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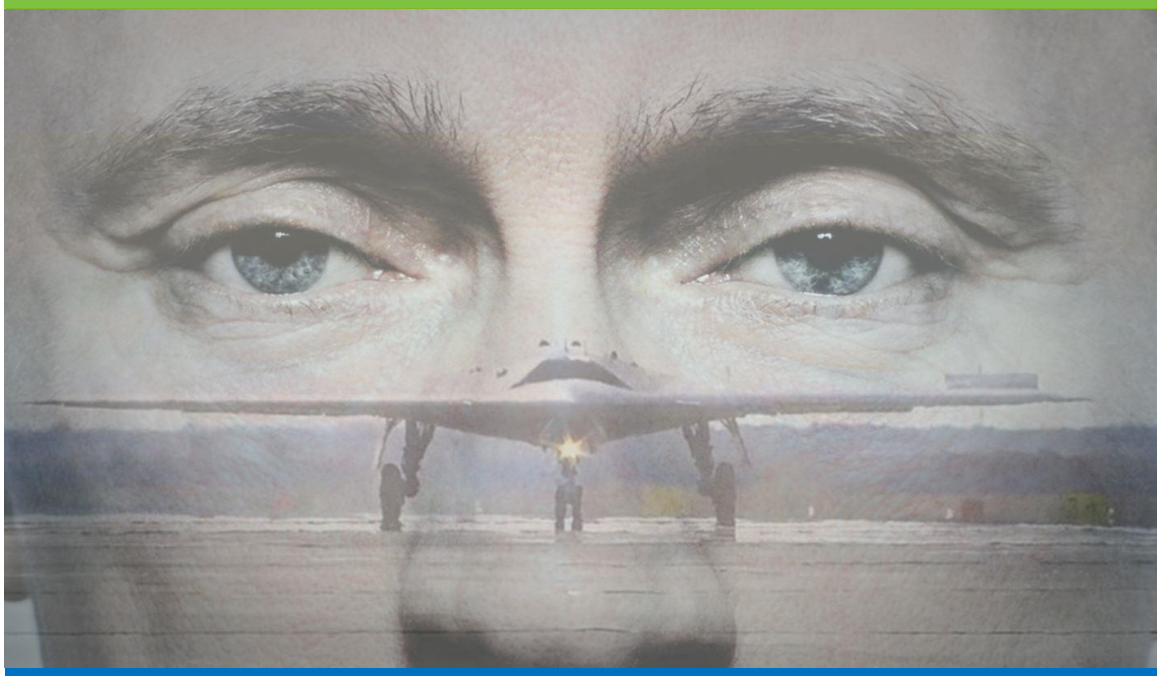

Artificial Intelligence and Autonomy in Russia

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Abstract

This report provides a comprehensive overview of the current state of civilian and military artificial intelligence in Russia, examining all relevant sectors, key institutions, and trends. In particular, the report explores how Russia is applying AI to its military capabilities. This report is part of an effort by CNA to provide timely, accurate, and relevant information and analysis of the field of AI in Russia, and follows a series of more than twenty biweekly newsletters on the same topic. It relies on Russian-language open source material.

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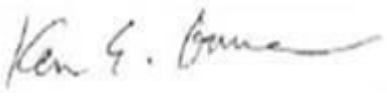

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Executive Summary

The Russian leadership views the ability to innovate as one of the hallmarks of a great power and sees military innovation as essential to Russia's overall defense posture in a changing threat environment. The goals of Russia's artificial intelligence (AI) and autonomous ecosystem are best understood within the context of Russia's economic development and modernization efforts, and include those initiatives aimed at the improvement of the well-being of Russian citizens as well as the conditions for business and entrepreneurial activity.

The following report details the Russian AI ecosystem and is part of a yearlong effort, conducted on behalf of the Department of Defense Joint Artificial Intelligence Center (JAIC), to understand the evolving field of AI and autonomy in Russia. While focusing on AI and autonomy, the report also seeks to place AI within the larger technological environment in Russia.

Governance and legal aspects of AI in Russia

The Russian government is building the structural legal and governance framework necessary to develop and compete in the rapidly growing field of AI and autonomy. It is attempting to implement nationwide strategies with goals and metrics to promote an environment supportive of digital—particularly AI—development in Russia. Implementation of these efforts, however, is largely government driven through state-owned businesses. And while AI initiatives are taking hold across the Russian government, the lack of emphasis on private initiatives could hurt Russian efforts in the future. While many Russians are looking to the benefits of greater digitization across Russia, there is also some criticism of government efforts to increase access to private data. Russian citizens are weary of unchecked AI development and its potential impacts on society.

Russia's AI ecosystem

Russia's AI ecosystem consists of clusters of interlinked activities between government, state-corporate, military, academic, and private actors. However, a key feature of Russia's AI ecosystem is its leadership by state-owned companies and the large portion of federal funding for the AI sector. These state-owned companies include incubators, funders, and initiatives aimed at facilitating AI development. The heavy reliance on federal funding has some in Russia concerned that it undermines initiative and technological risk-taking and growth. While surveys and international rankings (such as article surveys and institution rankings) of

Russia's place in the field of AI suggest that it lags behind other, larger players, it is making some improvement.

AI-related academic entities, training and education

Russia faces a shortage of technically proficient experts across its commercial, industrial, and defense sectors, and this is particularly the case in the field of AI. Causes for this include the exodus of technologically trained professionals to high-paying jobs abroad, lingering impacts from the fall of the Soviet Union and the time after that, and the disparate demographics across Russia's vast landscape. The Russian government recognizes these challenges and is taking steps to mitigate them. These steps include numerous programs targeting broad sets of demographics, ranging from encouraging trained tech experts to educating the broader populace on AI-related technologies. Despite these steps, education and training weaknesses are likely to challenge Russia's attempts at technological innovation for some time, depending on how the new measures detailed in this report take effect and how long it takes them to do so.

Private sector AI in Russia

Technological developments and growth in the Russian AI private market are driven primarily by state-backed R&D efforts, although private demand for AI solutions is increasing. In general, the private AI market has been dominated by a focus on exploiting advancements in Natural Language Processing (NLP) and other forms of automated data analysis, although interest in computer vision and other types of recognition and prediction capabilities is growing. Outside of broad automated NLP applications for financial and retail purposes, the most important AI technologies that have gained private market attention are in facial recognition software, facility and perimeter security, driverless cargo transportation and agribusiness, public transportation control systems and railway network integration, automated platforms for training neural nets and other AI methods, and automated medical analysis.

Military AI in Russia

Judging from senior political and military statements and professional military writings, the consensus of Russian security experts and policy-makers is that the development and use of AI is essential to the future success of Russia's armed forces and key to its military power. While military AI has followed many of the same trends in Russia that it has in other developed

militaries, the Russian military establishment does emphasize specifically the areas on which it is already focusing, such as information management for decision-making and autonomy. Russian military strategists have placed a premium on establishing what they refer to as "information dominance on the battlefield," and AI-enhanced technologies promise to take advantage of the data available on the modern battlefield to protect Russia's own forces and deny that advantage to the adversary. That being said, there is also an ongoing discussion in the Russian military as to the ultimate goal of military AI. There is a prevalent view that an operator needs to stay in the decision cycle to avoid unintended consequences, both militarily and ethically, but also discussions that predict total autonomy as an inevitable feature of future conflict, in part fueled by interpretations of US AI-related intentions.

International cooperation

Despite the challenges mentioned above, Russia is seeking to be one of the key thought leaders in the field of AI. Russian leaders emphasize the promise AI has for the lives of ordinary citizens, from medical innovations to improved economic performance. However, the Russian leadership also emphasizes the danger AI can pose in the wrong hands or with the wrong intentions. Perhaps more than anyone else, Russian leaders focus on the need to protect traditions and the internal stability of their society, reflecting a longstanding Russian concern over outside interference in Russian affairs. Russia is seeking beneficial partnerships in technology and AI development across the globe; for example, it has entered into substantial agreements with China and South Korea through Huawei and Samsung. However, China and South Korea are more the exception than the rule. The geopolitical interests of working with Russia often do not outweigh the commercial benefits available in other ecosystems such as the United States and the European Union. Despite this, we expect its growing relationships with other mature technological societies to yield some benefit.

Figure 1. Graphic depicting AI-enhanced fighter engineering

Source: "Еффективность и внешнее (концептуальное) проектирование авиационные комплексов" [efficiency and external (conceptual) design of aviation complexes], ГосНИИАС [GosNIIAs], https://gosniias.ru/index.htm.

Contents

Methodology and Structure

This report is the result of the work of the CNA Russia Studies Program over the past year to map out and understand the AI ecosystem in Russia. First, the team developed and implemented a biweekly newsletter highlighting ongoing developments within the field of technology, AI, and autonomy in Russia. These newsletters also featured spotlights focusing on various military AI-related initiatives and key AI organizations. They also performed a critical role in mapping out the AI ecosystem in Russia and provided keys to areas in need of deeper research. Through this research, we were able to understand the relationships between various organizations across the public, private, and military sectors.

We collected data from a wide range of Russian-language sources, to include legal documents, official statements, industry product information, Russian professional military journals, conference proceedings, and individual publications. The significance of each source varied between sections. For example, the government section relied heavily on the many official documents available whereas the military section relied more on open source Russian news reports. The research had to balance the need to collect as much information as possible with the acknowledgment that many of the sources who speak and write about AI do not necessarily understand the complicated and vast field that falls under the umbrella of *artificial intelligence and autonomy.* To that end, the CNA team worked with CNA's Center for Autonomy and Artificial Intelligence to understand better some of the technological significance of various reports. Note, however, that the emphasis of our report is not a technical review of AI developments in Russia.

The first section of this report provides an overview to assist the reader in understanding Russia and the various metrics by which analysts often evaluate it. This portion of the report is unique in that it does not address AI or autonomy in particular but we feel provides essential context that will enrichen the discussion of Russian technological innovation, AI, and autonomy. Specifically, this section will be of greatest use to readers whose primary background is on AI and autonomy rather than Russia specifically.

The subsequent sections describe the efforts that the Russian government is taking to create an atmosphere in Russia conducive to technological advancement. It covers the broader "digitization" efforts and situates AI within that broader framework. The section serves as the backdrop and context for the following sections. The third section focuses on the AI-specific ecosystem in Russia, its key players, and interactions. After that, four sections examine AI related to Russia's education, private sector, military, and international cooperation in order to give some granularity to our discussion of the Russia AI ecosystem.

Russian Power in Perspective

This section offers a perspective on Russian state capacity and Russian power in the international system to provide a context for Russian investments in artificial intelligence and autonomous systems.[1] *Though we feel all readers can benefit, this section will be of greatest use to readers who come to the topic of Russian AI and Autonomy from an AI or non-specialized international relations background. Readers who already possess a deep understanding of Russian national security issues may wish to proceed directly to the next section. This background can help set expectations on whether Russia is likely to be a long-term strategic rival. Can it develop indigenously or absorb advanced technologies produced by others? Is it a country in stagnation, decline, or resurgence? In this section we place emphasis on economic, military, demographic, and technological dimensions of Russia. This chapter does not seek to provide comprehensive coverage of the subject, as it is not the focus of this report, but offers a lens on Russia, with a modicum of historical context.*

Russia is best conceived of as a relatively weak great power, with weak signifying its position relative to the United States and China, rather than an absolute description of the state's ability to influence world affairs. On balance, it is one of the most powerful states in the international system, and an enduring power, which historically has defied secular trends of rise or decline. Russia has a tremendous capacity for resurrecting itself, having undergone periods of resurgence, stagnation, decline, or even state collapse.[2] Indeed, it was able to recover within one generation after the Russian civil war in the inter-war period, and following the collapse of the USSR in 1991. Russia has featured prominently in the great power conflicts of the last three centuries, and within post-war struggles over the structuring of international order. The country's national elite see Russia as a hereditary great power, entitled to status; with a seat at the decision-making table in major international organizations, and in extraterritorial geopolitical space where Russian interests predominate.

Contemporary Russia is neither a rising nor a declining power, but best conceived of as a nation in stagnation. Following a precipitous decline after the collapse of the Soviet Union in 1991, by most meaningful measures Russian power and state capacity had been resurgent from 2000-

[1] Parts of this section are derived from, or informed by Michael Kofman et al., *Russia's State Capacity in 2030*, CNA Occasional Paper, Aug. 2020.

[2] A good discussion can be found on this subject in Stephen Kotkin, "Russia's Perpetual Geopolitics: Putin Returns to the Historical Pattern," *Foreign Affairs* 95, no. 3 (2016), https://www.foreignaffairs.com/articles/ukraine/2016-04-18/russias-perpetual-geopolitics.

2014. Therefore, economic stagnation is a relatively recent development (post-2012) due to structural economic challenges, domestic political ossification, and exigent external factors such as global energy prices. Nonetheless, Russian power relative to that of the United States is not set to decline in an appreciable way in the near term. The country has significant economic resources, strong human capital, a large and modernized conventional military, and is in a league only with the United States when it comes to its diverse nuclear arsenal. Moreover, it is useful to separate different resources a state has as measures of power, versus power 'in practice,' and what it can get other countries to do that they would otherwise not.[3] In this latter category, Russia performs well in the ability to determine outcomes in international affairs relative to its available means.

Russia has historically been saddled with a political and economic system that is retrograde and profligate, i.e. the country has tremendous potential in its natural and human resources, but is rarely able to realize it. The economy and society are both dominated by the state, which is inefficient, corrupt, and often ineffective at implementing strategic planning. This enduring reality was summarized by historian Vasily Klyuchevsky with the comment, "the state grew fat, but the people grew lean."[4] Thus, the country has often struggled to attain a sustainable model of economic development without succumbing to stagnation or requiring state coerced mobilization. Throughout history, the issue of power transition has also been difficult in Russian politics.[5]

Military

The Russian military consists of roughly 850,000-900,000 active-duty personnel, composed of 400,000 contract servicemen, some 250,000 conscripts, and perhaps 200,000 officers. Conscripts are distributed unevenly, concentrated in the ground forces and the airborne, while contract servicemen and warrant officers perform more complex tasks and are expected to fill battalions that are generated to participate in any conflict. The Russian National Guard constitutes another force which is 180,000 strong, and there are paramilitary security agencies such as the FSB border guard and coast guard. The Russian armed forces are functionally

[3] Robert A. Dahl, "The concept of power," *Behavioral Science* 2, no. 3 (1957), https://onlinelibrary.wiley.com/doi/10.1002/bs.3830020303.

[4] Kotkin, "Russia's Perpetual Geopolitics: Putin Returns to the Historical Pattern."

[5] Thomas E. Graham, "The Sources of Russian Conduct: Kennan's Long Telegram needs an update for Putin's Russia," *The National Interest*, Aug. 24, 2016, https://nationalinterest.org/feature/the-sources-russian-conduct-17462.

divided into General Purpose, Strategic Deterrence (select conventional and nuclear capabilities) and Quick Reaction (high readiness/mobility) forces.

The Russian defense budget appears deceptively small. Although market exchange rates suggest a Russian defense budget of $60 billion, in reality this is a highly misleading figure, and observably cannot account for the size and scope of Russia's military. Organizations that compare defense spending, such as the IISS annual report 'The Military Balance,' show Russian expenditure to be a paltry $45 billion based on constant 2010 market exchange rates, less than that of the United Kingdom. These are remarkable assertions that generate an obvious input-output problem. Russian armed forces, including conventional and nuclear components, are vastly larger in size, greater in fielded capability, and in a higher state of readiness than those of France or the United Kingdom.[6]

Since material, labor, and various other input costs vary dramatically across countries, a more appropriate comparison for autarkic defense industries – where trade flows are heavily restricted by geopolitical dynamics and national regulations – would use import-adjusted purchasing power parity (PPP).[7] Indeed, market exchange rates are most useful to capture the value of trade, but do a poor job of accounting for domestic economic activity taking place. Using such measures, Russian military expenditure is actually in the range of $150-180 billion USD, amounting to roughly 4 percent of Russian GDP.[8] This is a conservative estimate given that some expenditure is classified or spent on civilian organizations involved in the nuclear enterprise with military applications.

Although it is a commonly held belief that the US defense spending exceeds Russia's by 10 to one ($700 billion to $60 billion),[9] it is actually closer to four to one when accounting for how much less expensive equivalent military goods and services are to produce and provide in

[6] Michael Kofman and Richard Connolly, "Why Russian military expenditure is much higher than commonly understood (as is China's)," *War on the Rocks*, Dec. 16, 2019, https://warontherocks.com/2019/12/why-russian-military-expenditure-is-much-higher-than-commonly-understood-as-is-chinas/.

[7] The main difference in PPE and ME GDP estimates is that market exchange rates do a good job estimating the size of Russia's oil and gas sector because those commodities and the assets and services that produce them can – to a far greater extent – be freely traded. The international market price converges to the local price. With defense technology, however, both imports and exports are heavily restricted by nearly all countries. As a result, the market exchange price fails to converge to the local price, and exchange rate derived analyses fail to account for the true value of Russia's military hardware and personnel investments.

[8] Kofman and Connolly, "Why Russian military expenditure is much higher than commonly understood (as is China's)."

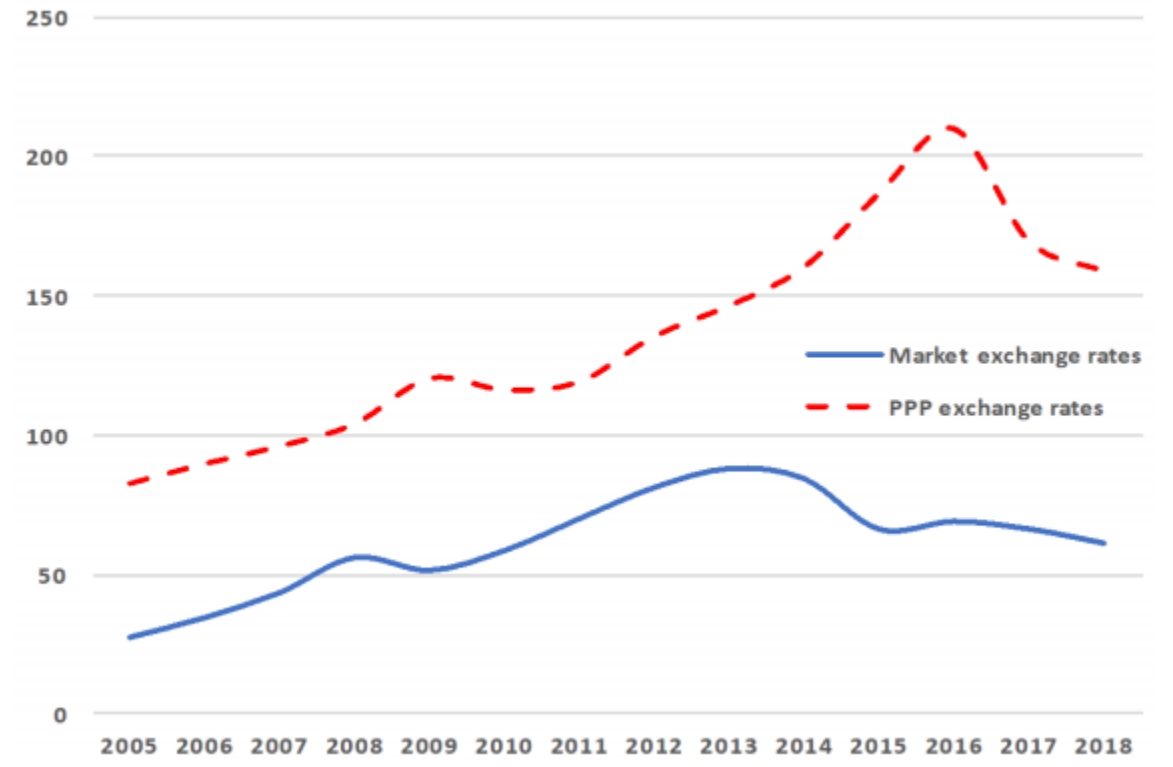
[9] For example see the latest defense spending comparisons released in International Institute for Strategic Studies, *The Military Balance 2021* (Routledge, 2021), https://www.iiss.org/publications/the-military-balance.

Russia when purchased in local currency. A much larger share of the Russian budget is spent on procurement vice personnel, when compared to Western militaries. Approximately 50 percent of the Russian defense budget goes to the State Armament Program (1.6 trillion RUB in 2020). This is roughly a third of total military expenditure, approximately $55 billion USD in PPP-adjusted value, and has been sustained consistently at this rate 2016-2020.

The Russian defense budget has largely flatlined, but not due to economic constraints. Many of the procurement orders for modernization and rearmament were filled 2011-2015, and the military industrial complex was broadly recapitalized in terms of equipment, technical expertise, etc. The purchasing power parity differences are useful to consider when examining state spending figures for AI or autonomous system development, particularly in cases where the systems do not depend on imported technology, foreign labor, or components, i.e. the inputs are local in RUB.[10]

[10] Russian defense firms are also consistently underestimated in international rankings. The reason is that organizations like SIRPI measure these in market exchange rate, even though the companies' primary source of income is domestic defense sales. This is essentially measuring as though the Russian government bought its defense kit in dollars instead of rubles. Such measures also exclude Russian giants like Rosatom, which produce nuclear weapons, and the giant conglomerate Rostec with total military revenues of $16.9 billion in 2019, but in effect $42 billion when considering PPP-adjusted measures. For more, see RSI Research Report Russian Defense Industry Analysis, Jan. 2021, #9.

Figure 2. Russian military expenditure: market exchange rates versus PPP-adjusted estimate (USD billion)



Source: Richard Connolly, *Russian Military Expenditure in Comparative Perspective: A Purchasing Power Parity Estimate*, CNA, IOP-2019-U-021955-Final, 2019, https://www.cna.org/CNA_files/PDF/IOP-2019-U-021955-Final.pdf .

The Ministry of Defense's main challenge in procurement or research and development is not borne of economic constraint, although the state is keen not to permit a runaway defense budget. Instead, the issue is serial production and defense industrial capacity, which consistently underperforms, leading to a typical under execution of 250 billion RUB worth of financial advances. Perhaps 5 percent of the defense budget is therefore rolled over every year. Russia is good at research and development, or prototyping, but does poorly in serial production. This problem can be observed in other sectors, and appears pernicious given weak supporting industries, or component production for complex systems. Typically, one organization underperforms in developing or producing an essential component which creates a bottleneck for production.

Economy

Russia is often portrayed as the world's 11th largest economy, comparable to that of Canada, based on market exchange rates. Yet here too PPP offers a starkly different picture. Russia is the sixth largest economy in the world, and the second largest in Europe based on PPP GDP measures, valued at about 4.3 trillion in 2019.[11] It is on track to overtake Germany once again as the largest economy in Europe. Russia is positioned as a high middle-income country, with a well-educated, and urbanized society, and per capita incomes higher than China. The Russian economy is dominated by a competitive resource extraction sector, and a revenue dependent sector that consists of mostly uncompetitive industries. The first exports resources to the global economy, while the second consumes subsidies and sells primarily to the domestic market. The latter does not invest in human or fixed capital as it is comprised of highly uncompetitive or state-protected firms. Consequently, much of the government revenue is earned from the export of resources, even if this represents only one sector of a more diversified economy.

The Russian economy suffers from underinvestment with around 20 percent of GDP invested annually, while manufacturing is also uncompetitive. Earnings from exports are therefore spent to maintain output and employment among underperforming sectors. Since much of the Russian government's revenue comes from oil and gas exports (around 40-45%), it is fair to describe Russia as a petrostate. Russia's economic cycle consists of growth in resource export revenues, followed by a rise in domestic consumption and imports. The Russian economic strategy is premised on keeping the value of the ruble low to encourage exports, building up foreign exchange reserves, especially in gold, and keeping employment high even as wage growth stagnates. This is a conservative economic approach, with little state contribution to GDP growth or spending to accelerate the economy. While it maintains a stable macro-economic picture, and low public debt, the standards of living decline, resulting in public discontent and economic uncertainty (this is a significant factor behind recent protests in Russia).

Inflation in Russia is relatively low compared to previous decades, but the overall strategy produces weak economic growth while maximizing the regime's cushion in the event of major economic shocks or new sanctions. Essentially, the state stockpiles reserves when oil prices are high, then spends some modicum when oil prices are low to avoid shocks to the financial system. Without structural reforms, Russia is unable to generate GDP growth of 4 percent or

[11] Here PPP-based adjustments can exaggerate economic performance, because they do a poor job of capturing export and import of goods at international market prices, and it may be preferable to average the two measures together for a more fair estimate.

more, which would be necessary for further development, and is therefore relatively stagnant growing at around 1.3 percent in 2019 (before the pandemic). This could be achieved with high oil prices, but they are cyclical, hence Russia will still average relatively low growth over the course of a decade. Though it is worth considering that this rate of growth is on average higher than that of some major European economies. Hence the weakness of Russian economic performance is often overstated.

The Russian political elite is unwilling to implement structural reforms to the economy, and instead has attempted to accelerate GDP growth via infrastructure projects, which has been proven to be an unsuccessful strategy. However, Russia's economy is resilient. Russia's GDP suffered a 3.1 percent contraction in 2020, which proved quite smaller than European peers, as the euro area economy is expected to shrink by 7.3 percent.[12] The current thinking in the Russian political administration is that there is a need for meta-reforms to the system of governing and practices before any meaningful reforms are launched.[13] This approach sheds light on the difference between reform projects that tackle governance efficiency, and seek to prevent regime degradation, versus those that might profoundly alter the system and would be heavily resisted by other elites or networks.

Russia is a state capitalist system, with a substantial portion of the economy dominated by majority state owned or controlled enterprises, together with more than 70 percent of the financial system. It is a system rife with cronyism, with individuals receiving positions and contracts that grant them access to rents. Thus, much of the political and economic elite is organized as patronage networks and characterized by rent seeking behavior. The elite is answerable to those upon whose patronage they depend rather than the public interest. There are competent institutions and competent managers in the system, such as in the Central Bank or Ministry of Finance, but sizable portions of the economy are de facto in the hands of elites whose opportunity for earnings depend on access in the Kremlin, not the competitiveness of their enterprises, or their competence in managing them.

[12] Anna Andrianova, "Russia Suffers Smaller Economic Slump Than Peers in 2020," *Bloomberg*, Feb. 1, 2021, https://www.bloomberg.com/news/articles/2021-02-01/russia-suffers-smaller-economic-slump-than-peers-in-2020.

[13] Fabian Burkhardt, "Foolproofing Putinism," *Riddle*, Mar. 3, 2021, https://www.ridl.io/en/foolproofing-putinism/.

Technological innovation

Russian leaders often speak to the importance of innovation, and there are innovation strategies abound as planning documents.[14] However, this rhetoric is poorly matched with investment and prioritization. Russia's spending on research and development is roughly 1 percent of GDP, which lags that of comparable OECD states.[15] Although metrics suggest a steady improvement in Russia's innovation and quality of research,[16] the education system is not keeping up with the needs of a modern economy. There is a dearth of financing for R&D, and little available private capital since most of the financial system is state dominated or directly controlled. Russian patent submissions hover around 30,000 per year, similar to that of India, though quite small compared to the US (515,180 in 2018).[17]

At the same time Russia has several successful tech companies which hold dominant market positions in the country relative to that of Western firms. Russia is one of the few countries where Google, Facebook, and similar US brands do not hold majority shares of key sectors of the digital economy. Indeed Yandex (Russia's Google), VKontakte (Russia's Facebook), Kaspersky Antivirus, and similar firms retain majority market shares despite their limited appeal on the global market and unrestricted access to Google or Facebook in Russia. Despite the outward appearance of a monoculture resource extraction economy, there are high tech bright spots in Russia's information sector.

Overall, the country's position and global rankings in technology innovation have steadily improved over the past 20 years, but the skillsets of the workforce and overall structure of the state dominated economy offers a poor ecosystem compared to advanced Western economies. There is a perennial fear among Russian elites that the country is falling behind, perhaps best vocalized in 2016 by Russia's head of Sberbank (now called Sber), German Gref, when he said that "we have found ourselves in the ranks of countries that are losing, downshifter

[14] "Russian President Official Site," Конференция по искусственному интеллекту. Vladimir Putin spoke at the plenary session of the Artificial Intelligence Journey conference on artificial intelligence, Nov. 9, 2019, http://special.kremlin.ru/catalog/keywords/39/events/62003.

[15] "Russian Federation," *OECD Science, Technology and Innovation Outlook 2016*, https://read.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-innovation-outlook-2016/russian-federation_sti_in_outlook-2016-83-en#page5 (https://dx.doi.org/10.1787/sti_in_outlook-2016-83-en).

[16] Russia moved in global competitiveness from 67th place in 2012 to 43rd place in 2019. See Klaus Schwab, *The Global Competitiveness Report 2019*, World Economic Forum, 2019, http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf.

[17] WIPO Data Center, accessed May 5, 2020, https://www3.wipo.int/ipstats/index.htm

countries."[18] Positioning Russia to be more successful in technological innovation would require considerable investment and major internal reforms, neither of which appears likely in the near term.

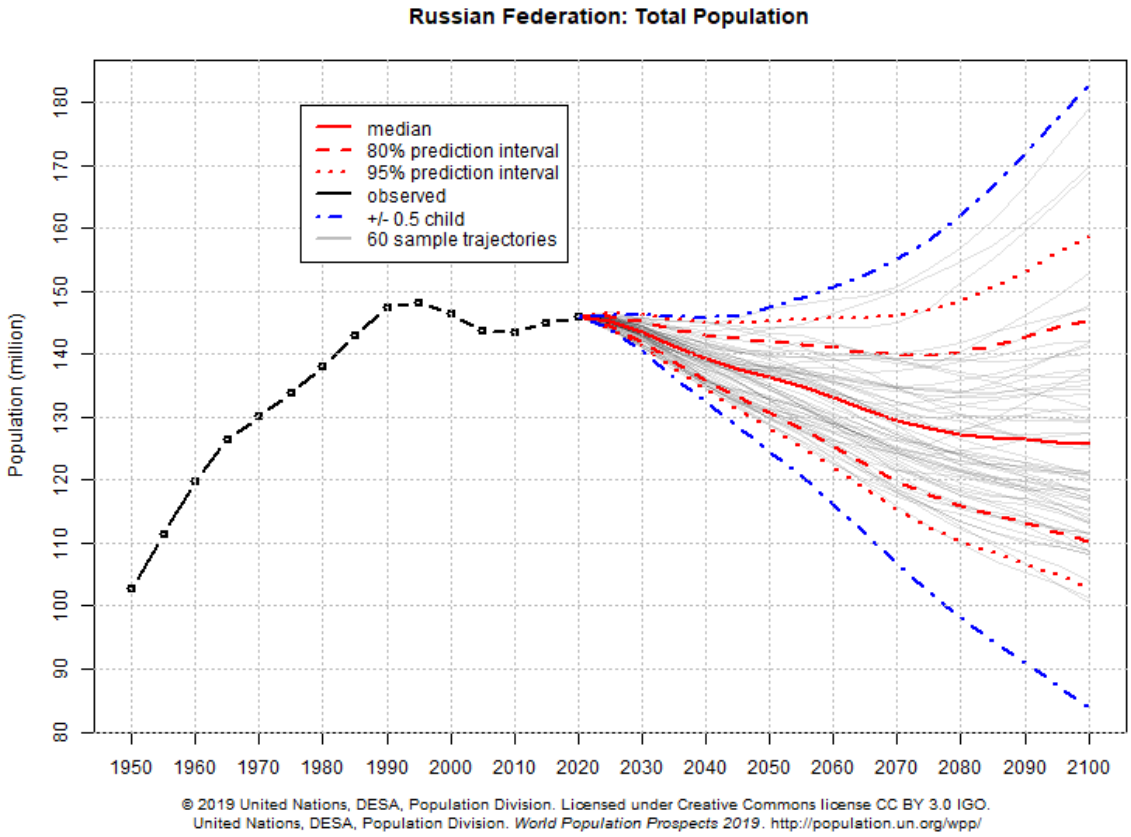
Demographics

Although Russia faces a steady population decline in the coming decades, its likely impact on state power and economic potential is not deterministic. The relationship between demographics and state power is hardly linear, and what matters most is quality of human capital versus just quantity. Russia, and the Soviet Union, have often been subject to doomsday demographic predictions which have consistently failed to come true. The median scenario predicted by UN demographers suggest a population decline of approximately 7.5 percent by 2050, which means Russia's population will diminish from 145 to 135 million.[19] More pessimistic predictions suggest a decline of 11-12 percent, but nowhere near the worst-case scenarios imagined in the early 2000s. Russia is expected to still be the most populous European country in 2050 by a broad margin.

[18] "'Downshifter' Russia Is Losing Global Competition, Warns State Bank Chief," *Moscow Times*, Jan. 15, 2016, https://www.themoscowtimes.com/2016/01/15/downshifter-russia-is-losing-global-competition-warns-state-bank-chief-a51474.

[19] Michael Kofman, "Russian demographics and power: Does the kremlin have a long game?," *War on the Rocks*, Feb. 4, 2020, https://warontherocks.com/2020/02/russian-demographics-and-power-does-the-kremlin-have-a-long-game/.

Figure 3. Probabilistic projection for Russia's population based on UN World Population Prospects (2019)



Source: UN Department of Economic and Social Affairs, Population Division, World Population Prospects 2019, 2019, accessed Apr. 19, 2021, https://population.un.org/wpp/Graphs/Probabilistic/POP/TOT/643.

Russia's demographic challenge is caused by high mortality rates, especially among men, and the knock-on effect of low births during the 1990s. The workforce has shrunk considerably year on year, essentially aging out without being replaced. However, Russia is also the net beneficiary of sizable labor migration, which fills labor force deficits in many economic sectors.[20] Hence Russia's population decline is partially offset by migrant labor which accounts

[20] Tatiana Karabchuk, "The Economic Impact of Migration in the Russian Federation: Taxation of Migrant Workers," *Asia-Pacific Population Journal* 32, no. 2 (2018),

for a substantial percentage of annual in and out migration.[21] The question of 'brain drain' is a complex one, and while there are indicators that members of the creative class emigrate due to poor opportunities, low pay, or political repression, the impact is highly uneven.

Russians are also living much longer, healthier lives compared to the 1990s and 2000s, and the fertility rate had improved considerably to approximately that of the US. There have been dramatic improvements from 2000-2015 in Russia's overall demographic trends, even if some of the gains have been reversed in recent years following an economic recession, sanctions, and the impact of the Covid-19 pandemic. Russia's population only began to decline by a modest amount in 2019. More significantly, Russia's chief labor problems historically have been labor productivity and labor force quality rather than size of the labor pool. However, Russia has experienced considerable labor productivity growth over the past two decades, comparable to countries in the EU, and this is one area of sustained improvement despite the contracting workforce.[22] The country faces pressure from a complex demographic challenge, but it is not going to run out of people, or 'brain power,' though the lagging education system and the drain of talent in certain sectors poses a continued problem.

Potential in AI development

As Western observers watch the Russian AI landscape, it is essential to take a measured approach and resist forecasts that predict Russia's inevitable demise and insignificance in the global drive for AI technology, as well as those fears that Russia is somehow going to break out with new AI-enabled technology that gives it a decisive advantage over the United States. The Russian technology landscape and infrastructure is not positioned to produce AI-related breakthroughs. Even so, it is in a position to follow closely behind and benefit from global advances in AI. The situation is analogous to the rise of the internet and subsequent cyberwar potential. Russia was not a major player in the basic research that enabled the internet, yet recent events have shown that it is a leader in weaponizing the internet. Similar to AI, Russia is not a leader in AI research, but it certainly has the potential for being a global leader in AI-

https://www.researchgate.net/publication/329243042_The_Economic_Impact_of_Migration_in_the_Russian_Federation_Taxation_of_Migrant_Workers.

[21] Maria Lipman and Yulia Florinskava, "Labor Migration in Russia," *PONARS Eurasia*, Jan. 2019, https://www.ponarseurasia.org/labor-migration-in-russia/.

[22] OECD (2020), Labour productivity and utilisation (indicator), doi: 10.1787/02c02f63-en (Accessed on July 31. 2020), https://data.oecd.org/lprdty/labour-productivity-and-utilisation.htm#indicator-chart

weaponization.[23] An interview with Russian-born professor, Sergey Levine, assistant professor at the University of California, Berkeley, and Craig Smith from the Eye on AI podcast perhaps captures this dynamic between Russia being a leader of technological breakthroughs and benefiting from the breakthroughs themselves.[24]

> CRAIG: How much do we know what's happening in China or Russia for that matter and how much do they know what's happening here. Do you have a view on that?
>
> SERGEY: It's a good question. I think that from my perspective, I would be very surprised if there is a major breakthrough that comes out of a lab that is not actively involved in the scientific community in this particular field.
>
> SERGEY: There is a tendency among scientists when they release a result to emphasize the things that are new, especially things that are radical about that result, but in reality, every result builds on prior work. In fact, it usually builds on prior work very, very closely. So, the more realistic view of a scientific result is that it's exactly the same as what someone did before with some small modification. Basically, every major result is like that from the most famous scientists in history to today and for that reason, I don't think anybody will be caught off guard, at least among the people that actually work in this area by something that's sort of is the result of decades of secret research. I think that the ideas are all in the air and while there might be small local things that people can come up with in secret on the whole, it's not like there's going to be a year's long gap somewhere. I just don't see that emerging.
>
> CRAIG: And do you have a view on this competition that people are starting to worry about between, particularly China and the US, but also Russia. I mean you read Russian, I would guess. Are there papers that you read in Russian that aren't published in English?
>
> SERGEY: No. The best papers from Russia are written in English right now. And I think that's the case for papers from China as well.
>
> CRAIG: That's right, yeah. So, unless there's a massively funded, which is possible in China, kind of Manhattan project to reach some goal, we know what's happening in China, at least at the basic research level.
>
> SERGEY: I think we do. And I think that the massively funded Manhattan project, I mean, I might sound naive in this regard because I'm certainly not an expert in political science or in economics, but I would say that a Manhattan project style effort for AI would be highly inefficient because it would be

[23] Analogy borrowed from Gregory Allen, Chief of Strategy and Communications at the Department of Defense's Joint Artificial Intelligence Center, https://www.ai.mil/.

[24] Craig Smith, "EPISODE #014: Thinking about robots II," Eye on AI Podcast, https://www.eye-on.ai/podcast-archive.

> difficult to get the best people and to retain the best people. And without the best people, it'd be very difficult to make substantive progress that actually pulls ahead of what the people that are working out in the open are doing.

Conclusion

Russia retains strengths in hard power, economic and military, with observable deficits in technology innovation, and a dearth of soft power. The economy is resilient, as is the political system, but on a stagnating trajectory which over time can turn into decline, especially in relative terms. Without political and economic reforms, the country cannot generate the sort of growth required for further development, and habits of chronic underinvestment bedevil its economic performance. While Russia is unlikely to witness any dramatic decline in the near or medium term, political ossification at the top and lack of economic reforms ensure anemic economic growth with overdependence on global energy prices.

Yet at the same time Russia has a strong resource base, consisting of a large economy, a well-educated populace whose quality continues to improve, and technological bright spots in commercial sectors. The state can lay out priorities, and mobilize its resources when the political leadership cares to see something done, in effect coercing the system to produce outcomes. This can at times compensate for poor implementation of strategic planning. Russia has also amassed considerable financial reserves, despite sanctions, and fared better during the Covid-19 pandemic than some other major economies.

Russia is slowly gravitating into China's economic orbit, both due to a lack of alternatives and a conscious strategy to engender greater interdependence with a rising economic giant. The rapprochement, and subsequent partnership with China comprises an important vector of Russian foreign policy, and perhaps the most consistent one since 1989.[25] Though Russia is somewhat disadvantaged by the relative simplicity and smaller size of its economy, the two countries have a de facto non-aggression pact and a host of technical cooperation agreements. Defense cooperation continues to increase between the two countries, along with technology exchanges, in a relationship whose implications continue to grow for US strategy.

[25] Technically L. Brezhnev begins the initiative towards rapprochement with China in 1982, which is subsequently realized by Gorbachev in 1989.

Governance and Legal Aspects of AI in Russia

In the last few years, the Russian government has prioritized the development of governance documents and the reform of its legal industry to set itself up for success in the rapidly growing field of AI. Through national-level programs such as the AI federal project and new laws, such as the regulatory sandboxes now in effect throughout the country, Russia is seeking to give Russians developing this important growth industry the resources, levers, and legal ability to experiment and learn without many of the traditional and bureaucratic impediments. These development plans have not been without criticism, as distrust of AI among ordinary Russians has risen and concerns over ethics, privacy violations, security, and the legal facets of AI remain. However, COVID has further revealed the necessity of increased digitalization throughout society and prompted the Russian government to pay enhanced attention to the matter, even as preexisting issues and hardships brought on by the pandemic threaten to delay or hinder AI development efforts indefinitely.

Figure 4. Russian legislative State Duma

Source: duma.gov.ru.

Figure 5. Timeline for adoption of AI-related regulations and federal laws

Source: Compiled by CNA.

National-level documents and programs

The Russian government prepared its first proposal on AI following a conference titled "Artificial Intelligence: Problems and Solutions - 2018," hosted by the Russian Ministry of Defense (MOD) with the Russian Ministry of Science and Higher Education and the Russian Academy of Sciences in March 2018.[26] The conference participants produced 10 recommendations for advancing AI in Russia, including holding an annual conference on AI, developing an AI infrastructure, creating a system for training AI specialists, and forming a consortium on big data and AI to unite governmental efforts on these technologies.[27] The recommendations centered on government action and made no mention of private entities.[28]

Figure 6. "Artificial Intelligence: Problems and Solutions – 2018" Conference

Source: Итоги конференции «Искусственный интеллект: проблемы и пути решения» 14-15 марта в парке «Патриот», ЯRobot, https://ya-r.ru/2018/03/22/itogi-konferentsii-iskusstvennyj-intellekt-problemy-i-puti-resheniya-14-15-marta-v-parke-patriot/.

[26] Министерство обороны Российской Федерации Russian Ministry of Defense, *Conference 'Artificial Intelligence: Problems and Solutions – 2019*, Конференция «Искусственный интеллект: проблемы и пути их решения – 2018» (2018), http://mil.ru/conferences/is-intellekt.hm.

[27] Ibid.

[28] Ibid.

Two months later, on May 7, 2018, Russian president Vladimir Putin issued a decree on Russia's national development goals through 2024, which, among other things, emphasized the need to digitally transform Russia's economy.[29] The decree laid out goals and tasks in this area, including the development of a flexible regulatory system for the digital economy, including in AI.[30]

Table 1. National-level documents and programs

Document/Program	Date approved	Description
Digital Economy Program	December 2018	Intended to bolster domestic spending on digitalization of the economy through seven priority program areas
AI Roadmap	October 2019	Outlines relevant AI subtechnologies and describes funding needed to develop each
National Strategy on AI Development	October 2019	Serves as the basis for planning and implementing state AI programs through 2030
AI Federal Project	August 2020	Adds funding and performance metrics to the goals in the national strategy; sets a schedule for developing and implementing AI technologies

Source: CNA.

Digital Economy program

Following from the May 2018 decree, the Russian government moved out on 13 national programs corresponding to Putin's goals.[31] One of these national programs, approved in December 2018, was the "Digital Economy" program, which aims to increase domestic

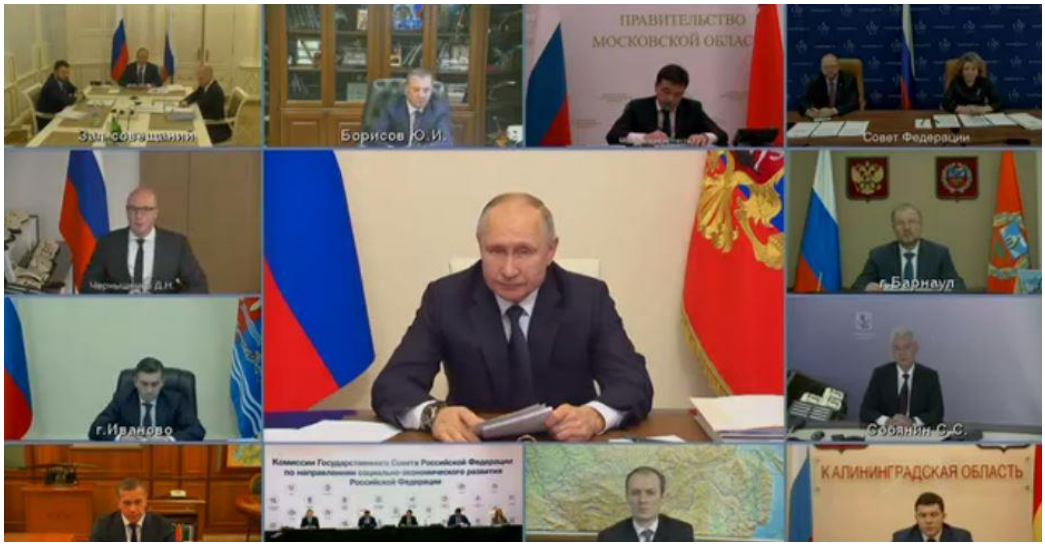
[29] Президент России President of Russia, *The President signed the Decree 'On national goals and strategic objectives of the development of the Russian Federation for the period up to 2024*, Президент подписал Указ «О национальных целях и стратегических задачах развития Российской Федерации на переиод до 2024 года» (May 7, 2018), http://kremlin.ru/events/president/news/57425.

[30] Ibid.

[31] "National projects 2019-2024," Национальные проекты 2019-2024, Rossiskaya Gazeta, Российская Газета, https://rg.ru/sujet/6234.

expenditure on the digitalization of the economy.[32] The "Digital Economy" program has six original program areas: information infrastructure, information security, digitalization of public services, end-to-end digital technologies, human capital, and adaptation of the regulatory environment.[33] In 2020, the government added a seventh program area, artificial intelligence.

Figure 7. Putin discussing the Digital Economy



Source: Joint meeting of the State Council and the Council for Strategic Development and National Projects Dec. 23, 2020, http://kremlin.ru/events/president/news/64736.

In the original road map for the "Digital Economy" program published in December 2018, the government indicated that it would increase domestic expenditure on digital economic development (from all sources, not just the federal budget) from 1.9 percent of GDP in 2018 to

[32] "The passport of the national program 'Digital Economy of the Russian Federation' has been published," Опубликован паспорт национальной программы «Цифровая экономика Российской Федерации», Government of Russia, Правительство России, Feb. 11, 2019, http://government.ru/info/35568/.

[33] Data Economy Russia 2024, *Road map for the digital economy*, Схема движения к цифровой экономике, https://data-economy.ru/dataeconomymap.

5.1 percent of GDP in 2024.[34] In September 2020, *Kommersant* reported that the government was planning to increase the "Digital Economy" program budget from the original 1.6 trillion rubles to almost 2 trillion rubles, with a particular emphasis on digital technologies projects (including big data and the internet of things) and a budget decrease for information security projects.[35]

AI roadmap

As a part of the digital technologies section of the "Digital Economy" program, the Russian government tasked Sber, a bank attempting to evolve into a tech company, with developing a roadmap on the development of AI and neurotechnologies.[36] The roadmap, published in October 2019, outlines relevant AI subtechnologies, including natural language processing, speech recognition, and computer vision, and lays out the share of funding needed from the budget and extra-budgetary sources for the development of each.[37] The document states that a total of 392 billion rubles is necessary for development in this area through 2024, though only 57 billion rubles would come from the budget, a total amount triple that found in the first draft of the document.[38]

[34] "Passport of the national program 'Digital economy of the Russian Federation," Паспорт национальной программы «Цифровая экономика Российской Федерации», Government of Russia, Правительство России, Dec. 24, 2018, http://static.government.ru/media/files/urKHm0gTPPnzJlaKw3M5cNLo6gczMkPF.pdf.

[35] Nikita Korolev, "The 'Digital Economy' will expand out of the budget," «Цифровую экономику» расширят вне бюджета, *Kommersant*, Коммерсант, Sept. 16, 2020, https://www.kommersant.ru/doc/4492928.

[36] Sberbank recently dropped the word "bank" from its logo and has invested in technologies ranging from cloud services to automated vehicles and high-tech gadgets over the last year. The company says it is becoming a "digital ecosystem," meaning it aims to have a role in all aspects of people's lives and in a large number of corporate services as well. Some examples of the services it offers to this end include online grocery buying, the ability to send money digitally for products and/or services, digital health services, options for buying and selling vehicles, etc. Igor Korolev, "Sberbank explained to the state how to spend 120 billion on artificial intelligence," Сбербанк объяснил государству, как потратить 120 миллиардов на искусственный интеллект, C-News, Dec. 18, 2019, https://www.cnews.ru/news/top/2019-12-11_sberbank_obyasnil_gosudarstvu.

[37] ME Мазуров, "Roadmap for the development of end-to-end digital technologies "Neurotechnologies and Artificial Intelligence," Дорожная карта развития «сквозной» цифровой технологии «Нейротехнологии и искуственный интеллект, (2019), https://digital.gov.ru/ru/documents/6658/.

[38] Igor Korolev, "Russian artificial intelligence grew wiser. Now it needs 392 billion," Российский искусственный интеллект поумнел. Теперь ему нужно 392 миллиарда, C-News, Oct. 28, 2019, https://www.cnews.ru/news/top/2019-10-28_rossijskij_iskusstvennyj.

National strategy on AI development

On February 27, 2019, Putin instructed the government to create a national strategy on AI, separate from the roadmap.[39] The intent of the document, also drafted by Sber and approved in October 2019, is to serve as the basis for planning and implementing state programs related to AI through 2030.[40] The national strategy does not contain details on funding for these programs, and should be viewed as a central planning document. It does, however, hold the first definition of "artificial intelligence" found in Russian law.[41]

> Artificial intelligence is a complex of technological solutions that allows [the imitation of] human cognitive functions (including self-learning and searching for solutions without a predetermined algorithm) and to obtain, when performing specific tasks, results comparable, at least, to the results of human intellectual activity. The complex of technological solutions includes information and communication infrastructure (including information systems, information and telecommunication networks, other technical means of information processing), processes and services for data processing and finding solutions.[42]

AI federal project

To achieve the goals set out in the national strategy, the Kremlin then ordered the development of an AI federal project to become the seventh facet of the "Digital Economy" program.[43] Once again, Sber prepared the draft of the document, which the government approved in August 2020.[44] The federal project adds funding and performance metrics to the goals enumerated in

[39] Tadviser, "National strategy for the development of artificial intelligence," Национальная стратегия развития искуственного интеллекта, https://www.tadviser.ru.

[40] Ibid.

[41] Margarita Sazonova, "Artificial intelligence and the law: is there a contract?," Искусственный интеллект и право: есть контракт?, Garant.ru, Гарант.ру, July 16, 2020, https://www.garant.ru/news/1401154/.

[42] Tadviser, "National strategy for the development of artificial intelligence."

[43] "Sberbank explained to the state how to spend 120 billion on artificial intelligence."

[44] Vladislav Skobelev and Anna Balashova, "The state project 'Artificial Intelligence' will cost almost 37 billion rubles," На госпроект «Искусственный интеллект» потратят почти 37 млрд. руб., RBC, Aug. 28, 2020, https://www.rbc.ru/technology_and_media/28/08/2020/5f4900119a7947026b495660.

the national strategy and sets out a schedule for the development and implementation of AI technologies.[45]

The project's explanatory note says that the funding will amount to around 36 billion rubles, with 22.5 billion rubles drawn from the "Digital Economy" program—a significant reduction from the 128.4 billion rubles originally proposed.[46] However, in December 2020, Russian deputy prime minister Dmitry Chernyshenko, the curator of the AI federal project, told Putin that the funding for the project will actually amount to 86.5 billion rubles, of which 24.6 billion rubles would come from the federal budget and 55 billion rubles of which Sber itself would provide.[47] Even this enhanced figure is quite a bit lower than the amount (392 billion rubles) Sber originally proposed as necessary for the development of AI in its first roadmap released in October 2019.[48]

Legal reform to foster AI development

In order to fulfill its lofty goals in the field of AI, Russia has begun to implement a series of legal reforms aimed at fostering innovation and allowing for experimentation by relaxing some previous regulations. This section will cover the main sector-wide laws and concepts for regulating AI development, though the government has also enacted a number of provisions aimed at promoting innovation in specific sectors. For example, in November 2020 Russian Prime Minister Mikhail Mishustin signed into law a roadmap titled "New types of entrepreneurship based on the introduction of advanced technologies," which contained stipulations allowing the Russian government to complete a thorough analysis of domestic UAV production.[49] Similarly, Mishustin approved a decree in December 2020 that gave

[45] Tadviser, "Explanatory note on the proposal to initiate a new federal project of the national program 'Digital Economy of the Russian Federation' No. D7-2020/001," Пояснительная записка к вопросу о рассмотрении предложения по инициированию нового федерального проекта национальной программы «Цифровая экономика Российской Федерации» №D7-2020/001, https://www.tadviser.ru/images/5/5b/2_537332695716751138 4.pdf; *Almanac of Artificial Intelligence, No. 6*, (2020), p. 44, https://aireport.ru.

