78 billion), to RUB27.7 billion (approx. €400 mill).[86] In April 2020, the Russian Ministry of Finance requested to block the budget of the national program "Digital Economy" (which the AI project is a part of) in order to redistribute funds to the reserve fund. The 2020 budgets decreased also in several other ministries and departments, reflecting the economic downturn.

The negative funding trajectory also reflects the Russian government's attempt to adapt to sanctions. The 2019 AI roadmap's assessment was that Russia would need to allocate RUB 56.8 billion (approx. €799 mill) for the development of AI over a four-year period (up to 2024). However, in the updated AI roadmap published in December 2022, the government cut the spending for AI to approx. RUB 24.6 billion (approx. €346 mill) for a seven-years period (up to 2030). The volume of expected extra-budgetary financing decreased even more dramatically: from RUB 334 billion (approx. €4.69 billion) until 2024 to RUB 111 billion (approx. €1.73 billion) until 2030. These remarkable reductions of funding have also been reflected in the expected volume of the domestic market of AI-based technology: while the 2019 AI roadmap expected RUB 160 billion (approx. €2.25 billion) by 2024, the number in 2022 got reduced more than ten times to RUB 14 billion (approx. €218 mill).[87]

The official Russian stance reiterates the same mantra that was common in the Russian official rhetoric after the sanctions were imposed in 2014. While lobbying around the Western capitals to end sanctions, the Russian officials systematically repeated that sanctions provided a great opportunity to create and promote domestic solutions and strengthen Russia's independence.[88] Similarly, the Ministry of Digital Development argued in January 2023 that the sanctions imposed in 2022 did not complicate the work of Russian companies on AI in any way, as most of algorithms are public open-source projects available for download and modification. The Ministry acknowledged that some developers experienced difficulties: their

84 "Investments in AI."
85 "DARPA, Budget."
86 "Finansirovanie iskusstvennogo intellekta v Rossii urezano na 100 milliardov."
87 "Iskusstvennyi intellekt poshel na ubyl."
88 "Ibid.; "Gosplany zaputalis' v neyrosetakh."

accounts were blocked, and there was an "ambiguous" attitude towards Russians programmers in various specialized communities. Overall, however, the sanctions have not affected the development of AI technologies in Russia.[89]

The actual situation, however, appears rather bleak. Most of those executing federal AI development projects in Russia are under sanctions, likely to encounter difficulties with access to sophisticated technology, such as microprocessors critical to move on with the development of AI.[90] One example is the decision of Nvidia to suspend sales in Russia, thus restricting access to graphics processing units used to power a host of AI products.[91]

Another detrimental effect of the Russian war in Ukraine, i.e., the massive withdrawal of high-tech companies and their investments from Russia has led to an abruptly decreased competition in the domestic economy, further undermining innovation. In the assessment of Gref, the exodus of foreign companies from the Russian market will cause losses to the national economy in the long term as "no Russian companies will be able to maintain the level of competition", and –"where is no competition, there is no innovation."[92]

89 "Iskusstvennyi intellekt poshel na ubyl."
90 Zysk, "Is Russia a threat in emerging and disruptive technologies?"
91 "Iskusstvennyi intellekt poshel na ubyl."
92 Myl'nikov, "Glava "Sberbanka": Ukhod firm iz RF grozit poteryami yekonomike."

6 Fielding and Operating Defense AI

Russia has been pursuing a wide range of programs aimed to leverage AI technologies and capabilities in the armed forces and security services. According to official sources, as of September 2022, the MoD's Main Directorate of Innovative Development has accompanied over 500 projects for subsequent implementation, 222 of which were planned for completion and implementation in 2022.[93]

Russia has exploited its operations in Syria to test and experiment with "more than 600 weapons and other forms of military equipment", 200 of which defined as "next generation".[94] AI-enabled systems have been reported employed also against Russia's neighboring countries, including during the 2022 reinvasion of Ukraine.