[46] "National strategy for the development of artificial intelligence."

[47] TACC TASS, "Funding for the AI federal project will amount to 86.5 billion rubles," Финанирование федерального проекта по ИИ составит 86,5 млрд рублей, Dec. 9, 2020, https://tass.ru/ekonomika/10214415.

[48] "Russian artificial intelligence grew wiser. Now it needs 392 billion."

[49] 2020 No. 2871-r Order of the Russian Government of November 5, Nov. 5, 2020, http://static.government.ru/media/files/PmWKZG0Bw67e1dKjzuQIhsgjoyy6NlYW.pdf.

instructions for participation in an experiment related to autonomous ships.[50] The table in Appendix A gives additional details on some of the sector-specific laws.

Regulatory sandboxes

On July 1, 2020, Russian Law No. 123-FZ, an experimental legal regime (or "regulatory sandbox") for the city of Moscow, came into effect.[51] The law aims to promote innovation over the next five years by allowing the development and testing of certain types of AI technologies, even if it runs afoul of current legislation.[52] It also contains definitions of "artificial intelligence" and "artificial intelligence technologies" that may prove useful in drafting future regulations.[53]

Importantly, No. 123-FZ also contains an amendment to the law "On Personal Data," passed in 2006, that allows for the processing of anonymized personal health data of citizens.[54] The previous version of the law "On Personal Data" required an individual's written consent before his or her biometric data could be processed.[55] The bill's authors stated that this change in the law was necessary because the development and testing of new technologies demands large amounts of data, and requiring consent for each piece would limit the efficient development of AI technologies.[56]

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[50] "The government officially launched an experiment on the use of unmanned vessels in Russia," Правительство официально дало старт эксперименту по использованию беспилотных судов в России, Glonass, Глонасс, Dec. 14, 2020, http://vestnik-glonass.ru/news/vo_vlasti/pravitelstvo-ofitsialno-dalo-start-eksperimentu-po-ispolzovaniyu-bespilotnykh-sudov-v-rossii/.

[51] "Artificial intelligence and the law."

[52] "Federal Law of the Russian Federation of April 24, 2020 No. 123,-FZ," Apr. 24, 2020, https://cis-legislation.com/document.fwx?rgn=124089." Veronica Fridman and Anna Botvinkina, "A new experimental legal framework in Russia shows the perils and promise of future AI regulation," Gowling WLG, Sept. 14, 2020, https://gowlingwlg.com/en/insights-resources/articles/2020/future-ai-regulation-in-russia/.

[53] "A new experimental legal framework in Russia shows the perils and promise of future AI regulation."

[54] "Artificial intelligence and the law."; "State Duma adopted a law on a special legal regime for the development of artificial intelligence in Moscow," Госдума приняла закон о специальном правовом режиме в Москве для развития искуственного инеллекта, Interfax, Интерфакс, Apr. 14, 2020, https://www.interfax-russia.ru/moscow/news/gosduma-prinyala-zakon-o-specialnom-pravovom-rezhime-v-moskve-dlya-razvitiya-iskusstvennogo-intellekta.

[55] Yulia Stepanova, "Personal data will be transmitted," Личные данные пропесочат, Kommersant, Коммерсант, June 26, 2020, https://www.kommersant.ru/doc/4391725.

[56] Margarita Grosheva, "AI developers will be allowed to use patient data without their consent," Разработчикам искуственного интеллекта позволят использовать данные пациентов без их согласия, Medvestnik,

The Russian government then decided to expand the experiment to the entire country, and, on July 31, 2020, it signed into law an experimental legal regime for the entire Russian territory.[57] Federal law No. 258-FZ came into force in January 2021. Similar to the Moscow law, it also aims to promote digital technology development, however, it applies to more than just AI technologies and has a shorter duration—just three years with the possibility of an extension.[58] To participate in the experimental regime, individual entrepreneurs or organizations will need to submit an application, after which first the Ministry of Economic Development and then the relevant sectoral ministry will review the application and decide whether they will give approval.[59] In July 2020, the Ministry of Economic Development and Trade chose the first projects to which the regulatory sandboxes will apply, including the creation of robotic hotels, cargo transportation provided by drones, and the commercial use of self-driving cars.[60] At the end of October 2020, the Russian government approved a decree on the technologies that will fall under the special legal regime, including AI, quantum technologies, technologies for work with big data, and robotics.[61]

Concept for the development of AI regulation

On August 19, 2020, Russia took an additional step toward reforming its legal system to foster AI development with the passage of the "Concept for the development of regulation of relations in the field of AI and robotic technologies through 2024."[62] This document, developed in accordance with the National Strategy for the Development of AI passed in October 2019, identifies the major means by which Russia can transform its regulatory system to ensure the

Медвестник, July 17, 2020, https://medvestnik.ru/content/news/Razrabotchikam-iskusstvennogo-intellekta-pozvolyat-ispolzovat-dannye-pacientov-bez-ih-soglasiya.html.

[57] "Federal Law on an Experimental Legal Regime in the Field of Digital Innovations in the Russian Federation," July 22, 2020, http://www.consultant.ru/document/cons_doc_LAW_358738/.

[58] "A new experimental legal framework in Russia shows the perils and promise of future AI regulation."

[59] "How the law on 'digital sandboxes' will work – Deputy Ministry of Economic Development," Как будет работать закон о «цифровых песочницах» - замминистра экономического развития, D-Russia.ru, Aug. 11, 2020, https://d-russia.ru/kak-budet-rabotat-zakon-o-cifrovyh-pesochnicah-zamministra-jekonomicheskogo-razvitija.html.

[60] "Experimental legal regimes for digital innovation in Russia," Эксперементальные правовые режимы в сфере цифровых инноваций в России, Tadviser, https://www.tadviser.ru.

[61] Ibid.

[62] "More about the government's vision for regulation AI relationships," Подробнее о правительственной концепции регулирования отношений, возникающих в связи с ИИ, D-Russia.ru, Aug. 27, 2020, https://d-russia.ru/podrobnee-o-pravitelstvennoj-koncepcii-regulirovanija-otnoshenij-voznikajushhih-v-svjazi-s-ii.html."

efficient and effective development of AI and robotic technologies.[63] It consists of five parts: general provisions, such as goals for the concept and for regulation; industry-wide issues, such as legal liability and export conditions; sectoral areas that could improve with these technologies, such as medicine and transport; regulatory measures for financial stimulation of technological development, including public-private partnerships; and methods for realizing the concept.[64]

Key organizations and individuals

While the government has the ultimate responsibility for passing AI-relevant policies and legislation, the task of carrying out Russia's AI development strategy has typically fallen to state-owned businesses, rather than private entities.[65] Within the government, Deputy Prime Minister Dmitry Chernyshenko has the task of developing, implementing, and overseeing the "Digital Economy" program, while the Ministry of Economic Development is charged with carrying out the regulatory sandboxes program.[66] The Ministry of Telecom and Mass Communication has the lead on a number of initiatives dealing with data and the internet.[67]

The government has entrusted Sber, led by German Gref, a longtime Putin ally, with drafting all major AI-related national documents, including the first AI roadmap, the national strategy on AI development, and the AI federal project.[68] Sber has attempted to transform itself from a bank to a broader digital ecosystem that would be pervasive in people's lives through its smart devices and services. However, Putin warned Gref in December 2020 to remember that Sber is a bank first and foremost.[69] Also in December, Sber announced it will soon open the first AI

[63] Ibid.

[64] Ibid.

[65] Stephanie Petrella, Chris Miller, and Benjamin Cooper, *Russia's Artificial Intelligence Strategy: The Role of State-Owned Firms*, Foreign Policy Research Institute, 2020, p. 75, doi: 10.1016/j.orbis.2020.11.005.

[66] "Distribution of duties between the deputy prime ministers," Распределение обязанностей между заместителям Председателя Правительства, Government of Russia, Правительство России, http://government.ru/gov/responsibilities/#366; "Experimental legal regimes for digital innovation in Russia."

[67] "'Digital Economy' national program of the Russian Federation," Национальная программа Цифровая экономика Российской Федерации, Tadviser, https://www.tadviser.ru.

[68] Chris Miller, Stephanie Patrella, and Maia Otarashvili, *Russia's "Digital Economy Program" and the Kremlin's Information Security Agenda*, Foreign Policy Research Institute, 2020, p. 6.

[69] "The digital ecosystem of Sber," Цифровая экосистема Сбера, Sberbank, Сбербанк, https://www.sberbank.com/ru/eco; Evgeny Kalyukov and Mikhail Kotlyar, *Putin pointed out to Gref the need to*

Institute in Russia with the mission of promoting AI research.[70] The organization has committed a great deal of its own money to implementing government AI projects over the next several years, though Sber is also set to make a great deal of money from the development of AI.[71]

Figure 8. Herman Gref, CEO of Sber, and Russian President Putin

Source: "Vladmir Putin at consultation upon Siberia in Tomsk, 2006," Photo by Фото пресс-службы Президента России via Wikimedia Commons, Apr. 26, 2006, accessed Apr. 19, 2021, http://archive.kremlin.ru/events/photos/2006/04/105620.shtml.

remember the banking essence of Sber, Путин указал Грефу на необходимость помнить о банковской сути «Сбера».

[70] "Sberbank will open an Institute of Artificial Intelligence in Russia," «Сбер» откроет в России институт искуственного интеллекта, Vedomosti, Ведомости, Dec. 3, 2020, https://www.vedomosti.ru/finance/news/2020/12/03/849348-sber-otkroet-v-rossii-institut-iskusstvennogo-intellekta.

[71] Ekaterina Kinyakina, "Sberbank will earn 450 billion rubles on artificial intelligence," Сбербанк заработает на искусственном интеллекте 450 млрд рублей, Vedomosti, Ведомости, Feb. 20, 2020, https://www.vedomosti.ru/technology/articles/2020/02/19/823464-sberbank-zarabotaet.

Several other state-owned firms play a role in implementing the broader "Digital Economy" program. The government tasked Rostec, the massive state-backed military-industrial organization, with creating the roadmaps for blockchain and distributed ledger technology, the internet of things, and 5G telecoms (along with Rostelecom, Russia's largest digital services provider).[72] Rosatom, the state atomic energy corporation, is also deeply involved in the digital economy, with primary responsibility for development of quantum computing.[73] On August 27, 2020, Rostec and Rosatom jointly signed an agreement of intent with the Russian government to carry out the "Digital Technologies" federal project.[74] A number of additional state-funded entities, such as Skolkovo, also have more minor roles in Russia's digital modernization.

Skolkovo

Then-president Dmitry Medvedev launched Skolkovo in 2010 with the intention of creating an innovation cluster equivalent to Silicon Valley in the United States. Skolkovo includes five research clusters: Information technologies (IT), Energy, Nuclear, Biomedicine, and Space. Development of AI technologies is one of the primary focus areas of the IT Cluster.

[72] "The Russian government approved a roadmap for 5G development," Правительство РФ утвердило дорожную карту развития 5G, Rostec, Ростех, Nov. 19, 2020, https://rostec.ru/news/pravitelstvo-rf-utverdilo-dorozhnuyu-kartu-razvitiya-5g/; Yulia Tishina, "The internet of unnecessary things," Интернет ненужных вещей, Kommersant, Коммерсант, Dec. 10, 2020, https://www.kommersant.ru/doc/4605543; Tatiana Edovina, "Money for a figure," Деньги на цифру, Kommersant, Коммерсант, Feb. 13, 2020, https://www.kommersant.ru/doc/4243128.

[73] "Money for a figure."

[74] Vika Ryabova, "The government, Rosatom, and Rostec signed an agreement on the development of new digital production technologies," Правительство, «Росатом» и «Ростех» подписали соглашение о развитии новых цифровых производственных технологий, D-Russia.ru, Aug. 31, 2020, https://d-russia.ru/pravitelstvo-rosatom-i-rosteh-podpisali-soglashenie-o-razvitii-novyh-cifrovyh-proizvodstvennyh-tehnologij.html.

Figure 9. Skolkovo Innovation Center

Source: Русский: Инновационный центр "Сколково" via Wikimedia Commons, Sept. 26, 2018, accessed Apr. 19, 2021, https://old.sk.ru/city/p/main_objects.aspx.

Russian government agencies that are not themselves involved in Russian digital modernization are also increasingly announcing initiatives to utilize AI as part of their duties. In December 2020, the Russian Ministry of Digital Development published a list of AI projects it proposed to implement in four Russian ministries and three government departments by 2024.[75] The projects include the use of AI by the Ministry of Internal Affairs, AI analysis of images by the Ministry of Emergencies to identify and manage natural disasters, and the creation of a chatbot based on neural networks to assist the Ministry of Industry and Trade.[76] The government will fund these agency digitalization efforts, which may each cost tens of billions of rubles.[77]

Given that the impetus for these efforts comes from the senior most Russian leadership, the agency initiatives are likely credible, though it is unclear how evenly the ministries will be able to implement their projects or how successful the attempts will be. It is probable there will be varying levels of success as each ministry attempts to implement its own initiatives. We expect to see differing speeds in carrying out the efforts and, while some will fulfill all of their

[75] Elyas Kasmi, "AI will appear in Russian ministries and government departments to search for criminals and work with documents," В российских министерствах и госведомствах появится ИИ для поиска преступников и работы с документами, C-News, Dec. 16, 2020, https://www.cnews.ru/news/top/2020-12-16_v_ministerstva_i_gosvedomstva/.

[76] Ibid.

[77] Ibid.

objectives, others will not be able to implement all plans as intended. Additionally, it is unclear which ministries have enough personnel and experts capable of implementing AI-related plans. Despite Russian efforts to educate as many people as possible in AI capabilities, it is likely some government agencies will have more know-how to carry out their plans than others.

When ministries get access to massive state funds, we can also expect to see a certain amount of stove piping, as well as rent seeking and defensive attitudes toward their competitors (i.e. other government agencies). To justify their spending and show government leaders they are fulfilling their objectives, some ministries may misrepresent their efforts (likely by stating that they are doing more than in reality) to a certain extent in order to receive additional funds from the budget.

Criticism of AI development efforts

Russian digitalization efforts, and plans to develop the AI industry, have not been without pushback, including from ordinary Russian citizens. In a poll in July 2020, 20 percent of Russian respondents reported a negative attitude toward AI, citing fears of information leakage, privacy violations, technical failures, and the unpredictability of AI development.[78] This number was up from just 12 percent who reported a negative attitude in January 2020, likely due to the increased use of AI as a result of the pandemic.[79]

Some government digitalization plans drew specific criticism. The amendment to the law "On Personal Data" contained in Federal Law 123-FZ, which made it possible to use an individual's anonymized medical data without their consent, caused significant concern over what it could mean for data rights and the protection of privacy.[80] Numerous experts spoke about the potential for abuse that could occur as individuals lose control of their data and the impossibility of restoring the integrity of biometric data in case of a leak.[81] Much information about Russians, including their call records, cellphone locations, and air travel records are already available illegally for purchase at extremely cheap rates on the app Telegram or the dark web, but the proposed regulations would make the use of certain types of information,

[78] "Poll: Russians began to trust artificial intelligence less because of the pandemic," Опрос: россияне стали меньше доверять искусственному инеллекту из-за пандемии, Fingazeta, Фингазета, Fingazeta, Фингазета, July 23, 2020, https://fingazeta.ru/events/meropriyatiya/464641.

[79] Ibid.

[80] "Personal data will be transmitted."

[81] Ibid.

such as anonymized medical data, legal in some scenarios.[82] There were additional concerns over the regulatory sandboxes, given the possibility of cyber threats in some cases, and experts urged that special attention be given to data security when caring out experiments on the use of digital technologies.[83]

The development of AI brings up outstanding legal and ethical concerns as well. The legal status of AI-generated creations remains ambiguous, as does legal responsibility in case of an accident involving an unmanned vehicle.[84] Concerning intellectual property (IP) rights, at least, there was a proposal in October 2020 to grant the IP rights for AI-generated creations to AI developers (rather than to the AI itself, as currently enshrined in Russian law), though the law was met with mixed reactions.[85]

Citizens are also naturally concerned about the possibility of AI taking over jobs and replacing workers, particularly in low-skilled positions. In a recent survey of three thousand Russian citizens from across Russia, every third participant feared AI would eventually compete for their jobs.[86] The debate over the ethics of AI use in the workforce will continue to play out as the use of AI becomes more widespread.[87]

To increase confidence in AI, the Russian government released a plan in August 2020 that would encompass a number of confidence-building measures, including the launch of a popularization campaign on both social and mainstream media, an online AI portal where

[82] Ben Smith, "How Investigative Journalism Flourished in Hostile Russia," The New York Times, Feb. 21, 2021, https://www.nytimes.com/2021/02/21/business/media/probiv-investigative-reporting-russia.html.

[83] Yulia Stepanova, "Quicksand sandboxes," Зыбучие песочницы, Kommersant, Коммерсант, Aug. 20, 2020, https://www.kommersant.ru/doc/4459389?query=искусственного%20интеллекта.

[84] "Artificial intelligence and the law."

[85] "Russian authorities want to take away copyrights from artificial intelligence," Власти России хотят отобрать у искусственного интеллекта авторские права, C-News, Nov. 10, 2020, https://www.cnews.ru/news/top/2020-11-11_vlasti_zadumali_otobrat.

[86] "Every third Russian believes that he will have to compete with robots for his job " Каждый третий россиянин считает, что ему придется конкурировать с роботами за профессию, *Korins.ru*, Apr. 5, 2021, http://www.korins.ru/posts/6665-kazhdyy-tretiy-rossiyanin-schitaet-chto-emu-pridetsya-konkurirovat-s-robotami-za-professiyu.

[87] "Russian authorities want to take away copyrights from artificial intelligence."

citizens can get more information on AI development, an AI lecture series, and an AI trust index.[88] The program aims to reach a total of 33 million people by 2024.[89]

Looking ahead

The economic crisis brought on by COVID has proven a significant barrier to the implementation of Russia's national programs, including those under the "Digital Economy" program, though major challenges existed even before the onset of the pandemic. While the Russian government has lofty goals for digitalization of the economy and the development of AI technologies, the realities of the economic situation have necessitated adjustment of the implementation plans. At the end of 2019, the "Digital Economy" program had the worst budget execution of any of the national projects with just 53.6 percent of the budget spent.[90] Articles speculated that this was due to a number of reasons, including management issues and a lack of a holistic concept for the program's implementation.[91] In the first nine months of 2020, the budget execution was just 20.6 percent of that allocated for the year.[92]

On July 13, 2020, Putin issued instructions for the government to modify the national goals outlined in 2018 and shift the deadline for implementation from 2024 to 2030.[93] He said that Russia needed to "proceed from reality," and seemed to blame regional leaders for not executing program budgets as originally intended.[94] A presidential decree issued July 21 formalized the extension through 2030 and included a number of digital transformation goals to accomplish by then, including "digital maturity" throughout the economy and social sphere

[88] "Authorities plan to increase Russians' trust in AI through the media and social networks," Власти поанируют повышать доверие россиян к ИИ через СМИ и соцсети, TASS, Aug. 26, 2020, https://tass.ru/nacionalnye-proekty/9299615."

[89] Ibid.

[90] "'Digital Economy' national program of the Russian Federation."

[91] "'Digital Economy.' How to reorganize the national program so that it works in full force," «Цифровая экономика». Как реорганизовать нацпрограмму, чтобы она заработала в полную силу, C-News, Oct. 22, 2019, https://www.cnews.ru/articles/2019-10-22_tsifrovaya_ekonomikakak_reorganizovat."

[92] "'Digital Economy' national program of the Russian Federation."

[93] Maksim Rubchenko, "Putin postponed the deadline for implementation of the national programs," Путин отложил срок реализации нацпроектов, Vedomosti, Ведомости, July 14, 2020, https://www.vedomosti.ru/economics/articles/2020/07/13/834504-prezident-otlozhil-natsproekti.

[94] Ibid.

and increased investments in domestic technological solutions.[95] After Putin's order, government officials stated that they would begin preparing amendments to the national projects, which they hoped to complete in the coming months.[96] The same month, the Ministry of Finance proposed cutting most government spending by 10 percent through 2023 in an effort to balance a federal budget that had taken hits due to COVID and the collapse in oil prices.[97] On September 30, the government submitted its draft budget for 2021-2023 to the State Duma with adjustments made due to COVID.[98] Reports state that the government draft may have reduced funding for the "Digital Economy" program from almost 2 trillion rubles to just 92.1 billion rubles, with only 16.5 billion rubles allocated to the AI federal project, compared to the 22.5 allotted in the original conception of the project.[99] The final version of the bill that passed the Duma on December 9 contained somewhat more modest cuts, reducing the digitalization budget to 550 billion rubles.[100]

Of course, the impacts of COVID are likely to last long after the pandemic ends. The negative effects on the budget and the delays in implementation of the "Digital Economy" program and AI federal project will continue to have an impact on the government's ability to effectively carry out its digitalization plans in the future. Moreover, the crisis will only exacerbate other problems already beleaguering these plans, including low cash execution of the necessary expenses and the fact that the national programs attempt to cover such a wide range of objectives.

One positive indicator for the future of the "Digital Economy" program is that the pandemic has revealed the importance of digitalization in all aspects of society—although, according to the Federation Council, it has also revealed some unresolved issues, such as unequal access to

[95] "Decree on the National Development Goals of Russia until 2030," July 21, 2020, http://kremlin.ru/events/president/news/63728.

[96] Evgeniy Kalyukov, "Oreshkin spoke about the goals of the changing national projects," Орешкин рассказал о целях измененных нацпроектов, RBC, July 21, 2020, https://www.rbc.ru/economics/21/07/2020/5f16ae089a79472547f0211f.

[97] Ivan Tkacheva and Yulia Starostina, "The Ministry of Finance proposed a program to reduce budget expenditures," Минфин предложил программу сокращения расходов бюджета, RBC, July 21, 2020, https://www.rbc.ru/economics/21/07/2020/5f15ab829a7947382f5ec57e.

[98] Irina Peshkova, "The budget of the 'Digital Economy' may be cut to 92 billion rubles," Бюдлет «Цифровой экономики» может быть урезан на 92 млрд рублей, C-News, Sept. 21, 2020, https://www.rbc.ru/economics/21/07/2020/5f16ae089a79472547f0211f.

[99] Ibid.

[100] Roman Markelov, "Regarding numbers," В порядке цифр, Rossiskaya Gazeta, Российская Газета, Dec. 10, 2020, https://rg.ru/2020/12/10/kakim-budet-novyj-federalnyj-biudzhet-na-tri-goda.html.

digital technology throughout society.[101] Therefore, the government will likely prioritize rapid implementation of certain aspects of the digitalization agenda, such as those that ensure equal access to the internet, while carrying out work in other areas such as AI as they are able, given limited and stretched resources. We do not expect the share of state involvement in digitalization efforts to lessen and, in fact, it will likely increase as the government focuses enhanced attention on digital efforts (and AI in particular) as an important element of citizen-state interaction. The government believes that, if most funding for these initiatives comes from the state, it can increase its share of involvement in Russian life accordingly.

As previously mentioned, it is likely ministry AI-development initiatives will not develop at the same pace and, in fact, some may prove wholly unsuccessful. In contrast with the more flexible US ecosystem that has evolved over the span of decades, Russia is attempting to squeeze several decades of growth into just a few years. However, the personnel and infrastructure to implement needed reforms are not in place within all parts of the government yet, so, while some priority ministries (such as the state security services) may see greater resource allocation, others will likely prove unsuccessful at meeting their objectives in the timeframe laid out. As the government continues to push for and fund these efforts, it will be important to revisit the results periodically to assess which ministry efforts are progressing apace and which have fallen behind.

[101] "On the implementation of the national project 'Digital Economy of the Russian Federation'," О ходе реализации национального проекта «Цифровая экономика Российской Федерации», Federation Council, Совет Федерации, Nov. 18, 2020, http://council.gov.ru/activity/documents/121565.

The Russian AI Ecosystem

This chapter introduces the Russian AI ecosystem, key components of which are discussed in the chapters that follow. It first discusses the goals of Russia's ecosystem and priorities that the government has singled out for innovation. It then outlines the structure of the Russia AI ecosystem, including key funders. Finally, it highlights challenges to the growth and vibrancy of Russia's AI ecosystem.

The key feature of the ecosystem is leadership by state-owned companies (such as Sber, Rostec, and Gazprom Neft) and disproportionate funding from the Russian government for the development of AI-enabled technologies. There are government incubators (Skolkovo), funders (Russian Direct Investment Fund), and initiatives (National Technology Initiative) aimed at facilitating the development of AI-enabled technologies. While the private sector is diverse in terms of size (from the large Yandex.ru to much smaller companies), the number of startups is small compared to the numbers in the United States and China.

The government has prioritized the areas of healthcare, transportation, agriculture, fuel and energy industry, and manufacturing as key areas for the incorporation of AI-enabled technologies. In addition, a considerable effort is aimed at the incorporation of AI-enabled technologies into Russian government processes, including the interface between citizens and government services. Some of the key technological development has been stimulated by the COVID pandemic.

As discussed in this section, key challenges for Russia's development of AI include potential rent-seeking behavior by companies used to government funding, a need for greater computing power and indigenous hardware, given the challenges of procurement of Western equipment in light of sanctions, low rates of digital technology adoption across the private sector, and the need for greater international cooperation.

Russia's AI ecosystem in the broader context

The goals of Russia's AI ecosystem are best understood within the broader context of Russia's economic development and modernization efforts, and include the improvement of the well-being of Russians as well as the conditions for business and entrepreneurial activity. There is a considerable military effort in AI-enabled technologies coupled with an understanding that civilian AI tools will be applied in the military domain. The Russian leadership also views the ability to innovate as one of the hallmarks of a sovereign great power and military innovation,

including in AI, and see it as essential to Russia's overall deterrence posture in countering its perceived threat environment, hence, the effort to become one of the world leaders in AI.

While Russia's president Putin declared 2021 to be the Year of Science in Russia, Russia continues to struggle with innovation, as key metrics suggest. According to the Global Innovation Index (GII) 2020 data, Russia is 47th (out of 131 countries), and those data suggest that while Russia has invested more in innovation, its innovative results and output have decreased.[102] The GII rankings also note that Russia is 32nd out of 39 European economies in terms of innovation.[103] Russia's overall funding for R&D remains comparatively low. Funding for R&D is expected to gradually increase over the next several years, with 40 percent of civilian R&D focused on basic research.[104,105] According to data from the Scopus database, Russia hovers around 11th to 12th place in terms of number of scientific publications in disciplines such as astronomy, engineering, materials engineering, chemistry, and mathematics. (Its number of scientific publications in these areas is similar to those of Australia, Brazil, Iran, and South Korea.) This is an improvement from the place (15th to 16th) it held just seven years ago.[106] Russian analysts note that Russian science continues to be plagued by scholarship quality issues, including plagiarism and self-citations.[107] Government initiatives prioritize training the new generation of scientists and reversing brain drain issues (see the Education chapter of this report.)

As discussed in the previous chapter, Russia's AI strategy and numerous implementation roadmaps lay out markers for the evolution of the AI ecosystem as a whole. The goals are best understood within two 2018 National Projects: the "Digital Economy" national project, led by the Ministry of Digital Development; and, because the overall effort is embedded in Russia's broader innovation ecosystem, the national project "Science," led by the Ministry of Science and Education. Key metrics laid out by the Russian government on AI development in strategic

[102] See 2020 data on Russia on the website: Global Innovation Index," accessed Feb. 22, 2021, https://www.globalinnovationindex.org/analysis-economy.

[103] Ibid.

[104] Gaidar Center, *Russian Economy in 2019 Trends and Outlooks*, p. 499, https://www.iep.ru/en/publications/publication/russian-economy-in-2019-trends-and-outlooks-issue-41.html.

[105] See OECD data for Russia: "Russian Federation," OECD Data, accessed Feb. 22, 2021, https://data.oecd.org/russian-federation.htm.

[106] E. Erokhina, "Russian science in Scopus and WoS: quantity or quality," Indicator, Feb. 8, 2019, https://indicator.ru/engineering-science/rossijskaya-nauka-v-scopus-i-wos-kolichestvo-ili-kachestvo.htm.

[107] Gaidar Center, *Russian Economy in 2019 Trends and Outlooks*, p. 495.

documents, some of which were drafted with significant industry consultation, include the number of publications by Russian authors in international scientific journals and at top conferences as well as the number of patents and tools developed by companies. These metrics have been steadily improving, but are still wanting. In scientific journal rankings, Russia's overall ranking is 25 (1996-2019, out of 190 countries). In the field of AI, however, its ranking advanced from 21 to 16 between 2018 and 2019.[108] In total number of papers, Russian researchers estimate that Russia holds the 20th place in the world. They assess that in 2019 there were 16,000 active researchers in the AI field in Russia, 4,340 publications in peer-reviewed journals, and 16 publications at AI conferences.[109] Russia's nascent AI federal project provides key metrics that will be important for analysts to track moving forward.[110]

According to Stanford University's AI Global Vibrancy Tool, Russia's economy and R&D scores are comparatively low.[111] Russia is also 29th out of 194 on the AI Readiness Index.[112] Russian analysts from the Moscow Institute of Physics and Technology (MIPT) posit that "Russia is between the 20th and 30th places in the world in the general state of the AI industry, developments, financing, personnel, etc."[113] More recently, an MIPT report indicated that while the volume of AI-related revenue activity in Russia is growing approximately 10 times faster than Russia's GDP, it is still underfunded by the state, asserting the Russia's level of investment in AI is 350 times lower than China's.

Moscow Institute of Physics and Technology

The Moscow Institute of Physics and Technology is a leading Russian university and the focal point in Russia's academic work on artificial intelligence, providing useful insights into Russia's AI ecosystem.[1] MIPT is the leading academic institution that assists other Russian universities with AI RDT&E.

[108] See data: "SJR - International Science Rankings," Scimago, accessed Feb. 22, 2021, https://www.scimagojr.com/countryrank.php?category=1702&year=2019.

[109] *Moscow Institute of Physics and Technology (MIPT) 2019 Almanac*, p. 8-9.

[110] See text of the summary of the AI Federal Project, accessed Feb. 22, 2021.

[111] See data: "AI Global Vibrancy Tool," HAI, Stanford University, Human-Centered Artificial Intelligence, accessed Feb. 22, 2021, https://hai.stanford.edu/ai-global-vibrancy-tool.

[112] See data: "Government AI Readiness Index 2020," Oxford Insights, accessed Feb. 22, 2021, https://www.oxfordinsights.com/government-ai-readiness-index-2020.

[113] *Moscow Institute of Physics and Technology (MIPT) 2019 Almanac*, p. 8-9.

Underinvestment by the Russian government in AI is cited as one of the main factors for Russia's lagging performance in AI in 2020 compared to other leading countries.[114]

Structure of the ecosystem

The Russian AI ecosystem is best understood as clusters of interlinked activity within the government, state-corporate, military, academic, and private realm, each of which are discussed in the following chapters of this report in greater detail. A key feature of the ecosystem is leadership by state-owned companies (Sber, Rostec, and Gazprom Neft) and a significant amount of funding from the Russian government for R&D of AI-enabled technologies.

There are government incubators (Skolkovo), funders (Russian Direct Investment Fund), and initiatives (National Technology Initiative) aimed at facilitating the development of AI-enabled technologies. The private sector is diverse in terms of size (ranging from the large companies Yandex and Mail.ru, to smaller venture firms). The ecosystem is centered on Skolkovo and Skolteh, with the active participation of Sber (now Sber), Gazprom Neft', and companies such as Yandex and Mail.ru. Sber and German Gref play a prominent role in the ecosystem, given Sber's key role in developing the AI Strategy and the corresponding roadmap of AI development in Russia. (Other participants in the process included Yandex, Mail.ru, and Gazprom Neft. Alongside MTS and RFDI, these form the AI-Russia Alliance.) Large business entities have participated, including as part of ANO Digital Economy, in the process of developing laws and regulations.

An important role is set aside for key cities and regions. Moscow has been the site for both legal and practical implementation of AI-enabled tools. Some of Russia's regions have participated in smart cities and smart regions programs, and there have been efforts to create regional innovation centers. These have faced some criticism from industry commenters, who argue that such an approach may be inefficient.[115] Russian analysts also note that, "as a driver of digital change [, startups] are more typical of the advanced regions."[116]

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[114] "The volume of the AI market in Russia has almost reached 300 billion rubles " Объем рынка ИИ в России практически достиг 300 млрд рублей, *Izvestia*, Apr. 4, 2021, https://iz.ru/1151591/2021-04-14/obem-rynka-ii-v-rossii-prakticheski-dostig-300-mlrd-rublei.

[115] "Digitalize This: Will the National Plan Help Create its Own Silicon Valley in Russia?," [Цифровизируй это: поможет ли нацплан создать в России свою Кремниевую долину], Future Russia, Oct. 8, 2020, https://futurerussia.gov.ru/nacionalnye-proekty/cifroviziruj-etopomozet-li-nacplan-sozdat-v-rossii-svou-kremnievuu-dolinu.

[116] Gaidar Center, *Russian Economy in 2019 Trends and Outlooks*, p. 480.

There are numerous efforts to coordinate R&D involving academic institutes and business, enabled by government funding, as discussed in detail in the following sections of the report. Some have noted the government's extensive stimulation of the academic sector through, for example, Project 5-100 federal funding aimed at increasing competitiveness. But, there have been other efforts through, for example, creation of centers focused specifically on AI at key institutes such as the National Technology Initiative. Federal funding has come through multiple channels to many of these universities. For example, the MIPT AI center focuses on R&D and commercialization.

Military innovation is driven by the Russian Ministry of Defense, through State Armament Programs, and facilitated by Rostec and other defense enterprises, with funding from special incubators, as discussed in the subsequent sections of this report. But, while Russia is spending a significant amount of effort and funding on military efforts in AI-enabled technologies, there is also an expectation that civilian developments will translate into military advances. At present, direct civilian-military cooperation is relatively low, with only some schools like the Southern Federal University cooperating with MOD.

Figure 10. ROSTEC: State-owned defense and high tech holding conglomerate

Source: "Офис Ростех в Москве" [Rostec office in Moscow], via Wikimedia Commons, July 5, 2018, accessed Mar. 17, 2021, https://en.wikipedia.org/w/index.php?title=Rostec&oldid=1011352655.

Priority areas and technologies

The government has prioritized the areas of healthcare, transportation, agriculture, fuel and energy industry, and manufacturing as key areas for the incorporation of AI-enabled technologies. In addition, a considerable effort is aimed at the incorporation of AI-enabled technologies into Russian government processes. As discussed in further sections of this report, some of the key technological developments have been stimulated by the COVID pandemic. A feature of the Russian system is that the Russian state will retain access to all data, even though the state has led efforts to give developers better access to such data.

The AI federal project identifies a handful of priority areas for development, including healthcare, transport, agriculture, fuel and energy, and manufacturing industries, as discussed further in this report. In turn, the AI roadmap identifies the following priority areas (with those more significant levels of funding first): decision-making systems, computer vision, natural language processing, speech recognition and synthesis, and advanced AI methods and technologies. In addition, there are efforts to transform the interaction of the Russian government with its citizens and reduce bureaucracy through AI-enabled tools.

There are several thrusts in Digital Economy: end-to-end digital technologies (5G, robotics, VR, blockchain, quantum computing, new production tech) and AI. While the government has prioritized the development of technological solutions for the areas identified above, the private sector has worked to develop solutions in its own interest, to include digital assistants, and others, as discussed further in this report.

According to Russian scholars, Russia's IT industry is one of the few areas where exports exceed domestic sales, and the "the AI Development Strategy indicates priority areas [including] autonomous self-education, autonomous decomposition of complex tasks, algorithmic simulation of biological decision making systems, etc.)." [117] US analytical reports suggest a six-fold increase in the number of publications between 2010 and 2018 by Russian scientists in "fields such as machine learning, algorithms, and robotics," with nearly half in "computer vision, pattern recognition, linguistics, natural language processing, algorithms, and robotics."[118] The section of this report that follows will discuss in greater detail the elements of the academic and business environments that shape Russia's development of these particular technologies.

[117] Ibid., p. 506.

[118] Margarita Konaev and James Dunham, *Russian AI Research 2010 to 2018: Topics, Trends, and Institutions*, CSET Issue Brief, Oct. 2020, https://cset.georgetown.edu/wp-content/uploads/CSET-Russian-AI-Research-2010-to-2018.pdf.

Challenges for the Russian AI ecosystem

Analysts have argued that key challenges for Russia's development of AI include: rent-seeking behavior by companies used to government funding, the need for greater computing power and the need for indigenous hardware. Two other challenges, brain drain and the need for international cooperation, are discussed in their respective chapters later in this report.

Rent-seeking behavior

Russia's economic development strategy currently relies on the state to play a driving role in modernization. Also, there is general trend of decreasing foreign investment in venture projects coupled with the replacement of private funding by public funding.[119] This comes with many downsides. As an analyst at Russia's authoritative Gaidar Institute of Economic Policy notes, a potential key challenge is that

> direct [government] subsidies will not motivate market participants to boost their efficiency; on the contrary, subsidized companies will be prompted to adopt a rent-seeking behavior. Accordingly, it seems necessary to promote businesses' interest in digital transformation processes to ensure growth in the share of the private sector's R&D costs on information and communication technologies.[120]

Echoing this, there have been concerns across the Russian private sector, and among medium and small companies in particular, that government direction and funding will shape the market in a way that advantages state-owned firms and large companies.[121] Already, surveys suggest that instruments of state support are utilized by 72 percent of large companies, by 45 percent of medium-sized companies, and only by 42 percent of small businesses. They also note that "39 percent of startups are disappointed about the instruments of state support, including through development institutions, as according to their arguments, they do not get any tangible benefit."[122] As discussed further in this report, Russia's current strategy in the AI space envisions grants to medium and small companies. However, such support also perpetuates reliance on government funding that may, in turn, depress innovation.

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[119] Gaidar Center, *Russian Economy in 2019 Trends and Outlooks*, p. 504.

[120] Ibid., p. 549.

[121] See "Russian government engages with ICT industry and faces criticism," in *AI in Russia, Issue 7*, Russia Studies Program, CNA, DOP-2020-U-027701-Final2, 2020.

[122] Gaidar Center, *Russian Economy in 2019 Trends and Outlooks*, p. 505.

Hardware and digital technology adoption

There are concerns that Russia as a whole does not have sufficient IT infrastructure across the country or adequate computing power to conduct modern science, leading to efforts by scientists to push for a supercomputing roadmap.[123] While there are specific supercomputing tools for AI, including the Skoltech's Zhores supercomputer, which is being improved in order to enter the Top-500, and Sber's Kristophari, Russia's ranking in terms of supercomputing power remains low.[124] In addition, Russian economists acknowledge the continued challenge of reliance on "U.S., Taiwanese, and South Korean semiconductor equipment on which to run AI algorithms, given that the Russian electronics industry is small and highly focused on specific military production, not generalized products." [125]

Furthermore, while there have been many positive case studies suggesting the prevalence of digital technologies in Russian companies, assessments of the depth and integration into businesses suggest some causes for concern. According to Russian analysts,

> The most illustrative in this respect is the use of robotics by companies compared with the number of their employees. According to 2017 [International Federation of Robotics] data, on average in Europe, there were 99 robots per 10,000 jobs, and in countries like Singapore and South Korea that index was more than 600 robots; however, Russia's index was next to India's – 4 and 3 robots per 10,000 jobs, respectively. It should be noted that robotization is the most important factor in ensuring competitiveness in hi-tech industries like the automotive industry, optics, and electronics.[126]

To be sure, given the Russian government's push into AI and innovation in the last several years, Russia's numbers may improve, though catching up may prove impossible.

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[123] "В России разработали концепцию национальной суперкомпьютерной инфраструктуры," [Russia has developed a roadmap for national supercomputing infrastructure] TASS, Apr. 22, 2020, https://nauka.tass.ru/nauka/8309573.

[124] See "TOP500 List - November 2020," accessed Feb. 22, 2021, https://www.top500.org/lists/top500/list/2020/11/.

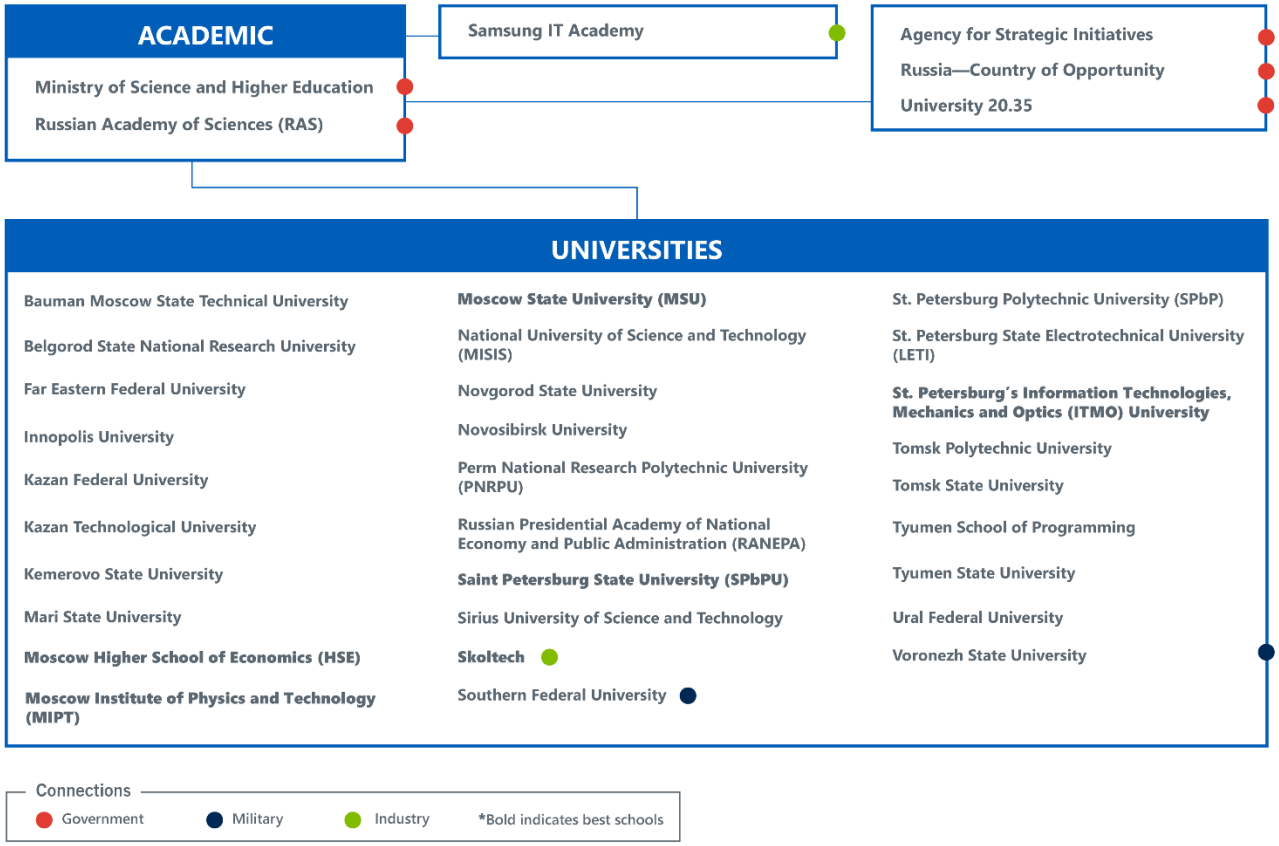
[125] Petrella, Miller, and Cooper, *Russia's Artificial Intelligence Strategy*.

[126] Gaidar Center, *Russian Economy in 2019 Trends and Outlooks*, p. 476. The report cites Robert D. Atkinson, "Which Nations Really Lead in Industrial Robot Adoption?" Information Technology & Innovation Foundation report, Nov. 19, 2018, https://itif.org/publications/2018/11/19/which-nations-really-lead-industrial-robot-adoption.

AI-related Academic Entities, Education, and Training

Russia is facing significant challenges when it comes to its technology-related demographics. This section explores Russia's rising demand for highly trained tech specialists and surveys its efforts to meet these demands by implementing education initiatives across all demographic groups. It provides an overview of the key academic institutions involved in developing AI and tech specialists, as well as government-funded efforts, including conferences, hackathons, programming competitions, and intensive training modules used in Russian classrooms. Additionally, while noting successes in Russia's capacity-building efforts, we also examine shortcomings, roadblocks, and challenges ahead. Finally, we discuss what these trends in human capital mean for the future of Russian IT and Moscow's ability to execute its AI goals.

Figure 11. Russia's academic AI ecosystem



Source: CNA.

Challenges to Russia's IT population

Shortage of tech experts

Since Putin's famous AI quote in 2017, the Kremlin has introduced a number of strategic initiatives to increase the quality and quantity of Russian AI research and further the development and implementation of digital solutions, aiming to meet bold benchmarks by the years 2024 and 2030.[127] However, Russia faces staggering shortages of tech experts, which can be attributed both to a skyrocketing demand and to challenges associated with training and retaining a skilled workforce. According to Deputy Head of the Ministry of Digital Science, the deficit of IT personnel in Russia currently totals between 500,000 and 1 million, despite state efforts to overcome this shortage.[128] This figure includes both highly-skilled specialists as well as generalists that can work across sectors. Director of Human Resources for the Digital Economy Valentina Kurenkova notes, "The projected explosive growth of the market for artificial intelligence technologies will lead to an additional demand of 95 thousand people annually, which means that the deficit will increase from year to year."[129] According to a recent report by the Ministry of Education, due to rising demands for AI across all sectors, there will be a shortage of 2 million experts by 2025.[130] The onset of the COVID-19 pandemic has only

Putin on AI

In 2017, following a rising global focus on artificial intelligence, Putin famously commented, "The one who becomes the leader in this sphere will be the ruler of the world."

[127] "Putin: Leader in artificial intelligence will rule world," CNBC, Sept. 4, 2017, https://www.cnbc.com/2017/09/04/putin-leader-in-artificial-intelligence-will-rule-world.html.

[128] "Python programmers in Russia receive up to 400 thousand rubles. But girls don't go to work for them," Программисты на Python в России получают до 400 тыс. руб. Но девушки к ним работать не идут, *CNews*, 2021, https://www.cnews.ru/news/top/2021-01-14_raskryt_potolok_rossijskih

[129] Georgy Voronovich, "Hundreds of thousands of new personnel: how the IT sector is supported in Russia," [Сотни тысяч новых кадров: как в России поддерживают IT-сектор], Gazeta.Ru, Dec. 12, 2020, https://www.gazeta.ru/tech/2020/12/04_a_13387279.shtml.

[130] "In Russia, there is a growing shortage of personnel in AI, big data and machine learning," [В России нарастает дефицит кадров по ИИ, большим данным и машинному обучению], CNews, Mar. 28, 2018, https://data.cnews.ru/news/top/2018-03-28_defitsit_kadrov_po_iibolshim_dannym_i_mashinnomu; "The basics of artificial intelligence will be taught in elementary school," [Основам искусственного интеллекта будут обучать в начальной школе], Rambler, Jan. 25, 2021, https://news.rambler.ru/education/45676470-osnovam-

accelerated this trend, as more than 24 percent of IT and tech businesses polled reported an increase in AI investments.[131]

The number of Russian AI experts, as opposed to tech experts more generally, is harder to estimate, as the field is somewhat nebulous and not rigidly defined. According to Sber CEO German Gref, there are only about 6,000-6,500 experts working as AI developers in Russia today, which he notes is not even the number of workers at one Microsoft lab.[132] This figure should be distinguished from the larger number of academic researchers in AI-related fields and the number of broadly AI-adjacent university graduates, which are also referenced in this section. These figures reflect academic output and indicate human capital/capacity, but not necessarily the "AI workforce."

Brain drain

Contributing to this stark shortage of Russian IT specialists is the phenomenon of "brain drain", where experts migrate to work in competing countries. Though there is a global shortage of AI expertise, and most countries actively seek to attract and retain tech experts, others have been far more successful in these endeavors; Based on employment data from 2019 AI publications, "American employers attract the lion's share of top AI talent – 46% worked for a US-based employer. China took the second spot on the list, accounting for 11% of employment, followed by the UK at 7%. Canada, Germany, and Japan each accounted for 4%."[133] Though there are a variety of factors that contribute to brain drain, such as quality of life in a given country, the markedly different salaries offered to IT graduates are likely the greatest driver. According to a 2020 report by the Foreign Policy Research Institute, Russian IT developers only earn around 25 percent of the salary of their US counterparts.[134]

iskusstvennogo-intellekta-budut-obuchat-v-nachalnoy-shkole/?utm_content=news_media&utm_medium=read_more&utm_source=copylink.

[131] "The basics of artificial intelligence will be taught in elementary school."

[132] "Gref urged to eliminate the shortage of specialists in artificial intelligence," [Греф призвал устранить дефицит специалистов по искусственному интеллекту], RIA Novosti, May 30, 2019, https://ria.ru/20190530/1555110473.html.

[133] Terry Brown, "The AI Skills Shortage," *IT Chronicles*, Oct. 11, 2019, https://itchronicles.com/artificial-intelligence/the-ai-skills-shortage/.

[134] Petrella, Miller, and Cooper, *Russia's Artificial Intelligence Strategy*.

Several have noted that brain drain has had a particularly noticeable effect on Russia's defense sector.[135] According to the Foreign Policy Research Institute (FPRI), "In 2016, half of Russian military-industrial complex enterprises were experiencing personnel shortages. The share of specialists in the defense industry under 30 years of age was just four percent. There is little evidence to suggest these figures have improved."[136] Patrella et al. attribute such difficulties in attracting and retaining talent in the defense sector primarily to low government investment in technology.[137]

Russian firms have attempted various strategies to curb brain drain, including lengthening contract terms, raising salaries, and recruiting foreign candidates and students. So far, however, nothing has sufficiently mitigated the flight of IT specialists. This, too, has been exacerbated by the ongoing pandemic; a letter from business representatives warned Prime Minister Mishustin that by the end of 2021, 10-15,000 thousand IT experts may leave Russia due to COVID-19-related effects on the industry.[138]

Accessibility and geographical challenges

An additional challenge to developing and maintaining capacity is that Russia's population is spread across an expansive landmass, most of which is relatively rural and separate from major population centers such as Moscow or St. Petersburg. This poses challenges across all age groups and makes implementing government-directed education initiatives challenging. At the university level, while the average Moscow oblast resident needs to drive only 8 kilometers to attend a university, those in other regions fare far worse: in Khabarovsk Territory, one must travel 474 km; in Buryatia, 339 km; in Transbaikalia, 331 km; in Magadan, 362 km; and in Sakhalin, 313 km.[139] Developing tech education centers in regions such as the Far Eastern Federal District, Irkutsk, and Tatarstan, and ensuring that schoolchildren across Russia have equal access to quality education and technology for virtual learning have been priorities for the Kremlin.

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[135] Samuel Bendett, "Russia Can't Find Enough Skilled Workers," Real Clear World, Mar. 5, 2016, https://www.realclearworld.com/blog/2016/03/russia_cant_find_enough_skilled_workers_111746.html.

[136] Miller, Patrella, and Otarashvili, *Russia's "Digital Economy Program" and the Kremlin's Information Security Agenda*, p. 6.

[137] Petrella, Miller, and Cooper, *Russia's Artificial Intelligence Strategy*.

[138] "Russian Tech Industry Faces Coronavirus Brain Drain," *Moscow Times,* June 17, 2020, https://www.themoscowtimes.com/2020/06/17/russian-tech-industry-faces-coronavirus-brain-drain-a70607.

[139] "RBC," https://www.rbc.ru/society/30/01/2017/588f0cab9a794716f7e77440.

Education centers

Leading Russian universities

While Russia has developed a number of exceptional institutions that produce high-quality research, only a few of its universities are top ranked globally, according to three of the most authoritative lists: Times Higher Education (THE) Ranking, the Quacquarelli Symonds (QS) Ranking, and the Shanghai Academic Ranking of World Universities. In hopes of improving Russia's global standing and developing world-class education centers, the Kremlin attempted to address this shortcoming in 2012, making it an official goal to have five top-100 universities by 2020, by the standards of these three ranking systems.[140] However, the goal was not met. As of February 2021, the only Russian university included in either the Shanghai Ranking or Quacquarelli Symonds 100 was Lomonosov Moscow State University (MSU, 93rd and 73rd, respectively).[141] In the 2020 THE Ranking, MSU was ranked 174th, and the next-ranked Russian university, MIPT, was ranked in the 201-250th group.[142]

Leading Russian AI universities

To get a sense of how Russian institutions rank in terms of AI research, one metric to examine is total number of academic papers published, which puts Russia in 20th place globally, according to Russian researchers. They assess that in 2019 there were 4,340 AI publications in peer-reviewed journals, 16 publications at AI conferences, and 16,000 active researchers in the field of AI in Russia, though this figure likely includes researchers in adjacent fields.[143] US analytical reports suggest this has greatly improved over the past decade, noting a six-fold increase in the number of publications between 2010 and 2018 by Russian scientists in "fields such as machine learning, algorithms, and robotics," with nearly half in "computer vision, pattern recognition, linguistics, natural language processing, algorithms, and robotics."[144] In

[140] Konaev and Dunham, *Russian AI Research 2010 to 2018: Topics, Trends, and Institutions*.

[141] "Academic Ranking of World Universities 2020," accessed Jan. 31, 2021, http://www.shanghairanking.com/ARWU2020.html; "QS Worl University Rankings 2021," QS Top Universities, accessed Jan. 31, 2021, https://www.topuniversities.com/university-rankings/world-university-rankings/2021.

[142] "Study in The Russian Federation," Times Higher Education, Jan. 31, 2021, https://www.timeshighereducation.com/student/where-to-study/study-in-russian-federation.

[143] *Moscow Institute of Physics and Technology (MIPT) 2019 Almanac*, p. 8-9.

[144] Konaev and Dunham, *Russian AI Research 2010 to 2018: Topics, Trends, and Institutions*.

terms of specific Russian universities, the Quacquarelli Symonds Ranking for Top Engineering and Technology Universities lists MSU as 59th, followed by St. Petersburg Polytechnic University (191st), and Novosibirsk University (193rd).[145] There are a number of Russian universities in the 200-300 range: MIPT (202nd), Saint Petersburg State University (SPbPU, 207th), St. Petersburg's Information Technologies, Mechanics and Optics University (ITMO, 207th), Bauman Moscow State University (243rd), the National University of Science and Technology (MISIS, 247th), the National Research Tomsk Polytechnic University (282nd), and the National Research Nuclear University (285th).[146]

Figure 12. Moscow State University

Source: "Moscow State University," May 31, 2015, accessed Mar. 16, 2021, https://en.wikipedia.org/w/index.php?title=Moscow_State_University&oldid=1011977107.

[145] "Engineering and Technology," QS Top Universities, accessed Jan. 31, 2021, https://www.topuniversities.com/university-rankings/university-subject-rankings/2020/engineering-technology.

[146] Ibid.

According to the MIPT 2020 AI Almanac, in 2019 about 18,300 students graduated from Russian universities in specialties including: applied mathematics and computer science; fundamental computer science and information technology; computer science and computer engineering; information and communications technologies and communication systems; mathematics and computer sciences; information systems and technologies; and applied informatics – all of which are considered relevant to the field of AI. About 2,000 of these students graduated from top Russian AI universities, which the report identifies as Moscow State University (MSU), MIPT, Moscow Higher School of Economics (HSE), Saint Petersburg State University (SPbPU), St. Petersburg's Information Technologies, Mechanics and Optics University (ITMO), and Skoltech. However, rankings for top Russian AI programs vary.[147]

In Moscow, there are several distinguished universities known for training top experts and producing high-quality artificial intelligence research. MSU, which often receives the highest rankings, is one of the schools at the forefront of these. According to MIPT's AI Index, MSU had around 350 graduate and almost 500 undergraduate AI students in 2019.[148] MIPT is another university leading the way in AI. According to the 2020 SuperJob ranking of top Russian tech universities, which is based on the average salary of the schools' graduates, MIPT came in first (IT graduates earn an average salary of 180,000 rubles ($2,403)).[149] In 2017, the Russian government selected MIPT to be home to the new Center for Artificial Intelligence, as part of the National Technological Initiative. In 2019 MIPT had about 250 graduate and 300 undergraduate students in AI.[150] A third school of note is the Higher School of Economics (HSE), which had around 250 graduate and 550 undergraduate students in AI in 2019.[151]

[147] For example, Georgetown University's CSET ranks the top 20 Russian AI research institutions, respectively, as follows (based on quantity of English-language AI research output): Russian Academy of Sciences, National Research University – Higher School of Economics, Moscow State University, Saint Petersburg State University, Moscow Institute of Physics and Technology, Kazan Federal University, Skolkovo Institute of Science and Technology, National Research Nuclear University MEPhI, Southern Federal University, Tomsk Polytechnic University, Ural Federal University, Peoples' Friendship University of Russia, Bauman Moscow State Technical University, Yandex, Siberian State Aerospace University, Tomsk State University, Saint Petersburg State Polytechnic University, Novosibirsk State Technical University, Novosibirsk State University, and the Far Eastern Federal University; Konaev and Dunham, *Russian AI Research 2010 to 2018: Topics, Trends, and Institutions*.

[148] *Artificial Intelligence Almanac: AI Index 2019 - Russia*, MIPT, Moscow, No.4, Mar. 2020.

[149] "Ranking of technical universities in Russia 2020," [Рейтинг технических вузов России 2020], SuberJob, accessed Jan. 31, 2021, https://students.superjob.ru/reiting-vuzov/it/.

[150] *Artificial Intelligence Almanac: AI Index 2019 - Russia*.

[151] Ibid.

St. Petersburg is also home to a number of renowned universities teaching artificial intelligence-related subject matter. St. Petersburg State University (SPbU) had around 150 graduate and 300 undergraduate students in AI in 2019.[152] Also of note is St. Petersburg Polytechnic University (SPbPU). In July 2020, SPbPU also opened an Institute of Cybersecurity and Information Protection, with the first courses on certain subjects, including cyberpsychology, protection against digital reproduction, and penetration testing.[153] The Institute is also collaborating on projects with industry partners such as LG, Bosch, Cisco, Huawei, Gazprom Neft, GosNIIAS, and Transmashholding JSC.[154] Also of note is St. Petersburg's Information Technologies, Mechanics and Optics (ITMO) University. Since 2018, ITMO also has also offered a master's program in neurotechnology and software engineering, which guides research on technologies including artificial intelligence (AI), virtual reality and augmented reality (VR/AR), the internet of things (IoT), and technologies used to study "the brain, the nervous system, cardiovascular, respiratory and muscle functions, as well as eye movements."

Many universities' AI programs have partnered with businesses in the industry, which offer an opportunity for students to apply what they have learned in a real-world setting through on-site practicums and internships. In return, these businesses hope to attract some of Russia's top, in-demand graduates for full-time employment. These joint education programs include ITMO and Nexign's telecommunications software program, ITMO and Robotrack's neurotechnology software program, Rosatom and Sirius University's international school of quantum computing, and MIPT's two-year master's program titled "Digital Technologies in Business'' with Mobile TeleSystems (MTS) and the Skolkovo Business School.[155] Another

[152] Ibid.

[153] "Институт кибербезопасности открылся в Петербургском Политехе," [Cybersecurity Institute opens in St. Petersburg Polytechnic University], TASS, July 3, 2020, https://tass.ru/obschestvo/8879257; "В Политехе создан Институт кибербезопасности и защиты информации," [Institute of Cybersecurity and Information Protection established at Polytech], St. Petersburg Polytechnic University of Peter the Great, July 6, 2020, https://www.spbstu.ru/media/news/education/institute-cybersecurity-informationprotection-polytech/.

[154] "Институт кибербезопасности открылся в Петербургском Политехе."; "В Политехе создан Институт кибербезопасности и защиты информации."

[155] "The Master's program in Neurotechnology and Software Engineering receives corporate status and will offer two new specializations," [Магистерская программа «Нейротехнологии и программная инженерия» получила корпоративный статус и открыла две новые специализации], ITMO News, July 29, 2020, https://news.itmo.ru/ru/education//news/9607/; "About us," ["О нас"], Robotrack, https://robotrack-rus.ru/o-nas/; "MTS, MIPT and SKOLKOVO open the master's program 'Digital Technologies in Business'," [МТС, МФТИ и СКОЛКОВО открывают магистратуру 'Цифровые технологии в бизнесе], COMNEWS, July 22, 2020, https://www.comnews.ru/content/208225/2020-07-22/2020-w30/mts-mfti-i-skolkovo-otkryvayut-magistraturu-cifrovye-tekhnologii-biznese; "Recruitment for a new master's degree from MIPT, SKOLKOVO and MTS is open: 'Digital technologies in business'," [Открыт набор на новую магистратуру от МФТИ, СКОЛКОВО и

example is Samsung's IT Academy, which is teaching one-year courses in AI, IoT, and mobile app development at 34 universities throughout Russia, engaging more than 1,000 students per year.[156] This symbiotic relationship between educational institutions and business also serves a role in retaining Russian talent and resisting brain drain to competing countries.

Rising programs and new initiatives

Other Russian universities that are leading the way in artificial intelligence include the Southern Federal University (SFU), the Ural Federal University (UFU), and Innopolis University. In July 2020, SFU and MIPT jointly began offering a master's program titled "Computer Mathematics: Theory and Applications."[157] In August 2020, UFU announced that in 2021 it would begin offering a master's program in IT security, consisting of 22 disciplines, including "legal aspects of information security, organization of secure network communications, and methods and tools for analyzing big data." Experts from both MIPT and the Ural Center for Security Systems will be assisting in the training program.[158] Russia's first Artificial Intelligence Institute opened at Tatarstan's Innopolis University in December 2020. The institute will develop educational programs at the bachelor's, master's, and postgraduate levels, offering instruction on topics including data science, AI microelectronics, and machine

МТС: «Цифровые технологии в бизнесе»], MIPT, https://mipt.ru/news/otkryt_nabor_na_novuyu_magistraturu_ot_mfti_skolkovo_i_mts_tsifrovye_tekhnologii_v_biznese; "Росатом и РКЦ запустили первую международную школу по квантовым вычислениям," [Rosatom and RQC launched the first international school on quantum computing], TASS, Sept. 14, 2020, https://nauka.tass.ru/nauka/9447715.

156 "IT Academy of Samsung begins new year in Russia and Kazakhstan," [Проект «IT Академия Samsung» начинает новый учебный год в России и Казахстане], Samsung, Oct. 21, 2020, https://news.samsung.com/kz_ru/project-it-akademiya-samsung-nachinaet-novyi-uchebnyigod-v-rossii-i-kazakhstane.

157 "SFedU and MIPT are implementing a joint master's program for the National Technical Initiative markets," ["ЮФУ и МФТИ реализуют совместную программу магистратуры для рынков НТИ"], Southern Federal University, July 22, 2020, https://www.sfedu.ru/www2/web/press-center/news/63261; NTI Autonet, "About Us," Scientific Design Bureau of Computing Systems, https://autonet-nti.ru/en/autonet/; https://www.nkbvs.ru/en/o-firme/.

158 "UrFU will launch training in information security in 2021 with MIPT and an IT company," [УрФУ запустит подготовку кадров по защите информации в 2021 году с МФТИ и ITкомпанией], Aug. 13, 2020, https://futurerussia.gov.ru/nacionalnye-proekty/urfu-zapustitpodgotovku-kadrov-po-zasite-informacii-v-2021-godu-s-mfti-i-it-kompaniej; "Recruitment 2021: University and MIPT launch a new IT program," [Набор–2021: вуз и МФТИ запускают новую IT-программу], UrFU, Aug. 18, 2020, https://urfu.ru/ru/news/32873/.

learning.[159] Though more rural regions are improving their capacity to produce high-quality AI research, it has been noted that many of these regions, including the Far East, Irkutsk, and Tatarstan, face a considerable shortage of technical experts as well as AI and end-to-end technology development.[160]

Figure 13. Southern Federal University

Source: Wikipedia contributors, "Southern Federal University," Wikipedia, The Free Encyclopedia, https://en.wikipedia.org/w/index.php?title=Southern_Federal_University&oldid=997974890 (accessed March 17, 2021).

[159] Vladimir Bakhur, "The first AI Institute in Russia was created at Innopolis University campus," [Первый в России Институт ИИ создан на базе Университета Иннополис], CNews, Dec. 10, 2020, https://www.cnews.ru/news/line/2020-12-10_pervyj_v_rossii_institut; Vladimir Bakhur, "Innopolis University will develop an AI platform for demand forecasting," https://www.cnews.ru/news/line/2020-12-24_universitet_innopolis_razrabotaet.

[160] Dmitry Stepnov, "Russia is experiencing a shortage of personnel in the field of artificial intelligence," [Россия испытывает дефицит кадров в сфере искусственного интеллекта], Russian Planet, [РУССКАЯ планета], Nov. 18, 2020, https://rusplt.ru/society/rossiya-ispitivaetdefitsit-kadrov-5fb5464d.html.

The Kremlin has emphasized the need to create new education centers and develop existing ones, both in line with its goal to increase the number of Russian universities in the top global rankings, and in an effort to develop high-quality AI and tech education centers across Russia. As part of its national project "Science," Russia is also aiming to develop at least 15 world-class innovative sites that combine science and tech by 2021.[161] Priority areas for these centers include AI, robotics, and digital technologies.[162] Between 2020 and 2022, the federal budget will provide 3.28 billion rubles ($43 million) in grants to support this project. In 2020, 721.1 million rubles ($10 million) went to Tyumen State University, Belgorod State National Research University, Kemerovo State University, Perm Federal Research Center of the Ural Branch of the Russian Academy of Sciences, and the REC Management Company from the Nizhny Novgorod Region.[163] In line with this project, the Samara Scientific and Education Center is also focusing on the development of new AI-based engineering systems, generation propulsion and fuel systems, and smart transport systems.[164]

Following the increased demand for tech experts, other Russian universities have recently begun offering new bachelor's or master's programs in various AI or tech concentrations. These schools include Mari State University's Institute of Digital Technologies which opened in June 2020; RANEPA's Institute of Economics, Mathematics and Information Technologies' (EMIT's) new Data Science and Artificial Intelligence master's program; Novgorod State University's Department of Information and Communication Policy's courses on data mining and AI; and Tyumen School of Programming's new neural networks course.[165] They also

[161] "Tatiana Golikova and Andrey Fursenko held a meeting of the Council of world-class scientific and educational centers," [Татьяна Голикова и Андрей Фурсенко провели заседание Совета научно-образовательных центров мирового уровня], Russian Government, Feb. 20, 2020, http://government.ru/news/39005/.

[162] "Правительство определило список получателей грантов среди научнообразовательных центров," [The government determined the list of grant recipients among research and educational centers], *D-Russia*, June 29, 2020; "Утверждён список получателей грантов среди научно-образовательных центров," [List of grant recipients among research and educational centers approved], Russian Government, June 27, 2020, http://government.ru/news/39940/.

[163] "Правительство определило список получателей грантов среди научнообразовательных центров"; "Утверждён список получателей грантов среди научно-образовательных центров."

[164] "Samara REC claims world-class status," [Самарский НОЦ претендует на статус мирового уровня], Regnum, Oct. 30, 2020, https://regnum.ru/news/innovatio/3103265.html.

[165] "В МАРГУ будут готовить специалистов в области цифровых технологий," [MarSU will train specialists in the field of information technology], Potok Media, June 29, 2020, https://potokmedia.ru/news/198650/v-margu-budut-gotovit-specialistov-v-oblasti-cifrovyhtehnologij/; "Representatives of VTB's Data Science team speak about the professions of the future and explain why their banks need graduates from RANEPA," [Представители Data Sciencекоманды ВТБ рассказали о профессиях будущего и объяснили, почему их банкам нужны выпускники РАНХиГС], AI News, July 27, 2020, https://ai-

include a new joint robotics education program between Perm National Research Polytechnic University (PNRPU), St. Petersburg State Electrotechnical University (LETI), and the Kazan Aviation Institute.[166] Often, the federal government subsidizes the creation of these programs through direct funding or by paying the tuition for students.

Addressing Russia's underlying IT challenges

In addition to its efforts to develop world-class universities, the Kremlin has instituted a number of initiatives and training programs to develop the capacity of its IT specialists. In government reports and decrees, there is a sense of urgency in ensuring that a sufficiently large and capable workforce is trained to meet the needs of the future. According to a recent Ministry of Education report, by 2022, every fifth employee who is engaged in "non-standard tasks" will use artificial intelligence.[167] Therefore, a growing number of Russians must develop competencies in how to use and interact with AI, as well as how to develop AI-based tools. These training initiatives are organized, executed, and funded by a number of bodies including the National Technological Initiative, the Agency for Strategic Initiatives (ASI), the "Russia—Country of Opportunity" nonprofit, the Innovation Promotion Fund, the Presidential Grant Foundation, and the Young Professionals Union.

news.ru/2020/07/predstaviteli_data_science_komandy_vtb_rasskazali_o_professiyah_budushego_i.html; "University of London Teaching," RANEPA, https://www.ranepa.ru/eng/center-london/#data.

[166] "Perm Politekh is continuing to accept students to the first in Russia network online MA on robotics," [Пермский политех продолжает прием на первую в России сетевую онлайн магистратуру по робототехнике], PSTU, July 20, 2020, https://pstu.ru/news/2020/05/15/10556/.

[167] "The basics of artificial intelligence will be taught in elementary school."

Figure 14. Russian President Putin, Moscow AI Conference 2018

Source: Russian President Putin speaking at an AI conference in Moscow, 2019, Presidential Administration of Russia, http://en.kremlin.ru/events/president/news/62003.

Programs that target Russian youth

Supplemental training programs that can be used in the classroom are widely implemented in curricula across Russia. One such example is "Digit Lesson" (which can also be translated as "Numbers Lesson"), a project started in 2018 organized by the Ministry of Education, the Ministry of Digital Development, Communications and Mass Media of Russia, and the nonprofit organization (ANO) "Digital Economy."[168] The courses are presented in the form of online games targeted for three student age groups: those in elementary school, middle school, and high school. In 2020-2021, the coursework includes lessons on AI and machine learning (partnered with Sber), neural networks and communications, social networks (partnered with

[168] "Принципы работы искусственного интеллекта изучат школьники Карачаево-Черкесии на 'Уроке цифры'," [The principles of artificial intelligence will be studied by schoolchildren of Karachay-Cherkessia at the "Digital Lesson"], Interfax Russia, Sept. 11, 2020, https://www.interfax-russia.ru/south-and-north-caucasus/news/principy-rabotyiskusstvennogo-intellekta-izuchat-shkolniki-karachaevo-cherkesii-na-uroke-cifry; "всероссийский образовательный проект в сфере цифровой экономики," [All-Russian educational project in the field of digital economy], УРОК ЦИФРЫ, https://xn--h1adlhdnlo2c.xn--p1ai/.

@Mail.ru), cybersecurity (partnered with Kaspersky Labs), unmanned vehicles (partnered with Yandex), and digital production (partnered with 1C Programmers' Club). At the end of each course, students receive a certificate. The program is implemented in all 85 districts of Russia and was recently made available in 100 countries with Russian-speaking students. Additionally, the Ministry of Education recently decided to implement artificial intelligence training more regularly as a part of the computer science curriculum, with coursework to be introduced on a trial basis as soon as September 2021.[169]

In addition to classes, a variety of extracurricular training activities are available to students and schoolchildren. One such program, Robotrack, has developed robotics and technology clubs for children since 2015, as part of the National Technological Initiative.[170] According to its website, Robotrack offers training courses of varying degrees of advancement for children ages 4-6, 7-10, 11-14, and 15-17. In total, there are 104 clubs in more than 40 cities in Russia and seven cities in Kazakhstan.[171]

Outside of the classroom, there are a wide variety of AI events geared towards schoolchildren, typically in the format of an initial training program followed by some sort of competition. One notable event is the WorldSkills competition, which is open to students ages 16-22 (with a Junior WorldSkills version for those ages 12-16).[172] The event consists of 130 competencies focused on seven skill sectors: building and construction technology, information and communication technology, manufacturing and engineering technology, social and personal services, transportation and logistics, education, and creative arts and fashion. The information and communication technology section features competencies including VR/AR development, neural network design, machine learning and big data, cybersecurity, blockchain technology, and application development.[173] The manufacturing and engineering technology section features competencies including mobile robotics, the internet of things, and space systems engineering.[174] More than 2,800 contestants have participated. Another such event is the NTI Circle Movement's Junior Olympiad, an engineering competition with five technological focus

[169] "The basics of artificial intelligence will be taught in elementary school."

[170] "About us."

[171] Ibid.

[172] "WorldSkills Russia 2020," https://worldskills.ru/final2020.

[173] Ibid.

[174] Ibid.

areas: virtual, robotic, space, habitat, and neurotechnologies. More than 28,000 students in grades 5-7 have participated.[175]

Programs for young professionals and adults

Competitions geared towards more experienced rising and established AI experts have a dual function of honing participants' skills while also identifying viable digital solutions to real-world problems. Such events are typically partially funded by corporate partners who benefit from the digital solutions designed by participants. In many cases, prizes for these competitions include internships or contracts with the corporate sponsors. Frequent sponsors of these events include Rosatom, Rostech, Yandex, Sber, Rostelecom, Gazprom Neft, MTS, and Megafon. Larger events are held in stages: first, widely across Russia in qualifying regional blocks, then working up to smaller rounds of finals.

Such events include RuCode's intensive AI and algorithmic programming training festivals, which were held three times in 2020 and drew more than 20,000 participants.[176] The events are free and available to anyone—participants ranged from students to field experts. The first part of these online festivals consists of free training courses including: "Quick Start to Recreational Programming," "Quick Start to the C++ Programming Language," and "Quick Start to Artificial Intelligence." Following the educational stage of the program, participants present projects that solve real modern-day problems using AI, and compete in an algorithmic programming championship.[177] Another large competition is the "Digital Breakthrough" event, where contestants design digital solutions for problems in the fields of education, infrastructure and communications, digitalization of production, and big data and AI. In 2020, industry partners included Rostelecom, the Federal Tax Service, Rosstat, PJSC Gazprom Neft, Rosatom State Corporation, MTS, and Megafon. According to the Digital Breakthrough website, there were 94,333 registrations, and more than 4,700 digital assistants created. The total prize fund for the competition reached 50 million rubles, with an additional grant fund of 100 million

[175] "About the olympiad," [ОБ ОЛИМПИАДЕ], NTI Circle Movement Olympiad.Junior, [Олимпиада Кружкового движения НТИ.Junior], accessed Jan. 7, 2021, https://junior.nti-contest.ru/; Ksenia Kolesnikova, "The winners of the Olympiad of the NTI Circle Movement were announced," [Названы победители олимпиады Кружкового движения НТИ.Junior], *Rossiiskaya Gazeta*, Dec. 22, 2020, https://rg.ru/2020/12/22/nazvany-pobediteliolimpiady-kruzhkovogo-dvizheniia-ntijunior.html.

[176] "ABOUT THE FESTIVAL," [О ФЕСТИВАЛЕ], RuCode, accessed Jan. 31, 2021, https://rucode.net/.

[177] Ibid.

rubles, and more than 2,000 winners. Prizes for the grand finals include job offers, contracts, and project investments.[178]

Russia also hosts a number of educational international conferences about AI. The largest of these was Sber's AI Journey conference, which drew over 9,000 participants in 2019 and was streamed more than 1 million times in 2020.[179] In 2020, the three-day conference focused on the topics of science, society, and regions of Russia. Preceding the conference was a three-part online competition testing computer vision, natural language processing, and knowledge graph skill sets.[180] These were followed by an "AI Journey Junior," conference which was held for middle and high school students. A more expansive list of Russian AI conferences is included in Appendix B of this report.

One notable initiative designed to train a wide range of people—including students, entrepreneurs, chief data officers (CDOs), and technology leader—is University 20.35.[181] Founded by the National Technological Initiative, University 20.35 offers intensive 10 to 15 day courses as well as tailored training for up to three months, where a personalized track for each participant is created based on his or her experience and desired end goal.[182]

On occasion, there are also free training programs for the average Russian adult who has not yet reached retirement age. In 2020, after a successful trial version was implemented the previous year, a new program within the "Human Resources for the Digital Economy" federal project was launched, which allows Russians in 48 regions to take virtual training courses. After applying, participants can enroll in up to 72 academic-hours of coursework in any one of 22 competencies, including AI, cybersecurity and data protection, programming and creation of IT products, digital marketing, and 3D manufacturing. Participants receive a certificate upon completing the course. The program is free and funded by the federal budget.[183]

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[178] "The largest hackathons in Russia! — The Final," [Самые масштабные хакатоны России! -- Финал], Digital Breakthrough, [Цифровом прорыве], accessed Nov. 30, 2020, https://leadersofdigital.ru/#topics.

[179] "'Sberbank' will hold an online conference for schoolchildren on artificial intelligence," ["Сбер" проведет онлайн-конференцию для школьников по искусственному интеллекту], TASS, Oct. 26, 2020, https://tass.ru/ekonomika/9821223; "About," Artificial Intelligence Journey, accessed Nov. 30, 2020, https://ai-journey.ru/en/about

[180] "About"; "'Sberbank' will hold an online conference for schoolchildren on artificial intelligence."

[181] "RVC," https://www.rvc.ru/en/eco/education/2035_university/. Other projects of the National Technological Initiative can be found here: https://nti2035.ru/talents/circles.

[182] Ibid.

[183] "Residents of 48 regions of Russia will receive personal digital certificates," [Персональные цифровые сертификаты получат жители 48 регионов России], Izvestiya, Oct. 15, 2020, https://iz.ru/1074361/2020-10-

Impact and outlook

Challenges such as workforce shortages, brain drain, geography, historically low government investment, and complex bureaucratic roadblocks pose obstacles to Russia's desire to match or surpass other global leaders in artificial intelligence. In light of these challenges, the Kremlin has instituted a number of strategic plans to increase its global standing in the sphere of artificial intelligence—of which training initiatives are no small part. Educating youth, creating world-class centers of tech education, and building and retaining a capacity of highly-skilled tech experts are all prioritized in recent government led efforts to develop AI. For example, according to the December 2019 Passport of the AI Federal Project, Russia should double the size of the AI community by 2024.[184] Additionally, it should increase the number of AI specialists trained in higher education from 650 per year (as of December 31, 2019) to 4,241 per year by 2024.

Outlook for Russia's AI

Facing such obstacles, Russia has limited prospects of realizing a commercial or academic AI sector on par with the United States or China in the near to medium term.

Russia may seem overly ambitious in attempting to reach these and similar goals put forth by the Kremlin in such compressed timeframes. However, Russia is demonstrating a clear prioritization of developing its capacity to research artificial intelligence and implement AI-based digital solutions, warranting increased attention from the West.

Should Russia be successful in implementing these reforms, assuming continued investment over time, its global standing and capacity to research and produce systems utilizing AI will incrementally rise, opening the door for potential competition with other leading AI research countries. Should Russia fail to implement these reforms, it will continue to struggle in global rankings, in retaining domestic talent and attracting foreign talent, and in reaching digitization.

15/personalnye-tcifrovye-sertifikaty-poluchat-zhiteli-48-regionov-rossii; "Residents of 48 regions of Russia will receive personal digital certificates," [Персональные цифровые сертификаты получат жители 48 регионов России], CNews, Oct. 15, 2020, https://cnews.ru/link/n516959; "WHAT IS UNIVERSITY 20.35," 2035, https://2035.university/en/.

[184] Petrella, Miller, and Cooper, *Russia's Artificial Intelligence Strategy*.

Private Sector AI in Russia

Overview

Technological developments and growth in the Russian AI private market are driven primarily by state-backed R&D efforts, although private demand for AI solutions is increasing. In general, the private AI market has been dominated by a focus on exploiting advancements in natural language processing (NLP) and other forms of automated data analysis, although interest in computer vision and other types of recognition capabilities is growing quickly.[185] The most important AI technologies that have gained private market attention outside of broad automated NLP applications for financial and retail purposes are in facial recognition software, facility and perimeter security, driverless cargo transportation and agribusiness, public transportation control systems and railway network integration, automated platforms for training neural nets and other AI protocols, and automated medical analysis.

Most R&D efforts remain supported or hosted directly by government institutions and programs, but a large part of the demand-side motivation for private AI research comes from the Russian state as well, most notably in public safety and transportation, as well as in state-dominated fields such as healthcare. Many primary investors are state-owned or –associated banks and other financial corporations. The Russian state is keenly interested in both increasing private investment and accessing international IT markets for Russian products. In this way, the state is strongly incentivizing startup development and collaborative initiatives at both the R&D stage as well as getting products to market.[186]

The national strategy "Digital Economy"—a subset of the renewed national programs investment strategy package—has been a source of critical support, funding, and impetus for further AI developments in the country.[187] The strategy has promoted a series of major digital

[185] Almanac Artificial Intelligence, *"AI Index 2019 – Russia," Almanac Analytical Report, No. 4*, (2019), https://aireport.ru/en/results2019.

[186] Yaroslav Lissovolik, "National Projects: Russia's New Development Paradigm," Valdai Club, Feb. 20, 2020, https://valdaiclub.com/a/highlights/national-projects-russia-s-new-development/.

[187] Decree of the President of the Russian Federation No. 490, *On the Development of Artificial Intelligence in the Russian Federation*, October 10, 2019, http://www.garant.ru/products/ipo/prime/doc/72738946/; Petrella, Miller, and Cooper, *Russia's Artificial Intelligence Strategy*.

hubs across the country, most importantly the Skolkovo Foundation, and has spurred state demand for AI-based digitalization solutions for federal and regional bureaucracies.[188]

Figure 15. Skolkovo Innovation Cluster

Source: Andrey Filippov, "Skolkovo Technology Park," Flickr, Aug. 31, 2017, https://www.flickr.com/photos/andrey_filippov/26858057359/.

Under this new programmatic and funding aegis, a great deal of resources has been allocated towards easing barriers to entry for new private AI actors, helping set up support infrastructure, creating registries of domestic AI firms, and making other efforts to reduce problems with information, collaboration, and scaling-up within the private sector.

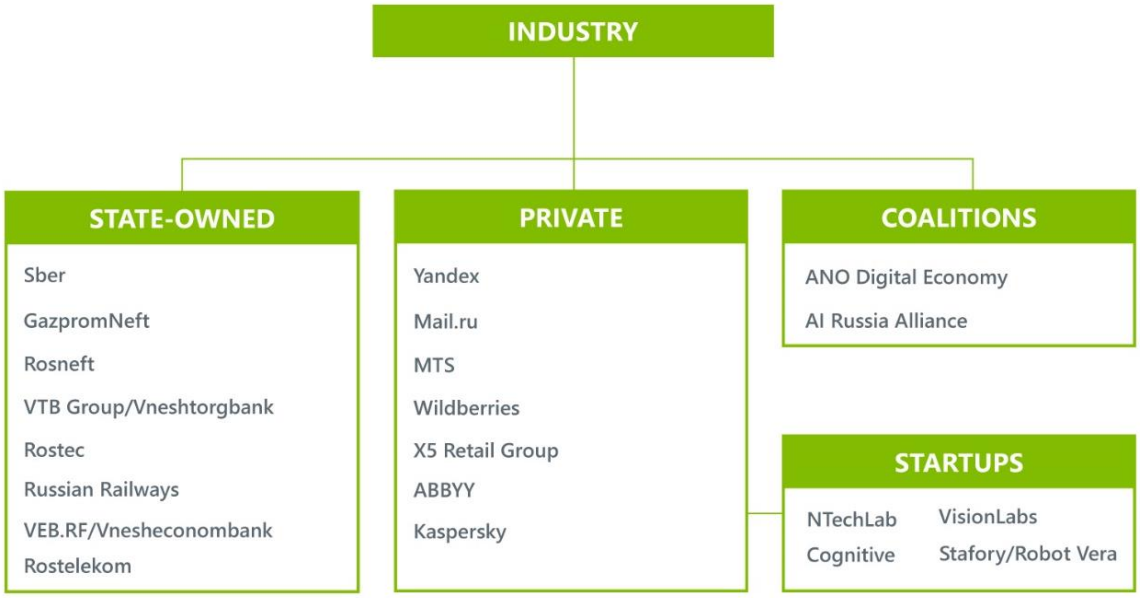
Although the Russian economy remains subject to major countervailing pressures of state corruption and resource misallocation, trends towards further growth and development are clear. The national-level focus on AI as a key sector of growth, the concentration of considerable political will, and wide state and business interests in integrating the domestic market with export and collaboration opportunities abroad means that private actors have found relatively more benign conditions than other sectors of the Russian economy.

[188] Nikolai Markotkin and Elena Chernenko, "Developing Artificial Intelligence in Russia: Objectives and Reality," Carnegie Moscow Center, May 8, 2020, https://carnegie.ru/commentary/82422.

Structure

The vast majority of Russian AI research and development takes place within state-owned firms, with the country's largest technology company Yandex somewhat sidelined in this sphere due to tensions with the government.[189] Thus, unlike in the US and China, where public-private collaboration has yielded great successes, the Russian government has preferred to keep AI development close, primarily entrusting these efforts to state-backed companies.

Figure 16. Major industry players in the Russia AI ecosystem



Source: CNA.

Most R&D in the AI field comes from government sources and is predominantly funneled through the Skolkovo Foundation and its subsidiaries, associated organizations, and grantee institutions. Planned as Russia's new "Silicon Valley" under President Medvedev, it has

[189] Evan Gershkovich, "The Uneasy Coexistence of Yandex and the Kremlin," *The Technology Review*, Aug. 19, 2020, https://www.technologyreview.com/2020/08/19/1006438/yandex-putin-arkady-volozh-kremlin.

reoriented itself as a major institutional site for funding and hosting technology start-ups, a physical plant for young developers, and a coordinating entity providing support for integrating startups into wider international markets.[190]

Beyond providing coordinated funding streams and grants, over the course of 2020 Skolkovo has hosted or sponsored several professional and amateur competitions, trade shows, conferences, and other collaborative and competitive fora, all with an eye to supporting Russian domestic AI startups and bridging gaps between R&D and market applications.[191] Given the relative size of the Russian AI field to Western and Chinese competitors, these venues have been particularly important for incentivizing innovation and collaboration, publicizing research and new products, and facilitating connections with better-financed programs abroad.

The Skolkovo network is not limited to reliance on state funding streams and programs, however, private sector investment is now also channeled through Skolkovo. This is primarily due to its coordinating role and given the institution's importance in organizing conferences, friendly competitions, and hosting basic research centers such as AI Journey.[192] The increasing importance of internet-based platforms to aid in testing and training AI algorithms also keeps Skolkovo at the center of AI development infrastructure in Russia. Many startups and new research platforms rely on rentable or sharable processing infrastructure, domestic versions of which are often provided by or hosted through Skolkovo, such as the new Christofari supercomputer developed jointly by Sber and Nvidia.[193]

In addition to Skolkovo, significant research hubs exist in clusters at state universities, especially MIPT, the Higher School of Economics (HSE), and the Far Eastern Federal University (FEFU). These hubs take significant state support but are also used extensively by private

[190] Igor Drozdov, "The Skolkovo Foundation: fostering innovation and entrepreneurship in the Russian Federation," *WIPO Magazine*, Sept. 2020, https://www.wipo.int/wipo_magazine/en/2020/03/article_0007.html; "What is Skolkovo?," Skolkovo Foundation, https://old.sk.ru/foundation/about/.

[191] "Intensive on the preparation of projects and startups in the field of AI will be held in Moscow," Content-Review.com, Oct. 23, 2020, http://www.content-review.com/articles/51402/; "The first platform for collecting data for research was presented at the 'Archipelago 20.35'," TASSNAUKA, Nov. 16, 2020, https://nauka.tass.ru/nauka/10018715.

[192] "Artificial Intelligence Journey," AI Journey, https://ai-journey.ru/en#:~:text=AI%20Journey%20is%20a%20series,in%20AI%20development%20and%20application.

[193] "Sberbank and SberCloud open their supercomputer cloud to all developers," CNews, Dec. 4, 2020, https://www.cnews.ru/news/top/2020-12-04_sber_otkryl_svoe_superkompyuternoe; "Sberbank plans to open Russia's first AI institute," TASS, Dec. 3, 2020, https://tass.com/economy/1230907.

market entities and investors. Close collaboration with state-owned firms such as Sber, Gazprombank, Rosatom, and Rostec have also helped encourage these increasingly endowed hubs of academic and government R&D to engage directly with corporate and consumer market priorities.[194]

Sber, as noted ealier, has been a pioneering actor in the AI development environment in Russia. It has extensive state and private business connections, as well as growing involvement in coordinating academic research, private investment, and international interest through joint projects.[195] The company has long invested in technology in order to diversify its offerings and increase its banking and financial efficiency. It recognized early that AI could prove beneficial for these purposes and invested in the development of related technologies (including data processing) for its own usage.[196]

Sber has also been at the forefront of the development of Russia's AI ecosystem broadly, leading efforts for the government in this space.[197] As discussed previously, the government assigned Sber a particularly large role in developing the current AI regulatory framework.[198] Although once a feeble, heavily bureaucratic organization from the Soviet era, Sber is now seen in Russia as an example of how innovation can lead to greater efficiency, and the loyalty of its CEO, German Gref, to the Kremlin has likely contributed to Sber earning the lead role in Russian AI development.[199]

Despite obvious equities with AI in the military sector, Rostec, the state-owned defense behemoth, has taken a less prominent role in AI development from the private market perspective. Under the Digital Economy Program, Rostec has responsibility for a number of roadmaps, including 5G, blockchain, and the 'Internet of Things,' but does not have an official

[194] *Russia's Defense Industry and Political Economy: Russia's 'Digital Economy Program' and the Kremlin's Information Security Agenda*, FPRI Eurasia Program, Sept. 2020.

[195] See discussions in "AI in Russia" Issue #17 (pp. 20-21) among others.

[196] Shura Collinson, "Sberbank opens Russia's biggest data-processing centre at Skolkovo," Sberbank.ru, October 27, 2017, https://www.sberbank.ru/en/press_center/all/article?newsID=cd64e0d9-0f03-47dc-82df-6be0a22997bb&blockID=1539&regionID=77&lang=en.

[197] Julien Nocetti, *The Outsider: Russia in the Race for Artificial Intelligence*, French Institute of International Relations, 2020, https://www.ifri.org/en/publications/etudes-de-lifri/russieneireports/outsider-russia-race-artificial-intelligence.

[198] "Sberbank explained to the state how to spend 120 billion on artificial intelligence."

[199] Petrella, Miller, and Cooper, *Russia's Artificial Intelligence Strategy*.

role in AI development.[200] The organization is working on a number of AI technologies, including facial recognition in the civilian sector, and integrating AI into military systems, such as electronic warfare systems, but does not occupy a prominent place in the creation of the state's official AI strategy.[201]

Similarly, state-owned energy companies, such as Gazprom Neft and Lukoil, are working on developing and integrating AI relevant to the oil and gas industry, though they do not themselves have a prominent place in Russia's overall AI development plans.[202] Rather, the government has allowed these companies to develop AI technologies to assist in production and which will, by extension, allow Russia to compete more effectively in world markets. For example, Gazprom Neft has hosted an "Electronic Asset Development" initiative since 2012, which has supported in-house software development to exploit machine learning techniques to assess the most efficient ways to develop new and mature oil fields.[203] Western imposition of sanctions on these companies, though, have hampered these efforts to some degree by making securing international partnerships difficult.[204] This makes the domestic development of the AI industry in both public and private sectors all the more important for major state corporations especially.

MIPT estimated the size of the Russian AI market as being around 240 billion rubles (3.4 billion USD) and around 400 companies using AI technologies, noting that based on those estimates, "the market in Russia is by 2 orders smaller than the global market. However, Russia has strong companies that are leaders in their segments on the world level." They further estimated 198 startups and a total of 59 venture deals, suggesting that "by the total number of startups, Russia is dramatically behind the rest of the world. But if you take account of the fact that the Russian

[200] "The Russian government approved a roadmap for 5G development"; "The internet of unnecessary things"; "Money for a figure."

[201] Felix Light, "Russia is Building One of the World's Largest Facial Recognition Networks," *Moscow Times*, Nov. 12, 2019, https://www.themoscowtimes.com/2019/11/12/russia-building-one-of-worlds-largestfacial-recognition-networks-a68139; "Rostec Develops 4th Generation Combat Gear," Rostec.ru, Jan. 29, 2021, https://rostec.ru/en/news/rostec-develops-4th-generation-combat-gear/; "Infantry: Ratnik, Sotnik And Invisibility Capes," StrategyPage.com, Aug. 9, 2020, https://www.strategypage.com/htmw/htinf/20200809.aspx.

[202] "Artificial intelligence in oil prospecting," *Invest Foresight*, May 14, 2019, https://investforesight.com/artificial-intelligence-in-oil-prospecting/.

[203] "How artificial intelligence is finding fields," *Gazprom Neft Press*, Oct. 31, 2018, https://www.gazprom-neft.com/press-center/lib/2152397/.

[204] Konaev and Dunham, *Russian AI Research 2010 to 2018: Topics, Trends, and Institutions*; "Shell pulls out from proposed Mertoyakhaneftegaz JV with Gazprom Neft," NS Energy, Apr. 14, 2020, https://www.nsenergybusiness.com/news/shell-exit-meretoyakhaneftegaz-jv/.

economy is ≈2% of the world economy, the number of startups also corresponds to ≈2% of the world number of startups in the field of AI in the order of magnitude, but with only 0.3% in investments."[205] The private AI ecosystem is thus surprisingly vigorous, given its small share of total AI technology development globally and the challenges of the Russian economy.

Private investment in Russian AI development remains low, relative to established investment ecosystems in Europe, the United States, and East Asia. At the same time, it is growing rapidly from this comparatively low level. According to IDC, Russian private investment in AI totaled $172.5 million in 2019, with expected growth around 23 percent.[206] Most private investment remains focused on servers, IT services, and AI applications, especially in financial and retail trade sectors.[207]

Major private tech companies find themselves largely left out of official government efforts to grow Russia's AI sector. While Yandex has developed some AI products, including a Siri-like virtual assistant called 'Alice' that utilizes AI algorithms, the organization as a whole has taken a backseat to Sber in the creation of Russia's AI ecosystem. The Russian government views Yandex with suspicion, due to its private ownership, and Putin has previously suggested that Americans had a hand in forming the company. In 2019, Yandex entered a deal that restructured the company and gave veto power over major decisions to a Kremlin-linked group, a move likely to raise government oversight in the company and allow the Kremlin to keep close a major Russian technology company.[208]

Despite this somewhat fraught relationship, Yandex, alongside other major companies such as Mail.ru, Gazprom Neft, MTS, RFDI, have formed the "AI-Russia Alliance" that has successfully provided feedback for government initiatives. Other large tech and tech-adjacent companies in terms of revenue in Russia include Croc, Kaspersky Lab, Avito, and Yota.

The relative dearth of private business involvement in Russian AI development could have a severe impact on innovation, as state-owned firms generally lack the competitive pressures typically necessary to result in rapid breakthroughs. Entities associated with the government are also subject to the whims of politics, as seen in the arrest of Alexander Povalko, head of the

[205] *Artificial Intelligence Almanac: AI Index 2019 - Russia*.

[206] Anna Ustinova, "Russian companies have invested more than $ 170 million in AI," Comnews, https://www.comnews.ru/content/205551/2020-04-13/2020-w16/rossiyskie-kompanii-investirovali-ii-bolshe-170-mln.

[207] Andrea Minonne, David Schubmehl, and Takashi Manabe, "Worldwide Artificial Intelligence Spending Guide," International Data Corporation, 2020, https://www.idc.com/getdoc.jsp?containerId=IDC_P33198.

[208] Max Seddon, "Yandex agrees restructuring with Kremlin," *Financial Times*, Nov. 18, 2019, https://www.ft.com/content/999e3ca6-09db-11ea-bb52-34c8d9dc6d84.

state-backed Russian Venture Company, in June 2020 on fraud charges. This type of inherent political risk could discourage potential innovators from joining the field and improving the development process. Therefore the fact that state-owned firms have primary responsibility for AI development and implementation certainly contribute to Russian efforts trailing behind those of other major states in the future.

Processes

Startup growth in Russia has increased considerably in the last few years, and this is directly associated with the maturation of a coherent state policy on AI R&D and private market support. Not only are grant and other funding sources better developed than in prior years, but a great amount has been invested in competitions, conferences, and other research-to-product pipelines that have brought about both efficiency and innovation.[209]

Although these sources are certainly still limited, given the continuing weakness of private venture capital alternatives, Russian analysts note that "as a driver of digital change [startups] are more typical of the advanced regions."[210] Some argue that the promotion of public-private hubs for investment and development may be inefficient, and while it certainly leads to an unequal distribution of startup concentrations regionally, it has the potential to create cores of competence that can be built upon as the broader AI infrastructural ecosystem further matures.[211] Furthermore, given the tendency for cluster patterns in the tech industry generally, it is unclear whether inefficiency losses are not counterbalanced by concentrated human and infrastructural capital in the short to medium term, especially when seeking to arrest Russia's problems of 'brain drain.'[212]

More importantly, major domestic and international companies now regularly attend sponsored showcases of new AI technology, which in turn create new opportunities for product development and further identification of actual market needs. This increase in

[209] Note that fairly small private venture capital organizations are only starting to emerge, see for example: "Launch of the closed private venture capital club Digital Disrupt," TA Adviser, Dec. 3, 2020, https://www.tadviser.ru/index.php/%D0%9A%D0%BE%D0%BC%D0%BF%D0%B0%D0%BD%D0%B8%D1%8F:Digital_Disrupt.

[210] Gaidar Center, *Russian Economy in 2019 Trends and Outlooks*, p. 480.

[211] "Digitalize This: Will the National Plan Help Create its Own Silicon Valley in Russia?"

[212] Robert Kobza, "Russia's People Problem," *Georgetown Security Studies Review*, Apr. 6, 2020, https://georgetownsecuritystudiesreview.org/2020/04/06/russias-people-problem/.

contacts with international companies, as well as more coherent assessments of the actual state of the private market domestically, is likely to provide considerable benefits over time by solving coordination problems among institutional investors and improving the investment climate overall.

This has been sped up by the exogenous shock of the COVID-19 crisis. Russian AI researchers and technology entrepreneurs have been quick to find innovative uses for AI. These have included new public safety features using facial recognition software, which are now integrated into the dense network of security cameras in major Russian cities, as well as the use of cutting-edge neural net imagery algorithms to use on medical data—especially lung images, which have been found to aid in COVID-19 diagnostics and prediction.[213] Moscow itself now hosts over 100,000 high-resolution CCTV surveillance cameras in a sophisticated network that allows for easy integration to new AI software.[214]

Facial recognition technology has been a particular focus for all actors within the Russian AI ecosystem, from government tenders to AI R&D programs and developers to private market companies seeking to bring products to market. A technology of relevance for surveillance, controlling access to infrastructure and services, and for home devices as well, facial recognition has many applications that are incentivized by considerable government and private demand. From the automated access to the Moscow Metro to COVID lockdown procedures, facial recognition is likely to be a major source of continued innovation.[215]

Integration into already-existing CCTV regimes in Moscow and other major Russian cities has been a comparative success in Russia's COVID response, with clear security implications

[213] "Moscow will expand its experiment on the implementation of artificial intelligence in medicine," Lenta.ru, Nov. 24, 2020, https://lenta.ru/news/2020/11/24/med/; "Moscow authorities decided to expand the number of medical applications of artificial intelligence to 10," D-Russia, Nov. 26, 2020, https://d-russia.ru/vlasti-moskvy-reshili-rasshirit-do-10-chislo-medicinskih-primenenij-ii.html; "Artificial intelligence helps check 500,000 CT scans for COVID-19 in Moscow," TASS, Nov. 25, 2020, https://tass.com/society/1227967.

[214] Sam Ball, "100,000 cameras: Moscow uses facial recognition to enforce quarantine," *France 24*, Mar. 24, 2020, https://www.france24.com/en/20200324-100-000-cameras-moscow-uses-facial-recognition-to-enforce-quarantine.

[215] See for example, Jake Rudnitsky, "Moscow Metro to Let Riders Pay With a Glance by Year-End," *Bloomberg*, Mar. 3, 2021, https://www.bloomberg.com/news/articles/2021-03-03/moscow-metro-to-let-riders-pay-with-a-glance-by-year-end; Andrea Palasciano, "Russia ramps up facial recognition systems," *Tech Xplore*, Mar. 10, 2021, https://techxplore.com/news/2021-03-russia-ramps-facial-recognition.html.

beyond the pandemic.[216] The Russian government is not shy about the easy dual-purpose nature of including advanced facial recognition AI algorithms in already extensive surveillance infrastructure. It should be expected that the current system supplied by the Russian startup NTechLab to Moscow City – initially built to aid police investigations and now altered to enforce quarantine lockdowns – will be brought to bear for counterespionage and domestic political surveillance, a development long expected by analysts.[217] New deployments of facial recognition systems for use against protest movements advocating for the release of opposition leader Alexei Navalny, for example, have already been reported on in international media.[218]

Promoting processes of digitalization and encouraging new private entrepreneurship have the benefit of being directly the aim of major state programs. State support through the "Digital Economy" framework, including grants to 20 million rubles for startups and up to 300 million rubles for large initiatives aimed at digitalizing projects, have been well placed to ease problems in investment and development infrastructure, although problems continue to be flagged because of lags in regional-level spending, even given the availability of federal funds.[219] As noted above, Moscow city government especially has pioneered many forms of AI integration into state procedures and internal digitalization projects, which has spurred development of new products by private market startups as well. In this way, Moscow is an important factor in increased aggregate demand for AI products, which will likely continue to result in the greatest new private market advances in imagery and NLP.

[216] Patrick Reevell, "How Russia is using facial recognition to police its coronavirus lockdown," *ABC News*, Apr. 30, 2020, https://abcnews.go.com/International/russia-facial-recognition-police-coronavirus-lockdown/story?id=70299736.

[217] Jenna McLaughlin and Zach Dorfman, "'Shattered': Inside the secret battle to save America's undercover spies in the digital age," Dec. 30, 2019, https://news.yahoo.com/shattered-inside-the-secret-battle-to-save-americas-undercover-spies-in-the-digital-age-100029026.html.

[218] Gleb Stolyarov; Gabrielle Tétrault-Farber, "'Face control': Russian police go digital against protesters," *Reuters*, Feb. 11, 2021, https://www.reuters.com/article/us-russia-politics-navalny-tech/face-control-russian-police-go-digital-against-protesters-idUSKBN2AB1U2.

[219] Vladimir Kozlov, "Russia's national program for digital economy stumbles," *BNE Intellinews*, Sept. 4, 2020, https://www.intellinews.com/russia-s-national-program-for-digital-economy-stumbles-188718/.

Key technologies and initiatives

There has been particularly strong growth in the fields of commercial banking, retail, and industries that use AI natural language processing to analyze large amounts of unstructured data; this is especially the case for procurement, accounting, HR, and customer support services.[220]

For example, according to a visualization "map" of the Russian AI ecosystem drafted by MIPT (the interactive website can be found at http://airussia.online/#titul), there are 420 total companies as of February 2021. The number of companies by clusters of their effort are as follows, although note that there is some double counting of larger companies, such as Yandex, which undertakes projects in several different areas such as NLP and data analysis):[221]

Table 2. Clusters of companies by AI research

Area of research	Number of companies
Computer vision	63
Business Intelligence and Analytics	63
Natural Language Processing	48
Healthcare	48
Data analysis	46
Advertising	27
Legaltech	26
Financial technologies	18
Robotics	16
Cyber security	14
Retail	13
Industry	11
Internet of Things	10
Speech recognition	10
Logistics	7

Source: This data is from http://airussia.online/#titul, accessed Feb. 23, 2021.

[220] "In 2021, the Russian AI market will return to double-digit growth rates," CRN, Sept. 2, 2020, https://www.crn.ru/news/detail.php?ID=147880; "Artificial Intelligence Market Grows Amid Pandemic," Volbusiness.ru, Aug. 13, 2020, http://www.volbusiness.ru/news-page/13045.

[221] This data is from http://airussia.online/#titul, accessed Feb. 23, 2021.

Many key technologies involve the use of large volumes of imagery data for either automated processing or directing machines. In the former case, this has been of particular relevance to the "Smart City" network of surveillance that has been deployed in Moscow and is being promoted in other regions.[222] This network allows for increasing automation of urban traffic patterns, public transport access, perimeter security, and a variety of civic services such as utilities payments. Although these are state-funded projects, they are supplied by private vendors who then also use the AI technology for other private market products, such as domestic virtual assistant technologies.[223] Interestingly, the dominance of areas related to computer vision, pattern recognition, and natural language processing closely tracks with the relative AI publications produced by Russian researchers, as reported by Konaev and Dunham.[224]

Many private sector uses for AI are in the field of self-driving vehicles, which are being used to direct transport patterns at freight yards; in public transportation networks; and for new advances in self-directed agricultural combines and harvesters which are starting to compete on the international agribusiness market.[225] For example, the company Cognitive Pilot, a joint venture between Sber and Cognitive Technologies, is one example of a successful marketer of unmanned systems in the agriculture field. Sber, Yandex, and others are involved in self-driving vehicles as well. In addition, there are numerous companies, large and small, involved in the development of drones of various sizes for government, industrial, and commercial applications.