Russia has been pursuing integration of AI into several priority areas: command, control, communication and decision-making; unmanned vehicles for missions such as surveillance, reconnaissance, situational awareness, search and rescue, target acquisition, attack; nuclear weapons, high-precision and other weapon systems; air defense, early warning, electronic warfare, space based systems; training, logistics, manufacture; cyber operations, and influence operations to shape the psychological domain. It is beyond the scope of this report to provide a full list of the programs that Russia is pursuing, many of which also remain classified. The following examples serve to illustrate the main thrust of Russia's current defense AI work:

- **AI and Command, Control, Computers, Communication, Intelligence, Surveillance and Reconnaissance (C4SIR)**
  One of the central, long-standing objectives in the Russian military reforms has been the development of C4ISR, seen as critical to gaining and maintaining information superiority.[95] The ability to select extensive data collected from various domains (air, ground, sea, space and cyber), analyze it and make decisions under high time-pressure (for instance in case of an incoming attack) has been seen as increasingly important in contemporary warfare. The top political and military leadership, including Putin and defense minister Sergei Shoigu, has systematically highlighted the critical importance of rapid decision-making and improving C2, communication and transmission systems.[96] AI is seen as central to facilitate and accelerate this process, provide an improved protec-

93 Poroskov, "Iskustvennyi intellekt: novoe soderzhanie voennoi moshchi."
94 "All of Russia's latest weapons tested in Syria, says defense chief;" "Russia tested 320 types of weapons in Syria"; "Russia tested 'over 200 new weapons' in Syria: MP."
95 Sukhankin, "Russia Adopts National Strategy for Development of Artificial Intelligence Publication."
96 "Putin otsenil rol' iskusstvennogo intellekta v proizvodstve vooruzheniya"; "Putin otsenil rol' iskusstvennogo intellekta v vooruzhenii;" "Shoigu: sistemu upravleniya i svyazi VS RF usovershenstvuyut s primeneniem tekhnologii II;" McDermott, "Tracing Russia's Path to Network-Centric Military Capability."

tion to own forces and undermine the adversary.[97] Reportedly, the National Defense Management Center, established in 2014 and providing the main joint all-domain C2 structure, applies AI to support information collection, selection, analysis, and decision-making.[98]

Furthermore, Russia has been developing a new command and control system (informatsionnaya sistema boevogo upravleniya – ISBU) that uses AI and Big Data to integrate C4ISR capabilities. ISBU aims to provide the military leadership possible courses of action based on the assessment of the situation on the ground. It was reportedly tested for the first time during the Tsentr-2019 strategic exercise.[99] To accelerate the speed of decision-making, Russia is also working on applying elements of AI in control, reconnaissance, and navigation systems, as well as in situational analysis technology.[100]

- **AI and unmanned systems**

  The Russian MoD sees the development of AI-enabled unmanned vehicles for air, ground, and sea-based missions as an important element of C4ISR. Their development has been high on the MoD's agenda for a long time, and the programs have gradually expanded to include more than 100 types of UVs that are at different stages of research, development, testing and implementation.[101] The focus is on expanding speed, range, endurance and the scope of missions, such as surveillance and reconnaissance; air, ground and underwater attack roles, including kamikaze drones; vehicles to detect and counter drones; tactical, short-range loitering munitions; bomb identification and demining; anti-submarine warfare; deep-water missions including hydroacoustics; detecting air defenses; electronic warfare; and situational awareness. Various developers work also on drones for search and rescue, transportation and logistics.[102] Russia has also shown an interest in swarming technology for air and ground-based missions.[103]

97 Edmonds/Bendett/Fink/Chesnut/Gorenburg/Kofman/Stricklin/Waller, "Artificial Intelligence and Autonomy in Russia."
98 "Natsional'nyi tsentr upravleniya oboronoi RF primenyaet iskusstvennyi intellect;" Edmonds/Bendett/Fink/Chesnut/Gorenburg/Kofman/Stricklin/Waller, "Artificial Intelligence and Autonomy in Russia."
99 Markotkin/Chernenko, "Developing Artificial Intelligence in Russia: Objectives and Reality;" McDermott, "Moscow Showcases Breakthrough in Automated Command and Control."
100 Sergeantov, Smolovyi, Terent'iev, "Transformatsiya soderzhaniya voiny: kontury voennykh konfliktov budushhego."
101 "Putin otsenil rol' iskusstvennogo intellekta v proizvodstve vooruzheniya;" "Putin otsenil rol' iskusstvennogo intellekta v vooruzhenii;" "Shoigu: sistemu upravleniya i svyazi VS RF usovershenstvuyut s primeneniem tekhnologii II."
102 Zakvasin, "'Iskusstvennyi intellekt — sredstvo, a ne samotsel': v tekhnopolise 'Yera' rasskazali o rabote unikal'nogo klastera;" Edmonds/Bendett/Fink/Chesnut/Gorenburg/Kofman/Stricklin/Waller, "Artificial Intelligence and Autonomy in Russia;" McDermott, "Russia's Path to the High-Tech Battlespace;" McDermott, "Moscow's Pursuit of Artificial Intelligence for Military Purposes;" Palavenis, "The Use of Emerging Disruptive Technologies by the Russian Armed Forces in the Ukrainian War."
103 "Vysshii bespilotazh: Voennye vpervye otrabotali deistviya udarnykh grup dronov;" Elfving, "Ryska obemannade farkoster – Det västliga försprånget inhämtat?"

- **AI and nuclear forces**

  Russia pursues autonomy in nuclear forces to strengthen their credibility. The priority has been given to means for accelerating decision-making, force protection, and capabilities able to defy missile defenses. An example of the latter is Russia's "wonder weapons," such as the Poseidon nuclear powered and nuclear capable autonomous underwater vehicle (AUV); the Burevestnik nuclear powered and nuclear capable cruise missile; and hypersonic weapons such as the Avangard hypersonic boost-glide vehicle. AI and autonomy elements are also applied in the guidance systems of the Sarmat intercontinental ballistic missile and the Kinzhal air-launched ballistic missile.

- **AI to augment Aerospace Forces and other weapon systems**

  Russia is working on enhancing a host of capabilities of the Aerospace Forces with AI. Their objective is to disrupt or damage the pillars of the US and NATO information technology enabled warfare, including communications, critical infrastructures and other technological networks that developed countries depend on, including space-based systems such satellites, command, and operational networks.[104] An example is the RB109-A Bylina system, which aims to collect large amounts of data and uses AI to prioritize and jam electronic signals. AI has been tested alsofor application in aircrafts, such as Mig-35, SU-35 and possibly SU-57 to enhance their operations, including on-board information management and target recognition.[105] Russia is reportedly examining the possibility of using an autopilot with AI, which is being studied on the basis of one of the domestic helicopters.[106] An important focus area is the so-called weapons based on new physical principles, such as electromagnetic, radiological, geophysical and directed energy weapons for missions such as counter-UAV, anti-satellite weapons, such as the Peresvet.[107] Likewise, Russia pursues AI applications in air defense systems, such as the Pantsir-S.[108]

  High on the priority list for AI application are long-range precision missile systems. AI is also a component in military robots, for instance a fighting vehicle based on the BMP-3 infantry vehicle and the Sinitsa remote-controlled combat module.[109] The T-14 Armata tank is reportedly being developed to be capable of autonomous combat operations, equipped with fully digitized equipment.[110] Similarly, the Uran-9 tracked UGV vehicle and the Nerekhta reconnaissance UGV are planned to be introduced as a part of the Russian ground forces to

104 Work/Grant, "Beating the Americans at Their Own Game."
105 Palavenis, "The Use of Emerging Disruptive Technologies by the Russian Armed Forces in the Ukrainian War;" "MiG-35 fighter to have smart system of target recognition."
106 Poroskov, "Iskustvennyi intellekt: novoe soderzhanie voennoi moshchi."
107 "Putin: Boyevye lazery uzhe postupayut na vooruzhenie voisk."
108 "Pantsir systems demonstrated effectiveness in Ukraine — Rostec."
109 "Chto za BMP-3 s iskusstvennym intellektom sozdali v Rossii?"
110 "The T-14 Armata tank will receive artificial intelligence."

carry out "experimental military service".[111] Russia is also working on AI projects aimed to improve the control of artillery targeting systems, and on new generation infantry combat systems such as the Ratnik, which is to include, among other advanced elements, a software link with small UAVs and other AI-enabled systems.[112]