As noted above, there has been a massive growth of facial recognition and image recognition solutions, especially in light of the need to manage medical data during the COVID pandemic, and multiple companies and startups working in the medical image analysis space. To that end, a great deal of work has been done on automated computer vision and imagery, recognition software, and machine learning-assisted big data analysis to deal with the vast quantities of image and video data produced by existing camera infrastructure.

The Russian government is more holistic about its key focuses in supporting private AI development, even if the ecosystem is currently trending most promisingly towards unmanned

[222] Maria Stanovaya, *RPolitik Analytical Report, Bulletin No. 1 (65)*, RPolitik, Jan. 12, 2021, pp. 18-19. See also "AI in Russia" report #9 (pp. 4-5) on the "Safe City" programs that are spurring video surveillance product development in particular.

[223] See discussions in "AI in Russia" reports #14 (pp.8-9), #15 (p. 9) and #19 (p. 12) among others.

[224] Konaev and Dunham, *Russian AI Research 2010 to 2018: Topics, Trends, and Institutions,* p. 8.

[225] See discussion on AI in Russian agriculture in "AI in Russia" report #15 (pp. 17-18).

vehicles, image recognition and analysis, and business processes digitalization. The 2020 AI federal project outlines the following priorities for AI development:

- In healthcare, AI could be employed for business processes; digitization, quality improvement, and analytics of data; construction of predictive models to help with diagnostics and forecasting.[226]
- In transport, the goal is AI-enabled tools to create "a unified digital transport and logistics environment (including in terms of ensuring the functioning of the backbone network of transport and logistics centers); introduction of management of transport infrastructure facilities by information systems using biometric data using elements of AI; equipping unmanned vehicles with AI enhanced systems that ensure their use as mobile transport security posts (traffic controllers) on public transport infrastructure."[227]
- In agriculture, the key focus is on data related to soil and specific industries. It includes "crop type classification, crop condition assessment (crop monitoring, damage assessment), yield assessment, display of soil characteristics and types, soil erosion, multispectral images, stereo photography, land imaging in all weather conditions, three-dimensional forest structure, height of the land surface and objects.[228]
- In the fuel and energy industry: "support will be provided for the implementation of AI in industry companies. In particular, artificial intelligence will be used to create a modernized technology for the interpretation of seismic data, a methodology for the integrated interpretation of geographic information system data, a system for modeling resources of oil and gas fields to identify promising objects, geological modeling technology for accounting and automatic updating of geological and physical data, an artificial intelligence module for forecasting, production and movement of petroleum products in the oil industry on the digital platform GIS TEK for oil companies."[229]

In regard to manufacturing, the outline notes that, "AI solutions will also be introduced into the activities of federal executive authorities. In particular, a module of a self-learning system for unstructured text recognition and intelligent classification will be created, which will help

[226] Summary of the AI Federal Project, Aug. 27, 2020, accessed Feb. 22, 2021.

[227] Ibid.

[228] Ibid.

[229] Ibid.

optimize the procedure for providing public services." Furthermore, "Supporting activities include the creation of a competence center for digital transformation of industry, providing aggregation and analysis of industry data, retraining, and replication of best practices and solutions in the field of end-to-end digital technologies and artificial intelligence." [230]

Figure 17. UAV-enabled pipeline maintenance

Source: "Starting from July 2020, ZALA AERO GROUP will begin regular air monitoring of infrastructure facilities of LUKOIL-Komi LLC," Zala Aero Group, Sept. 2020, https://zala-aero.com/en/news/zala-uas-survey-the-arctic-and-antarctic-regions.

Challenges for private sector AI in Russia

Although Russia continues to face considerable negative pressure regarding private businesses' freedom from political interference and maintaining the rule of law in the face of widespread and deep corruption, the AI field has been more insulated from these concerns than other sectors. This is partially because it remains a small, burgeoning field with many startups but few large, rapidly growing, and highly profitable former startups. Another reason

[230] Summary of the AI Federal Project, Aug. 27, 2020, accessed Feb. 22, 2021.

is that, because of the online nature of much of the work, it is relatively easy to do business virtually or in small offices rather than centralized hubs.

This is the case across the post-Soviet space, where digital sectors in Ukraine and Belarus both have been relatively insulated from costs associated with corruption and uneven enforcement, because of the widespread availability of fast internet connections and processing power, the limited need for physical infrastructure or costly brick-and-mortar presence subject to licensing and regulation, and the ability to back up IP and other outputs through foreign servers.[231]

Finally, the Russian state has considerable interest in the field of AI technology as a sphere in which 'catch up' is required for security and economic purposes. It wants to digitalize the Russian bureaucracy for reasons of efficiency and anticorruption, as well as reasons based on economic and foreign competition.[232] This interest has led to considerable state support in the form of the ecosystem of grants, research institutions, universities, and state-backed programs designed to make startup development and product testing simpler and more straightforward.

Although there are considerable doubts about the genuineness and veracity of Russian government statements on corruption, it is undoubtedly true that bureaucratic inertia and inefficiency remain considerable annoyances to regime leadership.[233] Although high-level corruption is an important part of the broader ruling system, petty corruption and bureaucratic slowdowns, especially in relation to technocratic matters of finance or internal processes, is viewed far more dimly.[234] Current Russian Prime Minister Mikhail Mishustin is well-known as a technocratic figure able to balance the needs of a corrupt higher-order

[231] Tetyana Tyshchuk and Andrei Kirilenko, *From Legacy to Digital: Ukraine's Plugged-in Economy*, Voxukraine, https://voxukraine.org/longreads/plugged-in-economy/index-eng.html; Mark Hillary, "What Belarus offers the tech sector," Apr. 4, 2018, https://www.computerweekly.com/opinion/What-Belarus-offers-the-tech-sector.

[232] Lowry A., "Russia's Digital Economy Program: An Effective Strategy for Digital Transformation?," in *The Palgrave Handbook of Digital Russia Studies*, ed. Wijermars M. Gritsenko D., Kopotev M.; Jake Cordell, "New Russian Prime Minister Is No Stranger to Business Community," *Moscow Times*, Jan. 20, 2020, https://www.themoscowtimes.com/2020/01/20/new-russian-prime-minister-is-no-stranger-to-business-community-a6896.

[233] Cheng Chen, "What Is behind Anti-Corruption? A Comparison of Russia and China," *Communist and Post-Communist Studies* 53, no. 4 (2020); Noah Buckley, *Corruption and Political Power in Russia*, Foreign Policy Research Institute, 2018, https://www.fpri.org/wp-content/uploads/2018/04/buckley.pdf.

[234]Kristina Arianina and Patrick Brooks, "Anti-Corruption Guidance in Russia: What's a Company to Do?," The Anticorruption Blog, May 6, 2019, https://www.anticorruptionblog.com/russia/anti-corruption-guidance-russia-whats-company-to-do/; Vladimir Gel'man, "Politics versus Policy: Technocratic Traps of Russia's Policy Reforms.," *Russian Politics* 3, no. 2 (2018).

political system with desires for bureaucratic and state-society procedural reforms with an eye to apolitical efficiency gains.[235] To that end, the Russian state's AI programs certainly fall into the latter camp, especially given their currently small market value relative to the energy sector.

Insofar as there are opportunities for negative pressure from state actors, there are strong countervailing pressures from the very top, especially when public interest and press reporting is at its most effective. That being said, rule of law concerns continue, with both nepotism and corruption impacting institutions and programs that provide R&D for later use in products for the private sector.[236]

Another problem remains the continued reliance on state funding, sponsorship, and support for the AI field. Although state support has been necessary to provide the basic infrastructure and economic conditions for innovation and production, it is still not yet a mature system of competing venture capital outfits. AI developers in Russia continue to over-rely on processes that are subject to bureaucratic inertia, duplication, inefficiency, and manipulation, even if the state remains officially in favor of streamlining such operations.

Additionally, relying on the Russian state means reliance on a budget-limited source of funds that will not be able to fund all potential AI startups and established ventures. Private capital will need to be integrated into the field if economies of scale are to be achieved, more aggressive development schedules are to be pursued, and large numbers of new companies are to be encouraged.

[235] See Chris Giles, "Russia's role in producing the taxman of the future," *Financial Times*, July 19, 2019, https://www.ft.com/content/38967766-aec8-11e9-8030-530adfa879c2.and Leonid Bershidsky, "Russia's New Prime Minister is a Bureaucratic Superman," *Moscow Times*, Jan. 16, 2020, https://www.themoscowtimes.com/2020/01/16/russias-new-prime-minister-is-a-bureaucratic-superman-a68935.

[236] S.S. Donetskaia, "Researching Corruption in Russian Universities," *Problems of Economic Transition* 59, no. 7-9, https://www.tandfonline.com/doi/full/10.1080/10611991.2017.1394746.

Military AI and Autonomy in Russia

Since the launch of a modernization drive in 2009, Russia's military has been developing rapidly by steadily integrating the lessons learned from its observation of foreign militaries, its research and development efforts, and its recent battlefield operations, particularly its operations in Syria. The Russian military is heavily emphasizing autonomy across developments in aerial, ground, and maritime unmanned and robotic platforms and components. While it works to develop the technical capability to field more capable unmanned systems, Russian strategists continue to discuss and speculate on the nature of modern and future warfare and how AI-enhanced and autonomous systems will be featured.

Figure 18. Okhotnik UCAV

Source: Ria Novosti, https://iz.ru/1145514/anton-lavrov-roman-kretcul/stainoe-oruzhie-minoborony-v-poiske-protivolodochnogo-drona.

Concurrent with the development of military unmanned systems, the MOD has begun to invest significant human and material resources in the development of artificial intelligence (AI) capabilities across its departments, academies, institutions, and R&D centers. A nexus of AI and unmanned systems is of special interest to the MOD as it seeks to learn from its Syrian and Ukrainian combat experience to formulate and conceptualize future warfare.[237] With Russian president Vladimir Putin and defense minister Sergei Shoigu calling for Russia to start integrating AI in military systems, the domestic defense-industrial ecosystem is responding with concepts, trials, and technologies aimed at ensuring that Russia becomes one of the leading powers in this new military-technological race.

The role of AI in Russia's military

Russian political and military leadership, strategists, and key industry personalities are intensely debating and discussing the role of AI in the future of armed conflict and the role it should play in Russia's military. Like those of other countries exploring the possibilities of AI and autonomy, Russia's technological and military ecosystems are planning for AI to manage information and broaden mission spaces. In April 2021, the Russian MOD announced that it intends to create a specialized department within MOD for the development of AI.[238]

[237] Lester Grau and Chuck Bartles, "Integration of unmanned aerial systems within Russian artillery," *Fires: A Joint Publication for U.S. Artillery Professionals*, no. July-Aug. (2016).

[238] "The Ministry of Defense will create a department for artificial intelligence," (Минобороны создаст управление по искусственному интеллекту), Ria Novosti, Apr. 26, 2021, https://ria.ru/20210426/minoborony-1730064599.html.

Digitization. Although the Russian government has not officially defined this term, it appears often in Russian writings on the confluence of technology and military capabilities. Digitization is largely understood as the "widespread introduction, development, and application of information technology in the military." The application of information technology to the military is leading to a qualitative transformation in military capability that will dramatically affect weapons systems and the ways in which they are employed.

Intellectualization. Also not officially defined, one professional military journal refers to intellectualization as the widespread implementation of AI [presumably the military in this context] "capable of performing creative functions that are traditionally considered the prerogative of a person (i.e., perceived by a person as reasonable)." Another earlier description from 2008 refers to the introduction of specially developed "intelligent" systems created by human experts, stored in databases that are created in advance, that increase the efficiency of information processes.

Russian military writers commonly refer to the "intellectualization" or "digitization" of the military with the "widespread introduction, development, and application of modern information technologies on the basis of computer technology and communication."[239]

In addition to the potential advantages provided by this new technology in and of itself, Russian strategists have an appreciation for and concerns about the technological abilities of other countries, particularly the United States and China. These are fueled by longstanding security concerns, such as the fear of a surprise and debilitating attack or the increasingly potent role of information in influencing its domestic population. Russia's security establishment—and much of its population, for that matter—have long assessed that the US continually seeks to keep Russia marginalized and weak, and that it will seek opportunities to change Russia's political leadership and the attitude of its populace to make Russia more amenable to US worldwide aspirations. Indicative of this, then-deputy defense minister Yuri Borisov in 2018 asserted that cyber wars had already become a reality in modern confrontations and that these

[239] O.V. Maslenikov et al., "Intellectualization is an important component of digitization of the Armed Forces of the Russian Federation," Интеллектуализация - важная составляющая цифровизации вооруженных сил российской федерации, *VM*, no. 7 (2020), https://vm.ric.mil.ru/upload/site178/RJvfqCrBxZ.pdf.

battles are continuously being played out in the information space, where victory depends on AI-enabled technologies.[240]

AI debate within Russian military

Russian discussions about military AI clearly recognize the technical challenges and the ethical risks of fully autonomous systems but also have a sense of inevitability that military systems will become completely autonomous.

Commensurate with the burgeoning field of military AI globally, Russian military leaders, strategists, and industry debate the potential risks versus reward of AI and autonomous systems playing an increasingly greater role in information management and decision-making. The Russian military looks to potential AI-enabled technologies to mitigate the natural, physical, and psychological constraints on human operators. At the same time, there is concern over the ramifications of future AI-enhanced systems being able to set goals, eliminating the operator all together.[241] Russian discussions of military AI clearly recognize the technical challenges and the ethical risks of fully autonomous systems but also have a sense of inevitability that military systems will become completely autonomous. This appears to arise from a perception of the intent of the United States and China in their respective military AI programs.

There is also some skepticism toward broad AI and the ability of AI systems to replace a military leader's decision-making capability. Analysts note that the lack of training data prevents AI systems from creating ingenious, resourceful, creative, and high-risk solutions.[242] In contrast, military leaders, such as Colonel-General Vladimir Zarudnitsky (approximately three-star equivalent), the head of the Military Academy of the Armed Forces, asserted that an assessment of the trends of military AI leads one to conclude that the transition from human control over military robotics to greater autonomy is inevitable and that Russia needs to plan for it.[243] Yet another military article asserts that AI technology "enhances any military

[240] Yuri Borisov, "The development of artificial intelligence is essential for the successful conduct of cyberwarfare," [Развитие искусственного интеллекта необходимо для успешного ведения кибервойн], Ministry of Defense of the Russian Federation, Mar. 2018, https://function.mil.ru/news_page/person/more.htm?id=12166660@egNews.

[241] V.M. Burenok, R.A. Durnev, and K.U. Kryukov, "Intelligent Armament: The Future of Artificial Intelligence in military Affairs," *Weapons and Economics* 1, no. 43 (2018), http://www.viek.ru/43/4-13.pdf.

[242] Ibid.

[243] Col-Gen V.B. Zarunitsky, "The nature and content of military conflicts today and in the foreseeable future," *Voennaya Mysl*, no. 1 (Jan. 2021), https://vm.ric.mil.ru/upload/site178/8sGnTJ8GHJ.pdf.

professional experience, augmenting the military's capabilities with expertise and predictive power beyond the reach of humans." [244]

Former Deputy Prime Minister Yuriy Borisov, mentioned earlier, insists that because new technologies are created by humans, they simply will not work without humans.[245] Russian president Vladimir Putin himself weighed in on the debate, stating that although the use of AI-enhanced weapons will likely determine the future of combat, AI will never replace humans. AI systems must be ultimately controlled by humans and should be viewed as "faithful assistants."[246] This highlights the tension that exists in official discussions about the role of AI. Some statements forecast the ultimate autonomy of AI systems, while others proclaim that humans must always be in control. Additionally, the MOD already appears to be making plans for AI-enabled robotic systems that can act autonomously and presumably independent of humans. What appears missing from the conversation is a way to balance the two views. It is not clear in Russian military thinking where human control would end and where independent AI-enabled action would begin.

In the interim, there is also discussion of what can reasonably be achieved by developing AI and autonomous technologies and integrating them into the Russian military. According to an article by the Russian Rocket Forces Academy, the Russian military should be able to achieve greater capabilities via fielding military robots, combat and reconnaissance semi-autonomous platforms, AI-assisted analysis of information and intelligence, and increased AI-assisted decision-making based on real-time analysis of complex, dynamic environments.[247] Colonel-General Zarudnitsky asserted that it will be crucial for the Russian military to build self-learning systems capable of analyzing large volumes of data for applications in weapons management, strategic forecasting, and decision-making. [248]

There is also discussion among Russian military scholars and commentators of the relative path the evolution of military AI will take in minimizing the role of the human in operations. Military writers recognize that narrow AI-enabled technologies lack a single organizational environment where the diverse set of military systems can interact. If a country could produce

[244] Maslenikov et al., "Intellectualization is an important component of digitization of the Armed Forces of the Russian Federation."

[245] "The development of artificial intelligence is essential for the successful conduct of cyberwarfare."

[246] Russian President Vladimir Putin, "Artificial Intelligence is the main technology of the 21st Century," AI Journey 2020 Conference, Dec. 4, 2020, http://kremlin.ru/events/president/news/64545.

[247] Burenok, Durnev, and Kryukov, "Intelligent Armament: The Future of Artificial Intelligence in Military Affairs."

[248] Zarunitsky, "The nature and content of military conflicts today and in the foreseeable future."

a unified information environment for its military that connected disparate AI-enhanced systems, those systems could then develop their own kill chains, decisions, etc., which would fundamentally alter how modern militaries conduct operations at all levels. This line of thinking usually ends with Russian speculation about the full replacement of humans at the tactical and tactical-operational levels. [249]

Information confrontation and battlefield dominance

The Russian leadership views information confrontation as being one of the fundamental ways in which countries compete. The promise of AI in the field of information management places the technology squarely in the center of Russian concerns. Russian strategists break down information confrontation into its psychological and technical components, although both shape the strategic environment.

From the standpoint of technology, AI has the potential to help Russian forces gain information dominance on the battlefield. The enormous amount of information available through networked sensors, space-based architectures, and cyberspace makes rapid information collection, analysis, prediction/decision dissemination a prerequisite for winning on the modern battlefield. Information dominance requires both defensive capabilities and the ability to disorganize an adversary's offensive capabilities. The need to disorganize an adversary's forces originated in literature centered on electronic warfare (EW) but has migrated beyond that branch of military studies into discussions about how other offensive operations, aided by advanced technology such as AI and automation, can render the command and control of an adversary's forces inept at dealing with the rate of change on the modern battlefield.

Much of the discussion of information and modern warfare mentions the centrality of network-centric warfare, defined in Russian as "the integration of military command and control at all levels from individual servicemen to higher levels into a single network that provides a qualitatively new level of integration." According to some authors, this integration is necessary for obtaining operational superiority over an adversary's forces.[250]

In addition to the military, however, AI plays a role in broader information confrontation between countries. Russian political and military leaders and strategists talk about the changing nature of international competition and the use of non-military means for conflict—

[249] Col. D.V. Galkin, Col. P.A. Polyandra, and Col. A.V. Stepanov, "The state and prospects of employment of AI in military affairs," [Состояние и перспективы использования искусственного интеллекта в военном деле], *Military Thought*, [Voennaya Mysl], Jan. 2021, pp. 113-124.

[250] Maslenikov et al., "Intellectualization is an important component of digitization of the Armed Forces of the Russian Federation."

those instruments a state employs that are outside the usual tools of war. From this perspective, Russia is in a state of continuous low-level conflict, particularly with the United States, over the information available to each society and the impacts that information can have on a society's attitude toward its leadership. Much of this conflict occurs in cyberspace through all the various mediums from which individuals receive information. Insofar as AI is mentioned in relationship to cyber, it is usually in terms of AI making the tools employed in information confrontation more effective and, thus, posing a greater threat to the psychological attitude of Russia's domestic population.[251] One author in the journal *Military Thought*—the professional publication of the Russian General Staff—referred to digital technologies and AI as "active tools for the de-sovereignization" of Russia.[252] Here he is referring to the concept of sovereignty often used by the Russian leadership vis-à-vis the integrity of the state and the need to keep foreign influence—information in this case—from influencing Russia's population.[253]

While there is considerable discussion from Russian political and military leadership, echoed widely in military journals, about information confrontation and "psychological warfare," there is less discussion about how AI figures into this conflict. This could be for two possible reasons. First, the use of AI in the cyber domain is highly technical and less apt to simplified descriptions. Second, the offensive and defensive aspects of cyber are highly classified, given the half-life of cyber techniques once they are known to an adversary.

AI and international security

Political and military leaders along with scientific researchers and diplomatic personnel have voiced concerns over the potential impact artificial intelligence can have on international stability and security. These concerns can fall roughly into two overarching themes: those threats inherent to AI as a technology, and the intentional use of AI by those with mal-intent toward another country. Both of these threats are voiced in Russia in terms largely consistent with overarching themes in AI while also graphing onto existing Russian concerns about international security and its impact on Russia. For example, how will greater decision-making ability and autonomy affect job security? Evgeniy Pashentsev, in an interview with Russia's

[251] Alexey Ramm, *Russian Information and Cyber Operations*, Center for Analysis of Strategies and Technology, 2017.

[252] D.G. Evstafiev and A.M. Ilnitsky, "Priorities for managing national security and defense in a post-global world," Приоритеты управления национальной безопасностью и обороной в условиях постглобального мира, *Voennaya Mysl*, no. 3 (2021).

[253] Galkin, Polyandra, and Stepanov, "The state and prospects of employment of AI in military affairs."

Ministry of Foreign Affairs journal, *International Affairs,* notes that ever-increasing job replacement can lead to growing instability within society and that this applies not just to production but to higher paying employment areas such as finance, services, and management.[254] The other obvious concern is with the danger of having algorithms and technologies where there is no human in the chain of decisions. This is usually related to the ethical concerns over the creation of lethal autonomous weapons systems (LAWS).

The other broad category of threats are the myriad ways people imagine AI impacting international security as a result of its intentional use by both state and non-state actors. Speaking to the United Nations in 2002, Putin expressed concern over the uncontrollable spread of digital technologies and, like actual weapons, falling into the hands of non-state actors, leading to extreme risks to international security. He also voiced the need for AI regulation that lessens not only technological threats but also threats to traditions, law, and morality—the Russian leadership's ever-present concern over the possibility of outside forces undermining the psychological state of Russia's domestic population.[255] The comparison of information operations with actual weapons is not new in the Russian discussion. In 2019, Nikolai Patrushev, secretary of the Russian Security Council, referred to artificial intelligence, among other technologies, as potentially creating the same level of damage as a weapon of mass destruction.[256]

Going back to Evgeniy's *International Affairs* interview, he proposed a classification system to characterize threats from the intentional use of AI in information and psychological confrontation. In Table 3, the threat parameter lists those factors needed to understand the multidimensional scope of the threat. The range indicates the different values the parameters can take.

[254] Evgeney Pashentsev, "Artificial Intelligence and Security: What is Good and What is Bad," Искусственный интеллект и безопасность: что во благо, а что во зло?, *International Affairs* (2019), https://interaffairs.ru/news/show/24219.

[255] Vladimir Putin, "75th session of the UN General Assembly: Vladimir Putin made a video address at the plenary session of the 75th session of the United Nations General Assembly.," (United Nations, New York, September 22, 2020, 2020), http://www.kremlin.ru/events/president/news/64074.

[256] "Russia's security chief calls for regulating use of new technologies in military sphere: New technologies may be "as deadly as weapons of mass destruction", the official warns," *Tass*, 2019, https://tass.com/defense/1055346

Table 3. Threat characterization of AI in information and psychological warfare

Threat parameter	Range of threat			
Territorial coverage	Local	Regional	Global	
Degree of damage	Insignificant	Significant	Large	Catastrophic
Speed of propagation	Slow	Fast	Impetuous	
Form of distribution	Open	Hidden		

Source: Evgeney Pashentsev, "Artificial Intelligence and Security: What is good and What is bad," Искусственный интеллект и безопасность: что во благо, а что во зло?, *International Affairs* (2019), https://interaffairs.ru/news/show/24219.

There is deep concern in Russian security discussions over the potential intentional and unintentional dangers posed by the continued introduction and eventual impacts of AI. While there is general concern over maintaining control of AI-enhanced systems, there is a particular emphasis on AI's potential for increasing the sophistication and lethality—psychologically speaking—of the tools of information warfare.

AI, autonomy, and nuclear weapons

AI and autonomy play a significant role in Russia's nuclear forces just as they did for Soviet nuclear forces during the Cold War. In a number of ways, the role of AI and autonomy conform to particular Russian security concerns, including the potential credibility and survivability of Russia's nuclear deterrent.

The smaller size of both the Russian and US nuclear arsenals, compared to their respective sizes during the Cold War, coupled with Moscow's hyperbolic assessments of US attack and missile defense capabilities, has increased Russian concerns about the potential effectiveness of missile defense. With smaller arsenals, missile defense is seen as potentially being more effective in reducing the impact of a second strike—the cornerstone of Mutually Assured Destruction. The scenario is as follows. The United States, for whatever reason, launches an attack targeting Russia's political leadership, nuclear command and control, nuclear forces, and critical infrastructure. This attack utilizes capabilities such as long-range precision strike munitions, offensive cyber operations, and space-based assets. Depending on its success, Russian military analysts assess that there is a chance that Russia will not have enough of its nuclear arsenal left to penetrate US missile defense systems with enough warheads to cause

unacceptable damage.[257] If true, this could yield scenarios in which the United States does have an incentive to strike first because the resultant damage would be below unacceptable thresholds. This logic is the key driver behind the Russian leadership's continued apoplectic response to US and NATO missile defense initiatives and especially the US withdrawal, in 2002, from the 1972 Anti-Ballistic Missile (ABM) Treaty. It is difficult to overstate the role the US withdrawal plays in Russian discussions about the threat it sees from the United States. As recently as last December, Putin stated that the United States initiated the current arms race by its withdrawal from the treaty.[258]

One particular AI-related concern is over the advance of space-based optical-electronic reconnaissance systems and the threat they pose to Russia's Strategic Rocket forces.[259] Unlike the US, whose most reliable leg of the nuclear triad is its ballistic missile submarines, Russia's land-based deterrent, and especially its road-mobile nuclear forces, are the most survivable component of Russia's nuclear deterrent.[260] Therefore any technology that would make it easier to find and destroy Russian nuclear forces, especially land forces, is of particular concern to the Russian leadership.

This concern arguably drives Russia's launch-on-warning nuclear posture. Launch-on-warning is a posture in which a country, having received indications of an incoming attack, launches its retaliatory strike assets before those assets can be destroyed.[261] Following the Cold War, military analysts suspected this was the posture of the Russian Federation and Russia's most recent declaratory policy seems to support that view.[262] The overall concern over the

[257] Petr Topychkanov, "Autonomy in Russian Nuclear Forces," in *The Impact of Artificial Intelligence on Strategic Stability and Nuclear Risk, Vol. 1*, ed. Vincent Boulanin (May 2019), p. 73, https://www.sipri.org/publications/2019/other-publications/impact-artificial-intelligence-strategic-stability-and-nuclear-risk-volume-i-euro-atlantic.

[258] "Putin: The arms race has already begun," Путин: гонка вооружений уже началась, *Kommersant*, 2020, https://www.kommersant.ru/doc/4617177.

[259] A.V. Evsyukov and A.L. Khryapin, "The role of new strategic weapons systems in ensuring strategic deterrence.," Роль новых систем стратегических вооружений в обеспечении стратегического сдерживания *Voennaya Mysl*, no. 12 (2020), https://vm.ric.mil.ru/upload/site178/AMIei6v9c7.pdf.

[260] V.F. Lata, "Present and Future of the Strategic Missile Forces as the Guarantor of the Defense and Security of Russia," Настоящее и будущее рвсн как гаранта оборонной, безопасности россии, *Herald of the Academy of Military Sciences* 2, no. 63 (2018), http://www.avnrf.ru/attachments/article/1125/AVN-2(63)_101-184_print.pdf.

[261] Lawrence Freedman and Jeffrey Michaels, *The Evolution of Nuclear Strategy*, 4th ed. (London: Palgrave MacMillan, 2019), p. 286.

[262] Cynthia Roberts, "Revelations about Russia's Nuclear Deterrence Policy," War on the Rocks, June 2020, https://warontherocks.com/2020/06/revelations-about-russias-nuclear-deterrence-policy/.

possibility of a US aerospace attack and the survivability, in part, drives Russian initiatives to integrate autonomy and AI in their nuclear systems.

The Russian military sees the integration of autonomy and AI elements as key to buttressing the credibility of its nuclear deterrent to the United States, maintaining the force, improving its early warning ability, maintaining a reliable second-strike capability, and defeating adversary (US) missile defense systems, among other applications. Early warning, given the logic above, is especially important and AI technologies promise to enhance Russia's early warning system to better assess threats and damage prediction.[263] It should be noted that, even during the Cold War, experts recognized the importance of nuclear crisis management and mitigating the risks of third party-induced nuclear escalation.

In an article published in *Voenniaya Mysl*, the authors assert that Russia must integrate AI into its decision-making support to protect against the US concept of "global strike," and to monitor dynamic geopolitical and military developments.[264] In an impending attack, AI and semi-autonomous systems can assist in decision-making given the short response times. This could involve improving the way in which military forces and resources are protected from an impending strike and how best to plan a retaliation.[265] In turn, it has been reported that Russia's National Defense Management Center (NDMC)—which is the key military C2 node in a crisis or conflict, and houses the Russian military's supercomputing power employed for real-time and forward-looking analysis of the military-political situation—could employ AI-enabled technologies to assist with information collection and analysis as a decision aid.[266]

Most recently, reporting indicates that the radar stations that are part of Russia's missile attack warning system will be upgraded with AI technology to boost their ability to measure and assess incoming threats. However, no part of this system will "think" on its own, and the available reporting warns against the risks of expanding the role AI plays in nuclear infrastructure and planning.[267] This sentiment is often echoed in Russian discussions of the

[263] Dmitry Stefanovich, "Artificial Intelligence and Nuclear Weapons," Russian international Affairs Council, May 6, 2019, https://russiancouncil.ru/en/analytics-and-comments/analytics/artificial-intelligence-and-nuclear-weapons/.

[264] Galkin, Polyandra, and Stepanov, "The state and prospects of employment of AI in military affairs."

[265] "Artificial Intelligence and Nuclear Weapons."

[266] "Russian National Defense Management Center uses artificial intelligence," (Национальный центр управления обороной РФ применяет искусственный интеллект), Regnum.ru, Jan. 27, 2020, https://regnum.ru/news/polit/2836730.html.

[267] "Russia to boost missile attack warning system's capabilities after upgrade," Tass.ru, Feb. 15, 2021, https://tass.com/defense/1256603.

role of AI in nuclear arsenals despite much discussion over Russia's Perimeter nuclear command and control system.

The Perimeter system, nicknamed the "Dead Hand," is an automated nuclear command and control system developed by the Soviet Union, and considered to be still in use for delivering assured nuclear retaliation. This system is switched on during a crisis period, when the threat of nuclear attack is considered high. Utilizing various sensors it can detect a nuclear attack in progress, and command the launch of a retaliatory strike by Russian nuclear forces in the event the political leadership is incapacitated. The original purpose of the system was twofold: to ensure a retaliatory strike capacity remained in the event of a decapitating first strike, and to reduce time pressure on leadership to make a decision regarding nuclear launch by creating conditions so that retaliation could be executed while already under nuclear attack. The system allowed delegation from political leadership in an emotional and difficult moment, increasing military confidence in crisis decision-making. The system is not fully automatic, but believed to be semi-automatic in design, supposedly employing a human command unit, which would still reconcile the delegated authority provided, with the situation reported by the system's various sensors. Its existence implies the preference for semi-automatic, vice fully automated systems, in resolving the challenges imposed by time pressure, imperfect information, and emotion that fundamentally affect human decision-makers and thereby reducing the risk of miscalculation on both sides, and the likelihood that these circumstances will lead to the wrong decision in highly consequential choices.[268]

In a recent article in *Voenniaya Mysl*, several military authors affiliated with the Russian Ministry of Defense and/or Bauman Moscow State Technical University, discussed US debates about the role of AI in nuclear weapons. They argued that most studies suggest that AI could launch a nuclear strike if it sees an advantage, and pointed out contrasting perspectives in the United States on this matter: a 2018 RAND report by Edward Geist and Andrew John titled *How Might Artificial Intelligence Affect the Risk of Nuclear War?* and a 2019 *War on the Rocks* article by Adam Lowther and Curtis McGiffin titled "America Needs a Dead Hand." They posit that Russia "would need to support decision-making on the employment of nuclear forces, definitely using AI as an instrument of analyzing the dynamically changing geopolitical and military environment, and leaving the appropriate decision-makers to make final employment

[268] Defense Intelligence Agency, *Russia Military Power: Building a Military to Support Great Power Aspirations*, 2017, https://www.dia.mil/portals/27/documents/news/military%20power%20publications/russia%20military%20power%20report%202017.pdf.

decisions."[269] However, the articles do not mention that in September 2019, Lt. Gen. Shanahan, then director of the Joint Artificial Intelligence Center, publically rejected the logic outlined in Lowther's *War on the Rocks* article.[270]

As discussed further in this paper, Russia is employing AI and automation in its air and missile defense systems. Russian strategists see the processing power of AI as essential to accelerating the speed at which an integrated air defense system (IADS) can monitor, detect, and respond to an impending aerospace attack. This includes the Pantsir air defense system as well as the S-500 missile defense system—the latter of which has some intercept capability against ICBMs toward the end of the missile's trajectory.

Putin's novel nuclear weapons

In a dramatic speech in March 2018, Putin highlighted new semi-autonomous and possibly autonomous nuclear weapons joining the Russian arsenal, claiming that they could "reach anywhere in the world" and that the West should understand that Russia was not "bluffing."[271] Putin's speech and the purported capabilities of these weapons, to include AI-enhanced technologies, highlight the Russian leadership's concern for US missile defense with each explicitly being able to avoid or mitigate against missile defenses. The new systems are displayed in the table below.

Table 4. Russia's new novel nuclear weapons

System	Weapon type	AI/Autonomy aspect	Status
Burevestnik	Nuclear-powered cruise missile	Guidance	In development
Avangard	Hypersonic glide vehicle	Guidance	In service
Poseidon	Nuclear powered UUV	Guidance	In development
Sarmat	Intercontinental ballistic missile	Guidance	In development
Kinzhal	Air-launched ballistic missile	Guidance	In service

Source: CNA.[272]

[269] Galkin, Polyandra, and Stepanov, "The state and prospects of employment of AI in military affairs."

[270] Sydney J. Freedberg Jr., "No AI For Nuclear Command & Control: JAIC's Shanahan," *Breaking Defense*, Sept. 25, 2019, https://breakingdefense.com/2019/09/no-ai-for-nuclear-command-control-jaics-shanahan/.

[271] "Putin spoke about the latest types of Russian weapons," Ria Novosti, Mar. 1, 2018, https://ria.ru/20180301/1515566394.html.

[272] "Putin spoke about the latest types of Russian weapons," Путин рассказал о новейших видах российского вооружения, *Ria Novosti*, Mar. 1, 2018, https://ria.ru/20180301/1515566394.html; Dmitry Stefanovich,

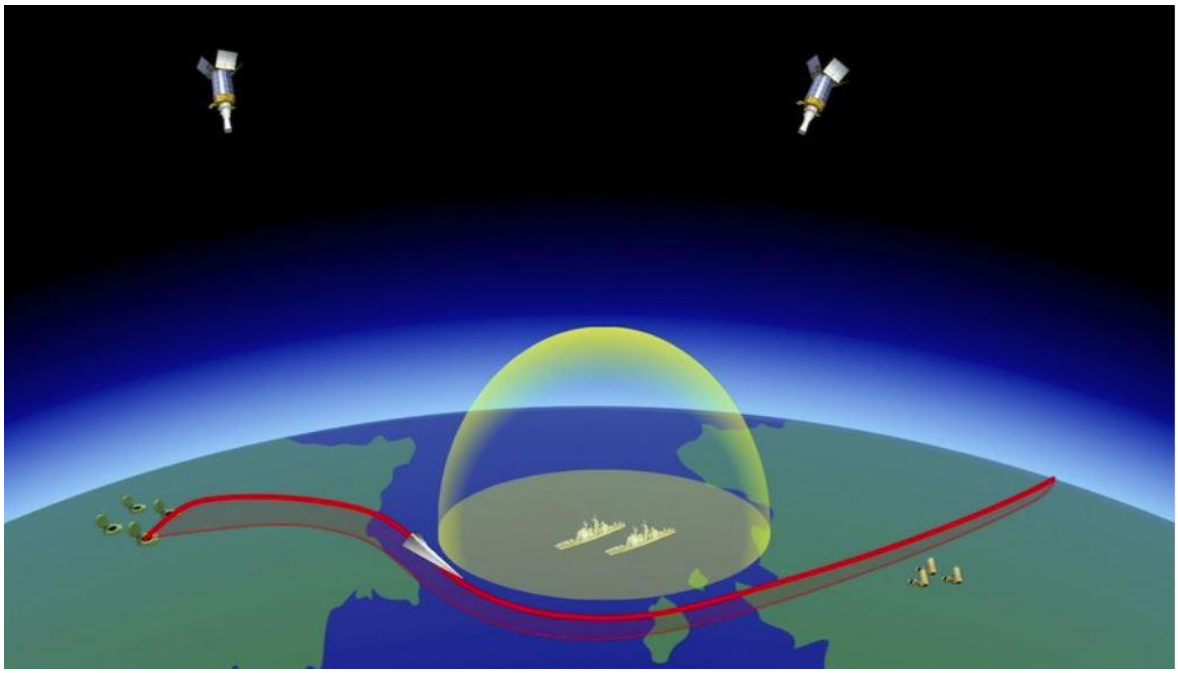
Of these systems, there is the least amount of reporting on the Burevestnik nuclear-powered cruise missile. The advantage of this system, from the Russian perspective, is its ability to patrol and loiter for an indefinite amount of time due to its nuclear propulsion system and strike on command. Like the other systems, the primary AI/autonomy-related aspect, according to open source reporting, is its guidance system. One Russian military journalist, Alexey Ramm, notes that the ability of the missile to loiter over water for long periods of time creates guidance problems. Historically, cruise missiles have relied on various guidance systems for most of their flight path to include inertial systems, terrain contour matching (TERCOM), and space-based positioning systems.[273] For long flight paths over water this has generally meant reliance on the Russian GLONASS system or GPS. Ramm notes that the long loitering periods make it doubtful that the missile would rely solely on GLONASS but does not offer any indications as to what alternative system it would use to maintain accurate knowledge of its position over extended periods.[274]

"Avantgard and others: on the role of new systems in strategic forces," «Авангард» и другие: о роли новых систем в стратегических силах, *Izvestia*, Jan. 2019, https://iz.ru/829623/dmitrii-stefanovich/avangard-i-drugie-o-roli-novykh-sistem-v-strategicheskikh-silakh ; Министерство обороны Российской Федерации Russian Ministry of defense," Блок планирующий крылатый, Military Dictionary, http://dictionary.mil.ru/folder/123087/item/130016/; Mark B. Schneider, "Russian Modernization of its Nuclear and Military Forces in 2021," *Real Clear Defense*, 2021, https://www.realcleardefense.com/articles/2021/02/20/russian_modernization_of_its_nuclear_and_military_forces_in_2021_661111.html.

[273] "Cruise Missile Basics," Missile Defense Advocacy Alliance, 2021, https://missiledefenseadvocacy.org/missile-threat-and-proliferation/missile-basics/cruise-missile-basics/.

[274] Alexy Ramm, "Winged "petrel" : What is known about the mysterious Russian weapons," крылатый <<буревестник>>: что известно о таинственном русском оружии, *Izvestia*, Mar. 5, 2019, https://iz.ru/852592/aleksei-ramm/krylatyi-burevestnik-chto-izvestno-o-tainstvennom-russkom-oruzhii.

Figure 19. Avangard ballistic-launched hypersonic glide vehicle



Source: Russian TV One.

The Avangard is a ballistic-missile launched hypersonic glide vehicle that, once released takes a non-ballistic, maneuverable flight path to its target. The advantage of such a system is both its speed and its ability to purportedly evade missile defense systems, again highlighting the Russian concern with US missile defenses. One particular challenge of hypersonic glide vehicles is their difficulty of maintaining and updating their telemetry given the extreme heat produced by their hypersonic speed through the atmosphere. Herbert Efremov, the lead designer of the system, notes that the vehicle calculates its path before it actually launches, utilizing AI-enhanced systems, and that no one actually knows what path it has decided to take on its way to its target. This include the Russians launching the vehicle as well, resulting in a "surprise for everyone."[275]

[275] "Meduza interviewed Herbert Efremov, a developer of Russian hypersonic weapons. His name was kept secret until September 2020," Спецкор «Медузы» Лилия Яппарова встретилась с секретным конструктором ракет Гербертом Ефремовым и поговорила с ним о будущем оружия, *Meduza*, Oct. 7, 2020,

The Poseidon, sometimes referred to as Status-6 or Kanyon, is an autonomous (robotic in some Russian reporting) vehicle resembling a torpedo that is designed to deliver a retaliatory nuclear strike.[276] It is powered by a small nuclear reactor giving it "unlimited distance" and is equipped with a large nuclear warhead for destroying coastal infrastructure.[277] Poseidon will be carried by a converted Russian Belgorod nuclear submarine which will be capable of carrying multiple Poseidon weapons. While Poseidon clearly classifies as an autonomous nuclear drone (or semi-autonomous at a minimum) it is unclear what elements of machine learning AI might exist within the torpedo. One possibility suggested in the reporting is that it has complex navigation algorithms that help it maneuver sea floor contours.[278] That being said, intelligent path finding/motion planning is not new to AI and robotics and, unless it is very close to the sea floor, it seems that path planning across an ocean would be fairly simple compared to the more complex environment robots are navigating at the time this report was written.[279]

https://meduza.io/feature/2020/10/07/meduza-vzyala-intervyu-u-gerberta-efremova-razrabotchika-rossiyskogo-giperzvukovogo-oruzhiya-ego-imya-derzhali-v-sekrete-do-sentyabrya-2020-goda.

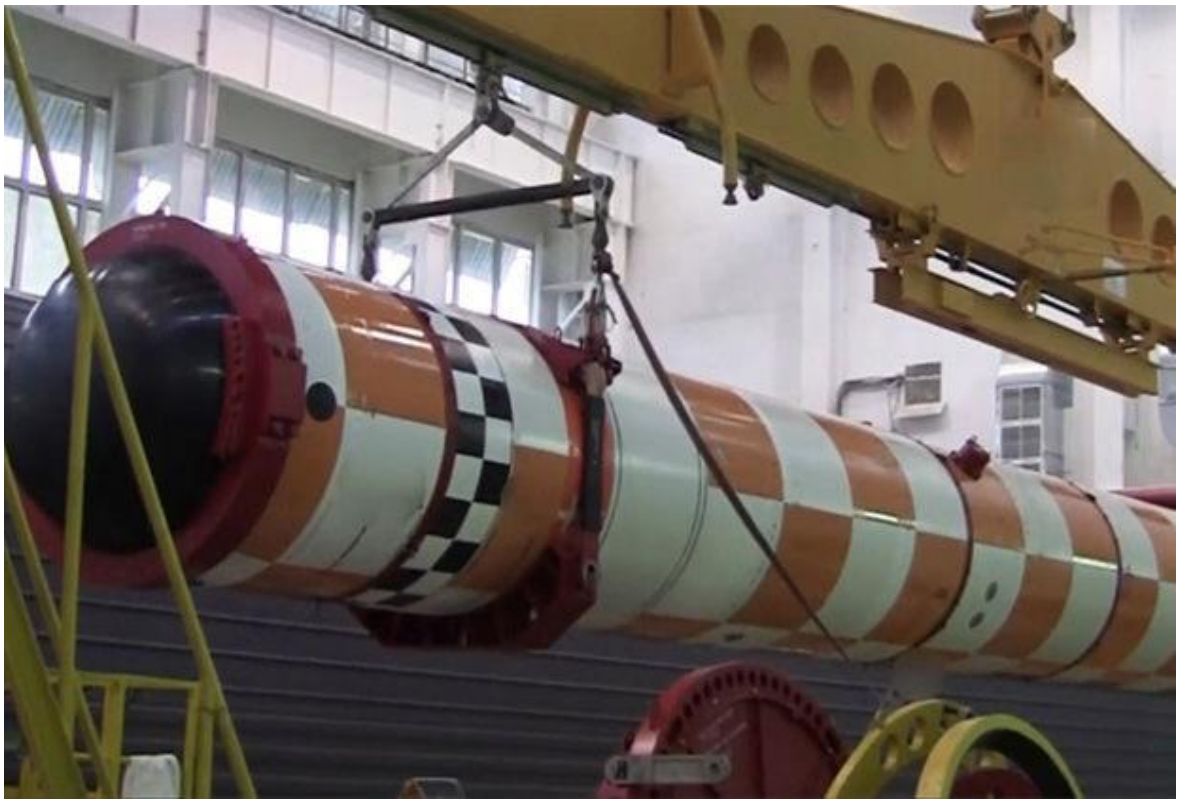
[276] "Unmanned underwater vehicle 'Posiedon' Dossier," Tass.ru, https://tass.ru/info/5388731.

[277] Anton Lavrov and Alexey Ramm, "Poseidon in a boat: the submarine is being prepared for testing nuclear robots," Izvestia.ru, Feb. 2021, https://iz.ru/1123160/anton-lavrov-aleksei-ramm/poseidon-v-lodke-submarinu-gotoviat-k-ispytaniiam-iadernykh-robotov.

[278] V.S. Pryamitsky, "Posiedon' Error or Achievement," VPK.ru, June 9, 2019, https://vpk.name/news/318706_poseidon_oshibka_ili_dostizhenie.html.

[279] Stuard Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 4 ed. (Hoboken, NJ: Pearson Education, 2021); Yongping Pan, Basil M. Al-Hadithi, and Chenguang Yang, "Editorial: AI for Robot Modeling, Path Planning, and Intelligent Control," *Frontiers* (2020), https://www.frontiersin.org/articles/10.3389/frobt.2020.00019/full.

Figure 20. Poseidon UUV



Source: Russian Ministry of Defense, https://vpk.name/news/318706_poseidon_oshibka_ili_dostizhenie.html.

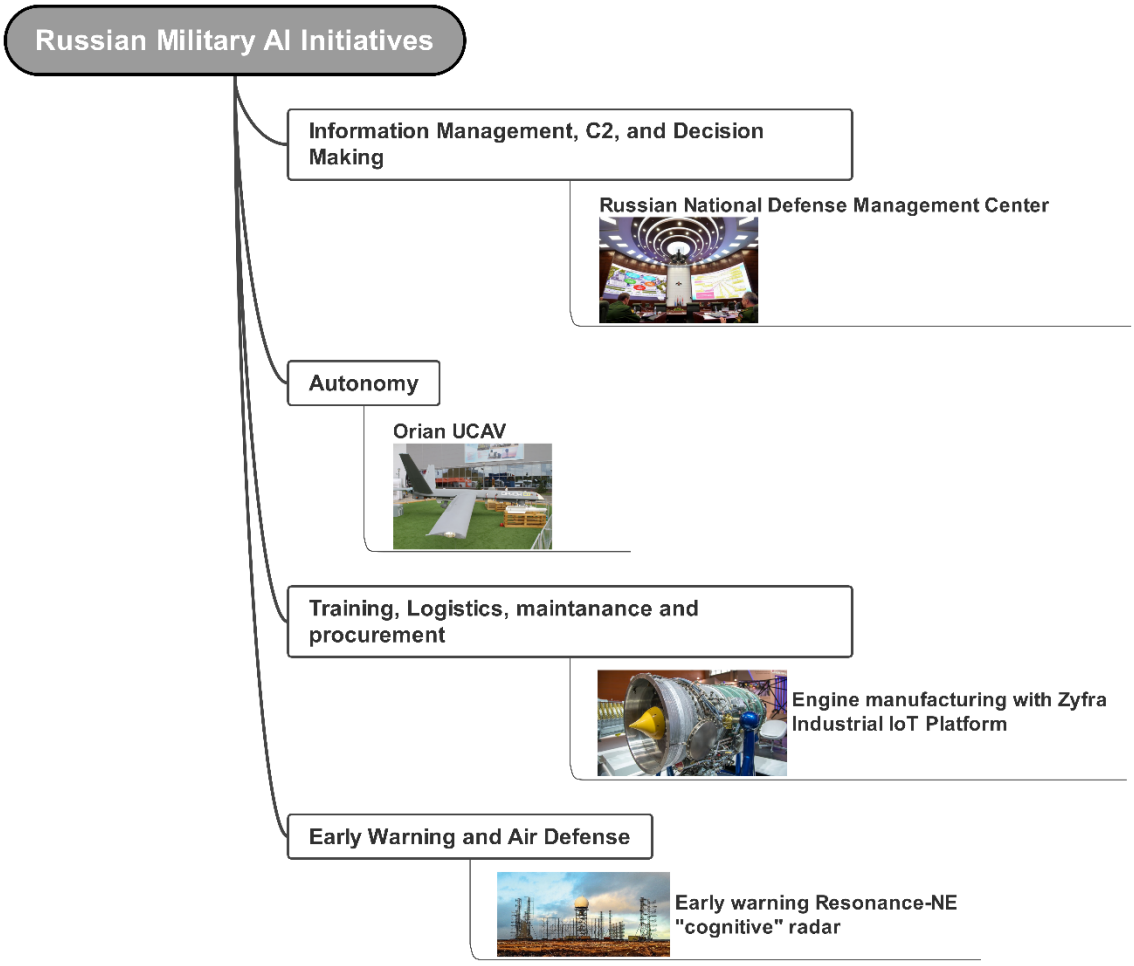
The final two systems feature the same characteristics as the other hypersonic and cruise missile platforms mentioned earlier. The Sarmat heavy intercontinental ballistic missile (ICBM) is intended to replace Russia's older SS-19 ICBM and is capable of carrying a number of different warheads. Over and above the traditional characteristics of ICBMs, we include it here due to its ability to deploy the already mentioned Avangard missile and the particular autonomy-related challenges of that missile. Additionally, the Kinzhal is an air-launched ballistic missile likely developed on the design of the ground-launched Iskander ballistic missile and is also reportedly maneuverable.[280]

[280] "Kinzhal," Missile Threat: CSIS Missile Defense Project, 2021, https://missilethreat.csis.org/missile/kinzhal/.

Key military AI initiatives

This section explores some of the key AI initiatives the Russian military is pursuing as they relate to core Russian views on the character of modern conflict. The section represents more of how AI and autonomy graph onto existing Russian views of modern warfare and less on how technologies are derived and characterized with respect to how they fit within the field of AI.

Figure 21. Russian military AI initiatives with key examples



Source: CNA.

Information management for command, control and decision making

The Russian military is attempting to implement AI-enhanced systems that will help manage the large amounts of information from a multitude of sources on the battlefield. This is taking place from the tactical to the operational and strategic levels. In many ways, the Russian military is making up for its serious lack of information management and battlefield transparency throughout the Cold War. While the Soviet military could bring tremendous combat power to bear, it had difficulty "seeing" the battlefield. This persisted and was driven home by the poor ISR performance during the Georgia War.[281] This is coupled with a focused review of US military actions taken since the fall of the Cold War that demonstrated to the Russian military leadership the potential impact of information dominance in modern conflict—highlighted by the common reference to US netcentric warfare in their discussions about war.

At the strategic level, Russian authors in leading military journals reflect the view that AI systems, coupled with the vast data available on current world events, could assist in analyzing dynamically changing geopolitical and military environments.[282] This is part of the motivation behind the creation of the NDMC whose mission is as follows:

> Provide centralized combat control of the Armed Forces of the Russian Federation…[and the] collection, generalization and analysis of information on the military-political situation of strategic areas of the world and the socio-political situation in the Russian federation in peacetime and wartime.[283]

The NDMC purportedly uses AI in its daily functioning to collect and organize information. The types of information vary from the status of military units and operations, especially those of deployed Russian units, the status of the nuclear triad, and international geostrategic developments.[284] The center's role in assessing international developments is particularly interesting. In December 2019, Russian Defense Minister, Sergei Shoigu, stated that Russia had

[281] Ruslan Pukhov, *The Tanks of August*, Center for Analysis of Strategies and Technologies, Moscow, http://cast.ru/files/The_Tanks_of_August_sm_eng.pdf.

[282] Galkin, Polyandra, and Stepanov, "The state and prospects of employment of AI in military affairs," pp. 113-124.

[283] Ministry of Defense of the Russian Federation, "National Defense Control Center of the Russian Federation," https://structure.mil.ru/structure/ministry_of_defence/details.htm?id=11206@egOrganization.

[284] "Russian National Defense Management Center uses artificial intelligence."

created a system that would allow Russia to predict the beginning conditions that lead to armed conflicts using a special database.