- **AI and cyber operations**

  Russia sees AI as a critical capability in offensive cyber operations, as well as in cybersecurity and cryptography.[113] The objective is to strengthen Russia's information security and leverage AI on a broader scale to enhance cyber capabilities. The list of known Russian offensive cyber operations is extensive,[114] also during the invasion of Ukraine. Despite initial claims that Russia failed to launch cyber-attacks during the invasion, research findings show that they have figured prominently alongside the military operations. In the first five weeks of the war, Russia conducted an intensive campaign involving around 800 attacks against Ukrainian targets in the cyber domain.[115] A combination of Ukraine's preparedness and support provided by The US Cyber National Mission Force that arrived in Ukraine before the invasion, together with international cooperative cyber defense task force, have helped to neutralize and minimize the impact of the Russian cyber attacks.[116]

- **AI and influence operations**

  AI-enabled systems figure prominently as a tool in creating new opportunities and augment traditional Russian methods of influence, including disinformation, demoralization and propaganda. Russia seeks to influence both the perception of the domestic and foreign populations with the use of AI. For instance, specially developed Russian drones and cell site simulators have been able to impersonate cell phone towers with the objective of intercepting, jamming, spoofing or broadcasting tailored content on civilian mobile phones belonging to the opposing forces. Based on information harvested from their smartphones, Russia projected content with the aim to harass, intimidate and undermine morale, for instance by revealing seemingly compromising details about the adversary's commanders or divulging knowledge about soldiers' own families. Such methods have also been documented in Syria and in Eastern Europe, for instance directed at NATO soldiers deployed in the Baltic

111 Cranny-Evans, "Russia to conduct mass testing of Uran-9 UGV in 2022."
112 Sukhankin, "'Special Outsider': Russia Joins the Race for Global Leadership in Artificial Intelligence."
113 Edmonds/Bendett/Fink/Chesnut/Gorenburg/Kofman/Stricklin/Waller, "Artificial Intelligence and Autonomy in Russia"; Bateman/Beecroft/Wilde, "What the Russian Invasion Reveals About the Future of Cyber Warfare;" Beecroft, "Evaluating the International Support to Ukrainian Cyber Defense."
114 See for instance, "Russia Cyber Threat Overview and Advisories;" Hakala, Melnychuk, "Russia's strategy in cyberspace."
115 Corera, "Inside a US military cyber team's defense of Ukraine;" Beecroft, "Evaluating the International Support to Ukrainian Cyber Defense".
116 Ibid.

republics as a part of NATO's Enhanced Forward Presence mission.[117] Among other means, Russia used AI to generate synthetic texts, fake images and users to spread the Russian narrative through social media. One example was the deepfake of President Volodymyr Zelenski that called for Ukraine to surrender to Russia, in an attempt to confuse and stir up the public sentiment.[118]

AI enabled systems are likely to be used in mass surveillance and operations aimed to shape the psychological domain both in the domestic, not least urban, environment and on the battlefield. For instance, among ERA's R&D programs is a search and rescue drone with an onboard AI-enabled system capable of analyzing situation and recognizing persons that "pose a threat to society", such as "terrorists".[119] Technologies such as facial and pattern recognition can be used to enhance Russian influence operations by collecting of information, assessment, predicting and thus improving the ability to influence the behavior of the population. Notably, in the 2022 AI roadmap, the Russian Ministry of Digital Development requires the regions to collect anonymized Big Data for the purpose of training AI systems – an advantage the authoritarian system takes from week data protection.[120]

- **AI and the Russian defense industrial base**

  The Russian defense industry has also shown an interest in AI applications to reduce the number of real tests, improve quality, and accelerate production.[121] There are reportedly installations in the production lines capable of recognizing details, tools, and human action. The objective is to reduce the role of human factor in manual operations in production of weapons and military equipment, such as rocket engines.[122] The Russian United Aircraft Corporation plans to use a digital system based on AI to automatically control the quality of aircraft parts for the MIG fighter jets.[123] Likewise, the state-owned Rostec have been testing the Zyfra Industrial Internet of Things Platform, which uses AI to track the manufacture of engines and simulates their tests in a virtual environment.[124]

117 "Electronic warfare by drone and sms;" "Reports suggest Russia engages in psychological warfare in Avdiyivka – media;" "'We are watching you': Russia accused of sending threatening texts to British troops;" Grove/Barnes/Hinshaw, "Russia Targets NATO Soldier Smartphones, Western Officials Say;" Giles, "Time to Shed More Light on Russian Harassment of NATO Forces' Families;" "Russian Harassment of NATO Personnel, Families: The Next Chapter in Information Warfare?"
118 Ashlstrom/Revelli/Riddell/Mainor/Serabian, "The IO Offensive: Information Operations Surrounding the Russian Invasion of Ukraine."
119 Zakvasin, "'Iskusstvennyi intellekt — sredstvo, a ne samotsel': v tekhnopolise 'Yera' rasskazali o rabote unikal'nogo klastera."
120 "Plyus aytifikatsiya vsei strany."
121 McDermott, "Moscow's Pursuit of Artificial Intelligence for Military Purposes."
122 Poroskov, "Iskustvennyi intellekt: novoe soderzhanie voennoi moshchi."
123 Ibid.
124 McDermott, "Moscow's Pursuit of Artificial Intelligence for Military Purposes."

7 Training for Defense AI

The Russian authorities argue that the country has the potential to join the club of global AI leaders because of Russia's strong intellectual traditions and high level of education in science, technology, engineering, and mathematics.[125] In reality, however, the educational system does no longer appear to be conducive to high-tech development. While Russia was ranked fourth in the OECD's 2019 global index of education, less than one per cent of Russia's graduates earned an information, communications, or technology-based degree. The Lomonosov Moscow State University – considered Russia's highest ranked computer science research institution – was listed 43rd globally in 2017, 60th in 2018, and 78th in 2019.[126]

The 2019 national AI strategy has highlighted the importance to strenghten education and training in AI.[127] To improve the pool of experts in new technologies, Russia has been testing various strategies to train new generations of specialists.[128] AI centers, offering professional education, have been created at the top Russian universities and research centers. Many offer a possibility to participate in real development projects provided by corporate partners, such as Gazprom Neft, MTS, Sberbank, Russian Railways, the Skolkovo Institute of Science and Technology, and others.[129] A cooperation agreement was signed by the FPI and the Russian Ministry of Science and Higher Education with the objective to facilitate creation of new scientific schools and centers of competence focused on EDT.[130]

Furthermore, the Russian authorities organize a variety of learning opportunities to attract university students, schoolchildren, teachers, and other professionals. For instance, more than three thousand students enrolled in advanced AI master's programs in 2022. Likewise, medical doctors, teachers, and lawyers, as well as manufacturing industry, communications and transport sector employees have obtained the opportunity to take a special AI educational module to improve their qualifications. To ensure quality of training specialists with AI competencies, Putin ordered in November 2022 to develop university rankings in the AI field. He also underscored the need to introduce elements of AI into curricula of mathematics and computer science.[131] In October 2022, for instance, more than 19 thousand school teachers from different regions of Russia took part in training in AI technologies in an online course.[132]

125 "O razvitii iskusstvennogo intellekta v Rossiiskoi Federatsii."
126 Dear, "Will Russia Rule the World Through AI? Assessing Putin's Rhetoric Against Russia's Reality."
127 Ibid.
128 "AI Is for Active Involvement...of Russian Students in Artificial Intelligence Research;" "Konferentsiya 'Iskusstvennyi intellekt: problemy i puti ikh resheniya – 2018'."
129 Ibid.
130 "Minobrnauki i FPI podpisali soglashenie o sotrudnichestve po proryvnym razrabotkam."
131 Putin, "Speech at Artificial Intelligence Journey 2022."
132 "Bolee 19 tysyach pedagogov obuchilis' tekhnologiyam iskusstvennogo intellekta,"