> If we put into the database all the information about the actions, for example, of a military group in Yugoslavia (how many ships, with how many carriers, how many planes, how many missiles, at what time - in the daytime, at night, what happened), then it acts as an "alarm clock" that says "you know, the situation is very similar in such and such a region of the world, because [it has] the same number of ships, aircraft carriers, aircraft, cruise missile carriers, [and] precision weapons, so there is a high probability, that this part of the world may experience what happened in Yugoslavia.[285]

Shoigu further said that the system not only forecasts conflicts but recommends a response based on previous mistakes. It is possible that the NDMC envisions having a system with similar goals to that of DARPA's Knowledge-directed Artificial Intelligence Reasoning Over Schemas (KAIROS) system which seeks to "develop a schema-based AI system that can identify complex events and bring them to the attention of users."[286] Schema, according to DARPA, are created in humans by abstracting narrative structures based on real world experiences. To date, AI-related systems have been either been unable to match schema to real world events or require excessive manual training to be practical.[287] Reporting on NDMC has not revealed anything like the schemas referred to in KAIROS and there is little more on how this system learns from mistakes and how previous conflicts are coded. Shoigu did assert that the Ministry of Defense has the technical capabilities to accumulate and systematize the necessary information.

The latter part of the mission statement derives from the earlier discussed concern that adversaries such as the United States seek to undermine Russian authorities and create instability within Russia to foment political change, leading to a justification for US military action. While most analysts understand the NMDC to be primarily focused on the status of the Russian military and the international environment, it would stand to reason, based on the center's mission statement and the security environment in Russia, that the political and military leadership foresee a role for the center in monitoring the conditions and stability of Russia's domestic population.

At the operational level, the Russian military has focused heavily on integrating information from different platforms across military branches in an attempt to better coordinate forces and

[285] Alexander Peshkov, "Shoigu: MOD has conflict prediction system," TvZvezda.ru, Dec. 2019, https://tvzvezda.ru/news/forces/content/201912161125-PViRZ.html.

[286] "Knowledge-directed Artificial Intelligence Reasoning Over Schemas (KAIROS)," DARPA, 2019, https://www.darpa.mil/program/knowledge-directed-artificial-intelligence-reasoning-over-schemas.

[287] Ibid.

make faster decisions. Statements and discussion often refer to various military automated systems (ASVN), often referred to simply as automated control systems (ACS). ACS is not new, but the concept is the basis for how the Russian military is conceptualizing and using AI and autonomy to make Russian forces more efficient and more lethal. According to the Russian military's encyclopedia an ACS is defined as follows:

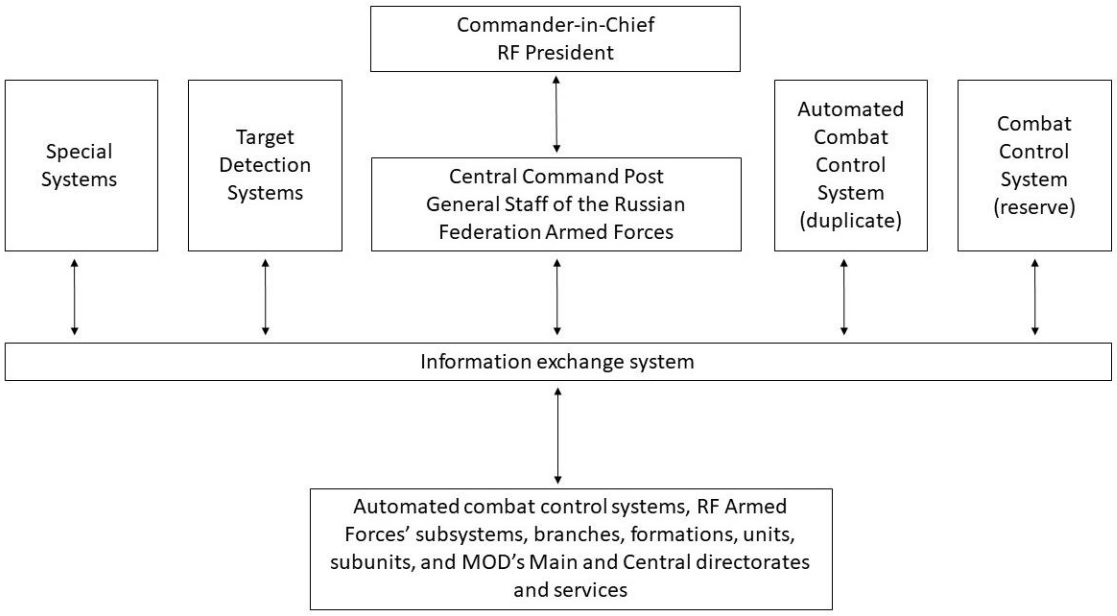
> A system that automates such processes or functions of command and control of troops and (or) weapons (combat assets) such as: collection, processing, storage and delivery of information necessary to optimize command and control of troops and weapons.[288]

The actual name of the overarching ACS systems is "ACS of the Armed Forces of the Russian Federation (ASU VS RF). "ASU VS RS" is the umbrella term for a number of ACS systems that operate at various levels and disparate purposes for command and control. The basis for the overarching system is reportedly Akatsiva-M, an operational-level system that provides commanders with real-time combat situational awareness. As of the time of this report, Russia is continuing to upgrade all of its operational units with the new systems.[289]

[288] Ministry of Defense of the Russian Federation, "Military Automated System," in *Military Encyclopedia*, https://encyclopedia.mil.ru.

[289] Ministry of Defense of the Russian Federation, *The communications equipment complex has completed the transfer of the control system of the Elninsk motorized rifle division of the Western Military District to a new level*, Dec. 7, 2020, https://function.mil.ru/news_page/country/more.htm?id=12301550@egNews.

Figure 22. Russian military depiction of its automated control system



Source: "Military Automated System (ASVN)," Russian Ministry of Defense website, accessed Apr. 19, 2021, https://encyclopedia.mil.ru/encyclopedia/dictionary/details_rvsn.htm?id=12531@morfDictionary.

The ACS may be similar to the US DOD Joint All-Domain Command and Control (JADC2) system concept. The JADC2 is designed to link sensors from all services to better enable commanders to make decisions through the integration of numerous sources of information, dramatically shortening the time required to take action.[290] The JADC2 explicitly lists cloud computing as part of its structure for sharing information and it is likely that the Russian ACS also envisions cloud computing. In 2019, the head of the Russian Ministry of Defense Information Systems Department noted that the Russian military is in the process of transitioning to cloud technologies and with the simultaneous development of a data transmission network, these will enable the MOD to create a single information services platform.[291] He also listed focus areas for the development of the system:

[290] John R. Hoehn, *Joint All-Domain Command and Control (JADC2)*, Congressional Research Service, 2020, https://fas.org/sgp/crs/natsec/IF11493.pdf.

[291] Victor Khudoleev, ""Digits" in the service in the army of a new generation," «Цифра» на службе в армии нового поколения, *Red Star*, 2019.

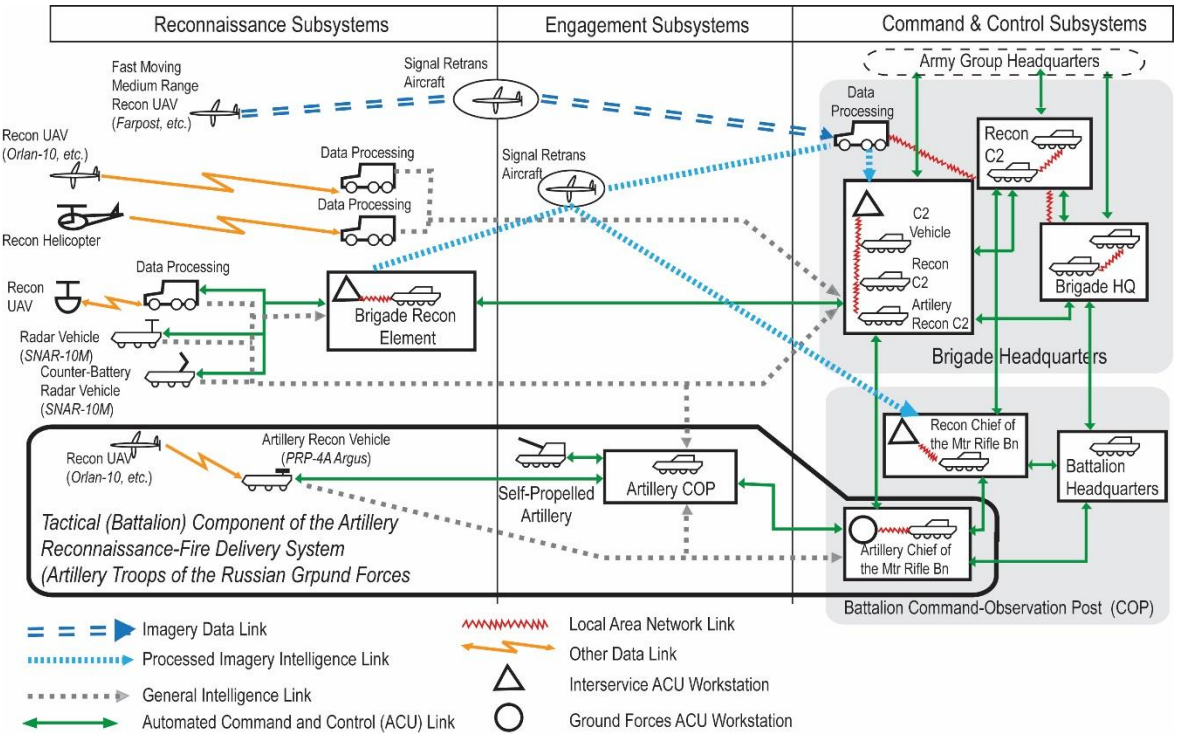
- First, software and hardware platforms are being created for centralized (cloud) computing, together with decentralized computing (so-called foggy) computing, which complement each other.
- Second, tools are being developed for mining large arrays of heterogeneous, unstructured data.
- Third, software tools are being created to provide work with multiple thematic databases with different access rights
- Fourth, software tools (information services) are being introduced that perform various information tasks in the interest of functional subsystems.[292]

The graphic on the following page represents an example of how Russia's ground forces envision and are deploying the ACS-linked systems. In this case, it represents the interconnectedness (green arrows indicating ACS connection) of an "artillery reconnaissance fire delivery system" that links all elements needed to engage critical targets with long-range precision munitions.[293]

[292] Ibid.

[293] V. Litvinenko and S. Voronkov, "Fire and artillery Maneuvers: The role of artillery of tactical formations of a new type in armed conflicts of the late XX - early XXI centuries," Огонь и маневр артиллерии: Роль артиллерии тактических формирований нового типа в вооруженных конфликтах конца XX - начала XXI в.в, *Armeiskii Sbornik*, no. 2 (2017), https://varb.mil.by/nauka/sbornik/Sbornik_31-2016.pdf; Lester Grau and Chuck Bartles, *The Russian reconnaissance Fire Complex Comes of Age*, The Foreign Military Studies Office, U.S. Army, 2018, p. 3.

Figure 23. Russian reconnaissance strike system



Source: CNA reproduction of graphic from Litvinenko and Voronkov, also found in Grau and Bartles.

An operational example of the Russian military implementing an ACS environment is a 2019 Caspian Fleet drill, in which Russian air, land, and sea forces were combined into a single information space. Data on detected targets were loaded into the system in real time and depending on the target type, the command chose the best attack methods. All information was received in real time and analyzed using an automated command and control system with AI elements, according to the press reports.[294]

Another example was a June 2019 simulated aerospace attack against the Crimean Peninsula. An ACS integrated S-400 and Pantsir-S air defense systems—together with other radio-

[294] Alaksei Ramm and Bogdan Stepovoi, "Sea-based reconnaissance: AI will direct ship-based missiles" (Разведка с моря: корабельные ракеты направит искусственный интеллект), Iz.ru, July 15, 2019, https://iz.ru/898018/aleksei-ramm-bogdan-stepovoi/razvedka-s-moria-korabelnye-rakety-napravit-iskusstvennyi-intellekt.

technical, aviation and Black Sea forces—to defeat a sudden attack of 70 cruise missiles. Military personnel in charge of the operation claim that the Russian military is implementing lessons learned from Syria into the design and functioning of the ACS.[295]

Figure 24. S-400 taking part in the Crimea ACS exercise

Source: Alexey Kozachenko, "Crimea Strong: a modern air defense system was tested on the peninsula," Izvestia.ru, June 2019, https://iz.ru/892304/aleksei-kozachenko/krymskaia-krepkaia-na-poluostrove-ispytana-sovremennaia-sistema-pvo.

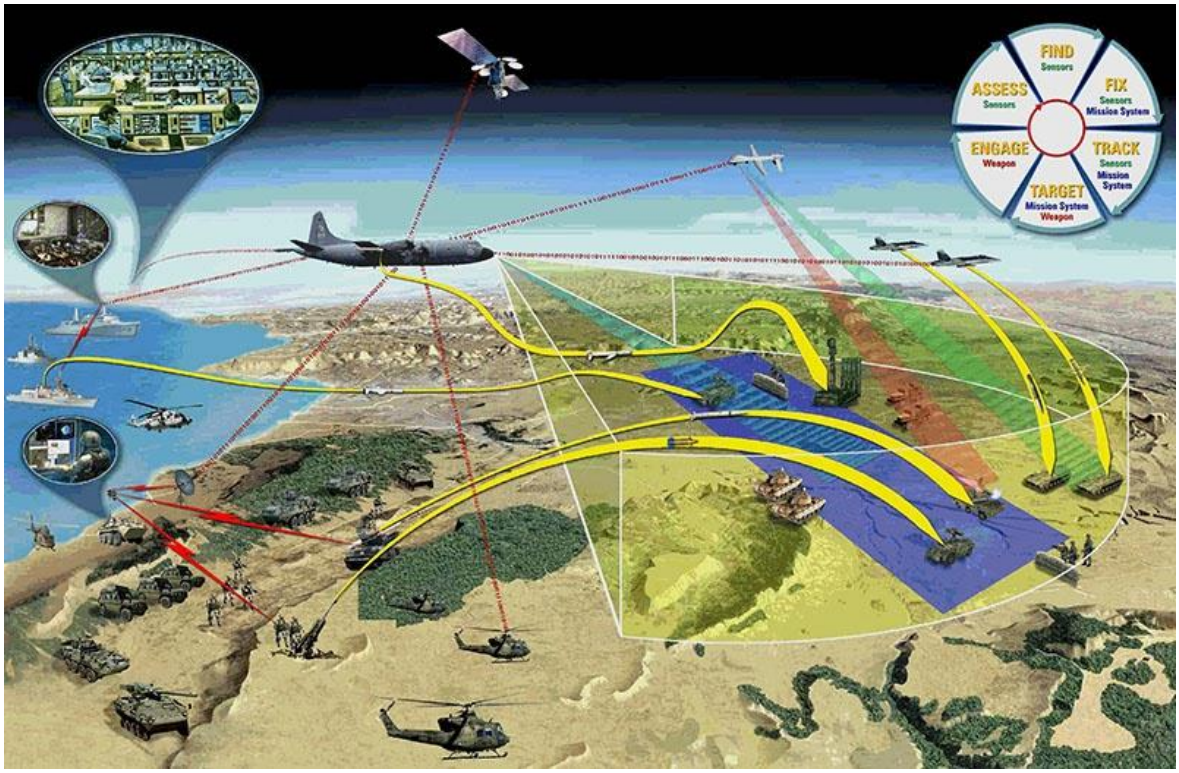
Currently, this ACS functions via human operators. The MOD thinks that in the future, this system will be equipped with AI in order to independently detect potential targets and distribute missile strikes without human intervention.[296]

[295] Alexey Kozachenko, "Crimea Strong: a modern air defense system was tested on the peninsula," Izvestia.ru, June 2019, https://iz.ru/892304/aleksei-kozachenko/krymskaia-krepkaia-na-poluostrove-ispytana-sovremennaia-sistema-pvo.

[296] "Double calculation: "Tornado" and "Iskander" are part of a single combat contour," [Двойной расчет: «Торнадо» и «Искандер» замкнули в единый контур], Izvestia.Ru, Aug. 10, 2020,

During the recent IDEX-2021 military exhibition in Abu Dhabi, Rosoboronexport showcased several new products to include a unified tactical-level control system, ESU TZ that is part of its larger Sozvezdie ACS, produced by a Rosoboronexport subsidiary called Sozvezdie. Currently, the system showcased in Abu Dhabi enables artillery and rocket forces to work in an integrated information environment. The article covering the event compares the ESU TK to the US Future Combat System (FCS) and the JADC2 system, asserting that unlike the Russian ESU TK, the FCS failed and the US started over with the JADC2.[297]

Figure 25. US graphic in Russian article describing ESU TK and netcentric warfare



Source: "Network-centric warfare" from Lyudmila Gundarova, "Through hardships to "Constellation", через терниии к <<Созвездно>>, *Zvezda Weekly*, Mar. 31, 2021, https://zvezdaweekly.ru/news/202131528-TqVxx.html.

https://iz.ru/1046036/anton-lavrov-roman-kretcul/dvoinoi-raschet-tornado-i-iskanderzamknuli-v-edinyi-kontur.

[297] Lyudmila Gundarova, "Through hardships to "Constellation", через терниии к <<Созвездно>>, *Zvezda Weekly*, Mar. 31, 2021, https://zvezdaweekly.ru/news/202131528-TqVxx.html.

At the tactical level, the Russian military sees AI as requisite to managing the large volumes of data and short decision timeframes. For example, there have been several initiatives in the design of Russian fighter aircraft to use AI to help manage the flow of information available to the pilot in order to simplify decision-making in aerial combat. The Su-35S, a heavy long-range multirole fighter, utilizes an onboard information and control system called IUS-35, which consists of several separate computers that bring together separate information channels in the aircraft into a single information feed that provides "intellectual support" to the pilot for target acquisition and aircraft combat maneuvering. During the Syria conflict, the system also increased the number of sorties conducted per day, using its ability to streamline pre-flight preparation and improve mental endurance by the pilot.[298]

Figure 26. Su-35

Source: Su-35, Oleg Belyakov, http://www.airliners.net/photo/Russia---Air/Sukhoi-Su-35/1570109/L/&sid=7adfd8f27673cbbb0d20ba69478da963, https://commons.wikimedia.org/w/index.php?curid=11500200.

[298] "Su-35," Sukhoi, https://www.sukhoi.org/products/samolety/256/. "Information and control system IUS-35 of the Su-35S fighter," [Информационно-управляющая система ИУС-35 истребителя Су-35С], BMPD, https://bmpd.livejournal.com/3047341.html.

Early warning and air defense

The Russian military is hoping that AI's potential for rapidly managing information from multiple sources and identifying threats can mitigate one of its most significant security concerns: an aerospace attack from the United States. An aerospace attack from the US would involve salvos of long-range, precision-strike munitions from air and sea platforms. The Russian military—having watched the campaigns in Yugoslavia, Iraq, Libya, and Afghanistan—identified the aerospace attack as the key military operation used by the United States to cripple an opponent early in a conflict. Not having a strike capability comparable to that of the United States, the Russian military (and the Soviet military before it) responded asymmetrically by developing extensive IADS and standalone systems to mitigate against a US aerospace attack.

Russian strategists see the processing power of AI as essential to accelerating the speed at which an IADS can monitor, detect, and respond to an impending aerospace attack. AI would better handle large volumes of strike munitions traveling at different speeds, altitudes, radar profiles and trajectories.[299] Military strategists note that the challenge of managing the information and the speed required to do so only become more difficult with the burgeoning role of hypersonic weapons. Some claim that only AI can handle these types of threats in a timely manner.

In 2019, the military conducted a drill utilizing a radar base that employed AI technology to defend against an aerospace attack. The system's algorithms monitored the airspace and, when a threat was detected, coordinated air defense systems to match the appropriate shooter to target and provided guidance to Russian aircraft on the direction of the attack.[300]

The Pantsir air defense system, for example, is purported to incorporate AI technologies that assist it in operating semi-autonomously, locating targets, classifying them by degree of danger, and recommending optimal solutions for defeating those targets.[301]

[299] Galkin, Polyandra, and Stepanov, "The state and prospects of employment of AI in military affairs."

[300] Aleksei Kozachenko and Aleksei Ramm, "Watching From Afar: Air Defense Forces Received Ground AWACS" (Далеко слежу: войска ПВО получили наземный АВАКС), Iz.ru, Sept. 15, 2019. https://iz.ru/918749/aleksei-kozachenko-aleksei-ramm/daleko-slezhu-voiska-pvo-poluchili-nazemnyi-avaks.

[301] "Pantsir with intellect: the system can counter attacks without operator input," [«Панцирь» с интеллектом: комплекс сможет отражать атаки без оператора], Izvetsia.ru, July 28, 2020, https://iz.ru/1040704/anton-lavrov-bogdan-stepovoi/pantcir-s-intellektom-komplekssmozhet-otrazhat-ataki-bez-operatora.

Figure 27. Pantsir air defense system

Source: Vitaly Kuzmin Military Blog, accessed Apr. 22, 2021, http://vitalykuzmin.net.

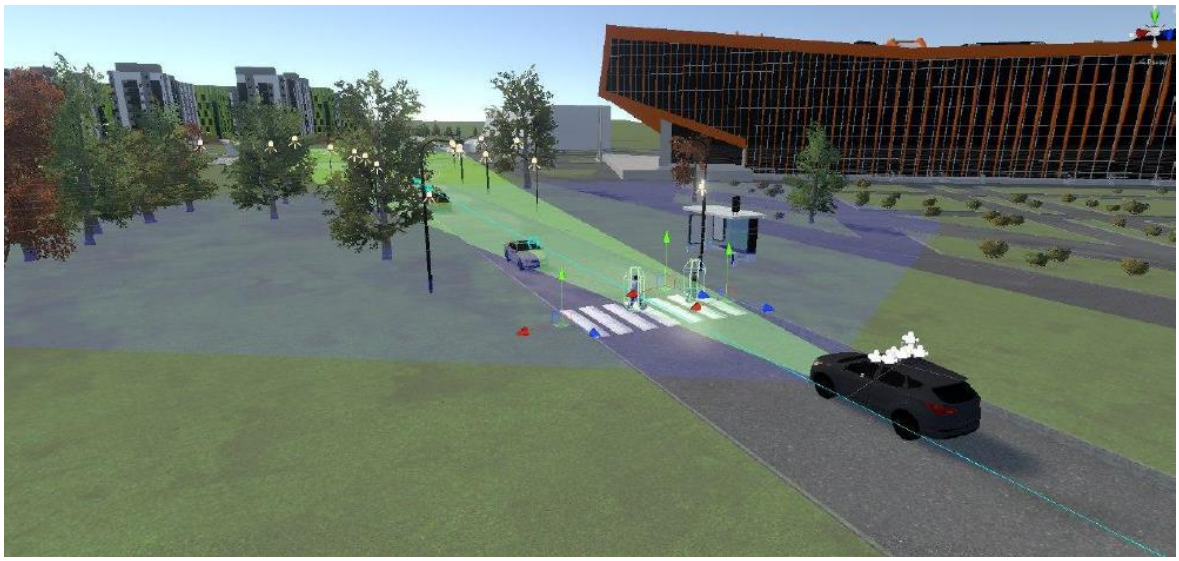
The proliferation of drones in modern combat has driven the Russian military to look for solutions to these low-flying, difficult to detect aircraft. This initiative has been driven in large part by the Russian experience in Syria where Russian bases have come under several attacks by inexpensive drone swarms. One example of the use of AI in addressing the drone threat is a system the Russian military is developing that analyzes the terrain surrounding its bases and calculates the most likely route the drone would take in order to take advantage of the terrain, simplifying defense planning of those bases.[302]

[302] "В России разработали систему прогнозирования маршрутов движения дронов противника," TASS, Aug. 2020, https://tass.ru/armiya-i-opk/9232665.

Logistics, training, maintenance and manufacturing

Russian military writers acknowledge the role that AI can play in improving predictive maintenance, logistical support, and supply/demand forecasting to Russia's forces. AI has the potential to optimize efficiency and cost while also increasing safety.[303] An interesting article appearing in *Morskoi Sbornik*, the official magazine of the Russian Navy, describes the use of AI in connection with cyber operations and naval logistics. The article ties cyber operations closely with network-centric warfare—the concept mentioned earlier related to the interconnectedness of military systems yielding more accurate and faster operations. As part of network centric warfare, one task is the control over and the denigration of information related to "information logistics" to include perpetuating false logistics hubs, warehouses, supplies reports, etc. The article posits the role of AI software in the creation of a false environment that is meant to confuse and compromise an adversary's logistics system.[304]

Figure 28. Training simulation for Kamaz logistics truck



Source: Innopolis University Center for Technological Components for Robotics and Mechanics, http://www.robotics.innopolis.university/.

[303] Galkin, Polyandra, and Stepanov, "The state and prospects of employment of AI in military affairs."

[304] A. Muhitov, *Artificial Intelligence Systems in the Cyberarchitecture of the Rear and Technical Support of the Navy*, Системы искусственного интеллекта в киберархитектуре тылового и технического обеспечения вмф, Morskoi Sbornik (June 2018), https://morskoysbornik.ric.mil.ru/upload/site231/7Sk8VdFnhM.pdf.

Autonomy

The Russian military is pursuing a wide range of systems and platforms with some level of autonomy. The Russian military's investment in autonomous technology derives from its belief that the application of autonomy increases Russian combat power. It does this primarily by preserving the lives of Russian soldiers and managing the information derived from the external environment of the battlefield more efficiently and with greater efficacy that systems relying solely on human action. [305]

Russian president Vladimir Putin has publically emphasized the importance that autonomy plays in shaping the current battlefield and the future of armed conflict, and this sentiment is shared by Russia's military leadership and key researchers.[306] In April 2021, the Chief of the Main Army Staff, Vasily Tonkoshurov, briefed Russia's Defense Minister Sergei Shoygu on the progress made in fielding and testing Russia's first military unit with strike robots. This unit is experimental and will provide insight into how Russian ground forces will doctrinally integrate robotic units into Russia's ground forces.[307]

In 2016, Andrei Grigoryev, Director of the Advanced Research Foundation (ARF)—Russia's DARPA analogue—discussed the changing relationship between soldiers and robots stating:

> I see more and more robotization, in fact there will be a war of operators and machines, and not soldiers on the battlefield who shoot at each other. Military tasks will be solved with minimization of personnel losses. The soldier will gradually turn into an operator and move away from the battlefield.[308]

And in 2020, ARF Deputy Director Vitaly Davydov echoed Grigoryev stating that

> Neither we, nor any other country, will turn away from the use of combat robots if we do not want people to continue to die on the battlefield. Robotic

[305] Samuel Bendett, "Russian Ground Robots: A Candid Evaluation and Ways Forward," Mad Scientist Labratory, June 2018, https://madsciblog.tradoc.army.mil/63-russian-ground-battlefield-robots-a-candid-evaluation-and-ways-forward/.

[306] "Putin shares his view on what Russian Army needs most," *Tass*, 2017, https://tass.com/defense/927489; "AI use in controlling weaponry in future will largely determine battle outcome — Putin," *Tass*, 2020, https://tass.com/defense/927489.

[307] "Russian Army to set up first military unit armed with strike robots," *Tass*, Apr. 9, 2021, https://tass.com/defense/1276039

[308] "Advanced Research Foundation believes robots will lead the future wars," (Фонд перспективных исследований считает, что войны будущего поведут роботы), Ria.ru, July 6, 2016, https://ria.ru/20160706/1459555281.html.

> "brethren", which can act faster, more accurately and selectively than people, will gradually begin to supplant living fighters. But a person will set the task and [retain] control of the actions of robots.[309]

In 2021, Gen. Zarudnitsky, Head of the Military Academy of the Armed Forces General Staff, discussed the growing technological range of military systems and Russia's leading role amongst foreign states in these trends, to include,

> the robotization of all spheres of armed struggle, the development of artificial intelligence of robotic complexes, the expansion of the range of tasks performed by [robotic complexes] giving them the ability to act autonomously, transitioning from the principal of "robot control" to the principle of "setting tasks for the robot. [310]

An interesting recent statement by Viktor Bondarev, former head of Russia's Aerospace Forces, also touched on the role robotics will play in relation to the presence of soldiers on the battlefield, stating:

> The firepower of modern weapons systems has increased many times over the weapons of previous generations…It is clear that, if possible, a person should be removed from the battlefield, to be replaced by robotic systems. Also, modern developed states, including Russia, are experiencing serious demographic problems…[in areas where] human military units could be ambushed it is now possible to send combat robots. If the robot is damaged and lost, it is not a problem because human lives will have been saved.[311]

The difficulty with discussing Russian-related initiatives with autonomous systems is the difficulty shared by discussing autonomy in general, given how the understanding and use of the term varies across disciplines and discussions. There are myriad frameworks for understanding the nature of autonomous systems and their level of autonomy going back

[309] "Vitaly Davydov: Soldiers will be replaced by terminators," Виталий Давыдов: живых бойцов заменят терминаторы, *Ria Novosti*, Apr. 21, 2020, p. 202, https://ria.ru/20200421/1570298909.html.

[310] V.B. Zarudnitsky, "The nature and content of military conflicts today and in the foreseeable future," *Voennaya Mysl* Характер и содержание военных конфликтов в современных условиях и обозримой перспективе, no. 1 (2021), https://vm.ric.mil.ru/Nomera.

[311] "A human must be removed from the battlefield: combat robots are pushing soldiers out," Человека с поля боя надо убирать»: боевые роботы теснят солдат, *Moskovskij Komsomolets*, 2021, https://www.mk.ru/politics/2021/04/09/cheloveka-s-polya-boya-nado-ubirat-boevye-roboty-tesnyat-soldat.html.

decades.[312] Perhaps in its broadest since, the greater the autonomy a system has, the less it is reliant on the knowledge of its designer.[313]

The Russian military lacks a clear taxonomy of autonomous systems and a clear set of official definitions about military autonomy. For example, it is not clear that there is a rigorous discussion as to the demarcation between autonomous and semi-autonomous systems as one would find within NATO or the United States.[314] The Russian military encyclopedia does list a robotic system as:

> A system that is able to perceive information from the environment and, based on that, perform certain actions both autonomously and with an operator in the control loop. The most characteristic robotic system in the military is in fact an unmanned vehicle with elements of artificial intelligence, equipped with navigation devices and manipulators capable of replacing human action. Such robotic systems can be used for both combat (e.g. tank destroyers) and combat [support] (reconnaissance, mining and demining, decontamination, etc.)[315]

This definition illustrates the difficulty of exactness and simplicity when it comes to defining autonomy in that it touches on many different aspects of autonomy but also attempts to incorporate other technologies such as artificial intelligence or robotics. This challenge of defining autonomy is a characteristic of the field broadly and not just a challenge faced by Russia.[316] Additionally, the Russian definition does not distinguish between non-weaponized and weaponized autonomous systems in contrast to Department of Defense Directive 3000.09:

> Autonomous weapon system. A weapon system that, once activated, can select and engage targets without further intervention by a human operator. This includes human-supervised autonomous weapon systems that are designed to

[312] Andrew Ilachinski, *AI, Robots, and Swarms: Issues, Questions, and Recommended Studies*, CNA, DRM-2017-U-014796-Final, 2017, https://www.cna.org/cna_files/pdf/DRM-2017-U-014796-Final.pdf.

[313] Norvig, *Artificial Intelligence: A Modern Approach*, p. 42.

[314] Sten Allik, Sean Fahey, Tomas Jermalavičius, Roger McDermott, and Konrad Muzyka, *The Rise of Russia's Military Robots: Theory, Practice and Implications*, International Centre for Defense and Security, 2021, p. 2, https://icds.ee/en/the-rise-of-russias-military-robots-theory-practice-and-implications/.

[315] Ministry of Defense of the Russian Federation, "Robotic System," Робототехническая система, Encyclopedia of the Russian Ministry of Defense, https://encyclopedia.mil.ru/encyclopedia/dictionary/details_rvsn.htm?id=12334@morfDictionary.

[316] Dr. Vincent Boulanin and Maaike Verbruggen, *Mapping the Development of Autonomy in Weapon Systems*, Stockholm International Peace Research Institute, 2017, pp. 5-8, https://www.sipri.org/publications/2017/other-publications/mapping-development-autonomy-weapon-systems.

allow human operators to override operation of the weapon system, but can select and engage targets without further human input after activation.

Semi-autonomous weapon system. A weapon system that, once activated, is intended to only engage individual targets or specific target groups that have been selected by a human operator.[317]

Although not a Russian construct, Andrew Williams provides a number of dimensions through which one can approach autonomous systems that may be helpful in thinking about autonomy-related developments in Russia's military.[318] These are not discrete categories into which one can neatly place different autonomous systems—it is not a taxonomy. Instead it is a way of understanding how something is autonomous in relation to its environment and intent. In the table below, the autonomy dimensions are listed in the first column with their respective definitions in the middle column. The far right column provides a key example of that dimension being pursued or employed in the Russian military. Again, these represent certain ways of understanding and describing how a system has some degree of autonomy. More detail is available on these systems later in the report.

Table 5. Autonomy dimensions

Autonomy dimension	Definition: An autonomous agent…	Key Russian example
Goals	Has goals that drive its behavior.	The Marker UUV system carrying out orders from its soldier companion.
Sensing	Senses both its internal state and external world by taking in information (electromagnetic waves, sound)	The Bylina EW system sensing the battlefield's electromagnetic spectrum to support a range of autonomous and semi-autonomous actions
Interpreting	Interprets information by translating raw inputs into a form usable for decision making	The Su-35S multirole fighter's onboard computer automating information management for its pilot
Rationalizing	Rationalizes information against its current internal state, external environment, and goals using a	The Galtel reconnaissance UUV mapping the ocean floor having to assess its current state,

[317] Directive, 2012, *DoDD 3000.09: Autonomy in Weapon Systems*, Establishes DoD policy and assigns responsibilities for the development and use of autonomous and semi-autonomous functions in weapon systems, including manned and unmanned platforms, pp. 13-14, https://www.esd.whs.mil/portals/54/documents/dd/issuances/dodd/300009p.pdf.

[318] Andrew P. Williams, "Defining Autonomy in Systems: Challenges and Solutions," in *Autonomous Systems: Issues for Defense Policymakers*, ed. Andrew P. Williams; Paul D. Scharre (Norfolk: Headquarters Surpeme Allied Commander Transformation, 2015), pp. 76-77, https://www.researchgate.net/publication/282338125_Autonomous_Systems_Issues_for_Defence_Policymakers.

Autonomy dimension	Definition: An autonomous agent…	Key Russian example
	defined logic (e.g., optimization, random search, heuristic search and generates course of action to meet goals	bypass obstacles, and optimize the best path to complete its mission
Decision making	Selects course of action to meet goals	Rosmorport's design of semi-autonomous dredging platforms for dredging harsh environments
Evaluating	Evaluates consequences of its actions in reference to goals and external constraints	United Engine Corporation's AI-enhances software to help design and test aircraft turbines
Adapting	Adapts its internal state and functions of sensing, interpreting, rationalizing, decision making, and evaluating to improve its goal attainment	ARF's Fedor anthropomorphic robot's use in environmentally dangerous rescue missions

Source: CNA order-of-battle database on unmanned systems.

Regardless of the discussion over schema used to understand autonomy, the Russian military is pursuing a number of autonomous and semi-autonomous capabilities and systems to address assessed military needs in all military domains. Examples of these initiatives are spread throughout this chapter and Appendix D attempts to give an exhaustive list of those systems associated with some level of autonomy and/or AI.

Robotic swarms and the Russian military

One particular area of interest is in swarming technology. Robotic swarms and swarm technology refer to multiple robots collectively solving problems, in this case military-related problems. The concept is based on naturally occurring systems such as bird and fish swarms.[319] The Russian military's interest in swarming is consistent with Russian efforts to keep apace of military-related autonomy developments globally as well as an assessment of the potential for robotic swarms to address Russian-specific security concerns across physical domains.

Robotic swarms have the potential to address Russian security concerns in the maritime domain. While Russian naval power has always taken second seat to its land power, Russian

[319] Umlauft M, Schranz M, Sende M, and Elmenreich W, "Swarm Robotic Behaviors and Current Applications," *Front. Robot. AI* (2020): 1, doi: 10.3389/frobt.2020.00036, https://www.frontiersin.org/articles/10.3389/frobt.2020.00036/full.

undersea technology and capabilities have remained formidable and swarm technology may be able to compliment this strength.[320] One article in *Voennaya Mysl* notes that the Russian Navy is developing self-propelled UUV's to address the need for an increased duration at sea to perform tasks such as reconnaissance, especially in areas more difficult for manned systems such as maintaining maritime awareness in the arctic, a longstanding concern for Russia's military given its long border with the Arctic and assessments of US submarine capabilities.[321] Furthermore, the author claims these small autonomous systems enable rapid superiority in coastal reconnaissance, mine-related activity, and anti-submarine warfare.[322] Although it is difficult to say that a country's potential with autonomous systems graphs neatly onto its already existing military-technical strengths, the Russian Navy is capable of fielding advanced undersea systems which would have at least some complimentary value in its ability to field advanced undersea autonomous systems.

A new open source report asserts that the Russian Ministry of Defense has an anti-submarine warfare project utilizing drones that will be able to use AI-enabled swarm technology.[323] In order to accommodate the type of weapons required to prosecute submarines, the drone will have to have considerable payload such as the S-70 Okhotnik. The article describes the concept as being "several hunters" with anti-submarine detection equipment and weapons operation in a single network. These hunters can be launched from both ground bases and ships. The article suggests these UAVs will be semi-autonomous but be able to independently strike targets or pass that information for other platforms. Given the reference to "several" it is

[320] Michael Kofman and Jeffrey Edmonds, "Why the Russian Navy Is a More Capable Adversary Than It Appears," *National Interest*, 2017, https://nationalinterest.org/feature/why-the-russian-navy-more-capable-adversary-it-appears-22009.

[321] "Rubin's Chief Designer: we are creating an underwater city in order to get to Arctic riches," Центр робототехники Минобороны РФ: в Арктике появятся микророботы "карманного" формата, *Tass*, 2017, https://tass.ru/interviews/4502372.

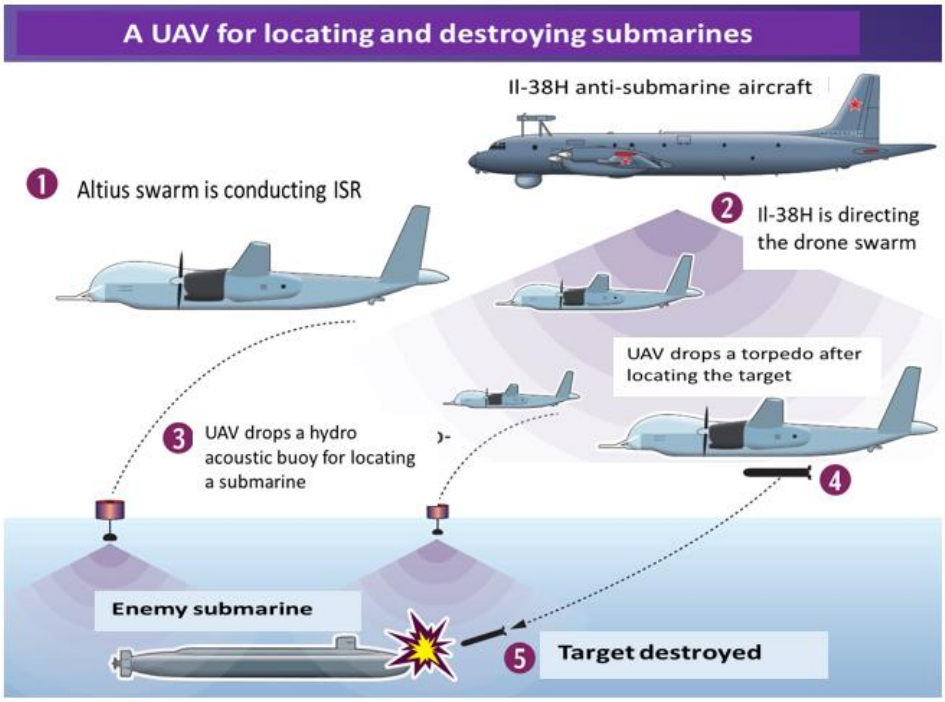
[322] S. M. Cherkasov and M. R. Gizitdinova, "Role of mobile underwater robots in solving the tasks of the navy ", Роль мобильных подводных роботов в решении задач военно-морского флота, *Voenna Mysl*, no. 1, http://militaryarticle.ru/voennaya-mysl/2008-vm/10195-rol-mobilnyh-podvodnyh-robotov-v-reshenii-zadach.

[323] Anton Lavrov and Roman Krezul, "Packing weapons: Ministry of defense in search of anti-submarine drone: Heavy drone will work together to detect and hit submarines," Стайное оружие: Минобороны в поиске противолодочного дронаТяжелые беспилотники будут действовать сообща, чтобы обнаружить и поразить субмарины, *Izvestia*, Apr. 2, 2021, https://iz.ru/1145514/anton-lavrov-roman-kretcul/stainoe-oruzhie-minoborony-v-poiske-protivolodochnogo-drona

unclear whether the article is referring to an actual "swarm" or a multi-robot system containing relatively few robotic systems.[324]

The article also mentions the anti-submarine complex Otvet (Answer) as one platform that would be used in concept with the UAVs.[325] Otvet is an anti-submarine torpedo launched from the universal launcher installed on most new design and modernized Russian ships. The article quotes Deputy Defense Minister Alexei Krivoruchko stating that once a submarine is found "at a distance of several tens of kilometers" the Otvet missile will be able to deliver the torpedo in a matter of seconds.

Figure 29. Translated Russian depiction of new anti-submarine drone configuration



Source: CNA translation: Krezul, "Packing weapons: Ministry of defense in search of anti-submarine drone: Heavy drone will work together to detect and hit submarines."

[324] Ilachinski, *AI, Robots, and Swarms: Issues, Questions, and Recommended Studies*.

[325] Yuri Gavrilov, "Look for our "Answer" underwater," Наш "Ответ" ищите под водой, *Russian Weapons*, Nov. 5, 2020, https://rg.ru/2020/11/05/korabli-vmf-usiliat-novym-protivolodochnym-raketnym-kompleksom.html.

Russian officials have also discussed the utility of robotic swarms for land operations. For example, Russian military officials have envisioned a role for swarms in urban warfare. Light and heavy UGV's operating in concert with swarmed ISR and combat UAVs to find and target adversary soldiers and platforms.[326] During Kavkaz-2020, one of Russia's yearly strategic command post exercises, three different types of UAVs, the Forpost, Orlan-10, Eleron-3, and others were "pooled" into one group.[327] Although the report does not give an account of the number of actual platforms involved in the grouping and whether or not it was an actual swarm, it underscores the Russian interest in having robotic swarms as part of its combat capability.

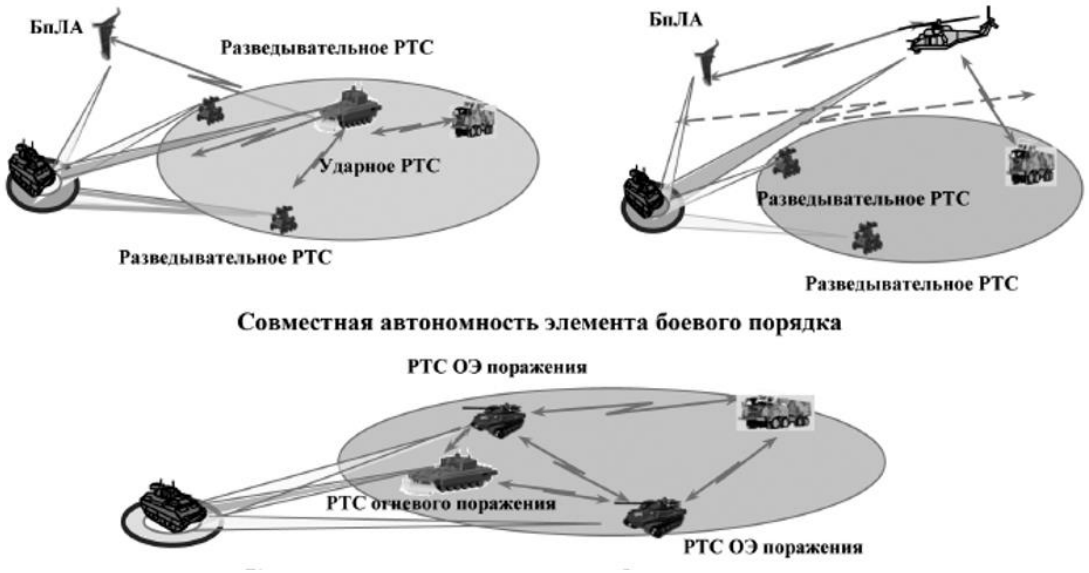
In the aerospace domain, the Russian military is looking to develop and employ robotic swarms for aerial reconnaissance, electronic warfare, and ground strikes. These systems will purportedly be able to swarm with manned aircraft, ground, and sea-based robotic systems. The Kronshtadt Design Bureau recently announced a new robotic swarm concept called "Molniya" that involved jet-powered stealth drones capable of conducting aerial intercept and ground strike missions.[328]

[326] Burenok, Durnev, and Kryukov, "Intelligent Armament: The Future of Artificial Intelligence in military Affairs."

[327] "Swarm of drones used in Kavkaz-2020 exercise first time against enemy forces," *Tass*, Sept. 24, 2020, https://tass.com/defense/1204513.

[328] "Swarming jet-propelled drones in development for Russian aerospace forces," Источник: для ВКС создают работающие в стае реактивные беспилотники, *Ria Novosti*, 2021, https://ria.ru/20210301/bespilotniki-1599368302.html.

Figure 30. Russian graphic depicting swarm integration across different platforms and with manned and unmanned systems.



Source: http://www.avnrf.ru/index.php/zhurnal-qvoennyj-vestnikq/arkhiv-nomerov/1162-vestnik-avn-3-2019.

Autonomy and conflict

Underscoring the importance of autonomy, and specifically UAVs, in combat, Chief of the General Staff General Valery Gerasimov noted in 2018 that today's combat is "…unthinkable without drones – they are used by gunners, scouts, pilots – everyone."[329] In addition to major worldwide trends in autonomy, several major conflicts have shaped how the Russian military will use its unmanned and autonomous military systems—Syria, and the 2020 Nagorno-Karabakh war. While Russian military forces in eastern Ukraine did use drones, primarily for reconnaissance and artillery spotting, Russian reporting on their use is fairly limited. The Russian military leadership has, however, proclaimed the benefits of autonomy in the Russian military's experience in Syria.

By July 2018, the number of Russian UAV flight missions in Syria stood at over 23,000, with 140,000 flight hours. This success is owed to numerous short and mid-range ISR drone

[329] "Russian drones during the operation in Syria spent in the air more than 140 thousand hours," (Российские беспилотники во время операции в Сирии провели в воздухе более 140 тысяч часов), Official website of the Russian MOD, July 6, 2018, http://syria.mil.ru/news/more.htm?id=12184627@egNews.

platforms. Yet, in Syria, Russia lacked a true combat UAV capable of striking targets, leaving that role to manned artillery and aviation units. The Russian UAV fleet has expanded to over 2000 drones today, with ground forces flying approximately 1500 UAVs.

Likewise, Syria continues to serve as a significant test bed for Russia's unmanned ground vehicle (UGV) technology for missions such as demining, and ISR.[330] Syria-tested Uran-6 and Uran-9 UGVs are entering service with engineering, combat and sapper units, and the MOD is using what it learned in Syria to build out domestic and international expertise in demining operations.

Figure 31. Soldiers training on the Strelets system

Source: "IA "Weapons of Russia," Alexey Kitaev (Фото: ИА "ОРУЖИЕ РОССИИ", Алексей Китаев), accessed Apr. 22, 2021, https://www.arms-expo.ru/photo/fotoreportazh/na-uchenii-razvedchiki-primenili-noveyshiy-krus-strelets-i-ekipirovku-ratnik/.

[330] Samuel Bendett, "Russian Ground Robots: A Candid Evaluation and Ways Forward," Mad Scientist Laboratory blog #63, https://madsciblog.tradoc.army.mil/63-russian-ground-battlefield-robots-a-candid-evaluation-and-ways-forward/; Ekaterina Eliseeva, "Sphera and Uran: RF Mine Action Center sappers are working on demining," "Скарабей", "Сфера" и "Ураны". Где и что разминируют саперы Противоминного центра РФ, Jan. 21, 2021, https://tass.ru/armiya-i-opk/10505797.

In April 2021, the Ministry of Defense announced that Russian ground forces in Syria had successfully used the tactical level "Strelets-M"—a modernized wearable intelligence, command and communication complex (KRUS)—to direct Orion tactical strike drones on terrorist targets in a test of the system.[331]

Another key conflict that put the MOD on notice was the recently concluded 2020 Nagorno-Karabakh war, where the attacking Azerbaijani ISR and combat drones, loitering munitions and ground troops defeated the Armenian forces in just a few weeks. One of the key takeaways from the conflict was the difficulty in defending against numerous small drones.[332] Noting this, the Russian MOD has voiced the need for a range of UAVs in combat and loitering roles to effectively penetrate adversary air defenses, neutralize ground formations and to work in swarms.[333] As an example, Rostec recently announced that Russian forces tested two loitering drones in Syria, Kub and Lancet, and that the Russian military will have priority in their acquisition in the near future.

The MOD is public about the Russian military's presence in Syria, and has deliberated extensively on the Nagorno-Karabakh lessons. At the same time, international observers noted and recorded Russian UAVs in Eastern Ukraine flying ISR and electronic warfare missions. Lessons from Ukraine are certainly adding to the MOD's formulation of military autonomy operational concepts. Taken together, these conflicts are driving the Russian military to seek greater ISR capacity.[334]

AI in autonomous and semi-autonomous systems

The MOD is coordinating resources for the development, evaluation, and eventual fielding of military autonomy, with AI now a major component in the development and procurement of

[331] "MOD tested in Syria a unique method for combat drones' targeting " В Сирии испытали уникальный метод наведения ударных беспилотников, *Ria Novosti*, Apr. 4, 2021, https://ria.ru/20210404/siriya-1604135512.html

[332] Michael Kofman, "A Look at the Military Lessons of the Nagorno-Karabakh Conflict: It would be a mistake for great and middle powers to ignore the Nagorno-Karabakh conflict.," *Moscow Times*, Dec. 21, 2020, https://www.themoscowtimes.com/2020/12/21/a-look-at-the-military-lessons-of-the-nagorno-karabakh-conflict-a72424.

[333] Ruslan Pukhov, "Second Karabakh War: Preliminary Lessons," (Вторая карабахская: промежуточные итоги), ONvo.Ng.ru, Oct. 22, 2020, https://nvo.ng.ru/realty/2020-10-22/1_1114_karabakh.html.

[334] Anton Lavrov and Roman Krezul, "Drone reconnaissance: bloodhound drones have appeared in the troops: New UAVs specialize in detecting enemy air defenses," Izvestia.ru, Nov. 2020, https://iz.ru/1089566/anton-lavrov-roman-kretcul/razvedka-dronom-v-voiskakh-poiavilis-bespilotniki-ishcheiki.

such systems.[335] In most public statements, AI is discussed in terms of command, control, and ISR for unmanned and autonomous vehicle development and testing. Specifically, the Russian military considers UAVs to be essential forward ISR and combat platforms that minimize both the number of personnel required and the danger often associated with reconnaissance missions. Responding to the MOD's urgency for domestically produced combat UAVs, defense-industrial entities are fielding several AI-enabled combat drone platforms. The long-range Russian Sokol Altius-U and S-70 Okhotnik combat drones will feature AI elements for command and control as well as enabling them to operate at some level of autonomy. These systems will also be able to interact with manned aircraft in a "loyal wingman" configuration. The MOD recently announced that Okhtonik will interact with the manned Su-57 Russian fifth-generation fighter, with the pilot commanding the UAV.[336] Both drones are designed to penetrate adversary air defenses, and detect and attack important targets such as missile launchers, adversary aircraft, and enemy command and control centers. Okhtonik, a stealthy, blended-wing 20-tonne drone, was originally created for high-intensity conflicts with the possibility of performing an interceptor role.[337] In September 2019, the MOD conducted the inaugural loyal wingman flight for first time, when the Su-57 and the S-70 Okhotnik drone flew together, marking an important step in Russian autonomy and "loyal wingman" development. Recently, the MOD announced that Okhotnik can launch hypersonic missiles when flying together with Su-57 – MOD claims this configuration can potentially replace entire manned aviation squadrons, leading the Russian military to start developing entirely new CONOPS for using both unmanned and unmanned aviation. This may potentially involve drones like Okhotnik or Altius lunching their own combat drone swarms, like the recently-announced Molniya, against adversary aerial and ground targets. In April 2021, Andrey Yelchaninov, First Deputy Chairman of the Board of the Russian Military-Industrial Commission, stated that fielding of the Okhotnik should begin in 2024.[338]

[335] Roman Biryulin, "Interview with Alexey Krivoruchko, Deputy Minister of Defense of the Russian Federation," [Интервью заместителя Министра обороны Российской Федерации Алексея Криворучко], Redstar.ru, Dec. 30, 2020, http://redstar.ru/oruzhie-rossii-operezhaet-vremya/.

[336] Anton Lavrov, "Closed sky: Russia is working on innovative air combat," Закрытое небо: в России создается инновационная система воздушных боев, *Izvestia*, Feb. 24, 2021, https://iz.ru/1127710/anton-lavrov/zakrytoe-nebo-v-rossii-sozdaetsia-innovatcionnaia-sistema-vozdushnykh-boev.

[337] "Altius Heavy Russian drone with artificial intelligence," «Альтиус». Тяжёлый российский беспилотник с искусственным интеллектом, TopWar.ru, Mar. 27, 2020, https://topwar.ru/169438-altius-tjazhelyjrossijskij-bespilotnik-s-iskusstvennym-intellektom.html.

[338] "Russian troops to start receiving Okhotnik strike drone in 2024 — official," *Tass*, Apr. 13, 2021, https://tass.com/defense/1277657.

At this point, it does not appear that Russia is able to produce fully military autonomous concept vehicles envisioned by the ARF. Yet it does experiment with this technology. For example, the ARF designs platforms to serve as test beds for experimentation. The ARF designed the Marker UGV project also to serve as a test bed for different domestic technologies that have military applications, enabling private and public companies to build relationships with MOD. The Marker acts as a universal platform with a modular architecture for testing deep neural networks to assist in decision-making, manned-unmanned teaming concepts, and interacting with existing and future unmanned aerial vehicles (UAVs).[339] Rostec is also working to create a viable test bed using an unmanned version of the new T-14 Armata main battle tank. Armata's developers recently announced that the T-14's unmanned version will not be mass-produced, but will serve as a demonstrator of advanced robotics technologies.[340] The MOD intends additional UGV concepts for use as test beds for refining technical capacity and combat applications.[341] Developing greater autonomy capabilities with existing tracked and wheeled platforms is becoming a major trend in both MOD and in the country's military-industrial complex. Using existing platforms by converting them to autonomous, semi-autonomous or even remote-controlled mode saved developers like Uralvagonozavod time and money, since they do not have to create new systems from scratch and can instead build on proven tank or armored vehicle platforms.

Another related example of domestic industry responding to the needs for military autonomy is Rostec's development of an automated intelligent control system for robotic formations that utilizes neural networks. The developer claimed the system integrates target information obtained from multiple sources such as satellites, drones, or radar, and transmits those data to robotic systems engaged in combat. Rostec claimed that the new development increases the effectiveness of combat systems threefold by minimizing human participation in the command and control process.[342]

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[339] Oleg Martyanov, "Oleg Martyanov: There won't be an army of terminators. There will be an army of Markers," Олег Мартьянов: в будущем будет не армия терминаторов, а армия умных "Маркеров", *Tass.ru*, June 29, 2020, https://tass.ru/interviews/8831445.

[340] "Unmanned Armata will not be mass-produced," *Ria Novosti*, Feb. 8, 2021, https://ria.ru/20201207/armata-1587961052.html.

[341] "The General Staff spoke about the development of promising weapon systems," В Генштабе рассказали о разработке перспективных комплексов вооружения, *Tass.ru*, https://tass.ru/armiya-i-opk/10644329.

[342] "Russian scientists are working on the creation of a neural network that will control robots during mine clearance operations," TvZvezda.ru, Aug. 26, 2020, https://tvzvezda.ru.

At sea, Russian military and the ARF have successfully tested a deep-diving Vityaz unmanned underwater vehicle (UUV) that descended to the bottom of the Mariana Trench, the deepest-explored part of the global maritime domain. The development team claimed on-board AI enabled better situational awareness and decision-making.[343] Another notable project is a Galtel UUV that explored the sea-bed off the Tartus Port in Syria, which supposedly also had on-board AI for decision-making and navigation.[344] Today, the Russian Naval leadership is preparing the service for future combat by emphasizing that crew training should include the operation of modern equipment and weapons with a high degree of automation.[345]

Military AI ecosystem

The Russian military AI and robotics ecosystem is growing rapidly, with new entities, organizations, and centers joining existing efforts. Major organizations with existing programs of records, government funding, and proven concept solutions are also expanding their focus. With MOD's growing interest in AI and robotics development and application, the key actors will probably receive increasing financial and logistics support. One significant trend to monitor is more Russian universities joining military and dual-use research into the military application of AI and robotics, given MOD statements from the ARMY-2020 Expo that there should be more cross-linking and cooperation between civilian and military entities and efforts.

Another significant trend is the funding and supporting work at government and public institutions between military and civilian AI and robotics efforts. In another attempt to crosslink military and civilian research, the MOD along with the Kurchatov Institute are starting an interdepartmental and interdisciplinary, peer-reviewed scientific journal called the Bulletin of the Military Innovative Technopolis (ERA). According to Colonel Dmitry Terebov, deputy head of the Main Directorate of Research Activities of the Russian Ministry of Defense,

[343] "The Vityaz became the first "robot" to reach the bottom of the Mariana Trench," Аппарат "Витязь" стал первым "роботом", достигшим дна Марианской впадины, *Ria Novosti*, May 9, 2020, https://ria.ru/20200509/1571206567.html?in=t.

[344] "Russian underwater robot completed its military mission in Syria," Российский подводный робот выполнил боевую задачу в Сирии, *Rossiyskaya Gazeta*, Feb. 22, 2018, https://rg.ru/2018/02/22/rossijskij-podvodnyj-robot-vypolnil-boevuiu-zadachu-v-sirii.html.

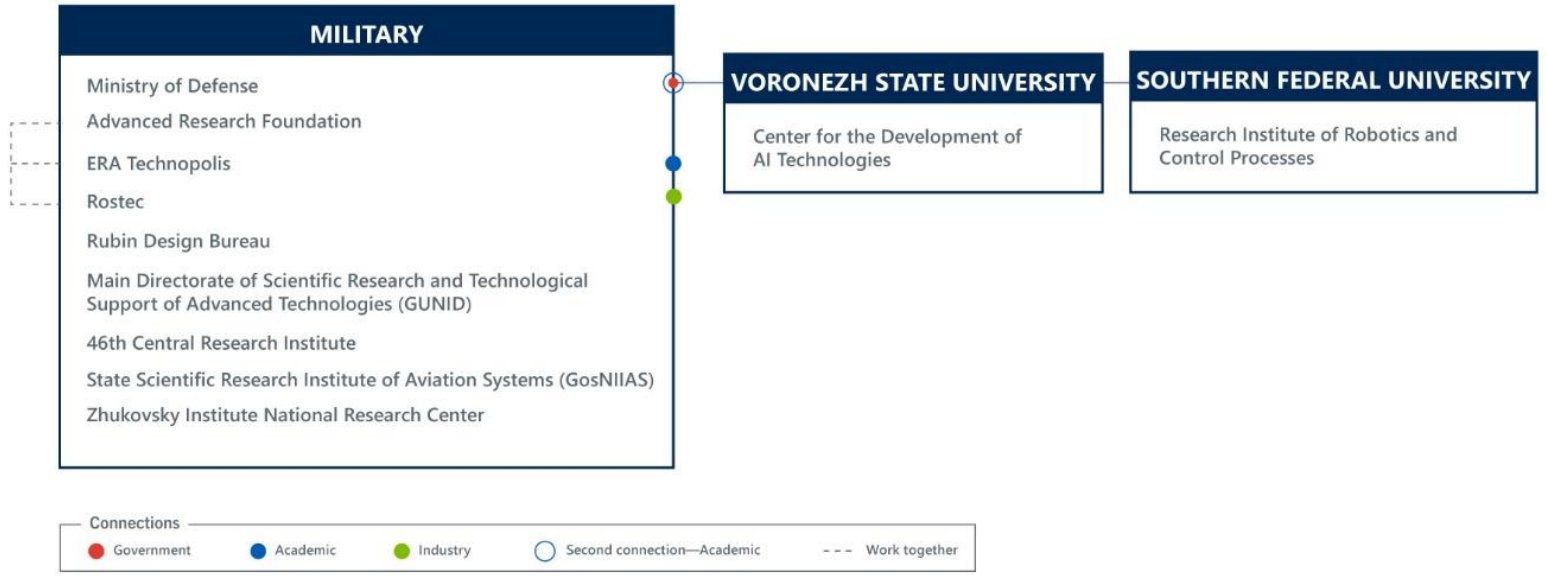
[345] "The Commander-in-Chief of the Russian Navy spoke about the crew training," Главком ВМФ рассказал о подготовке экипажей новых кораблей, Flot.com, Jan. 14, 2021, https://flot.com/2021/%D0%92%D0%BC%D1%841/.

> The publication of the journal will contribute to broad coverage of the results of breakthrough developments and achievements of the technopolis, as well as unite the scientific community, representatives of the civilian and military sectors in order to develop the scientific, technological, and industrial potential of the country and strengthen its defense.[346]

Finally, it is unclear at this point whether Russia's non-state-owned, private sector companies are joining this MOD-driven and -directed effort; their uncertainty about it or their unwillingness to become part of the domestic military research and development effort may prevent them from doing so. See Appendix C of this report for a list of key organizations in the military AI ecosystem.

[346] "Achievements of the country's leading scientists will be published in the Bulletin of the Military Innovative Technopolis "ERA"," В Вестнике Военного инновационного технополиса «ЭРА» будут публиковаться достижения ведущих ученых страны, Department of Information and Mass Communications of the Ministry of Defense of the Russian Federation 2021, https://function.mil.ru/news_page/country/more.htm?id=12349063@egNews.

Figure 32. Overview of Russia's military AI ecosystem



Source: CNA.

AI and autonomy-related Russian military platforms

The table below includes systems found in reporting to be associated with AI and/or autonomy. As in any classification of AI and autonomous systems, there is overlap between the categories. In surveying Russian systems associated with AI, we cast a wide net to include those systems whose AI-enhanced capabilities were not clear. In many instances, reporting simply asserts that a system has "AI components" with little more if any detail. Since the aim of this report is to map out the Russian AI and autonomy ecosystem, we thought it best to include any mention of AI or autonomy. For example, the Russian government has not disclosed the level of AI or autonomy with its Poseidon UUV—essentially a nuclear tipped torpedo for targeting coastal areas. There has been speculation, however, and we include that where it seems reasonable. Where platforms lack names, the team was unable to find any. For example, a report would refer to a UAV being developed by the MOD with claims about its AI-enhanced capabilities without giving a name. Finally, we hope this list is fairly comprehensive as of the time of writing but note that it is reflective only of the systems found in open source reporting. Following the table, we provide more in-depth descriptions and images of select systems featured in our *AI in Russia* newsletters.

Table 6. AI and autonomy-related Russian military platforms

Type	Name	Manufacturer	AI/Autonomy aspect
Unmanned combat, air, underwater, and ground vehicles			
UCAV	Okhtonik (Охотник)	Sukhoi (Сухой, Ростех)	ISR and autonomy for interceptor and ground attack roles
UCAV	Altius (Альтиус)	UZGA (УЗГА)	ISR and autonomy for interceptor and ground attack roles
UAV	Volk-18 (Волк-18)	Almaz-Antey (Алмаз-Антей)	ISR for detecting and attacking drones
UAV	Unknown	Kalashnikov (Калашников)	Logistics for transporting cargo
UAV	Unknown	N/A	ISR for detecting air defense
UAV (helicopter)	R-2200 (P-2200)	Rus Design Bureau (Конструкторское бюро Русь)	Autonomy for transportation

Type	Name	Manufacturer	AI/Autonomy aspect
UAV (helicopter)	Unknown	ARF (ФПИ)	ISR and autonomy for general operation
Unmanned naval vessel	Kadet-M (Кадет-М)	*Center for the Development of Innovation Activity SPbPU (Центр развития инновационной деятельности СПбПУ)*	Autonomy for ISR and combat operations
UUV	Poseidon (Посейдон)	Rubin and Malahit design bureaus (Рубин и Малахит Конструкторское бюро)	Autonomy and AI for navigation
UUV	Galtel (Гальтель)	Institute for problems of marine Technologies RAS (ИПМТ ДВО РАН)	Autonomy for ISR and situational awareness
UUV	Vityaz (Витязь)	ARF and Rubin Design Bureau (ФПИ и Рубин Конструкторское бюро)	ISR and Autonomy for deep-water missions
UGV	Udar (Удар)	Rostec (Ростех)	Autonomy for combat operations
UGV	Marker (Маркер)	ARF (ФПИ)	Autonomy and ISR as a test bed for UGV technology
Swarm technology	Unknown	Southern Federal University (Южный федеральный университет)	Swarm application for air and ground drones
Humanoid android	Fedor (Федор)	ARF and Android Technologies (ФПИ и Андроидная Техника)	Autonomy for operating in dangerous environments
AI and autonomy in military platforms			
Naval vessel	Project 22160 (Проект 22160)	Zelenodolsk and Zaliv shipyards (Зеленодольский ССЗ и Залив ССЗ)	Reducing crew through automation and AI
Tank	T-14 Armata (Армата)	Rostec (УралВагонЗавод-Ростех)	Autonomy for combat operations and a test bed for unmanned tank technology

Type	Name	Manufacturer	AI/Autonomy aspect
Aircraft	Su-35S (Су-35С)	Sukhoi (Сухой, Ростех)	On-board information management
Aircraft	MiG-35 (МиГ-35)	Russian Aircraft Corporation (ОАК-Ростех)	On-board information management , target recognition
Artillery	MSTA-SM (МСТА-СМ)	Rostec (Ростех)	Targeting automation
Truck	Kamaz truck (Камаз)	Kamaz (Камаз)	Driver assist navigation and endurance
Anti-personnel mine	POM-3 "Medallion" (ПОМ-3 «Медальон»)	NIII (Научно-исследовательский инженерный институт (НИИИ)	Autonomous target identification and activation
Mines	Surface (Поверхность)	Unknown	Autonomy for identifying and striking targets
Soldier gear	Sotnik (Сотник)	Rostec (Ростех)	System automation that connect different Sotnik elements
Information management and decision making			
National-level C2	NDMC (НЦУО)	Ministry of Defense (Министерство Обороны)	Monitoring of Russian forces and international geopolitical situation
Maritime	AquaHranitel (АкваХранитель)	Formosa System (Формоза-Сервис)	Maritime domain oversight
Military C2	ACS of the Russian Military (АСУ)	Ministry of Defense (Министерство Обороны)	System of systems utilizing AI for managing battlefield information
Aircraft management system	Kasatka (Касатка)	RadarMMS (РадарММС)	System for greater autonomy in aircraft, helicopters and drones.
Text analysis	Text Analysis (Анализ текста)	MSU and RAS (МГУ и РАН)	Information operations - identifying extreme or inappropriate content
EW system	Bylina (Былина)	Ruselektronics (Rostec) (Росэлектроника, Ростех)	ISR, IO and Autonomy for electronic warfare operations
Early warning and air defense			
Air defense	Derivatsiya (Деривация)	Burevestnik Central Research Institute (ЦНИИ «Буревестник»)	Autonomy for air defense operations

Type	Name	Manufacturer	AI/Autonomy aspect
Air defense	Pantsir-S (Панцирь-С)	KBP Instrument Design Bureau (АО «КБП)	Autonomy for air defense operations
Air defense	ResonanceNE (РезонансНИ)	Rezonans (Резонанс)	System automation
Air defense	Penicillin (Пенициллин)	Rostec (Ростех)	ISR, C2, system autonomy for detecting adversary assets
Early warning	Unknown	Unknown	AI-enhanced ballistic missile early warning
Logistics, training, and military manufacturing			
Quantum computing	Unknown	Rosatom (Росатом)	Quantum computing
Steel inspection system	Unknown	RT-techpriemka (Rostec) (РТ-Техприемка – Ростех)	Logistics- managing steel quality in defense enterprises
Engine manufacturing	Unknown	Rostec and Zyfra (Ростех и Цифра)	Logistics - managing engine production quality at defense enterprises
Unmanned navigation	Unknown	Rosmorport (Росморпорт)	Logistics for unmanned civilian maritime transport
Turbine design	Unknown	UEC (Объединённая двигателестроительная корпорация, Ростех)	Logistics for better turbine design
Naval simulator	Unknown	Unknown	System automation for training naval personnel

Source: CNA. Derived from open source reporting.

Select Russian military platforms

RB-109A Bylina		
Manufacturer	***System Type***	***AI/Autonomy Aspect***
Rostec	*EW platform*	*AI-enabled situational understanding, command and control, and jamming capabilities*

Source: "Bylina," https://iz.ru/1000101/aleksei-ramm-bogdan-stepovoi/vidit-tcel-bylina-smozhet-atakovat-protivnika-bez-uchastiia-operatora.

The Rb-019A Bylina is a Russian electronic warfare (EW) platform that is designed to provide situational understanding, command and control, and jamming capabilities within the electronic battlefield. The system consists of five trucks with multiple staff sections and is likely deployed at the EW brigade level.

According to open source reporting, once deployed the system automatically establishes communication links with higher headquarters, sister EW battalions, lower echelons, and other individual EW systems such as Moskva-1, Silitsy-2, Palatin, and Tirda-2S.

The system then purportedly surveys the electronic environment, distinguishing between different types of emitting platforms and indicating whether they are friend or foe, without the aid of a human operator. Platforms specifically named in the reports include radio stations, communication systems, radar systems, satellite communications, and AWCAS. There are particular references to the system's ability to find low-powered radios used by saboteurs—a common theme in Russian reporting that often calls out adversary special operations forces as posing a danger to Russian EW and C2 platforms. Based on this situational awareness, Bylina is then purportedly capable of independently jamming adversary systems without jamming Russian forces.

Bylina passed formal testing in 2017, culminating in its participation in Zapad-17, that year's strategic military exercise. Fielding began in 2018, and the MOD has stated that its goal is to field the system to all its EW brigades by 2025.

Sources: Alexey Ramm, Bogdan Stepovoi, "Seeing the Goal: "Bylina" will be able to attack the enemy without operators," *Izvestia,* Apr. 16, 2020, accessed June 4, 2020, https://iz.ru/1000101/aleksei-ramm-bogdan-stepovoi/vidit-tcel-bylina-smozhet-atakovat-protivnika-bez-uchastiia-operatora; Topwar.ru, "The Ministry of defense will receive the EW control system Bylina," Apr. 4, 2017, accessed June 4, 2020, https://topwar.ru/112602-minoborony-rf-poluchit-sistemu-upravleniya-stanciyami-reb-bylina.html; A.V. Karpenko, "Brigade Electronic Warfare Automated Control System, RB-109A Bylina," Bastion-karpenko.ru, Apr. 4, 2017, accessed June 4, 2020, http://bastion-karpenko.ru/rb-109a-bylina/.

Galtel		
Manufacturer	***System Type***	***AI/Autonomy Aspect***
Institute for problems of Marine Technologies RAS	*Unmanned underwater vehicle*	*AI-enabled situational understanding, sea floor mapping and maritime monitoring*

The Russian military and its defense and industrial complex are designing, testing, and evaluating a wide variety of unmanned underwater/surface vehicles (UUVs/USVs) some of which reportedly utilize AI technology. These range from small "glider" concepts to large, deep-water vehicles capable of operating at a depth of several kilometers. While a lot of information on these tests and trials is available in the open sources, the Russian Ministry of Defense (MOD) has made only one official admission of using a UUV on a military mission in the Middle East.

Source: Gatel, https://www.rbc.ru/politics/16/08/2018/5b74e27e9a79472d33b398b4.

The Galtel (Галтель) is an underwater reconnaissance robot. The system was first mentioned in public in 2012 at the APEC summit in Vladivostok, Russia, and is best known for its operations in Syria in support of Russian naval forces there. In 2017, the complex was featured

for completing its first successful mission, in which it patrolled the waters off the Russian logistics facility Tartus and completed underwater surveys of the ocean floor.

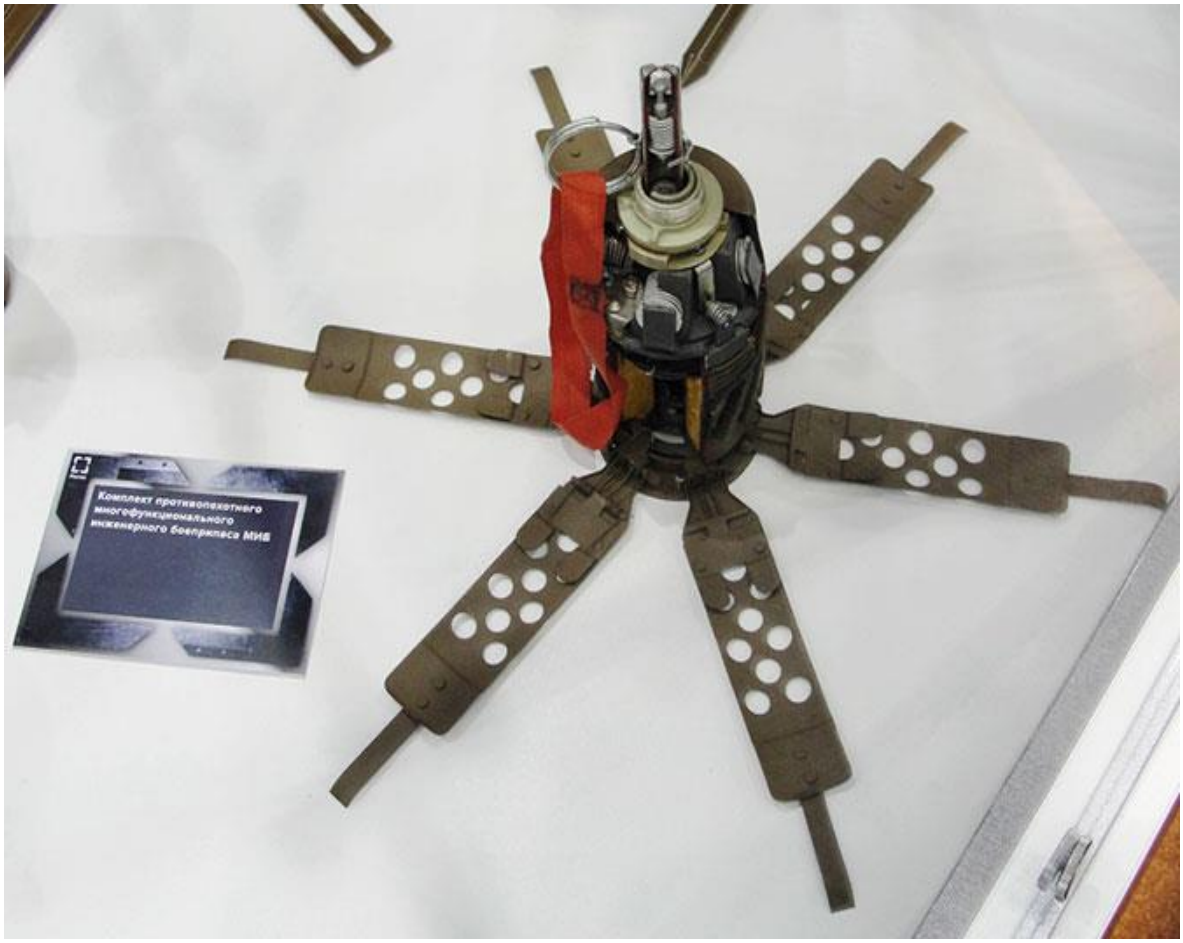
In an Interfax interview with Oleg Martinov, a member of the Military-Industrial Commission, he stated that in addition to the work cited above, the complex can conduct work on engineering structures, cable, and trunk pipelines. Threats to undersea cables, especially those connecting the US and its European allies, are a noted US/NATO concern.

The complex includes two autonomous uninhabited submarines with an operational limit of 24 hours and up to 100 kilometers, according to Russian reporting. Reporting also asserts that it can survey a four-square-kilometer area in 12 hours. The AI components of its control system purportedly enable it to independently assess its current situation, bypass obstacles, and select the best course to complete its mission.

Sources: Oleg Martinov, "Подводные лодки-роботы сегодня уже не фантастика" [Robotic submarines are no longer fiction], Interfax, Feb. 2018, https://www.interfax.ru /interview/600958; Andrew Chuter, "Russia's naval updates threaten undersea comms network, says top British military," *DefenseNews,* Dec. 2017, accessed June 2020, https://www.defensenews.com/naval/2017/12/15/russias-naval-updates-threaten-undersea-comms-network-says-top-british-military-officer/; Topwar, "Российский подводный робот «Галтель» успешно выполнил боевую задачу в Сирии" [The Russian underwater robot gatle has sucessfully completed a combat mission in Syria], Feb. 2018, accessed June 10, 2020, https://topwar.ru/136573-rossiyskiy-podvodnyy-robot-galtel-uspeshno-vypolnil-boevuyu-zadachu-v-sirii.html.

POM-3		
Manufacturer	***System Type***	***AI/Autonomy Aspect***
NII (Scientific Research Engineering Institute)	*Surface landmine*	*Target distinguishing Anti-personnel mine*

The Russian military is developing and possibly already fielding advanced landmines that utilize some AI-enabled capabilities. In 2015 through 2017, reports surfaced that the POM-3 (ПОМ-3) "Medallion" landmine had new features and capabilities not previously seen in Soviet or Russian landmines.



Source: POM-3 landmine, https://tvzvezda.ru/news/opk/content/201709260758-b9rq.htm.

What purportedly makes the POM-3 unique is its reported ability to distinguish between various targets. According to the head of NII, the mine is able to distinguish between a civilian— say, a farmer—and a soldier. A seismic sensor injected into the ground picks up

surface disturbances and an algorithm determines the profile of disturbance and whether it is friend or foe. The algorithm utilizes different signatures that a walking soldier makes with their attendant gear versus a walking civilian. When the mine determines that a threat has entered its kill radius, it launches its warhead to a height 1 to 1.5 meters before detonating. The name "Medallion" comes from the shape of the disks within the warhead that shatter into rotating triangular fragments.

Landmines using signatures are not new (an example is sea mines utilizing recordings of ship signatures), so the AI aspect of the mine is not necessarily clear from the reporting. It is also interesting that the mine purportedly can identify classes of people—e.g., it can distinguish a farmer or hiker from a solider. It is also unclear what assumptions the mine must make in order to do this.

The POM-3 is an antipersonnel fragmentation mine that is capable of deploying from numerous platforms and has a purported kill radius of 12 meters. The Scientific Research Engineering Institute (NIII) has been engineering explosive devices, among other weapons, since 1950. NIII is part of the larger Techmash Concern (http://tecmash.ru), whose primary production consists of ammunition for the Russian military. Techmash is part of the larger defense company Rostec (http://rostec.ru). The POM-3 was also on display at the Army-2019 military forum held in Moscow.

Sources: Dmitry Drozdenko, "The curse of the enemy infantry: what is terrible about the POM-3 mine" [Проклятие вражеской пехоты: чем страшна мина ПОМ-3], tvzvezda.ru, Sept. 9, 2017, accessed July 29, 2020, https://tvzvezda.ru/news/opk/content/201709260758-b9rq.htm; Defend Russia, "Cluster mines already distinguish humans from animals" [Кассетные мины уже отличают людей от животных]," June 27, 2019, accessed July 29, 2020, https://defendingrussia.ru/a/v_rossii_sozdali_umnyje_kassetnyje_miny-8773/.

Kamaz		
Manufacturer	***System Type***	***AI/Autonomy Aspect***
Kamaz and Innopolis University's Center for Technological Components for Robotics and Mechanics	*Land vehicle*	*Driver assist and autonomous operations for logistics. Includes UAV for negotiating terrain and navigation.*

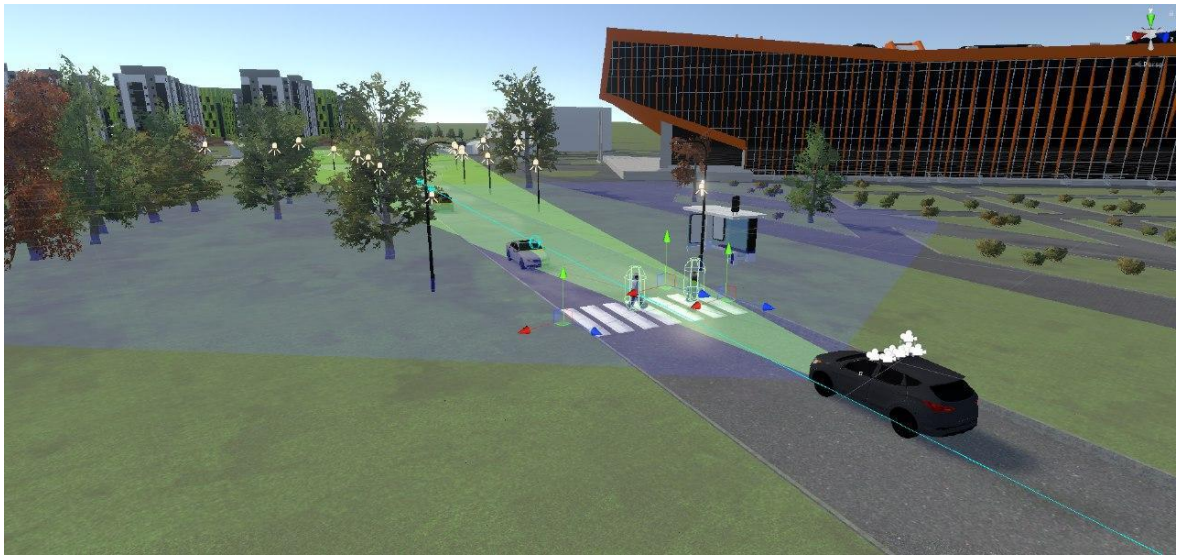
Source: Kamaz truck, www.robotics.innopolis.university.

The Laboratory of Autonomous Transport Systems, part of Innopolis University's Center for Technological Components for Robotics and Mechanics (www.robotics.innopolis.university) is developing an autonomous Kamaz truck that utilizes an onboard aerial reconnaissance module. The scientists claim to have created their own algorithms for object recognition, classification, and routing. According to the center director, Salimzhan Gafurov, the system

purportedly creates 2,048 different trajectories for the vehicle's anticipated movement over the next 6.5 seconds and updates these every .05 seconds. Additionally, the system continually monitors 360 degrees around the vehicle out to a range of 220 meters.

With the assistance of the onboard UAV (stored and charged on a platform of the truck), the truck can navigate through terrain without the use of maps. The truck does retain a driver, although developers claim there is no identified need for one. The truck has logged over 3,000 kilometers on the Innopolis compound. The center uses its own simulator to test a vehicle's ability to respond to various situations.

The online sourcing does not mention any military aspects of this technology, although those are obvious. Russian military planners assess that the electronic environment of the modern battlefield—including the availability of space-based information—is likely to be highly compromised. A system such as the one in development at the center would be consistent with Russian efforts to maintain military capabilities in a compromised environment.



Source: Training simulation for Kamaz logistics truck, http://www.robotics.innopolis.university/.

Consistent with the Russian military's efforts at integrating elements of AI into its forces, the Russian Aerospace forces have highlighted a number of areas where they believe AI-related technologies can complement mission success from aircraft control to target acquisition and engagement. Russia's Su-35S, a heavy long-range multirole fighter, is one example mentioned in media as incorporating AI. The Su-35S utilizes an onboard information and control system called IUS-35 (ИУС-35) that consists of several BAGET-53-31M computers.

Su-35		
Manufacturer	***System Type***	***AI/Autonomy Aspect***
Sukhoi, now part of United Aircraft (OAK)	*Combat aircraft*	*Pilot support for on-board information management and decision making*

Source: Su-35 control panel, https://www.sukhoi.org/products/samolety/256/.

The system combines many of the previously separate informational channels within the aircraft into a single system designed to combine, automate, and streamline information to the pilot to give them greater situational awareness. The system provides "intellectual support" for the pilot through its own target acquisition, orienting the aircraft relative to the target, and preparing its weapons systems to engage.

The addition of the system is credited with increasing the number of sorties the Su-35S was able to make in the Syrian conflict to 10 per day. It purportedly did so through pre-flight preparation and higher pilot endurance from the more intelligent information management.

Sources: Su-35, Sukhoi, https://www.sukhoi.org/products/samolety/256/; BMPD, "Information and control system IUS-35 of the Su-35S fighter [Информационно-управляющая система ИУС-35 истребителя Су-35С, https://bmpd.livejournal.com/3047341.html.

Marker		
Manufacturer	***System Type***	***AI/Autonomy Aspect***
The Advanced Research Fund (FPI) and NP Android Technology	*Experimental unmanned ground vehicle platform*	*UGV-UAV swarm, smart vision, natural language processing and MUM-T technologies and concepts. Also serves as a test bed for AI/autonomy technologies*

Source: Soldier demonstrating target designation capability of the Marker, https://fpi.gov.ru/projects/fiziko-tekhnicheskie-issledovaniya/marker/.

The Advanced Research Fund (FPI) and NP Android Technology (developer of the Fedor robot) are jointly developing the unmanned ground vehicle (UGV) Marker for the Russian Ministry of Defense, describing it as a "soldier's assistant on the battlefield." FPI is using the platform to test a variety of UGV technologies, including machine vision, communications, autonomous movement and navigation, and group swarming technologies. The Marker's modular technologies enable researchers to test a variety of capabilities for both the Marker and other UGVs. The company is also testing voice recognition software to enable eventual control by human voice. FPI currently has plans for five variants of the Marker: two tracked models; two wheeled models; and a fifth model, which will incorporate previous research results.

Source: Companies involved in Marker's design. Compiled by CNA. In the center: ARF logo; clockwise from the top: Southern Federal University, GosNIIAS, Sozvedie, Plaz, Kvant, and Android Technology logos.

Oleg Martyanov, the director of the National Center for the Development of Technologies and Robotic Basic Elements, FPI's lead research center on the Marker, recently commented on the Marker's potential swarm capability. He described a scenario in which five Marker platforms pursue a particular task autonomously, sharing information between them. He also mentioned the use of neural networks in describing the technologies involved in the Marker platform. The ultimate goal, he said, was to "teach" the Marker to perform tasks independently at great distances from the operator.

As a fighting vehicle, Marker can employ a wide array of weapons, including a large-caliber machine gun (7.62mm), anti-tank guided missiles, and grenade launchers. As demonstrated in avideo (link below), a soldier can designate targets to Marker from the soldier's weapon. The Marker will also be able to launch its own organic drones (quadcopters) for both reconnaissance and as loitering ammunition capable of engaging targets. A video advertising the Marker's military capability can be found at: https://fpi.gov.ru/projects/fiziko-tekhnicheskie-issledovaniya/marker/).

Source: Marker-associated quadcopters, https://fpi.gov.ru/projects/fiziko-tekhnicheskie-issledovaniya/marker/.

Sources: Олег Мартьянов: в будущем будет не армия терминаторов, а армия умных "Маркеров [There won't be an army of terminators. There will be an army of Markers], June 20, 2020, https://tass.ru/interviews/8831445; FPI at https://fpi.gov.ru/projects/fiziko-tekhnicheskie-issledovaniya/marker/.

Surface		
Manufacturer	***System Type***	***AI/Autonomy Aspect***
MOD developer not specified	*Sea mine*	*AI-enabled target discrimination and engagement*

According to Russian news sources, The Russian Navy is testing and preparing to field deployable minefields, called Surface [Поверхность} that utilize elements of AI. These systems purportedly analyze the sound, magnetic field – the magnoacoustic "portrait" of ships, submarines, and hovercraft.[347] The AI component of the minefield control center identifies and decides which platforms to target and is capable to determining friend of for based on the vessels signature.

Source: Be-12, Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Russian_Navy_Beriev_Be-12.jpg.

[347] Alexey Ramm and Alexey Kozachenko, "Хорошая мина при морской: флот получит боеприпасы с искусственным интеллектом: для ВМФ готовят самоовучающиеся заградительные пола," [Good mine for naval play: the fleet will receive artificial intelligence ammunition. Self-learning mine fields are being prepared for the Navy,], Izestia, Mar. 2019, accessed Oct. 2020, https://iz.ru/841783/aleksei-ramm-aleksei-kozachenko/khoroshaia-mina-pri-morskoi-igre-flot-poluchit-boepripasy-s-iskusstvennym-intellektom.

Once deployed, the mines are capable of self-organizing based on the magnetic and acoustic signatures of platforms in its area, utilizing a purported AI-enabled self-learning capability. It can also accept specific tasks, for example, avoiding mine detecting ships and lying in wait to only destroy landing ships. The former Chief of the Main Staff of the navy noted in an interview that, although navies have traditionally used mines in coastal areas to defend naval bases, these new technologies enable the mines to operate far from shore, in areas of predicted adversary naval activity.

Earlier reporting stated that numerous platforms could deploy the mine system, however, later reporting from last year singled out the Be-12 amphibious aircraft as being a primary carrier if Surface.[348] [349] Although the aircraft is one of the oldest in the Russian Navy, modernization and upgrades have kept it operational. The aircraft has a three-hour patrol and approximate operating range of 600 km.

Sources: Alexey Ramm and Alexey Kozachenko, "Хорошая мина при морской: флот получит боеприпасы с искусственным интеллектом: для ВМФ готовят самоовучающиеся заградительные пола [Good mine for naval play: the fleet will receive artificial intelligence ammunition. Self-learning mine fields are being prepared for the Navy,] Izestia, Mar. 2019, accessed Oct. 2020, https://iz.ru/841783/aleksei-ramm-aleksei-kozachenko/khoroshaia-mina-pri-morskoi-igre-flot-poluchit-boepripasy-s-iskusstvennym-intellektom; Ryabov Kirill, "Комплекс «Поверхность». Умные мины для военно-морского флота [Complex "Surface". Smart mines for the navy,] Topwar.ru, Sept. 2019, access Oct. 2020, https://topwar.ru/162249-kompleks-poverhnost-umnye-miny-dlja-voenno-morskogo-flota.html; Alexey Kozachenko, Alexey Ramm, Evgeny Dmitriev, "«Чайка»-носитель: самолеты Бе-12 вооружат умными минными комплексами Амфибии смогут устанавливать самообучающиеся заградительные поля ["Seagull" -carrier: Be-12 aircraft will be armed with smart mine systems: Amphibians will be able to establish self-learning barrage fields,] Izvestia, Sept. 2019, accessed Oct. 2020.

[348] Ryabov Kirill, "Комплекс «Поверхность». Умные мины для военно-морского флота," [Complex "Surface". Smart mines for the navy,], Topwar.ru, Sept. 2019, accessed Oct. 2020, https://topwar.ru/162249-kompleks-poverhnost-umnye-miny-dlja-voenno-morskogo-flota.html.

[349] Alexey Kozachenko, Alexey Ramm, and Evgeny Dmitriev, "«Чайка»-носитель: самолеты Бе-12 вооружат умными минными комплексами Амфибии смогут устанавливать самообучающиеся заградительные поля," ["Seagull" -carrier: Be-12 aircraft will be armed with smart mine systems: Amphibians will be able to establish self-learning barrage fields,], Izvestia, Sept. 2019, accessed Oct. 2020.

Altius		
Manufacturer	***System Type***	***AI/Autonomy Aspect***
UZGA	*ISR and combat long-range UAV*	*ISR and combat sorties against aerial and ground targets, will have on-board AI for C4ISR, potential loyal wingman to Su-57*

Source: Altius unmanned aerial vehicle, https://ria.ru/20190820/1557678707.html.

The new Russian "Altius" HALE unmanned aerial vehicle, in development since 2011, purportedly includes AI-related technologies enabling some level of autonomy in conducting operations.

In 2019, the UZGA Enterprise presented a modified version of this drone, which received a satellite communication system. With the use of such a system, the Altius flight range would be limited only by the fuel supply on board. Such a system allows this drone to conduct reconnaissance and attack targets at a distance of hundreds or thousands of kilometers from its base. The Altius can stay in the air between 24 and 48 hours, and its maximum range could be up to 10,000 kilometers, with the drone conducting reconnaissance from a height of 12,000 meters. At the end of 2019, the Ministry of Defense signed an agreement with UZGA to create an improved Altius version, which was given the designation "Altius-RU" (reconnaissance and

strike). This version should become the main serial deployment lineup for deliveries to the Russian Aerospace Forces and the Russian Navy.

The Altius will be equipped with the SP-2 inertial navigation system, providing the UAV with additional resistance to induced interference and the ability to operate in conditions of adversary electronic countermeasures. The Altius can lift up to one ton of bombs and missiles. It is assumed that the drone will be able to carry "Grom-2" bombs with a total mass of 598 kg (mass of a warhead, 480 kg) and a launch range of 10-50 km, or "Grom-1" guided missiles with a mass of 594 kg (mass of a warhead, 315 kg) with a launch range of up to 120 km. During the June 2020 visit by Deputy Defense Minister for Armaments Alexei Krivoruchko to the UZGA facility, photos of the updated Altius model were released for the first time. It was then confirmed that the drone will be able not only to conduct reconnaissance missions but also to strike at the enemy's ground targets.

This drone will be equipped with artificial intelligence elements, and will also be able to interact with manned aircraft in a MUM-T configuration. The MOD envisions this drone operating autonomously without the participation of an operator, as well as independently interacting with the Su-57 Russian fifth-generation fighter. The drone is supposed to independently plot a route to a target or a given patrol area without the help of a human operator, bypassing adversary air defenses, as well as detecting and attacking important ground targets such as missile launchers, communication centers, and enemy command and control centers.

As envisioned, once it receives targeting coordinates, the Altius will be able to compose an algorithm for finding the optimal route to the target and to calculate the most suitable point for dropping bombs. The drone will be able to do all this without the help of an operator, as the UCAV receives needed information about the enemy air defense facilities in real time, in order to build out its flight path. Having completed its combat mission, the Altius should be able to return to the base automatically along the safest flight route, or return to the patrol mode and continue to conduct reconnaissance tasks. It is worth noting that operators, working at all stages of UAV flight, currently control Russian military drones during operations.

In September 2019, the Russian Ministry of Defense demonstrated the MUM-T flight for first time, when the Su-57 piloted fighter and the 20-ton S-70 Okhotnik attack drone flew together. The Altius drone will also be equipped with the same ability to interact with a manned aircraft. Russian military community notes that the pilot will be able to find targets and transmit their coordinates to the UAV through a secure communication line. After receiving information from the pilot, the drone should be able to start performing the combat mission in an independent mode without further participation from the pilot or ground operators.

Sources: “Drone operators: training of drone crews has begun” [Люди для дронов: началась подготовка экипажей ударных беспилотников], Iz.ru, July 7, 2020, https://iz.ru/1032187/anton-lavrov-roman-kretcul/liudi-dlia-dronov-nachalas-podgotovka-ekipazhei-udarnykh-bespilotnikov; “Russian drone "Altius" first seen with ammunition” [Российский беспилотник «Альтиус» впервые засветился вместе с боеприпасами], Mk.ru, June 21, 2020, https://www.mk.ru/politics/2020/06/21/rossiyskiy-bespilotnik-altius-vpervye-zasvetilsya-vmeste-s-boepripasami.html; “Altius Heavy Russian drone with artificial intelligence” [«Альтиус». Тяжёлый российский беспилотник с искусственным интеллектом], TopWar.ru, Mar. 27, 2020, https://topwar.ru/169438-altius-tjazhelyj-rossijskij-bespilotnik-s-iskusstvennym-intellektom.html.

National Defense Management Center		
Manufacturer	***System Type***	***AI/Autonomy Aspect***
MOD	*Information integration and analysis center for the Ministry of Defense*	*Daily, round-the-clock assessment and coordination of military and national security activity domestically and internationally, will utilize AI for data analysis and to support decision-making*

Source: National Defense Management Center, https://ru.wikipedia.org/wiki.

One example of how AI-enabled technologies could be implemented in a decision-making capacity in the Russian military is the National Defense Management Center (NDMC), the Russian military's "nerve center" tasked with daily, round-the-clock assessment and coordination of military and national security activity domestically and internationally.

According to the open-source data available, the Russian military will utilize AI at the NDMC but will not outsource decision-making to AI systems. Instead, AI technologies will assist in decision-making, including collecting and submitting all the necessary information in order for the human operators to clearly understand the status of Russian forces and the state of military units in the country and on international deployments.

According to the official statements, the NDMC supposedly houses Russia's most powerful hardware and software systems, as well as a powerful military-related computer. The center was launched on December 1, 2014. As the closest equivalent to the US National Military Command Center in the Pentagon, this first-of-its-kind Russian facility performs the following official functions, as articulated by the Russian Ministry of Defense:

- Maintains the centralized combat control system to ensure combat readiness
- Monitors the state of the armed forces and strategically deployed forces, and assists them in performing their combat duties
- Informs the leadership of the Ministry of Defense, the Situation Center of the Ministry of Defense, and state officials on the military-political situation around the world and the socio-political situation across the Russian Federation
- Controls and coordinates Russian military forces' flights and air traffic
- Manages, coordinates, and controls naval forces during combat and international operations, and provides logistics and programmatic support to naval activities

To fulfill these functions, NDMC consists of three main departments:

- The Control Center of Strategic Nuclear Forces manages Russia's use of nuclear weapons and may deploy such weapons following the decision of senior military and political executive officials.
- The Combat Control Center monitors military-political developments around the world, forecasts potential threats to Russia and its allies, and manages armed forces that are not part of the Ministry of Defense, such as the national guard.
- The Daily Activities Control Center manages supply, maintenance, and logistics, as well as the health conditions of the nation's armed forces.

At the official opening of the NDMC, Defense Minister Sergei Shoigu stated that the center is "a step toward forming a single information space for solving tasks in the interests of the country's defense." Shoigu further stated that NDMC was envisioned as a 24-hour mechanism for managing all spheres of the Russian armed forces' activities. For example, it must ensure the ability and readiness of the troops to perform their tasks; enable the fulfillment of the state defense order; handle financial and material resources, including the recruitment of troops and training of personnel; solve medical and housing issues; and help manage Russia's international activities.

The center collects key information from regional and territorial commands, as well as military units and control posts. NDMC was designed to receive information from the lowest military unit levels, and, following analysis and evaluation, feed the data directly to those at the strategic

level. It integrates the work of military management, executive authorities, and local governments in the shortest possible time, enabling the Russian National Security Council, the General Staff of the Armed Forces, the leaders of the federal executive bodies, and various defense structures to work together.

According to reports, NDMC officials claim that the center monitors and coordinates, via video feeds and in real time, all major stages of manufacturing and repair of military equipment, starting with the signing of a state contract and the launch of products and ending with the delivery of a specific weapon to a specific military unit. To accomplish this task, the NDMC staff monitors such activity via 700 cameras in 500 military-industrial sites across the country, and their content is purportedly analyzed six times per every NDMC shift. Prior to NDMC's creation, such information exchange was "inconceivable" and the most complex and laborious task for the military involved dealing with various data and information collections and analyses.

According to Defense Minister Sergei Shoigu, the center's supercomputer, which is the only one in the Russian defense system, can store 236 petabytes of data (versus the Pentagon's 12 petabytes), and its productivity is estimated at 16 petaflops (versus the Pentagon's 5 petaflops); the speed of information processing is equivalent to 50 Lenin Libraries per second (the Lenin Library is Russia's State Library and has 17.5 million books). The center's supercomputer, developed by Russia's United Instrument-Making Corporation, is reportedly protected from cyber-attacks; NDMC's hardware and software have been fully made in Russia.

Sources: "Russian National Defense Management Center uses artificial intelligence" (Национальный центр управления обороной РФ применяет искусственный интеллект), Regnum.ru, Jan. 27, 2020, https://regnum.ru/news/polit/2836730.html; "NDMC is ready for action" (Национальный центр управления обороной готов к действию), Viktor Mysanikov, Nov. 7, 2014, http://nvo.ng.ru/realty/2014-11-07/1_action.html; "National Defense Management Center of the Russian Federation," Ministry of Defense of the Russian Federation (Национальный центр управления обороной Российской Федерации, Министерство обороны Российской Федерации (Минобороны России), Official MOD website, http://structure.mil.ru/structure/ministry_of_defence/details.htm; "Russian Federation's NDMC begun military service" (*NTSUO Rossikoi Federatsii zastupil na boyevoye dezhurstvo*), RVO, Dec. 2014, http://sc.mil.ru/files/morf/military/archive/rvo_2014-12.pdf; "Ministry of Defense: The general on duty monitors the defense of the Russian Federation every day" (Минобороны: За обороной РФ ежедневно следит дежурный генерал), Life.ru, Dec. 19, 2015, https://life.ru; "Russian Federation's NDMC begun military service" (*NTSUO Rossikoi Federatsii zastupil na boyevoye dezhurstvo*), *Rossiskoye Voyennoye Obozreniye,* Dec. 2014, http://sc.mil.ru/files/morf /military/archive/rvo_2014-12.pdf; "How the Russian defense management system works - two years of NTSUO " (Как работает российская система управления обороной - два года НЦУО), Geopolitika, Dec. 1, 2016, http://geo-politica.info/kak-rabotaet-rossiyskaya-sistema-upravleniya-oboronoy---dva-goda-ntsuo.html; "Digital military machine" (Цифровая военная машина), Lenta.ru, May 29, 2017, https://lenta.ru/articles/2017/05/29/command/; Mikhail Mizintsev, "The key to assessing the situation" (Ключ к оценке обстановки), *Military-Industrial Courier,* issue 46 (612), Dec. 2, 2015, http://vpk-news.ru/articles/28280.

Msta-SM 2S19M2		
Manufacturer	***System Type***	***AI/Autonomy Aspect***
Rostec	*Self-propelled artillery systems*	*Targeting automation via semi-automated guidance and fire control system*

Source: Msta-SM 2S19M2, https://iz.ru/1092597/anton-lavrov-aleksei-ramm/kromeshnaia-msta-na-iug-rossii-pridut-robotizirovannye-artustanovki.

The Ministry of Defense is equipping the Southern Military District's forces with the latest Msta-SM 2S19M2 self-propelled robotized artillery systems and expects deliveries to be complete within one to two years. These systems not only have an increased range and accuracy, but also can use "smart" high-precision shells.

Msta's claim to robotization is its integration of the tactical control system—a new automated guidance and fire control system for the howitzers. As a result, each combat vehicle can now automatically exchange information with battalion and battery command posts and with artillery radars. This includes the ability to receive and transmit information about each shot fired. If necessary, Msta can function remotely. Msta's capabilities will also benefit from closer integration with Orlan-10 UAVs that conduct reconnaissance and assist in adjusting firing over the entire firing range of these howitzers.

Rostec's Scientific Research Institute of Electronic Devices (part of the Tekhnomash concern of the Rostec State Corporation) has also developed AI-enabled ammunition that can reach a target despite an adversary's radio electronic countermeasures.

Sources: Anton Lavrov, Aleksei Ramm, "Nothing but Msta: roboticised artillery systems are due to arrive at Russia's south" [Кромешная «Мста»: на юг России придут роботизированные артустановки], Iz.ru, Nov. 27, 2020, https://iz.ru/1092597/anton-lavrov-aleksei-ramm/kromeshnaia-msta-na-iug-rossii-pridut-robotizirovannye-artustanovki; "Russia tested AI-enabled smart munitions" [В России разработали боеприпасы с искусственным интеллектом], Ria.ru, Dec. 2, 2012, https://ria.ru/20201202/boepripasy-1587365229.html.

S-500		
Manufacturer	***System Type***	***AI/Autonomy Aspect***
Almaz-Antey	*Air defense missile system*	*Maximum automation of all combat processes and operations*

On December 30, 2020, Russian Deputy Defense Minister Alexei Krivoruchko announced that Russia plans to complete tests of the S-500 Prometey (Prometheus) missile system and will officially acquire it in 2021. The S-500 is produced by Almaz-Antey defense corporation. Earlier, Lieutenant General Yuri Grekhov, the Deputy Commander-in-Chief of the Russian Aerospace Forces, remarked that the S-500 is developed with domestic electronic components, and with a high degree of automation of all combat processes and operations.

Source: https://ru.wikipedia.org/wiki/%D0%A1-500, https://russian.rt.com/russia/article/645906-s-500-chemezov-proizvodstvo.

The proposed automation is part of a broader MOD effort to automate multiple functions in Russian military systems that include combat vehicles of all types, unmanned and autonomous systems, and supporting complexes like the S-500.

Producers claim that the S-500 is capable of destroying all air targets within a radius of 400 kilometers. Additionally, they claim it can destroy incoming hypersonic missiles at a distance

of 600 kilometers. The system is also intended to intercept intercontinental ballistic missiles (ICBMs) towards the end of their trajectory. S-500 missiles can purportedly reach space-based objects in low orbits, possibly targeting reconnaissance and telecommunication satellites. In addition to addressing the adversary ICBM threats, the S-500 will also be able to effectively target high-altitude drones, especially given Russian MOD concerns that NATO long-range UAVs constantly conduct surveillance along Russian borders.