The Russian MoD, as well as the top political leadership, have been organizing and participating in conferences for knowledge exchange on AI to set the agenda and bring attention to the topic. High-level discussions devoted to AI, including those involving President Putin and other key figures, reflect the sustained interest and high priority the Russian authorities attach to the development in the field.[133] In addition, the MoD uses simulations to better understand further development of AI. It points at wargames with a wide range of scenarios as a useful tool to determine the impact of AI on changing character of military operations at the tactical, operational, and strategic levels.[134]

The Russian defense sector has struggled with the long-standing problem of shortages of professional expertise. The war in Ukraine has further aggravated the situation with an exodus of highly qualified scientific personnel, not least Russian IT specialists. It has further accelerated with the start of the mobilization in September 2022.[135]

Some of the known measures to recruit and retain talent in the armed forces are the so-called military scientific units (nauchnye roty). They have been created since 2013 on the foundation of Russian military research and higher educational institutions staffed by conscripts.[136] By 2022, the MoD has transferred eight scientific units to ERA.[137] They are operating within their respective R&D priority fields,[138] supporting the needs of several defense branches and specialist units (e.g., the Aerospace Forces and the 12th Main Directorate responsible for storage, maintenance and transfer of nuclear warheads). The Russian authorities hope that the conscripts in the scientific companies will choose to continue working at ERA after the end of their service, either as the next stage of their military-scientific carrier in the rank of lieutenant, or as civilian specialists. To make their work more attractive, all officers and civilian employees of ERA are to be provided with service housing in the Anapa at the Black Sea coast where ERA is located.[139]

133 "Konferentsiya 'Iskusstvennyi intellekt: problemy i puti ikh resheniya – 2018';" "Artificial Intelligence Journey 2022 Conference 'AI-Enabled Technologies for Economic Growth'."
134 "Konferentsiya 'Iskusstvennyi intellekt: problemy i puti ikh resheniya – 2018'".
135 "Iskusstvennyi intellekt poshel na ubyl;" Metz/Satariano, "Russian Tech Industry Faces 'Brain Drain' as Workers Flee;" "To Hobble Putin, Accelerate the Brain Drain."
136 "Okolo 400 nobobrantsev vesennogo prizyva otobrany dlya sluzhby v nauchnykh rotakh".
137 Ibid. The plan was to transfer 20 scientific units by 2020. See: Zakvasin, "'Iskusstvennyi intellekt — sredstvo, a ne samotsel': v tekhnopolise 'Yera' rasskazali o rabote unikal'nogo klastera."
138 "'Nauchnye roty:' Interview with Colonel Vyacheslav Presnukhin, Head of Main Directorate of Research and Technological Support of Advanced Technologies (Innovative Research) of the Ministry of Defense of the Russian Federation, "Innovatsii na sluzhbe Ministerstva oborony."
139 "Innovatsii na sluzhbe Ministerstva oborony."

To address the growing problem of brain drain, the Russian authorities also resort to decrees and resolutions, and create incentives such as funding for academic and scientific institutions, state support to purchase domestic replacements of foreign technology, and labor market incentives, in addition to simplifying procedures to employ foreigners.[140] However, in the deteriorating socioeconomic situation under increasingly repressive authoritarian rule, it is unlikely that these bureaucratic measures will be sufficient to make a significant difference.

140 "Artificial Intelligence and Autonomy in Russia: A Year's Reflection."

8 Conclusion

Russia's top political and military leadership has devoted an increasing attention to the development of defense AI, seen as critically important for national security, socioeconomic development, sovereignty, and thus for Russia's influence on the international stage. The interest has been corroborated in advances in strategic conceptualization, policy implementation, expanding the AI ecosystem, adapting the law, and educational framework. To accelerate the development, the state has brought in the support of major state-companies and corporations, academic and scientific institutions, and some private actors.

The Russian defense AI is evolving incrementally, rather than via abrupt changes. Russia is upgrading legacy systems with new technologies, while experimenting with selected "risky projects", i.e., novel weapons systems, materials and methods of warfare. The list of military and civilian dual-use AI programs is expanding and include weapons systems, military and special equipment and infrastructure that are at various stages of research, development, experimentation, training, and deployment.