Sources: “The S-500 anti-aircraft missile system will be acquired in 2021” (Зенитную ракетную систему С-500 планируют принять на вооружение в России 2021 году), Tass.ru, Dec. 30, 2020 https://tass.ru/armiya-i-opk/10382387?fbclid=IwAR1uCwv6mjd9VcspmEphVEMW-TQpuYR3ub7cncF6oRW8T_VzC1bj3yiCQVI ; "The “five hundred” approaches” (Пятисотка на подходе), Rg.ru, Mar. 5, 3030; https://rg.ru/2020/03/05/v-armiiu-rf-postupil-pervyj-komplekt-zrk-srednej-dalnosti-s-350.html ; “S-500 is almost ready” (С-500 оказался почти готов), Lenta.ru, Dec. 4, 2019, https://lenta.ru/news/2019/04/12/s500/ ; Aleksandr Karpov, Elizaveta Komarova, “The frontier of space defense: how the elements of the latest Russian S-500 systems are being tested” (Рубеж космической обороны: как проходят испытания элементов новейших российских комплексов С-500), Russian.rt.com, Mar. 27, 2020, https://russian.rt.com/russia/article/732179-s-500-rossiya-ispytaniya-oruzhie ; “Russian radars track 30 foreign spy planes and 6 drones over week,” Tass.com, Dec. 11, 2020. https://tass.com/defense/1233957 ; “Russian radars track 30 foreign spy planes and 6 drones over a week,” Tass.com, Dec. 11, 2020. https://tass.com/defense/1233957.

Penicillin		
Manufacturer	***System Type***	***AI/Autonomy Aspect***
Rostec	*Counter--battery system*	*ISR, C2, target detection, categorization*

Source: Military review, "Complex of sound-thermal artillery reconnaissance 1B75 "Penicillin"," Oct. 28, 2018, https://topwar.ru/148924-kompleks-zvukoteplovoj-artillerijskoj-razvedki-1b75-penicillin.html.

In December 2020, the Russian military began deliveries of its newest counter-battery system, "Penicillin," to the armed forces. The system features new detection systems and some degree of automation. It detects both sound and optical emissions through special optoelectronic modules and ground sensors. The system consists of six television cameras and six thermal imagers with a 70-degree field of view and 10-degree azimuth. The signals from these sensors are combined with four ground acoustic and seismic sensors. Penicillin's systems combine these various emissions to pinpoint the source of the strike. Limited open source reporting states that the system can detect firing and impacts out to 25 kilometers.

The Vega concern press reports on the Penicillin note that it should be able to alleviate much of the risk to forward scouts that normally provide targeting information on adversary strike systems and that it can operate in a fully automated mode without an operator.

The Russian military will field these systems at the regiment and brigade level at first, and then provide them to coastal troops.

Sources: Bastion Karpenko, “Complex Artillery Reconnaissance 1B75 “Penicillin,” http://bastion-karpenko.ru/penicillin/; Ria Novosti, “The expert assessed the prospects of the newest intelligence complex "Penicillin," Jan. 22, 2021, https://ria.ru/20210122/kompleks-1594109718.html; “The Penicillin newest artillery reconnaissance complexes is acquired by the Russian forces” [Новейшие комплексы артиллерийской разведки "Пенициллин" впервые поступили в войска], Tass.ru, Jan. 22, 2021. https://tass.ru/armiya-i-opk/10521623.

International Cooperation

For Russia, artificial intelligence is increasingly a priority area for international cooperation, highlighted at the highest level. When Vladimir Putin spoke (via videoconference) at the UN General Assembly in September 2020, advanced digital technology—particularly AI—was one of the focus areas of his speech. He stated that advanced digital technologies have made it possible to adapt to the changing circumstances of the pandemic, including through the provision of services and distance learning, and that AI has been useful in the medical domain because doctors can more accurately and rapidly make diagnoses and choose the ideal treatment for individuals.

At the same time, Putin said that digital technologies posed a threat to international security and stability, because they could spread uncontrollably and fall into the hands of radicals and extremists around the world. He argued that the UN had to seriously consider cybersecurity and privacy protection in setting policy on digital technology, so as to strike a balance between incentivizing the development of AI and implementing appropriate restrictive measures. He argued for a collective approach through which states could jointly agree on regulations that would halt potential threats, highlighting not just military and technological security, but also threats to traditions, law, and morality.[350] These concerns have shaped Russian views on regulation of AI development, as Russia seeks to establish itself as a thought leader on the ethics of AI development through participation in international discussions on setting rules in this field.[351]

In discussing AI with foreign counterparts, Russian officials have generally highlighted their government's desire to collaborate with other countries in this sphere. Such conversations are quite frequent, and with a diverse range of potential partners. For example, in September 2020 alone, Russian officials discussed potential cooperation in AI with their counterparts from Belarus, South Korea, and Germany, as well as at a BRICS forum. The public remarks that accompany such discussions invariably highlight Russia's leadership role in developing new

[350] The President of Russia, "75-я сессия Генеральной Ассамблеи ООН," [75th session of the UN General Assembly], Sept. 22, 2020, http://kremlin.ru/events/president/news/64074.

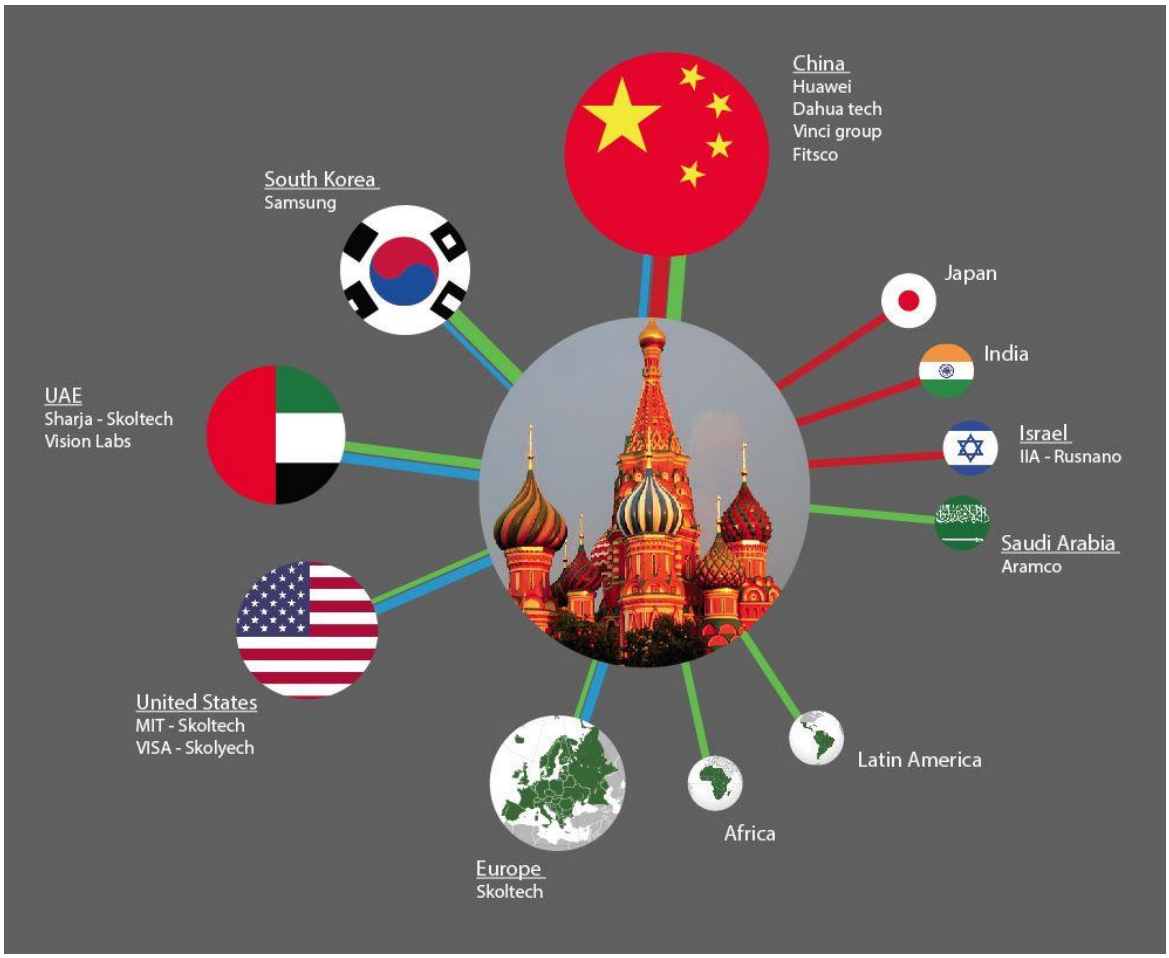
[351] "Искусственный интеллект и право: есть контакт?," [Artificial Intelligence and the law: is there a contract?], Garant.ru, July 16, 2020, https://www.garant.ru/news/1401154/.

technology and the consequent opportunities that international cooperation can promote in both Russia and the potential partner states.[352]

The graphic below depicts a broad overview of Russia AI-related international cooperation relationships. The countries are sized and binned into three simple relational categories of small, medium, and large depicting the relative level of AI cooperation. For each individual country or region, three types of relationship are depicted: governmental (red), industry (green) and academic (blue). The thickness of each line represents the level of AI cooperation in that field relative (bold) to other fields. Each country or region also has the entity, if significant, that figured into our analysis of the relationship e.g. China's Huawei. This graphic is the results of the team's subjective, not quantitative, assessment of the types, weight, and significance of the relationship and is meant merely as a guide or broad overview of Russia's international AI cooperation.

[352] "Рапота: Союзное государство Белоруссии и РФ должно учитывать развитие высоких технологий," [Rapota: The United State of Belarus and the Russian Federation should take into account the development of high technologies], TASS, Sept. 29, 2020, https://tass.ru/politika/9578271.""In phone talks with Moon, Putin says Russia set to cooperate on Korea peace: Cheong Wa Dae," Yonhap News Agency, Sept. 28, 2020, https://en.yna.co.kr/view/AEN20200928013300315; "В. Тимченко: Законодательная сфера регулирования развития искусственного интеллекта в России активно развивается," [V. Timchenko: The legislative sphere for regulation of AI development in Russia is actively developing], Federation Council, Sept. 21, 2020, http://council.gov.ru/events/news/119232/; Состоялась шестая встреча министров связи стран БРИКС, [Sixth Meeting of the BRICS Communications Ministers Held], Edited by Communications The Ministry of Digital Development, and Mass Media of the Russian Federation; "Declaration of the 6th BRICS Communication Ministers Meeting," BRICS (Sept. 17, 2020), https://eng.brics-russia2020.ru/documents/.

Figure 33. Russia AI-related international cooperation with selected examples



Source: CNA.

At the same time, there are some legal constraints on cooperation. For example, a new law was passed in April 2020 to establish an experimental legal regime to regulate conditions for developing and implementing AI technologies in Russia. It includes a provision that disallows foreign firms or joint ventures with dominant foreign ownership from applying to participate

in the regime.[353] Constraints on Russian participation in international cooperation in the AI field are not limited to such legal barriers. Other factors include the late entry of Russian researchers into the field compared to researchers from other countries and their still limited ties to international networks working in this field.[354] As a late entrant to the field, Russia has also sought to avoid legal restrictions on its AI development activities, as made clear in its role in the ongoing UN negotiations on lethal autonomous weapons systems (LAWS), discussed in detail below.

Overall, despite strong economic incentives and some political pressure to expand Russian AI capabilities through international cooperation, partnerships with foreign firms have played a relatively limited role in the development of Russian artificial intelligence. While the Chinese firm Huawei and the South Korean firm Samsung have established a strong presence in Russia, they are largely exceptions. There are no equivalent Western firms with a strong presence in Russia's digital technology market. While it is simple to blame sanctions for this state of affairs, sanctions cannot explain the absence of other Asian firms following the lead of the two front-runners. A more likely explanation is that commercial incentives trump geopolitical considerations: Russia is a relatively limited market, and it does not offer obvious comparative advantages in terms of providing young entrepreneurs who can be leaders in advancing the field when compared to East Asia or the West. As a result, most of the international cooperation efforts described below are either one-off commercial joint ventures or efforts by Russian AI companies to penetrate foreign markets.[355]

Russia's position on LAWS negotiations

Russia's recent position on LAWS (United Nations debate on the use of Lethal Autonomous Weapon Systems) is to disagree on the need for legally binding regulation and limitation from

[353] "Иностранным фирмам не разрешат участвовать во внедрении искусственного интеллекта в РФ," [Foreign firms will not be allowed to participate in the implementation of artificial intelligence in the Russian Federation], Interfax, July 6, 2020, https://www.interfax.ru/russia/716123.

[354] Irina Dezhina, "Разбег с барьерами. Что тормозит развитие российских нейротехнологий?," [Sprint with barriers. What is slowing down Russia's neurotechnologies development?], Poisk News, June 7, 2020, https://www.poisknews.ru/themes/medicine/razbeg-s-barerami-chto-tormozit-razvitie-rossijskih-nejrotehnologij/.

[355] The main exceptions are Huawei and Samsung, as noted above, and the MIT-Skoltech collaboration, which initially showed great promise but has largely faded because of constraints related to Western sanctions.

the international community on such weapons or other measures.[356] Russia claims that its approach is motivated by the fact that the AI mechanism capable of making lethal weapons truly autonomous is still a theory, not yet a practical reality in the present day. Russia has been an active in-person participant of every CCW (UN Convention on Conventional Weapons) meeting on LAWS since 2014, but continues to be an opposing actor towards LAWS legal negotiations. The Russian delegation at the LAWS discussions in 2018 and 2019, consisting of the Russian Ministry of Foreign Affairs, the Ministry of Defense and the Ministry of Industry and Trade, was disinclined to discuss significant restriction or complete prohibition of such autonomous systems. Such opposition was made even clearer by Russia's non-attendance of the most recent CCW meeting in September 2020, where Russian representatives were present neither virtually nor in-person.[357] Furthermore, Russia sought to reschedule the meeting, which had already been delayed by COVID-19, to a later time in 2021.[358]

Russia poses a hard-lined stance against LAWS negotiations for several claimed reasons:

LAWS lacks precise legal definition: The Russian Federation often mentions that forthcoming LAWS discussions will suffer great practical difficulties unless the sides first "harmonize the basic definitions of LAWS."[359] Russian negotiators believe that because lethal autonomous weapons systems have not yet been developed, predetermined definitions and preventative bans might restrict the broader development of AI and autonomous systems, including beneficial ones. For example, the Russian Foreign Ministry has pointed out the

[356] Andrey Malov, Advisor to the DNKV Ministry of Foreign Affairs of the Russian Federation, on the reasons for Moscow's skeptical attitude to the ban on "combat robots"," *Kimmersant.ru*, Aug. 16, 2018, https://www.kommersant.ru/doc/3714110?from=doc_vrez; *Stopping Killer Robots: Country Positions on Banning Fully Autonomous Weapons and Retaining Human Control*, Human Rights Watch, 2020, https://www.hrw.org/report/2020/08/10/stopping-killer-robots/country-positions-banning-fully-autonomous-weapons-and#.

[357] Dustin Lewis, "An Enduring Impasse on Autonomous Weapons," Just Security, Sept. 28, 2020, https://www.justsecurity.org/72610/an-enduring-impasse-on-autonomous-weapons/.

[358] Janosch Delcker, "The rise and rise of facial recognition — Von der Leyen decoded — Killer robots ban," *Politico*, Sept. 23, 2020, https://www.politico.eu/newsletter/ai-decoded/politico-ai-decoded-the-rise-and-rise-of-facial-recognition-von-der-leyen-decoded-killer-robots-ban/.

[359] Russia Federation statement to Group of Governmental Experts of CCW, CCW/GGE.1/2017/WP.8, Nov. 10, 2017, https://admin.govexec.com/media/russia.pdf.

"difficulties with a clear distinction between civilian and military developments in autonomous systems."[360]

Current international regulations are sufficient: The Russian delegation believes that further restrictions on LAWS are being pushed by "radical states and non-governmental organizations" that desire a complete ban on LAWS.[361] Russia's decision to cast LAWS restriction efforts as "radical" highlights the ongoing politicization of this debate into rival camps, with Russia firmly on the side seeking to maintain each country's right to build weapons of its choosing, while viewing those in favor of limits on LAWS as seeking to impose restrictions on national sovereignty.

In 2018 and 2019, the Russian delegation specifically indicated that current international law (including its humanitarian branch) is fully applicable to LAWS and does not need updates or adaptation. Russian officials pointed out that their country strictly adheres to the norms of international humanitarian law (IHL) as applicable to this type of weapons, and that Russian national legislation contains provisions that can address the possible commissioning of weapons that do not comply with Russia's legal obligations to IHL.[362] Russia's commitment to adhering to the norms of IHL in armed conflicts was emphasized again in a recent working paper it submitted to the 2020 CCW Group of Governmental Experts on LAWS.[363] Similarly, Russia advocates for the concept of "meaningful human control" over future LAWS, as a potential point of consensus with the international community, though it is doubtful the criteria for "meaningfulness" would be able to be developed without politicization.[364]

Development of autonomous weapons is not imminent: Russian delegations to the UN formally claim that LAWS discussions are premature because such weapons do not yet exist. For example, in its CCW position paper submitted in 2017, Russia alludes to the unlikelihood that lethal autonomous weapons will be a reality in the near future, calling them "as yet non-

[360] "Kalashnikov assault rifle - Russia opposes the ban on fully autonomous combat systems," Автомат с «калашниковым» - Россия выступает против запрета полностью автономных боевых систем, *Kommersant*, Aug. 16, 2018, https://www.kommersant.ru/doc/3714419.

[361] Ibid.

[362] Ibid.

[363] Russian Federation, *Russia Federation statement to Group of Governmental Experts of CCW, 2017: National Implementation of the Guiding Principles on Emerging Technologies in the Area of Lethal Autonomous Weapons Systems*, 2020, https://reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2020/gge/documents/Russia_2020.pdf.

[364] Ibid.

existent weapons systems."[365] However, critics point out the hypocritical nature of Russia's position since Russian defense companies are among the most active in advancing the development of such autonomous weapons.[366] Russia has invested heavily in research and development of autonomous weapons systems, and has made military investments in artificial intelligence and robotics a top national defense priority.[367] Arguably, this is in line with Russia's sovereign right to pursue its political, military, or economic interests as part of its response to what it sees as a world order defined by US hegemony.[368] Still, Russia has yet to provide constructive contributions to the LAWS discussion within CCW and thus is viewed by the international community generally as a non-cooperative actor in this sphere.

Both the US and Russia, among others, have expressed opposition to legally binding notions of LAWS in CCW discussions, yet Russia alone conveys an unwillingness to cooperate at the international level on discussions for defining and brainstorming a framework for LAWS. As long as autonomous systems remain a budgetary priority of Russia's national security and defense, one can expect Russia to continue to oppose further limitation or definition of LAWS in any form and prevent the CCW from restricting the types of technologies that can be used in the service of national security.

China

Over the last five years, China has become the key partner for Russia in the sphere of high technology in general and artificial intelligence in particular. This partnership has strengthened as a result of an increasing alignment of interests and security concerns, driven in part by a mutual sense that both countries are in competition with the United States and challenging its dominant role in the international system. US policy toward both countries—including sanctions, export controls, and tariffs—has pushed Russia and China to work more closely together in order to develop their high-tech industries. These geopolitical circumstances have increased "the determination of Chinese and Russian leaders to develop

[365] Ibid.

[366] David Gilbert, "Russian weapons maker Kalashnikov developing killer AI robots," *Vice*, July 12, 2017, https://www.vice.com/en/article/vbzq8y/russian-weapons-maker-kalashnikov-developing-killer-ai-robots.

[367] Decree of the President of the Russian Federation No. 490, *On the Development of Artificial Intelligence in the Russian Federation*.

[368] Patrick Tucker, "Russia to the United Nations: Don't Try to Stop Us From Building Killer Robots," Defense One, Nov. 21, 2017, https://www.defenseone.com/technology/2017/11/russia-united-nations-dont-try-stop-us-building-killer-robots/142734/.

indigenous replacements for foreign, particularly American technologies, from chips to operating systems, [and] has provided further motivation for cooperation."[369]

Russian-Chinese intergovernmental initiatives on AI

The history of Russian-Chinese technological cooperation in the AI sphere is described in detail in a recent report by Samuel Bendett and Elsa Kania. They highlight the origin of the modern relationship as emanating from Xi Jinping's state visit to Moscow in May 2015, which resulted in new agreements on cooperation in the digital economy.[370] Since then, cooperation in science and technology has become one of the pillars of the two countries' strategic partnership. Bendett and Kania highlight five areas in which cooperation in AI has been expanded over the last five years: dialogues and exchanges, joint investment funds, the development of industrial science and technology (S&T) parks, joint competitions, and the expansion of academic cooperation.[371] In June 2016, the China–Russia Innovation Park was announced, funded by the Shaanxi Provincial Government, the Russian Direct Investment Fund and the Sino-Russian Investment Fund. It was completed in 2018, with artificial intelligence enterprises taking part.[372] In 2017, China's Ministry of Science and Technology and Russia's Ministry of Economic Development set up the Sino-Russian Innovation Dialogue, which has taken place annually since then and is designed for companies from the two countries to showcase their products and conclude new cooperation agreements. The first dialogue took place in Beijing and featured over 100 Chinese and Russian enterprises from a range of industries including nanotechnology, robotics, and AI. Competitions have been taking place since 2018, when the first China–Russia Industry Innovation Competition took place. This competition, themed 'Innovation Drives the Future', highlighted big data, AI and high-end manufacturing. A joint government-funded investment fund was launched in September 2019, with an initial budget of $1 billion and a focus on financing AI research.[373]

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[369] Samuel Bendett and Elsa Kania, *A new Sino-Russian high-tech partnership,* Australian Strategic Policy Institute, Report # 22, 2019, https://www.aspi.org.au/report/new-sino-russian-high-tech-partnership.

[370] "China-Russia strategic partnership set to open new horizons," China Daily, Nov. 6, 2016, http://www.chinadaily.com.cn/world/2016liattendsSCOCCEEC/2016-11/06/content_27288768.htm.

[371] Bendett and Kania, *A new Sino-Russian high-tech partnership,*.

[372] Chen Lan, "Шелковый путь" приглашает российских бизнесменов," [Silk Road invites Russian businessmen], Rossiiskaia Gazeta, June 14, 2018, https://rg.ru/2018/06/14/v-siane-otkrylsia-mezhdunarodnyj-innovacionnyj-park-shelkovyj-put.html.

[373] Dimitri Simes, "Huawei plays star role in new China-Russia AI partnership," Nikkei Asia, Feb. 4, 2020, https://asia.nikkei.com/Spotlight/Asia-Insight/Huawei-plays-star-role-in-new-China-Russia-AI-partnership.

Over the past year, the two sides have further expanded all of these efforts, including through a two-year initiative that declared 2020 and 2021 to be years of Russian-Chinese scientific, technical, and innovation cooperation. While the program was initially intended to cover a broad range of technological cooperation, including artificial intelligence and the internet of things in particular, the Covid-19 pandemic has led it to shift its primary focus to health and biotechnology. As part of the effort, the two countries are developing a bilateral mechanism for the exchange of scientific information, with a primary but not exclusive focus on public health and biomedicine.[374]

Huawei as driver of cooperation

The key role in commercial cooperation between Russia and China in the field of AI has been played by Huawei, a company that has been described as the star player in the partnership. Huawei opened its first research institutes in Russia in 2017, with facilities in Moscow and St. Petersburg that focused on developing mathematical models for communication technologies. Three additional centers opened in 2019, as the company announced plans to triple its R&D staff in Russia.[375] Huawei's first major direct financial investment in Russian AI companies began in 2019, when it bought the rights to facial recognition technology developed by the Russian startup Vocord and hired the majority of Vocord's staff.[376] Later that year, it signed a cooperation deal with Skolkovo and then announced a plan to build an AI ecosystem in Russia by 2025 that will be comprised of 20 universities, over 100 software companies and more than 100,000 AI developers.[377]

Huawei's cooperation projects are based on a strategy for the Russian market. The strategy, called TIGER (Technology, Industry, Growth, Ecosystem, Reliability) involves joint work with Russian companies on the "development and employment of technologies, creation of

[374] "Russia, China discussing key projects for year of scientific cooperation," *TASS*, Dec. 25, 2019, https://tass.com/science/1103515; "После бури китайско-российское сотрудничество встретит процветающий завтрашний день," Chinese Embassy in Russia press release, June 22, 2020, http://ru.china-embassy.org/rus/gdxw/t1791912.htm.

[375] "Huawei Plans to Offer Some 1,500 Jobs in Research Centers in Russia Over Next 6 Years," Sputnik, Aug. 15, 2019, https://sptnkne.ws/8Xfm.

[376] Alena Sukharevskaia, "Huawei купила технологии российской компании в области распознавания лиц," [Huawei bought Russian technologies in the field of facial recognition], Vedomosti, June 3, 2019, https://www.vedomosti.ru/technology/articles/2019/06/02/803125-huawei-kupil.

[377] Olga Inshakova, "Huawei will create an artificial intelligence ecosystem in Russia," TB Forum, Feb. 25, 2020, https://eng.tbforum.ru/blog/huawei-will-create-an-artificial-intelligence-ecosystem-in-russia.

industrial solutions, programs to stimulate partners and create an ecosystem, which would ultimately lead to the development of Russia's own industry." Huawei is focusing on expanding Russia's AI ecosystem in three areas: (1) using the innovation laboratory Huawei OpenLab in Moscow to solidify collaboration with Russian partners in AI projects; (2) preparing Russian developers on the basis of the global Ascend Developer Community; and (3) developing courses connected to AI technologies and expanding the circle of Russian universities engaged in training in these areas. Huawei invested $5 million into partnerships in Russia in 2020. It plans to increase purchases from Russian suppliers from $392 million in 2017-2019 to $800 million in 2020-2025 and will increase the number of R&D centers in Russia to five.[378]

As part of this strategy, in 2020 Huawei's Russian Research Institute opened a joint R&D lab for AI and deep learning with the MIPT School of Applied Mathematics and Computer Science. The lab will focus on developing neural network algorithms for computer vision, machine learning, and artificial intelligence; developing methods for computational photography and image enhancement using mathematical modeling and advanced algorithms; and solving mathematically complex problems in order to create algorithms for simultaneous search and positioning. This was the 10th such joint laboratory Huawei has opened with Russian educational institutions and research institutes.[379] Huawei is continuing to target Russian academic institutions with funding and partnership agreements to utilize Russia's STEM education for its own RDT&E. Huawei is seeding AI and ML labs, research grants, and cooperative arrangements to tap into Russia's vast pool of capable STEM students. In return, Russian universities are getting much-needed funding and access to a global high-tech leader. This arrangement is expected to involve dozens of Russia's top schools and universities. As part of this plan, Huawei has set up a number of academies at regional universities, such as the Novosibirsk State Technical University and the Yekaterinburg-based A.S. Popov Ural College of Radio Engineering. These academies have recently diversified to include courses on AI and machine learning.[380]

[378] "Huawei готова инвестировать в новые технологии для создания в РФ цифровой инфраструктуры," [Huawei is ready to invest in new technologies to create digital infrastructure in Russia], *TASS*, June 25, 2020, https://tass.ru/ekonomika/8816823.

[379] "МФТИ и Huawei открыли совместную R&D-лабораторию по разработке технологий искусственного интеллекта," [MTPI and Huawei opened joined R&D laboratory to develop AI technologies], MSKIT.ru, Mar. 6, 2020, http://mskit.ru/news/n217346/.

[380] "Huawei и УРТК выпустили первых студентов по направлению Искусственного интеллекта," [Huawei and URTC certify the first students in the field of Artificial Intelligence], Huawei.com, June 15, 2020, https://e.huawei.com/ru/news/ru/2020/202006161749.

In the commercial sphere, Huawei has formed an extensive array of partnerships with Russian companies. It is working with the Russian AI company VisionLabs. Through this partnership, VisionLabs' expertise in computer vision will be used in the Huawei Atlas series of products for machine learning. As a first step, VisionLabs has added support for Atlas 800 to its existing Luna SDK software. Luna SDK is a cross-platform set of development tools with the functionality of recognizing and analyzing faces and other objects in 2D images using neural networks. The product was recently recognized in a US NIST competition as one of the fastest and most accurate of such products.[381] Huawei and CDNVideo signed a memorandum of cooperation that will allow CDNVideo to use Huawei's KunPeng virtual machines for its cloud servers. The two companies have investigated possibilities for working together to provide new services for users, including serverless computing, managed databases, and cloud storage. The ultimate goal is to create a combined ecosystem of products and services.[382]

Huawei is working with Russian companies in cloud computing, including a partnership with Kaspersky that bundles the latter's cloud security service with Huawei's FusionSphere cloud platform. Huawei is also working directly with Sber to launch its own cloud platform in Russia.[383] Huawei has also partnered with Rostelekom, Russia's largest long-distance phone and internet provider, to develop a home Wi-Fi router especially designed for gaming. The router uses AI technology to prioritize the delivery of data packets to and from gaming servers, without unduly delaying other applications. The two companies have been working together since 2016 to develop the technology and are planning to expand the technology to other uses.[384]

Huawei is looking to further expand its partnerships. To this end, it recently took part in a Russian Infoforum conference on the future of digital security, which included participation from Russian companies (e.g., Megafon, Rostelekom, Rosatom, and Russian Railways), and

[381] "VisionLabs and Huawei announce strategic partnership in computer vision," [VisionLabs и Huawei объявили о стратегическом партнерстве в области компьютерного зрения], Oct. 19, 2020, https://www.cnews.ru/news/line/2020-10-19_visionlabs_i_huawei_obyavili_o_strategicheskom.

[382] "Huawei и CDNvideo подписали меморандум о сотрудничестве для развития сервисов на базе ИИ, IoT и больших данных," [Huawei and CDNvdeo signed MOU in developing services on the basis of AI, IoT, and big data], Kommersant, Oct. 15, 2020, https://www.kommersant.ru/doc/4531348.

[383] Lauren Dudley, "Huawei Enlists Russian Talent and Technology to Ensure Future Innovation: Part 2," Council on Foreign Relations, Oct. 28, 2020, https://www.cfr.org/blog/part-two-huawei-enlists-russian-talent-and-technology-ensure-future-innovation.

[384] "«Ростелеком» и Huawei представили роутер «Игровой» с искусственным интеллектом," [Rostelekom and Huawei offer AI router], CNews, Nov. 17, 2020, https://www.cnews.ru/news/line/2020-11-17_rostelekom_i_huawei_predstavili."

from government agencies (e.g., the presidential administration, the Foreign Ministry, the Federal Communications Agency, and the Federal Tax Service). The conference participants discussed global trends in digital technology, its incorporation in government services, and the practice of building information security systems in the new digital reality.[385]

Although Huawei is the undisputed sector leader in Russian-Chinese AI cooperation, commercial partnerships between Russian and Chinese companies in the AI sector are not limited to Huawei. Fitsco, a Chinese rail transit signaling system provider, and Cognitive Pilot, a joint venture of Russia's Sber and Cognitive Technologies Group, announced a strategic alliance for sharing solutions for smart city planning and other AI-enabled transportation network technologies. This expands and deepens a partnership that had previously existed since the late spring, when the two began cooperating on a new advanced driver assistance system for Chinese light rail.[386] China's Dahua Technology and Russia's NtechLab are collaborating on a project to create a camera with facial recognition capabilities. Chinese software developer Vinci Group has agreed to work on AI products with the Russian IT startup Jovi Technologies.[387]

Overall, in the context of increasing tensions with the United States, China and Russia have clearly made an agreement to expand their technological cooperation, with artificial intelligence playing a key role in their plans for the future. Some analysts believe that the partnership could break down over China's willingness to reengage with the United States if the opportunity presents itself. [388] However, there have been no signs of any such divisions to date. On the contrary, the China-Russia relationship has continued to grow and deepen over the last year, even as the pandemic has shifted priorities increasingly toward the biomedical sphere.

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[385] "На международной конференции Инфофорума «Будущее цифровой безопасности. Экспертный взгляд» компания Huawei представила рекомендации по развитию цифровой экономики России," [At the international conference of the Infoforum "The Future of Digital Security. Expert view "Huawei presented recommendations for the development of the digital economy in Russia], Vedomosti, Nov. 10, 2020, https://www.vedomosti.ru/press_releases/2020/11/10/na-mezhdunarodnoi-konferentsii-infoforuma-buduschee-tsifrovoi-bezopasnosti-ekspertnii-vzglyad-kompaniya-huawei-predstavila-rekomendatsii-po-razvitiyu-tsifrovoi-ekonomiki-rossii.

[386] "Fitsco and Cognitive Pilot form strategic alliance to develop ITS in Asia and Russia," Traffic Technology Today, Sept. 11, 2020, https://www.traffictechnologytoday.com/news/public-transit/fitsco-and-cognitive-pilot-form-strategic-alliance-to-develop-its-in-asia-and-russia.html.

[387] "Huawei plays star role in new China-Russia AI partnership."

[388] Ibid.

South Korea and Japan

Although China is the primary focus of Russia's international cooperation efforts in the AI field, South Korea and Japan also play very prominent roles in this field. On a government level, cooperation with South Korea in the technology sphere is extensive, and has been further defined with the signing of the Nine Bridges Plan 2.0 in October 2020. As part of this initiative, innovation platforms were explicitly added to the list of priority areas for bilateral economic cooperation.[389] Although this is the first indication of an explicit role for artificial intelligence in Russian-Korean bilateral cooperation at the state level, commercial cooperation has been in place for many years.

Much as Huawei is the most important player in China's cooperation on AI with Russia, the key role for South Korea is played by Samsung. The Samsung AI Center Moscow plays the key role in this cooperation effort. It was founded in 2018 with the goal of harnessing Russia's expertise in the field of artificial intelligence and piggybacks on the Samsung R&D Russia center, which has been operating in Moscow since 1993. The AI center's main research areas include computer vision, robotics, and intelligent driving assistance. Its capabilities in vision analysis have enabled it to develop software that can turn a single still image into a video that can mimic a person's facial expressions and movement. Unlike conventional "deep fake" videos which require a 3D modeling process, the technology, developed jointly with Skoltech, can create a convincing fake video with just a single image. This capability has led to concerns that its AI technology could be used in the creation of "deep fake" videos that can influence the public.[390]

In addition to its commercial efforts in Russia, Samsung has set up an educational arm called the Samsung IT Academy. This academy has developed a series of one-year courses in artificial intelligence, the Internet of Things, and mobile app development, which are being taught at 34 universities throughout Russia (and in Kazakhstan), with an enrollment of over 1,000 students. The goal is for the program's alumni to help solve the significant staff shortage felt throughout

[389] "South Korea and Russia sign Nine Bridges Plan 2.0," Seetao, Oct. 29, 2020, https://www.seetao.com/details/44488/en.html. "Посол Южной Кореи: в Сеуле высоко оценивают успехи РФ в разработке вакцин против коронавируса," [South Korean Ambassador: Seoul appreciates Russia's progress in developing vaccines against coronavirus], Interfax, Dec. 3, 2020, https://www.interfax.ru/interview/739657.

[390] "Samsung Electronics Launches AI Center in Russia," Samsung press release, May 29, 2018, https://news.samsung.com/global/samsung-electronics-launches-ai-center-in-russia; "AI Cener Moscow," accessed Jan. 27, 2021, https://research.samsung.com/aicenter_moscow; Hwang Soon-min and Minu Kim, "Samsung's new AI technology can create fake interview video with single face image," Pulse News, May 24, 2019, https://pulsenews.co.kr/view.php?sc=30800028&year=2019&no=346851.

Russia's IT industry. Although university training is increasing, it is not sufficient by itself to address the shortage.[391] In addition to organizing semester long-classes, the academy also provides training during weekend festivals, such as one held in September 2020 through the virtual Baikal International Youth Forum, which involved 1,400 participants from throughout Russia.[392] The academy also organizes an annual Russia-wide competition for graduates of its university training programs.[393]

Unlike South Korea, Russian officials have only recently started to engage with their Japanese counterparts on artificial intelligence. As part of efforts to diversify the range of its high-tech partnerships, Russia recently presented a number of initiatives for cooperation with Japan in the technological innovation sphere. In June 2020, the Russian deputy minister of economic development met with the director general of the Department of Trade and Information Policy of the Japanese Ministry of Economy, Trade, and Industry to propose the creation of a "roadmap" for high-tech cooperation. During the meeting, she stated that IT is among the most active fields of Russian-Japanese cooperation and expressed a readiness for expanded work together in that sphere, including in the construction of a digital economy and the development of AI. In addition, the two sides touched on the topic of cooperation between innovative technology parks, innovative regions, foundations, development institutions, and research universities, with the aim of promoting a deeper merger of science and technology with industry and the environment in order to optimize the innovation ecosystems of both countries.[394]

[391] "Проект «IT Академия Samsung» начинает новый учебный год в России и Казахстане," [IT Academy of Samsung begins new year in Russia and Kazakhstan], Samsung, Oct. 21, 2020, https://news.samsung.com/kz_ru/project-it-akademiya-samsung-nachinaet-novyi-uchebnyi-god-v-rossii-i-kazakhstane.

[392] "Эксперты «IT Академии Samsung» приняли участие в международном молодежном форуме «Байкал»," [Samsung IT Academy experts took part in the Baikal international youth forum], Samsung News, Sept. 22, 2020, https://news.samsung.com/ru/experti-it-akademii-samsung-prinyali-uchastie-v-mezhdunarodnom-molodezhnom-forume-baikal.

[393] "Компания Samsung объявила победителей Межвузовского конкурса студенческих проектов «IT Академия Samsung»," [Samsung names winners of interuniversity competition Samsung IT Academy], Samsung, Nov. 12, 2020, https://news.samsung.com/ru/samsung-it-academy-contest-2020.

[394] "Замглавы Минэкономразвития предложила создать "дорожную карту" взаимодействия с Японией в сфере высоких технологий," [The deputy head of the Ministry of Economic Development proposed the creation of a 'road map' of high-tech cooperation with Japan], The Ministry of Economic Development of Russia, June 11, 2020, https://www.economy.gov.ru/material/news/zamglavy_minekonomrazvitiya_predlozhila_sozdat_dorozhnuyu_kartu_vzaimodeystviya_s_yaponiey_v_sfere_vysokih_tehnologiy.html.

United States

Russian cooperation with the United States on Artificial Intelligence is limited primarily to the academic sector, with only a few commercial ventures. Incentives are primarily profit seeking, with companies looking to enter large US markets such as the automotive, agricultural, and financial industries. Efforts to connect with academic institutions are a sign that Russians active in the AI field recognize the leading position of US scholars in the field. But the limited success of such efforts is a sign of the constraints posed by the hostile overall relationship between the two countries and the legal limits of the US sanctions regime. US sanctions that prevent the export of military and dual use technology to Russia allow the export of certain kinds of equipment, such as some computer chips, but limit interactions with many large state-run corporations which are on sanctions lists. Furthermore, many major US companies in this sphere, such as Google and Amazon, are reluctant to engage with some of the key Russian players because of fears that they could fall afoul of the sanctions regime.[395]

Government interactions are largely competitive. There is a strong perception, especially in Russia, that Russia and the United States are in the midst of a technological competition in AI. On the US side, then-US Congressman Will Hurd's draft resolution on building a US national AI strategy noted that Russia had sought leadership in this field and that in order to counter Russian advances. As he put it, "If we don't set the rules of the road for AI, China or Russia will. Vladimir Putin himself has said that the nation that leads in AI 'will be the ruler of the world.' I'd rather the future be defined by our values, not theirs."[396] In response, Sergei Boyarsky, the First Deputy Chairman of the State Duma Committee on Information Policy, Information Technology, and Communications said, "This is a new race. Previously, there was a race for space, and now for artificial intelligence." Boyarsky said it is natural for the US to fear Russia moving ahead in the field of AI, because technologies based on AI will deeply intertwine with our lives in the next 30-50 years. He asserted that Russia is ready to compete with the US over

[395] "Digital transformation in Russia: keeping competitive," DT - Global Business Consulting, May 2019, https://www.bakermckenzie.com/-/media/files/insight/publications/2019/05/digital_transformation_in_russia_keeping_competitive.pdf.

[396] "Moulton joins Hurd, Kelly in resolution to create national artificial intelligence strategy," Seth Moulton Press Release, Sept. 16, 2020, https://moulton.house.gov/press-releases/moulton-joins-hurd-kelly-in-resolution-to-create-national-artificial-intelligence-strategy.

the creation of AI and that countries that do not take AI seriously will end up sidelined in the future.[397]

Academic cooperation

The most consequential Russian-American cooperative initiative began over 10 years ago, when then-president Dmitry Medvedev launched the Skolkovo innovation cluster. He intended Skolkovo to be Russia's equivalent to Silicon Valley in the United States. The goal was to create a sustainable ecosystem of entrepreneurship and innovation, engendering a startup culture and encouraging venture capitalism. To this end, the government granted participants in the project various tax privileges and more liberal visa rules for securing the employment of foreign nationals. The federal government also built an extensive new transport infrastructure to connect the district to central Moscow and to local transportation hubs. Skolkovo includes five research clusters: IT, Energy, Nuclear, Biomedicine, and Space. Development of AI technologies is one of the primary focus areas of the Information Technologies Cluster.[398] To attract more international partnerships, Skolkovo recently launched the Softlanding program, which is designed to encourage foreign startups in the high-tech field to base themselves at Skolkovo.[399] This is a two-week program that familiarizes participants with the services and benefits offered by Skolkovo and the advantages of setting up a startup there.[400]

The main bilateral cooperation initiative within Skolkovo was comprised of the Skolkovo Institute of Science and Technology (Skoltech), which is a component of the Skolkovo innovation cluster. It is a private graduate research institute established in 2011 in collaboration with MIT to "cultivate a new generation of researchers and entrepreneurs, promote advanced scientific knowledge and foster innovative technology to address critical issues facing Russia and the world."[401] Viktor Vekselberg has been a critical player driving the initiation of this collaboration. As president of the Skolkovo Foundation, he was one of the key

[397] "В Госдуме рассказали о гонке РФ и США по созданию искусственного интеллекта," [The State Duma spoke about the race between Russian and the United States to create artificial intelligence], Crimeangazette.ru, Sept. 25, 2020, http://crimeangazette.ru/novosti/v-gosdyme-rasskazali-o-gonke-rf-i-ssha-po-sozdaniu-iskysstvennogo-intellekta.html.

[398] "What is Skolkovo?," Skolkovo, July 14, 2020, https://old.sk.ru/foundation/about/.

[399] "Программа по привлечению зарубежных стартапов запущена в'Сколково," [A program to attract foreign startups launched in Skolkovo], TASS, June 25, 2020, https://tass.ru/ekonomika/6588743.

[400] "Skolkovo Softlanding Program," accessed July 14, 2020, http://www.techno-preneur.net/Skolkovo-Softlanding-Program.pdf.

[401] "About," Skoltech, accessed July 14, 2020, https://www.skoltech.ru/en/about/.

leaders in the establishment of Skolkovo and played a significant role in convincing MIT to partner with Skolkovo in establishing Skoltech, a project for which MIT was paid $300 million in the initial phase of development. After several years of cooperation, Vekselberg was made an MIT trustee in 2013 and remained in that position until 2018. At that time, he was suspended from that position as a result of being named a designated individual on a Treasury Department sanctions list.[402]

The MIT-Skoltech collaboration has now entered its third phase. The first phase, which lasted through 2016, consisted of MIT assistance in the launch of Skoltech, including participation in the hiring of initial faculty and the admission of the first several cohorts of graduate students. During this period, MIT hosted more than 100 Skoltech students, 24 MIT instructors taught classes in Moscow, and 33 courses were developed at MIT for Skoltech as part of a joint curriculum development plan. MIT was also involved in the design of the Skoltech campus, provided training for administrative personnel, and helped design Skoltech's initial governance structure, administrative strategy, and operational plans.[403] The second phase, lasting from 2016 to 2019, focused on collaborative activities designed to foster continued development of the institute and Skolkovo as a whole. This phase focused on collaborative research projects that link researchers at the two partner institutions, joint conferences, and advice and support from MIT faculty members to Skoltech on research and institutional matters as needed.[404]

The deterioration of the US-Russia political relationship has had a significant effect on the MIT-Skoltech partnership, with MIT personnel taking a much less active role in Skoltech governance and being less directly involved in education. Despite constraints on cooperation and exchange stemming from the deterioration of the political relationship between the United States and Russia (and specifically because of sanctions), MIT nevertheless remains an integral part of Skoltech, having recently signed a new agreement that extends the partnership into a third phase that lasts through 2024 and continues the phase 2 educational exchange programs between the two institutes.[405] Recent collaborative projects announced by the program include

[402] Mike Eckel, "World-Renowned Scientific University Quietly Untangles Itself From Russian Billionaire," RadioFree Europe RadioLiberty, Jan. 14, 2019, https://www.rferl.org/a/mit-quietly-untangles-itself-from-russian-billionaire/29708417.html.

[403] "History," MIT Skoltech Program, July 14, 2020, https://skoltech.mit.edu/node/8.

[404] "MIT Skoltech Program," MIT Skoltech Program, July 14, 2020, https://skoltech.mit.edu/.

[405] "Skoltech sees new agreement with MIT as success for Russian science as a whole," TASS, Dec. 17, 2019, https://tass.com/economy/1100349.

two in the field of AI: "Machine Learning for Quantum-Enhanced Sensors" and "Theoretical Foundations of Unsupervised Deep Learning."[406] These projects are more of an exception now, with the primary focus firmly on educational exchange rather than joint projects.

Commercial cooperation

Commercial cooperation between Russia and the United States in the AI field remains relatively limited. The partnerships that do exist are generally pilot projects, such as a recent initiative by Synesis, a Skolkovo-based company, to use thermal imaging components of its Kipod "smart city" platform to measure customers' body temperatures and control social distancing norms in a large network of pharmacies in Florida.[407] Another such project has been developed in the agricultural sphere, where the Russian AI company Cognitive Technologies is introducing its Cognitive Agro Pilot autonomous driving system for tractors and field sprayers in the United States in February 2021, through a licensing agreement with a major American manufacturer of agricultural machinery.[408]

Russian companies have also engaged in testing of AI products in the United States on a limited basis. For example, in the summer of 2020, Yandex announced that it had begun testing driverless cars in Ann Arbor, Michigan. The choice of location was the result of a confluence of factors, including looser legal requirements in Michigan that allow companies to test driverless cars without an engineer on board the vehicle. Yandex had originally brought the vehicles to Michigan to showcase them with public test drives at the North American International Auto Show in Detroit. After the show was cancelled due to the Covid pandemic, Yandex decided to take advantage of the state's legal regime to find a location to perform long-term testing on the vehicles in a different environment in terms of road conditions and rules of the road. It eventually settled on Ann Arbor, because it is a relatively large city with a large number of research and engineering facilities that is also near the automotive hub city of Detroit. The vehicles are fourth generation driverless cars, made in partnership with Hyundai Motors and based on the Sonata model. Yandex has previously tested its vehicles in Skolkovo, Russia, and

[406] "Seed Funds," MIT Skoltech Program, July 14, 2020, https://skoltech.mit.edu/collaborative-projects/seed-funds.

[407] "Интеллектуальную платформу для борьбы с коронавирусом создали в Сколково," [Skolkovo develops intellectual platform to combat coronavirus], TASS, June 3, 2020, https://tass.ru/ekonomika/8636089.

[408] Laurie Bedord, "Russian Company Wants to Automate U.S. AG Equipment," Successful Farming, Nov. 6, 2020, https://www.agriculture.com/news/technology/cognitive-agro-pilot-coming-to-the-us.

in Tel Aviv.[409] Yandex's driverless car initiative began as an outgrowth of its relationship with Uber, after it effectively bought out the latter's operations in Russia in 2017. Soon after beginning its Ann Arbor testing program, the two companies announced that they had formed a separate company that will focus on self-driving cars, with Yandex owning a 73 percent stake, Uber a 19 percent share, and the balance owned by Yandex managers and employees.[410]

A potentially more substantial cooperative venture involves the establishment of a joint data laboratory by Sber and Visa, where anonymized credit card data will be studied in order to better predict trends in customer behavior. The laboratory, housed on Sber's campus, will utilize artificial intelligence and machine learning tools to create probabilistic hypotheses with the goal of "improving the convenience and quality of services for clients. Sber and Visa have collaborated in developing AI solutions before. For example, in June 2020, the companies teamed up with retailer Azbuka to create a cashier-less convenience store where shoppers are automatically charged for their purchases when exiting the building.[411]

Cooperation with European states and institutions

Russian cooperation on AI with the EU and EU member states is subject to some of the same constraints as Russian cooperation with the United States. However, because of more extensive economic links, there are more opportunities than with the United States for both sales of

[409] "«Яндекс» тестирует беспилотные автомобили в США," [Yandex testing unmammed vehicles in the USA], Aug. 6, 2020, https://www.cnews.ru/news/top/2020-08-06_yandeks_pristupil_k_testirovaniyu; "Яндекс запустил тестирование беспилотных автомобилей в США," [Yandex launches testing of unmammed systems in USA], RIA-Novosti, Aug. 6, 2020, https://ria.ru/20200806/1575446847.html; Greg Gardner, "Yandex, Uber's Russian Partner, Kicks Off Self-Driving Car Tests In Ann Arbor," Forbes, Aug. 6, 2020, https://www.forbes.com/sites/greggardner/2020/08/06/yandex-the-russian-partner-of-uber-begins-testing-avs-in-ann-arbor/#3b03c2d96471.

[410] Paul Sawers, "Uber and Yandex merge their ride-sharing services to form a new $3.8 billion company targeting Russia and neighboring markets," July 13, 2017, https://venturebeat.com/2017/07/13/uber-and-yandex-merge-their-ridesharing-services-into-a-new-company-targeting-russia-and-neighboring-markets/; Chris O'Brien, "Yandex and Uber spin out self-driving venture with $150 million investment," *Venturebeat.com*, Sept. 4, 2020, https://venturebeat.com/2020/09/04/yandex-and-uber-spin-out-self-driving-venture-with-150-million-investment/.

[411] "Сбербанк и Visa запускают в России лабораторию данных," [Sberbank and Visa launch a data laboratory in Russia], CNews, Sept. 30, 2020, https://www.cnews.ru/news/line/2020-09-30_sberbank_i_visa_zapuskayut_v; "Russian store goes cashierless with Sberbank and Visa," FinExtra, June 9, 2020, https://www.finextra.com/newsarticle/35980/russian-store-goes-cashierless-with-sberbank-and-visa.

technology and joint ventures, both in the commercial and academic spheres. Russian leaders have indicated that despite geopolitical tensions, the EU remains an important economic partner for Russia. Recently, Russian Foreign Minister Sergei Lavrov highlighted artificial intelligence as one of the areas where cooperation would bring benefit to both sides. At the same time, he noted that cooperation can only be equal, taking into account the interests of both parties. He noted that Russia will not make any one-sided goodwill gestures.[412] To further this cooperation, Russia has been playing key roles in European bodies that are establishing norms for AI technology. For example, In November 2020, the Council of Europe's Ad Hoc Committee on AI Technologies elected Andrey Neznamov, the executive director of the Center for Data Research for State Bodies of Sber, as the its chairman. Neznamov is a co-author of the National Strategy for the Development of AI and the Concept of Regulation of AI and Robotics Technologies.[413] As chairman of the intergovernmental group until the end of 2021, he will facilitate the organization and conduct of global consultations between European states and representatives of the science and business spheres on the regulation of AI technologies in Europe.[414]

Russian cooperation with Europe on AI has been constrained by several factors, including Western sanctions on technology transfer to Russia, security issues that make both sides cautious about revealing their vulnerabilities, a general lack of trust on cooperation in technology due to fear of hacker attacks, a sense of economic competition, and a slump in the Russian economy that has made Russia less attractive to European partners. At the same time, there are some areas where synergies are possible and cooperation may be advantageous to both sides. These include the use of AI in megascience projects where cooperation already exists, such as particle physics and the international space station. Healthcare R&D is another potential area for cooperation, since it can be kept largely separate from the more sensitive

[412] "Россия не допустит "игры в одни ворота" с Евросоюзом, заявил Лавров," [Lavrov says that Russia won't allow games into one goalpost with the EU], Nov. 3, 2020, https://ria.ru/20201103/evrosoyuz-1582872350.html.

[413] The Russian Federation has been a member of the Council of Europe since 1996 and having positions on various committees is not unusual. The Council of Europe is distinct and separate from the Council of the European Union.