However, the overall limited deployment of AI-enabled systems to date indicates that the Russian AI is still in early stages of maturity. The high-tech development has been undermined by periods of economic stagnation and recession, aggravated by the COVID-19 pandemic, several rounds of sanctions, a massive outflow of international corporations, worrying demographic trends and weak educational foundations. The full impact of these developments is yet to unfold. They have, however, already resulted in dramatic spending cuts for AI in the Russian civilian sector. To what extent it may reflect a similar spending trend in the armed forces remains unclear. However, as the 2023 state budget priorities suggest, Russia is willing to prioritize the defense sector. Despite the deteriorating economic environment, spending on the military and security services is planned to increase from 24 per cent in 2022 to approx. 33 percent in 2023 (RUB9.5 trillion, approx. €120 billion), at the expense of welfare, education, and the Russian taxpayers.[141] How much exactly will be directed to R&D is yet to be seen.

In addition to funding, several other factors will influence the future of Russian AI R&D. One important aspect is Russia's ability to circumvent sanctions and level out its dependence on Western technology, such as software and semiconductors imported from the US, Taiwan, and South Korea. Will China and other cooperation partners cushion the crash? In general, Russia is reluctant to create new dependencies on foreign EDT components seen as a source of vulnerability and potential security threats. However, Moscow has few other options than being pragmatic and supplementing its AI development with foreign technology, as the 2022 pur-

141 "Zasedanie Pravitel'stva: Federal'nyi byudzhet;" Grozovski, "Putin's War Costs: Shifting the Burden to the Population;" Wiśniewska Iwona, "Russia's 'war' budget for 2023–2025."

chases of Iranian drones, as well as electronics and other components from China have demonstrated.[142]

Nonetheless, there is a high degree of uncertainty regarding Russia's ability to make a broad adoption of military AI a reality in the short and medium term. The pervasive structural problems plaguing the defense sector, as well as the political and economic system at large, undermine a competitive research environment and stymie innovation. Addressing these problems require systemic reforms, which are unlikely to happen under the current regime. In addition, the direct and indirect negative consequences of the Russian war on Ukraine further aggravate the socioeconomic and financial foundations of the high-tech development. Consequently, Russia is unlikely to become one of the global leaders in AI development under current circumstances.

Still, some of the same problems also create incentives to accelerate the AI development. It is seen as an asymmetric way to offset some of the qualitative and quantitative weaknesses in the Russian military organization, including the growing need to compensate for extensive losses of personnel and material in Ukraine, for limited access to resources and technology, and the economic crisis.

The Russian AI-enabled systems – military and hybrid – will pose an increasing challenge for the US, NATO, and EU countries as a force enabler and force multiplier. Many of the programs Russia is pursuing aim to either match or undermine some of the key Western military capabilities, including command and operational networks, space-based systems, and other critical infrastructures that constitute the foundations of the US and NATO information technology-enabled warfare and for the functioning of Western societies. Likewise, Russia is investing in AI-supported asymmetric and indirect methods and means of warfare to undermine or bypass the opponent's military strengths and exploit vulnerabilities, preferably in a cost-effective manner with the use offensive cyber and influence operations.

142 Kuo, "How China Supplies Russia's Military"; Lo, "Chinese satellite start-up named in US sanctions aimed at Wagner group denies aiding Russia in Ukraine war."

However, to take the full advantage of AI, Russia will have to be able not only to develop the technology, but also successfully integrate it in doctrines and operational concepts. As the experiences of the war in Ukraine demonstrate, however, the institutional conservatism in the Russian military organization remains significant. Nevertheless, as the development of AI-enabled weapons system, equipment and infrastructure proliferates across foreign militaries, it is likely to provide Russia additional stimuli to prioritize AI R&D. Looking ahead, a growing experience of the Russian operators with the use of AI-enabled systems, their proven battlefield advantages, and a demographic shift to a generation born into technology and more familiar with using it can facilitate the transition to a broader use of AI-enabled systems. Despite the uncertainty about the further impact of the structural and circumstantial impediments to high tech development, it is highly likely that AI will remain a top priority for Russia as shield against new threats and a promise of a major military boost.

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