[414] The main task of the Council of Europe Ad Hoc Committee on AI is to determine the order of regulation for AI technologies in Europe. The committee was created in 2019 by decision of the Committee of Minister of the Council of Europe. It includes representatives of Council of Europe member states, as well as observers from various international bodies and representatives from the science and business spheres."Председатель межгосударственной группы по проведению глобальных консультаций Совета Европы," [Chairman of the intergovernmental group for global consultations of the Council of Europe], TAdviser, Nov. 9, 2020.

security issues. Similarly, smart cities and smart infrastructure are not as prone to suspicion and could be another area for cooperation.[415]

Academic cooperation

As with the United States, Skoltech is leading the way on academic cooperation with European researchers in the field of artificial intelligence. In one such project, scientists from the Skolkovo Institute of Science and Technology, the French INRIA institute, and the Japanese RIKEN institute are using AI algorithms to analyze brainwaves through electrical activity in order to understand people's emotional state and level of mental stress.[416] In a separate effort, researchers from the same Skoltech institute are working with scientists from Graz University and the Kanzelhoehe Solar Observatory in Austria to develop a new deep learning method for consistently classifying and quantifying the quality of solar images from ground-based solar observatories. The method was developed at Skoltech as part of the SPRING solar physics integrated networked research group, which provides autonomous monitoring of the sun using the latest technologies in the field of observational solar physics. SPRING is part of the SOLARNET project that is developing the European Solar Telescope (EST). The project is supported by the European Union Science and Innovation Horizon 2020. Skoltech (Russia) also participates in the initiative and is one of 35 international partners.[417]

Skoltech's academic partnerships with Western universities go beyond the EU member states. A partnership with Curtin University in Australia and the University of Calgary in Canada is working to develop an algorithm that can determine the viscosity of oil without having to extract samples by analyzing nuclear magnetic resonance scanning. Similar techniques may be used in agriculture and food science, according to the researchers.[418]

Some cooperation initiatives stretch beyond Skoltech and even outside of Moscow altogether. For example, scientists from Tomsk State University (TSU) and Bulgaria's University of Plovdiv,

[415] Ivan Danilin, "Digital Transformation: (re)constructing EU-Russia dialogue (the case of AI)," EUREN Brief 2, May 2019, http://eu-russia-expertnetwork.eu/en/analytics/euren-brief-02.

[416] "В Сколтехе компьютер обучают понимать эмоции людей," [Skoltech is training a computer to understand human emotions], ComputerWorld, Dec. 29, 2020, https://computerworld.ru/news/V-Skoltehe-kompyuter-obuchayut-ponimat-emotsii-lyudey.

[417] "Искусственный интеллект помогает наблюдать за Солнцем," [AI helps to watch the sun], ComNews, Dec. 14, 2020, https://www.comnews.ru/digital-economy/content/212176/2020-12-14/2020-w51/iskusstvennyy-intellekt-pomogaet-nablyudat-za-solncem.

[418] "Искусственный интеллект научился определять вязкость нефти," [AI is able to assess the viscosity of oil], CNews, Nov. 3, 2020, https://www.cnews.ru/news/line/2020-11-03_iskusstvennyj_intellekt.

using a grant from the National Science Foundation of Bulgaria, announced on April 21, 2020, that they will use big data processing algorithms created at TSU to understand the spread of myths about the dangers of vaccination and the benefits of homeopathy. Based on this work, researchers will develop recommendations for Bulgaria's healthcare sector by 2022.[419]

Joint academic programs are also being developed, such as the Data Science and Artificial Intelligence master's program recently set up at the Russian Presidential Academy of National Economy and Public Administration's (RANEPA's) Institute of Economics, Mathematics and Information Technologies (EMIT), in cooperation with the University of London.[420] A similar initiative developed by Siberian State University and Ulm University in Germany, won an international competition with a proposal to set up a long-term collaboration between the two universities in the AI field to organize exchanges, internships and joint research projects.[421]

Commercial cooperation

Russian companies have initiated several joint ventures with European partners in the field of artificial intelligence. For example, a Russian-British joint venture is using cascading neural nets for personality assessment. The partnership is between the British commercial firm BestFitMe and a Russian research institute.[422] In another case, a Russian-Ukrainian startup called Signum.ai has raised money to develop an app that can collect and analyze data from social media, blogs, forums, and other internet portals in real time using multiple methods including network analysis, and is pitched as a tool particularly useful for marketing and sales

[419] "Ученые РФ при помощи Big Data изучат, как в Болгарии распространяются мифы о вакцинации," [Russian scientists using Big Data to study how vaccination myths are spreading in Bulgaria], FutureRussia.gov.ru, Apr. 21, 2020, https://futurerussia.gov.ru/nacionalnye-proekty/ucenye-rf-pri-pomosi-big-data-izucat-kak-v-bolgarii-rasprostranautsa-mify-o-vakcinacii.

[420] "Представители Data Science-команды ВТБ рассказали о профессиях будущего и объяснили, почему их банкам нужны выпускники РАНХиГС," [Representatives of VTB's Data Science team speak about the professions of the future and explain why their banks need graduates from RANEPA], AI News, July 27, 2020, https://ai-news.ru/2020/07/predstaviteli_data_science_komandy_vtb_rasskazali_o_professiyah_budushego_i.html.

[421] "Ученым СибГУ вручили диплом за победу в конкурсе «Россия и Германия: научно-образовательные мосты»," [Siberian State University scientists were awarded a diploma for winning the competition "Russia and Germany: scientific and educational bridges], NGS24, Sept. 16, 2020, https://ngs24.ru/news/more/69469139/.

[422] "Искусственный интеллект научили определять черты характера по фото," [Artificial intelligence taught to identify character traits from a photo], Scientific Russia, July 29, 2020, https://scientificrussia.ru/articles/iskusstvennyj-intellekt-nauchili-opredelyat-cherty-haraktera-po-foto.

teams.[423] The Finnish-Russian industrial digitalization firm Zyfra has developed a digital production management platform that allows oil and gas companies to centralize operational management through the use of AI. It is focused on selling its products in South Asia and Latin America.[424]

Russian companies in the AI space are looking to sell their products in the European Union. The Skolkovo-based company Diagnostika-M, has sold components of its Radar-IQ security system to customers in Slovakia. The system uses AI for surveillance of secure zones, such as ports, airports, power stations, prisons, etc.[425] The commercial efforts go in both directions, with European companies looking to sell their AI-based products in Russia. For example, the European IT services company Atos recently launched a Russian-language chat bot that includes SAP Intelligent Robotic Process Automation (RPA), which automates repetitive manual processes by creating, scheduling, managing, and monitoring intelligent bots, allowing employees to spend time on high-value tasks rather than routine operations.[426]

Initiatives in other parts of the world

While East Asia and Europe have been the primary areas of focus for Russian technology companies seeking to develop joint projects in the AI field, they have also established several partnerships with counterparts elsewhere in the world, particularly in the Middle East and India.

[423] "Стартап с русско-украинскими корнями Signum.ai привлек $500 тысяч," [Startup with Russian-Ukrainian Roots Signum.ai attracted $500 thousand], Cnews.ru, July 7, 2020, https://www.cnews.ru/news/line/2020-07-07_startap_s_russkoukrainskimi.

[424] "Gazprom & Zyfra JV on digital industrialisation eyes India's oil & gas market," Economic Times, Nov. 25, 2020, https://m.economictimes.com/industry/energy/oil-gas/gazprom-zyfra-jv-on-digital-industrialisation-eyes-indias-oil-gas-market/articleshow/79392935.cms.

[425] "Резидент ОЭЗ «Технополис Москва» разработал систему охраны периметра с применением искусственного интеллекта," [Technolopis Moskva developed AI-enabled perimeter defense system], Aug. 17, 2020, https://safe.cnews.ru/news/line/2020-08-17_rezident_oez_tehnopolis.

[426] "Atos запустил русскоязычного бота на базе SAP Conversation AI," [Atos launched a Russian-language bot based on SAP Conversation AI], CNews.Ru, May 7, 2020, https://www.cnews.ru/news/line/2020-05-07_atos_zapustil_russkoyazychnogo.

United Arab Emirates and the Middle East

Partnerships in the UAE include both academic and commercial ventures. On the academic side, Skoltech has been working with the University of Sharjah to create a joint AI laboratory that could develop applications in the fields of medicine, energy and aerospace. This venture is based on an MOU that was signed by the two universities in November 2019.[427] On the commercial side, a joint venture between the Russian Direct Investment Fund, Medscan Group, and a UAE company called Group42 has launched a project to diagnose and detect pneumonia, including COVID-19, using CT scans combined with artificial intelligence technology developed by the joint venture.[428] VisionLabs has recently opened an office in Dubai. The office will be focused on sales and providing technical support for pilot projects in the region, as part of the company's strategic development plan to expand its position in the region and to work more effectively with partners and vendors throughout the Middle East. The Middle East is the company's second largest market. In the Middle East, its most popular products include the LUNA biometric platform for smart and safe cities, which is used by the Dubai police to direct transport and manage traffic flows, and a KYC identity verification product for banking.[429]

Not surprisingly, the use of AI for energy exploration is a major focus in Russian cooperation initiatives in the Middle East. According to Russian vice-premier Alexander Novak, Russia and Saudi Arabia's Saudi Aramco energy company are discussing partnering for work in energy projects under the auspices of the bilateral strategic cooperation program agreed on by both countries in October 2019. Plans include the use of artificial intelligence technologies to improve oil extraction capabilities for both partners.[430]

Russian companies have also turned to the Middle East for funding their AI initiatives. The facial recognition and computer vision startup NtechLab has raised $15m in new funding, in part from sources in unnamed Middle Eastern countries. The company, which was founded in

[427] "Inaugural joint Skoltech-UoS workshop focuses on AI applications and new technologies," Skoltech, Oct. 10, 2020, https://www.skoltech.ru/en/2020/10/inaugural-joint-skoltech-uos-workshop-focuses-on-ai-applications-and-new-technologies/.

[428] "Russian Direct Investment Fund starts COVID-19 diagnostics using AI technology," Tass.com, Apr. 24, 2020, https://tass.com/science/1149433.

[429] "VisionLabs поможет развитию искусственного интеллекта в ОАЭ," [VisionLabs will assist AI development in the UAE], CNews, Nov. 25, 2020, https://www.cnews.ru/news/line/2020-11-25_visionlabs_pomozhet_razvitiyu_iskusstvennogo.

[430] "Saudi Aramco рассматривает возможность участия в проектах в России," [Saudi Aramco reviews possibility of participating in projects in Russia], Vesti, Dec. 21, 2020, https://www.vesti.ru/finance/article/2501550.

2015, uses artificial intelligence and neural networks to identify faces, silhouettes and actions from video recordings. The funding is earmarked for further developing its product range and expanding into new markets. NtechLab said it plans to use the investment to develop automatic detection of "aggressive behavior" and to develop vehicle recognition software. The funding will also be used to expand into markets in the Middle East, Southeast Asia and Latin America.[431]

Elsewhere in the Middle East, cooperation with Israel has been facilitated by a 2010 bilateral agreement that calls for increased industrial R&D cooperation. Through this mechanism, the RUSNANO Group, a Russian nanotechnology innovation institution, and the Israel Innovation Agency have set up a grant mechanism for teams comprising both Russian and Israeli partners. According to the RUSNANO Group's website, projects must be related to the field of nanotechnology or related high-tech sectors, should have potential markets in Israel and Russia, and should plan to commercialize the technology in three to five years. The RUSNANO Group's Fund for Infrastructure and Educational Programs, which administers the Russian share of the grant funds, was founded in 2010 through reorganization of the state institution Russian Corporation of Nanotechnologies. Artificial Intelligence is one of the grant priority areas. Russian leaders see joint scientific R&D as a key area in developing Russia-Israel bilateral cooperation. This cooperation is seen as beneficial not just for the technological benefits, but also by giving Russia access to a key power broker in the Middle East. Technological cooperation also provides a link to the Russian-speaking diaspora in Israel that is pivotal to Israeli economic development.[432]

Other parts of the world

Russia's efforts to expand collaboration in AI to other parts of the world are relatively limited, and primarily focused on the marketing of Russian AI products. India is one country that has

[431] "РФПИ и фонды Ближнего Востока вложили более 1 млрд руб в российского разработчика NtechLab," [RDIF and Middle East funds invested over RUB 1 billion in Russian developer NtechLab], D-Russia.ru, Sept. 24, 2020, https://d-russia.ru/rfpi-i-fondy-blizhnego-vostoka-vlozhili-bolee-1-mlrd-rub-v-rossijskogo-razrabotchika-ntechlab.html.

[432] "Россия и Израиль начали новый отбор проектов по промышленным НИОКР," [Russia and Israel launch new projects for industrial R&D], Vedomosti, July 16, 2020, https://www.vedomosti.ru/press_releases/2020/07/16/rossiya-i-izrail-nachali-novii-otbor-proektov-po-promishlennim-niokr; "Россия и Израиль начали новый отбор проектов по промышленным НИОКР," [Russia and Israel launch new projects for industrial R&D], Rosnano, July 16, 2020, https://www.rusnano.com/about/press-centre/news/20200716-rosnano-rossiya-i-izrail-nachali-noviy-otbor-proektov-po-promyshlennym-niokr.

recently become a focus for Russian efforts to enhance cooperation in the AI sphere. This is just getting under way, primarily through the BRICS organization umbrella. At a December 2020 Russian government-organized event with extensive Indian participation, the first deputy chairman of Sber's executive board focused in his remarks on expanding cooperation between Russia and India in AI R&D, "as both countries aspire to gain leading positions in the global market."[433] Beyond this effort, there is little cooperation with India, though major Russian corporations such as Gazprom Neft are seeking to access the Indian market for AI-based solutions to increase hydrocarbon extraction efficiency.[434]

Russia has made some limited efforts to penetrate fairly distant markets in the field of AI, including in Latin America and Africa. Latin America is considered a potentially highly lucrative market, especially in the field of apps that help Spanish speakers learn English. A Russian company has developed an app aimed at children for this purpose that uses an AI-based voice assistant and is being marketed in Mexico and Chile, with plans to expand subsequently to other Latin American countries.[435]

Russian ventures in Africa remain relatively limited, with a focus on commercial sales of AI-enabled products and the education of African students at Russian higher educational institutions focused on technology. In the education sphere, there is a long history of African students being educated at Russian universities such as the Patrice Lumumba University for Friendship of the Peoples. The total number of African students studying in Russia in all fields is over 27,000. The largest percentage are in technical and engineering fields, including artificial intelligence, though exact numbers are not available.[436] In terms of commercial sales, Russian AI technologies are particularly in demand in mining and other natural resource extraction industries in Africa. One example is Tsifra Group, which has developed a platform for working with production data uses artificial intelligence and the industrial internet of

[433] "BRICS umbrella to increase India, Russia collaboration on artificial intelligence," Zee News, Nov. 18, 2020, https://zeenews.india.com/india/brics-umbrella-to-increase-india-russia-collaboration-on-artificial-intelligence-2325292.html.

[434] "Gazprom & Zyfra JV on digital industrialisation eyes India's oil & gas market."

[435] "Старт продаж приложения Buddy в испаноязычных странах Латинской Америки," [Buddy app is being sold in Spanish-speaking countries], T-Adviser, Aug. 12, 2020, https://www.tadviser.ru/index.php/%D0%9F%D1%80%D0%BE%D0%B4%D1%83%D0%BA%D1%82:MyBuddy.ai.

[436] "Yuri Kukin, Irina Mandrykina, Vadim Belozertsev, "За знаниями и снегом: что притягивает африканских студентов в учебе в России," [For knowledge and snow: what attracts African students to study in Russia], TASS, Dec. 29, 2020, https://tass.ru/obschestvo/10353061.

things in the mining, oil and gas, chemical, and engineering industries. Its products are used around the world, including in a number of countries in Latin America and Africa. It recently received 1 billion rubles in investment from VEB Ventures, the investment arm of VEB.RF, for the purpose of expanding its sales in international markets.[437]

[437] "VEB Ventures инвестирует 990 млн рублей в разработчика решений для цифровизации промышленности Группу «Цифра»," [VEB Ventures invests 990 million rubles in Tsifra Group developer of solutions for the digitalization of industry], Rubezh, Dec. 23, 2020, https://ru-bezh.ru/press-releases/38953-veb-ventures-investiruet-990-mln-rublej-v-razrabotchika-reshenij.

Appendix A: General and Sector-Specific AI-Related Laws

The table below lists general and sector-specific laws by their number and name, gives their date of passage, and describes them.

Table 7. AI-related laws

Law Number and/or Name	Date of Passage	Description
General AI-Related Laws		
Federal Law No. 123-FZ: On carrying out an experiment to establish special regulation in order to create the necessary conditions for the development and implementation of AI technologies in Moscow and amendments to Article 6 and 10 of the Federal Law "On Personal Data"	Apr. 24, 2020	Establishes an experimental legal regime in Moscow removing certain legal restrictions on the development and implementation of AI technologies. Also amended the law "On Federal Data" to allow for the processing of anonymized personal data, including citizen health data.
Federal Law No. 258-FZ: On experimental legal regimes in the field of digital innovations in the Russian Federation	July 31, 2020	Creates the legal conditions for accelerated development and adoption of AI technologies in certain spheres throughout Russia by removing some legal restrictions (i.e. "regulatory sandboxes).
Presidential Order No. 1661: On the approval of a list of dual-use goods and technologies that can be used in the creation of weapons and military equipment and for which export control is carried out	Dec. 17, 2011	Includes AI technologies on the list of goods for which Russia imposes export control, since they have dual use purposes.

Law Number and/or Name	Date of Passage	Description
Government Resolution No. 170: On approval of the list of technologies used in the framework of experimental legal regimes in the field of digital innovations	Oct. 28, 2020	Lists the types of technologies included in the experimental legal regime, including technologies for working with big data and quantum technologies.
Russian Ministry of Finance Order No. 207n: On the approval of budget classification codes related to the federal budget and state extra-budgetary funds	Nov. 29, 2019	Creates a budget code for the development of information security incident processing technology with AI in order to increase the automation of decision-making processes and reduce response time for incidents.
Government Resolution No. 549: On state support of leading companies in the development of products, services, and platform solutions based on "end-to-end" digital technologies	May 3, 2019	Sets out the goals, procedures, and conditions for granting subsidies from the federal budget to leading companies developing "end-to-end" digital technologies, including those using AI and big data.
Sector-Specific AI Related Laws		
Government Resolution No. 1415: On carrying out an experiment on pilot operation of highly automated vehicles on public roads	Nov. 26, 2018	Lays out the requirements for and regulations on conducting an experiment using automated vehicles on public roads.
Government Decree No. 724-r: On the concept of ensuring road safety with unmanned vehicles on public roads	Mar. 25, 2020	Describes principles and recommendations for safely operating unmanned vehicles on public roads, including the education and training of users and the transport infrastructure necessary for the safe passage of unmanned vehicles.

Law Number and/or Name	Date of Passage	Description
Government Decree No. 1416: On approval of the rules of state medical device registration	Dec. 27, 2012	Stipulates that registration is required for, among other things, special software, including AI, intended to prevent and diagnose disease, conduct medical research, monitor patient health, etc.
Government Decree No. 1906: On amendments to the rules of state medical device registration	Nov. 24, 2020	Makes a number of amendments to the above rules on medical device registration that served to simplify the procedure for registering software, including that with AI technologies.
Government Order No. 686n: On amendments to the approval of the nomenclature classifications of medical devices	July 7, 2020	Amends a previous order from 2012 on medical device nomenclatures to introduce the classification of programming software. Software using AI technologies is considered Class 3 software with a high degree of risk.
Federal Law No. 462-FZ: On amendments to the Air Code of the Russian Federation regarding the use of unmanned aircraft	Dec. 30, 2015	Amends the Russian Air Code (enacted in 1997) to lay out requirements for and regulations on the use of unmanned aircraft and drones.
Federal Law No. 404-FZ: On amendments to certain legislative acts of the Russian Federation	Dec. 12, 2019	Amends certain pieces of legislation to prevent illegal uses of unmanned aircraft.
Government Decree No. 658: On approval of the registration rules for unmanned civil aircraft with a maximum take-off weight from .25 kilograms to 30 kilograms imported into or produced in Russia	May 25, 2019	Lays out the rules for registering civilian unmanned aircraft of a lower weight. A follow-up letter from the Ministry of Transportation and the Federal Air Transport Agency date Oct. 1, 2019 said the rules do not provide for legal liability for non-registration of unmanned aircraft but do impose an administrative fine or temporary deprivation of the right to operate an aircraft.

Law Number and/or Name	Date of Passage	Description
Government Decree No. 576: On approval of the action plan (or "road map") for improving the legislation and eliminating administrative barriers to ensure implementation of the National Technology Initiative action plan "Aeronet"	Apr. 3, 2018	Approves a government road map with target dates for specific actions aimed at developing and promoting the domestic unmanned aircraft market.

Source: CNA.

Appendix B: Major AI-Related Conferences

Below is a list of major AI-related conferences and major military conferences with AI content held in Russia over the past few years.

AI Journey

- Host: Sber
- December 3-5, 2020; also held in 2019
- 20 "thematic streams", 20+ keynote speakers, 200+ speakers from around the world, 1 million+ streams
- Conference + junior conference + competition
- https://ai-journey.ru/en/conference

Russian Conference on Artificial Intelligence (RCAI)

- Host: Russian Association for Artificial Intelligence
- RCAI is the annual (until 2018 – biennial) conference held since 1988
- 18th Conference was held October 10-16, 2020
- Wide range of topics discussed
- https://caics.ru/en_raai

ARMY Expo

- Host: Russian Ministry of Defense
- Multi-day AI conference
- Fourth conference held on August 23-29, 2020, first held in 2015
- ARMY-2021 to be held August 22-28, 2021
- Has had an increasing focus on AI each subsequent year
- http://eng.mil.ru/en/army2021.htm

OpenTalks AI conference

- Host: IP Labs
- 100+ speakers, 1,200+ participants
- Held annually since 2018, usually in February
- Topics: Natural Language Processing, Computer vision, Predictive analytics, Reinforcement learning & AGI.

- https://opentalks.ai/

"Machines Can See"

- Host: VisionLabs
- Held June 8-10, 2020
- Held annually since 2017
- Topic: Artificial Intelligence, Computer Vision, and Machine Learning
- http://machinescansee.com/

"Big Data '20"

- Host: ComputerWorld Russia and Open Systems Publications
- Held June 4, 2020; held annually since 2012
- 400+ participants and 30+ speakers
- Topic: Big Data, data analytics and processing
- https://www.osp.ru/iz/bigdata2020/eng

"Dialogue" International Scientific Conference on Computational Linguistics and Intelligent Technologies

- Host: ABBYY
- Dialogue 21 will be held June 17-20, 2021; held annually since 1995
- 300 participants annually, 230 papers published in conference proceedings, 21 competitions held on dialogue evaluation
- MIPT partnered in Dialogue 2020
- Topic: Computer Linguistics/NLP
- http://www.dialog-21.ru/en/

"The Robotization of the Russian Armed Forces"

- Host: ERA (Russia Military Elite) Military Innovative Technopolis
- July 29-30, 2020, was 5th iteration
- Link to 2019: https://function.mil.ru/news_page/country/more.htm?id=12242791@egNews
- Link to 2020: https://www.era-tehnopolis.ru/events/v-voenno-nauchnaya-konferentsiya-robotizatsiya-vooruzhennykh-sil-rossii/

"Artificial Intelligence: Problems and Solutions" conference in 2018

- Hosts/participants: Russian Academy of Sciences, together with the Ministry of Education and Science of Russia, the FAUE of Russia, the Ministry of Industry and Trade of Russia and the Ministry of Defense of Russia
- March 14-15 at the Patriot Military-Patriotic Culture and Recreation Park of the Armed Forces
- Produced 10 influential recommendations for developing Russian AI/tech
- http://mil.ru/conferences/is-intellekt.htm

CNews and TAdvisor

The news websites CNews and TAdvsior have their own conferences and workshops: https://events.cnews.ru/ and https://www.tadviser.ru/.

Appendix C: Key AI-Related Defense Players

The key AI-related defense players in Russia are listed and described below.

Main Directorate of Scientific Research and Technological Support of Advanced Technologies (GUNID)

The GUNID directorate implements the MOD's support for innovation activity, involved in the collection, analysis, and systematization of information on advanced scientific achievements. It is the primary contractor coordinator for military robots.[438] It also organizes military exhibitions and events such as roundtables on AI developments and the Russian military. GUNID is responsible for selecting AI projects for showcasing during the annual Russian military ARMY exposition. GUNID oversees the ERA Technopolis', as well as other research and innovation activity across the MOD enterprise.

46th Central Research Institute

Currently, the 46th Institute is the MOD's research organization for the armaments development, and the methodology formation for the State Armament Program.[439] The Institute also develops the MOD proposals for the defense acquisition, as well as for military standardization. The 46th Central Research Institute is the MOD scientific organization for the development of the domestic technological base, the implementation of science-intensive projects in the defense industry, as well as for the preparation of proposals and decisions on the advancements of Russian technologies and scientific achievements.[440] This institution was a key presenter at the July 2020 robotics event at the ERA, where its representatives discussed

[438] Vadim Kozyulin, "Militarization of AI," Russian Center for Policy Research, July 2019, https://stanleycenter.org/wp-content/uploads/2020/05/MilitarizationofAI-Russia.pdf.

[439] "MOD's 46th Central Research Institute," (46 Центральный научно-исследовательский институт Министерства обороны Российской Федерации), Official website of the Russian Ministry of Defense, accessed Aug. 9, 2020, https://ens.mil.ru/science/SRI/information.htm?id=11391@morfOrgScience.

[440] Ibid.

technical vision in the robotic systems, and reviewed the robotic systems' current military uses and applications.[441]

Advanced Research foundation (ARF)

The goal of ARF is to promote research and development in the interests of national defense and state security, especially in leveraging new technologies to achieve results in the military-technical, technological, and socio-economic spheres.[442] The Russian government founded ARF in October 2012, and it is roughly analogous to the US Defense Advanced Research Project Agency (DARPA).[443] ARF is home to numerous high-tech labs that work on aerial, ground and underwater robotics,[444] and houses a center for robotics development.[445] In March 2018, the Foundation announced that it had prepared proposals for the MOD and asserted that AI development in Russia should proceed along four lines of effort: image recognition, speech recognition, management of autonomous systems, and support for weapon life-cycles with maintenance and logistics.[446] The ARF and ERA are cooperating on military R&D that includes autonomous systems and AI.

ERA Technopolis

In 2018, the MOD launched the ERA Technopolis (tech city) as the military's R&D and S&T institution, where young military officers can work alongside the non-military and civilian high-tech intuitions to develop breakthrough technologies for the country's armed forces.[447] In 2019, the MOD designated ERA as the military's main AI RDT&E hub, and opened an artificial intelligence laboratory there in 2020.[448] ERA has become the focal point for both AI

[441] "V Military Scientific Conference 'Robotization of the Armed Forces of the Russian Federation'," (V Военно-научная конференция "Роботизация Вооруженных Сил Российской Федерации"), Official website of the ERA Technopolis, accessed Aug. 9, 2020, https://www.era-tehnopolis.ru/events/v-voenno-nauchnaya-konferentsiya-robotizatsiya-vooruzhennykh-sil-rossii/.

[442] "FPI," (Фонд Перспективных Исследований), Official website, https://fpi.gov.ru/.

[443] Ibid.

[444] "FPI," (Фонд Перспективных Исследований), Official website https://fpi.gov.ru/about/laboratories/.

[445] "FPI."

[446] "Advanced Research Foundation proposes standards for artificial intelligence," (Фонд перспективных исследований предложил ввести стандарты для искусственного интеллекта), Mar. 20, 2018, https://topspb.tv/news/2018/03/20/fond-perspektivnyh-issledovanij-predlozhil-vvesti-standarty-dlya-iskusstvennogo-intellekta/. and "FPI discussed AI projects," (В ФПИ рассказали о проектах в области искусственного интеллекта), Ria.ru, Feb. 20, 2019, https://ria.ru/20190220/1551137812.html.

[447] "ERA Technopolis official webpage," https://www.era-tehnopolis.ru/.

[448] Ibid.

development, and for discussions on AI RDT&E between the Russian military, industry and academia. The ARF and ERA are cooperating on military R&D that includes autonomous systems and AI.

Rostec

Rostec is a state-owned defense and industrial conglomerate. Comprised of some 800 entities, corporations, enterprises and R&D institutions, it is Russia's largest defense-industrial institution.[449] Rostec subsidiaries specialize in a range of AI products for the nation's military and security services and agencies – its Kalashnikov, Technomash, Techpriyomka, Avtomatika Concern, Ruselectronics Holding, Kamaz and KRET subsidiaries are notable for their AI research and development efforts. Such as AI-controlled weapon station[450], an AI-enabled counter-UAS system[451], and AI-enabled smart munitions,[452] to name a few. Rostec's portfolio also includes of Russia's key facial recognition company – NtechLab. In April 2019, Rosobortonexport, the country's main arms export agency, and NtechLab presented a unique solution based on the FindFace face recognition system for the military and Special Forces.[453] Rostec is also cooperating with the ERA technopolis on AI RDT&E.

Rosoboronexport

Joint-Stock Company Rosoboronexport is Russia's only state-controlled intermediary in exports and imports of military and double-purpose products, technologies and services.[454] The Company is actively involved in pursuing national policy of the Russian Federation in military technical cooperation with foreign countries. Rosoboronexport's operations are overseen by the President of the Russian Federation, the Government of the Russian

[449] "Official Rostec webpage," https://rostec.ru/en/about/.

[450] "Rostec: Russia already has developments in self-learning weapons with artificial intelligence," (Ростех: Россия уже имеет наработки по самообучающемуся оружию с искусственным интеллектом), Tass.ru, June 6, 2018, https://tass.ru/armiya-i-opk/5268765.

[451] "Rostec presented anti-drone systems with artificial intelligence," (Ростех" презентовал противодронные системы с искусственным интеллектом), Aug. 24, 2020, https://ria.ru/20200824/armiya-1576259567.html.

[452] "Ammo with sartificial intelligence ammunition has been developed in Russia," (В России разработали боеприпасы с искусственным интеллектом), Dec. 2, 2020, https://ria.ru/20201202/boepripasy-1587365229.html.

[453] "Rostec Will Start Exporting Face Recognition Technology to the Armed Forces," Rostec official website, Apr. 25, 2019, https://rostec.ru/en/news/rostec-will-start-exporting-face-recognition-technology-to-the-armed-forces/.

[454] "Official Rosoboronexport webpage," http://roe.ru/eng/rosoboronexport/status/.

Federation, the Federal Service of Military-Technical Cooperation, and Rostec State Corporation.[455]

KRET

Concern Radio-Electronic Technologies (KRET) is a member of the State Corporation Rostec, and is the leading Russian designer and manufacturer of onboard radioelectronic equipment and electronic countermeasures for aircraft (over 80 percent of the market) and state identification systems (over 90 percent of the market). The company's products are sold in more than 30 countries.[456]

Rubin Design Bureau

The Joint-Stock Company "Central Design Bureau for Marine Engineering "Rubin" is the largest in Russia among marine engineering companies offering maritime design services. Over 85 percent of submarines in the Soviet and later Russian Navy were built on Rubin designs.[457] Today, Rubin is part of the United Shipbuilding Corporation. Rubin specializes in marine robotic systems - it built Vityaz deep-water UUV that descended to the bottom of the Mariana Trench in 2020. Vitayz was built with ARF and the Russian Navy.[458]

State Scientific Research Institute of Aviation Systems (GosNIIAS)

State Scientific Research Institute of Aviation Systems (Государственный научно-исследовательский институт авиационных систем), known by its acronym GosNIIAS, is a scientific center engaged in civil and military aviation systems research, airborne system algorithms and software development, as well as analysis of avionics and weapon systems efficiency.[459] GosNIIAS conducts work on military artificial intelligence and has been actively involved in developing neural networks for military UGVs.[460] GosNIIAS is also part of the

[455] Ibid.

[456] "Official KRET webpage," https://rostec.ru/en/about/companies/346/.

[457] "Official Rubin Deisgn Bureau webpage," http://ckb-rubin.ru/en/company_profile/.

[458] "Official; Vityaz-D UUV webpage," https://fpi.gov.ru/projects/fiziko-tekhnicheskie-issledovaniya/vityaz-d/.

[459] "Official GosNIIAS webpage," https://www.gosniias.ru/.

[460] Ibid. "Andrey Dutov: The center of AI technologies will be created in the Zhukovsky Institute," [Андрей Дутов: В НИЦ Институт имени Н.Е. Жуковского создадут центр технологий ИИ], aviaport.ru, Dec. 9, 2019, https://www.aviaport.ru/digest/2019/12/09/618139.html.

Zhukovsky Institute National Research Center that was created to develop new aviation technology and AI for the nation's aviation industry.[461]

Zhukovsky Institute National Research Center

The Zhukovsky Institute is a key platform for discussions on the current and future development of piloted and unmanned systems, and is an active participant in military-organized events on that topic.[462] In December 2019, the Zhukovsky Institute announced the creation of the Center for Artificial Intelligence Technologies (CAIT).[463] The center will work on the development of computer vision, predictive data analysis, deep neural networks (GNS), deep learning technologies, along with robotics and intelligent technologies.[464] GosNIIAS will be one of two institutions where CAIT work will be housed; the other is the Baranov Research Institute.

Research Institute of Robotics and Control Processes

The institute is housed in Russia's Southern Federal University (located in Rostov-on-Don) which stands apart as one of the MOD's UARC-type (university affiliated research center) research and development intuitions. In 2020, the SFU's Research Institute of Robotics and Control Processes announced that it has created an AI-based control system for robotic swarms, such as unmanned boats, cars and flying vehicles.[465] The SFU is already developing autonomous assault and reconnaissance UGV and UAV swarms for the MOD that can be used in urban combat.[466]

Center for the Development of AI Technologies

The Center is housed at the Voronezh State University, and was opened in 2018 with support from Rostec's Sozvezdie Holding. The Center will work on machine learning, Big Data analysis

[461] "Andrey Dutov: The center of AI technologies will be created in the Zhukovsky Institute."

[462] Ibid.

[463] Ibid.

[464] "Official GosNIIAS webpage"; "Andrey Dutov: The center of AI technologies will be created in the Zhukovsky Institute."

[465] "From "defense" to "civilian": Southern Federal University scientists are developing smart technologies based on artificial intelligence for autonomous control of robots," [От «оборонки» к «гражданке»: ученые ЮФУ разрабатывают умные технологии на основе искусственного интеллекта для автономного управления роботами], Southern Federal University (SFU) website, Mar. 26, 2020, https://www.sfedu.ru/www2/web/press-center/news/62523.

[466] Ibid.

and information processing technologies.[467] The Center's graduates will develop projects in artificial intelligence information systems, and will conduct research on new information processing technologies and machine learning for the Russian civil and military industry.

Russian Academy of Sciences

The Russian Academy of Sciences (RAS) is a state academy of sciences, a science organization that carries out scientific supervision of scientific research in the Russian Federation and leads all national scientific research.[468] RAS partnered with the MOD on the inaugural 2018 "AI: Problems and Solutions" Conference. [469]

Moscow Institute of Physics and Technology

The Moscow Institute of Physics and Technology (MIPT) is one of the leading Russian universities in the areas of physics and technology.[470] MIPT is the focal point in Russia's academic work on artificial intelligence. MIPT houses DeepPavlov Neural Networks and Deep Learning Lab.[471] It also houses National AI Center that is part of the National Technology Initiative (NTI).[472] MIPT is the leading academic institution that assists other Russian universities with AI RDT&E.

[467] "Rostec opened the Center for the Development of Artificial Intelligence Technologies," [Ростех открыл Центр развития технологий искусственного интеллекта], Rostec.ru, Oct. 10, 2018, https://rostec.ru/news/rostekh-otkryl-tsentr-razvitiya-tekhnologiy-iskusstvennogo-intellekta/.

[468] "Official RAS webpage," http://www.ras.ru/about.aspx.

[469] "AI Conference," (КОНФЕРЕНЦИЯ ПО ИСКУССТВЕННОМУ ИНТЕЛЛЕКТУ), https://xn--80abdxcgbiual9c5b.xn--p1ai/conf.

[470] "Official MPIT webpage," https://mipt.ru/english/about/about-mipt/.

[471] "Official Deeppavlov lab webpage," https://deeppavlov.ai/team.

[472] "MIPT-based national tech research center reports on AI industry status in Russia and worldwide," MIPT.ru, Oct. 6, 2019, https://mipt.ru/english/news/mipt_based_national_tech_research_center_reports_on_ai_industry_status_in_russia_and_worldwide?sphrase_id=311646.

Appendix D: Russian Military AI and Autonomous Related Systems

The following table provides some information about those systems with AI or autonomy-related reporting. The threshold for making this list was low in that only the mention of AI or autonomous activity associated the system was required for entry. Additionally, we expect this list to change significantly over the near term as Russia continues to experiment and field new concepts and systems utilizing AI or autonomy in some way. This was done in an attempt to capture the breadth of possible Russian military-related developments in AI and autonomy. Where system information or designation was not known it is designated as such. It is not uncommon for reporting to surface on a particular new technology or enhanced military platform without a corresponding designation or name. The "Development Status" categories were distilled from announcements made by manufacturers, military personnel, and journalists and we define them as follows:

1. Basic research: A military or industrial entity has announced the research and development of a particular technology or system, usually accompanied by a brief description of capability and purpose.
2. Prototype development and field tests: A military or industrial entity has announced a prototype that is undergoing field tests. This is often accompanied by more precise details as to dates and status of the prototype.
3. Fielded prototype: A military or industrial entity has announced a limited number of prototypes that are undergoing more thorough and rigorous testing. At his stage it is possible the military will test the system in Syria with subsequent announcements.
4. Accepted and in production: A military or industrial entity has announced that a given system or technology has passed field testing and has been accepted by the military and is entering production for fielding with military units.

Table 8. Russian systems incorporating AI or autonomy

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
Unmanned combat, air, underwater, and ground vehicles					
UCAV	S-70 Okhtonik (С-70 Охотник)	United Aircraft Corporation (ОАК, Сухой, Ростех)	Fielded prototype headed into limited prototype production	ISR and autonomy for interceptor and ground attack roles	https://iz.ru/1125699/anton-lavrov-aleksei-ramm/okhotnik-v-piatom-pokolenii-su-57-i-drony-stanut-ispolzovat-vmeste and https://ria.ru/20210317/bespilotnik-1601569846.html
UCAV	Altius (Альтиус)	UZGA (УЗГА)	Fielded prototype headed into scaled production in 2021	ISR and autonomy for interceptor and ground attack roles	https://topwar.ru/169438-altius-tjazhelyjrossijskij-bespilotnik-s-iskusstvennym-intellektom.html
UAV	Volk-18 (Волк-18)	Almaz-Antey (Алмаз-Антей)	Development prototype	ISR for detecting and attacking drones	https://iz.ru/1122825/2021-02-10/pervyi-v-rf-avtonomnyi-dron-okhotnik-volk-zavershil-ispytaniia
UAV	No official designation available	ZALA-Aero –Kalashnikov (ZALA-AERO – Калашников)	Development prototype	Logistics for transporting cargo	https://kalashnikovgroup.ru/press-center/news/zala_aero_predstavila_kontseptsiyu_ispolzovaniya_bpla_dlya_dostavki_gruzov
UAV	*No official designation available*	MOD developer not specified	Fielded prototype	ISR for detecting air defense	https://iz.ru/1089566/anton-lavrov-roman-kretcul/razvedka-dronom-v-voiskakh-poiavilis-bespilotniki-ishcheiki
UAV	*Eleron-3 (Элерон-3)*	Eniks (ЭНИКС)	Scaled production	Tactical ISR	https://armystandard.ru/news/20212151532-yoUPQ.html?fbclid=IwAR1ylv-BV3_3CBe0csj1jRosiL6-rn8VvX7YaPUmmAGIoWbPGmOP4-6JTPc

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
UAV	*Eleron-7 (Элерон-7)*	Eniks (ЭНИКС)	Fielded prototype	Tactical ISR	https://xn--b1aga5aadd.xn--p1ai/2019/%D0%91%D0%BF%D0%BB%D0%B025/
UAV	*Eleron-10 (Элерон-10)*	Eniks (ЭНИКС)	Development prototype	Tactical ISR	https://armystandard.ru/news/20212151532-yoUPQ.html?fbclid=IwAR1ylv-BV3_3CBe0csj1jRosiL6-rn8VvX7YaPUmmAGIoWbPGmOP4-6JTPc
UAV	*Granat-1,2,4 (Гранат-1, 2, 4)*	Kalashnikov (Калашников)	Scaled production	Tactical ISR	http://bastion-opk.ru/granat-1/ *and* https://vpk.name/images/i216420.html *and* http://mil.ru/924gcba/equipment/more.htm?id=12047545@morfMilitaryModel
UAV	*Zastava (Застава)*	UZGA (УЗГА)	Scaled production	Tactical ISR	https://diana-mihailova.livejournal.com/5755713.html
UAV	*Orlan-10 (Орлан-10)*	Special Technology Center (STC) (Специальный технологический центр – СТЦ)	Scaled production	Tactical ISR	http://xn--d1acaykgvdf0he1a.xn--90anlfbebar6i.xn--p1ai/news_page/country/more.htm?id=12304235%40egNews
UAV	*Orlan-30 (Орлан-30)*	Special Technology Center (STC) ((Специальный технологический центр – СТЦ)	Scaled production	Tactical ISR	https://zvezdaweekly.ru/news/t/20206251815-uqqk7.html
UAV	*Takhion (Тахион)*	Izhmash («Ижмаш — Беспилотные системы»)	Scaled production	Tactical ISR	https://tvzvezda.ru/news/forces/content/202012281555-vnVpf.html
UAV/UCAV	*Orion (Орион)*	Kronshtadt Design Bureau (Кронштадт)	Scaled production	MALE ISR and combat platform	https://ria.ru/20201228/orion-1591162329.html

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
UAV	*Forpost (Форпост)*	UZGA ((УЗГА)	Scaled production	ISR MALE platform	https://diana-mihailova.livejournal.com/5755713.html
UAV	*Grom (Гром)*	Kronshtadt Design Bureau (Кронштадт)	Development prototype	"Loyal wingman" combat and ISR platform	https://tass.ru/armiya-i-opk/10876259 *and* https://tvzvezda.ru/news/ekskluziv/content/20208241728-xo0R0.html
UAV	*Korsar (Корсар)*	Rostec (Ростех)	Development prototype	MALE ISR and combat platform	https://vpk.name/library/f/korsar-bla.htm
UAV	*Zala VTOL*	Rostec (Ростех)	Scaled production	AI-enabled ISR and logistics platform	
UAV	*Karnivora (Карнивора)*	Mikran MPP (НПФ "Микран")	Development prototype	Counter-UAS drone	https://bmpd.livejournal.com/3454971.html
UAV	*Argument (Аргумент)*	SAT Aeronautics Design Bureau (Современные авиационные технологии» (САТ)	Basic research to development prototype	Combat drone based on a SR-10 jet trainer	https://lenta.ru/news/2021/02/27/argument/
UAV	*Sirius and Helios (Сириус и Гелиос)*	Kronshtadt Design Bureau (Кронштадт)	Basic research into development prototypes	MALE and HALE ISR and combat platforms	https://ria.ru/20200824/armiya-1576227147.html *and* https://ria.ru/20200823/bespilotnik-1576192955.html
UAV	*No official designation given*	Rostec (Ростех)	Basic research into development prototype	Flame-throwing drone for RBC forces	https://ria.ru/20200928/dron-1577865508.html
UAV loitering munition	*Kub-BLA (КУБ-БЛА)*	Rostec (Ростех)	Fielded prototypes	Tactical, short-range loitering munitions	https://iz.ru/1126653/aleksei-ramm/u-rossii-est-svoia-lineika-bespilotnikov-kamikadze

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
UAV loitering munition	*Lancet-3 (Ланцет)*	Rostec (Ростех)	Fielded prototypes	Tactical, short-range loitering munitions	https://iz.ru/1126653/aleksei-ramm/u-rossii-est-svoia-lineika-bespilotnikov-kamikadze
UAV (helicopter)	R-2200 (P-2200)	Rus Design Bureau (Конструкторское бюро Русь)	Fielded prototype	Autonomy for transportation	https://www.aex.ru/news/2020/8/13/215677/
UAV (helicopter)	Strekoza (Стрекоза)	Rostec (Ростех)	Development prototype	Small drone for bomb identification and neutralization	https://rg.ru/2020/10/22/rossiia-pokazala-sapernyj-mini-bespilotnik-strekoza.html
UAV	VRT300	Russian Helicopters («Вертолёты России»)	Fielded prototype	ISR in Arctic conditions	https://russian.rt.com/russia/article/580649-rossiya-bespilotniki-arktika-forum
UAV (helicopter)	*No official designation available*	ARF (ФПИ)	Development prototype	ISR and autonomy for general operation	https://ria.ru/20170112/1485561185.html
UAV (quadrocopter)	*Veer (Веер)*	Eniks (ЭНИКС)	Development prototype	ISR and search and rescue	https://xn--b1aga5aadd.xn--p1ai/2020/%D0%92%D1%8B%D1%81%D1%82%D0%B0%D0%B2%D0%BA%D0%B89/
UAV (helicopter)	*Katran (Катран)*	Russian Helicopters («Вертолёты России»)	Development prototype	Combat operations	https://tvzvezda.ru/weapon/prochee/content/201805071210-3zdh.htm
UAV (helicopter)	*Voron-777 (Ворон 777)*	Iskatel Design Bureau (КБ "Искатель" Московского авиационного института (МАИ)	Development prototype	ISR and EW	https://ria.ru/arms/20170616/1496639867.html
UAV (helicopter)	*Briz (Бриз)*	Radar MMS (Радар ммс)	Development prototype	ISR	https://tvzvezda.ru/news/opk/content/201602161510-lw3e.htm

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
UAV (helicopter and multirotor)	*No official designation given*	Copter Express Technologies (Коптер Экспресс Технологии)	Fielded prototype	Heavy drone for rescuing people from burning buildings	https://iz.ru/1110332/2021-01-12/budushchee-priletelo-mchs-nachnet-spasat-liudei-iz-goriashchikh-vysotok-dronami
UAV (multirotor)	*No official derogation given*	Zhukovsky and Gagarin Academy with the Russian VKS (Военно-воздушная академия им. профессора Н.Е. Жуковского и Ю.А. Гагарина)	Development prototype	Medical logistics and medical transportation	https://nauka.tass.ru/nauka/8956935
UAV (VTOL)	*Fixar-007*	Fixar	Scaled production	Industrial and ISR applications	https://fixar.pro/outdoor-en/
UAV (quadrocopter)	*SeaDrone*	SvyazSpetszachita (Связь Спецзащита)	Development prototype	ISR in the Arctic region	https://flot.com/2020/%D0%A4%D0%BE%D1%80%D1%83%D0%BC%D0%90%D1%80%D0%BC%D0%B8%D1%8F133/
UAV (quadrocopter)	*Albatros-2 (Альбатрос-П)*	Stilssoft LLC (ГК "Стилсофт")	Fielded prototype	ISR and guard duties	https://xn--b1aga5aadd.xn--p1ai/2019/%D0%A4%D0%BE%D1%80%D1%83%D0%BC%D0%90%D1%80%D0%BC%D0%B8%D1%8F94/
UAV (helicopter)	*Grach (Грач)*	Arzamas instrument-making plant named after P.I. Plandin (Арзамасский приборостроительный завод имени П.И. Пландина)	Development prototype	EW	https://xn--b1aga5aadd.xn--p1ai/2019/%D0%A4%D0%BE%D1%80%D1%83%D0%BC%D0%90%D1%80%D0%BC%D0%B8%D1%8F80/
UAV (helicopter)	*Aura-100*	AURA	Development prototype	ISR, logistics, search and rescue	https://ria.ru/20190826/1557923325.html?fbclid=IwAR0P1Xij2Ogj1zOYIg8R4B

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
					RuFtKl3KztQ43tRCCIVYbKSqltWUdTLmAZAEM
UAV (quadrocopter)	*Nanorazvedchik (Наноразведчик)*	ERA Technopolis and Detsima (технополис "ЭРА" и компания "Децима"	Development prototype	ISR	https://xn--b1aga5aadd.xn--p1ai/2019/%D0%A4%D0%BE%D1%80%D1%83%D0%BC%D0%90%D1%80%D0%BC%D0%B8%D1%8F133/
UAV (multirotor)	*BANS (БАНС)*	Onboard Aviation Systems (BANS) (Бортовые аэронавигационные системы" (БАНС)	Development prototype	ISR drone that runs on hydrogen	https://xn--b1aga5aadd.xn--p1ai/2019/%D0%A4%D0%BE%D1%80%D1%83%D0%BC%D0%90%D1%80%D0%BC%D0%B8%D1%8F10/
UAV (disc)	*Gubkin University Discoplan (Дископлан)*	Gubkin Oil and Gas State Enterprise (РГУ нефти и газа (НИУ) имени И.М. Губкина)	Development prototype heading in for field tests	ISR drone for oil and gas enterprises	https://iz.ru/848466/olga-kolentcova/opoznannyi-obekt-novyi-diskoplan-prosledit-za-truboprovodami
UAV swarm	*Molniya (Молния)*	Kronshtadt Design Bureau (Кронштадт)	Development prototype	ISR, EW, air and ground attack	https://xn--b1aga5aadd.xn--p1ai/2021/%D0%91%D0%BF%D0%BB%D0%B04/
UAV swarm	*Staya-93 (Стая-93)*	Zhukovsky and Gagarin Academy with the Russian VKS (Военно-воздушная академия им. профессора Н.Е. Жуковского и Ю.А. Гагарина)	Development prototype	Attacking ground targets	https://russian.rt.com/russia/article/680772-staya-93-roi-bespilotniki
UAV	*Glaz (Глаз)*	Mikran (Микран)	Fielded prototype	ISR system used from a flare gun	https://tass.ru/armiya-i-opk/6433061

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
UAV team	*TAKR-7001 (ТАКР 7001)*	Aviation Systems Corporation (ПП "Авиационные системы")	Fielded prototype	A fixed-wing and multirotor drone team for ISR	https://xn--b1aga5aadd.xn--p1ai/2019/%D0%A4%D0%BE%D1%80%D1%83%D0%BC%D0%90%D1%80%D0%BC%D0%B8%D1%8F116/
UAV	*Sova (Сова)*	Zhukovsky and Gagarin Academy with the Russian VKS ((Военно-воздушная академия им. профессора Н.Е. Жуковского и Ю.А. Гагарина)	Fielded prototype	ISR – drone disguised as an owl	https://iz.ru/894873/2019-07-01/voennyi-ekspert-nazval-naznachenie-bespilotnika-sovy
UAV	*C-UAS rifle drone*	Almaz-Antey (Концерн воздушно-космической обороны «Алмаз–Антей»)	Development prototype	C-UAS drone that can carry a carbine or a semi-automatic gun	https://vz.ru/news/2019/3/13/968224.html
UAVs	*In 2019, MiG Corporation claimed it was working on a lineup of combat drones. So far, none have been shown to the public nor displayed at military expos.*	MiG Corporation (МиГ)	Basic research	ISR and combat drone lineup	https://ria.ru/20191208/1562109076.html

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
Unmanned naval vessel	Kadet-M (Кадет-М)	*Center for the Development of Innovation Activity SPbPU (Центр развития инновационной деятельности СПбПУ)*	Fielded prototype	Autonomy for ISR and combat operations	https://media.spbstu.ru/news/university/102/
UUV	Poseidon (Посейдон)	Rubin and Malahit design bureaus ((Рубин и Малахит Конструкторское бюро)	Fielded prototype	Autonomy and AI for navigation	https://iz.ru/1121208/dmitrii-kornev/poseidon-v-pomoshch-nachinaiutsia-ispytaniia-strategicheskogo-oruzhiia-rf
UUV	Galtel (Гальтель)	Institute for problems of Marine Technologies RAS (ИПМТ ДВО РАН)	Fielded prototype heading into possible scaled production	Autonomy for ISR and situational awareness	https://rg.ru/2018/02/22/rossijskij-podvodnyj-robot-vypolnil-boevuiu-zadachu-v-sirii.html
UUV	Vityaz (Витязь)	ARF and Rubin Design Bureau (ФПИ и Рубин Конструкторское бюро)	Fielded prototype heading into possible scaled production	ISR and Autonomy for deep-water missions	https://ria.ru/20200509/1571206567.html?in=t and https://tass.ru/armiya-i-opk/8682529
UUV	Klavesin -1 (Клавесин-1Р)	Institute for Problems of Marine Technologies (IPMT) Far East Division of RAS (ИМПТ ДВО РАН)	Development prototype	Deep-water ISR	http://robotrends.ru/robopedia/klavesin-1r
UUV	Klavesin -2R-PM (Клавесин-2Р-ПМ)	Rubin Design Bureau (Рубин Конструкторское бюро)	Development prototype	Deep-water ISR	https://tass.ru/armiya-i-opk/5402375 and https://tass.ru/armiya-i-opk/8682529
UUV	Yunona (Юнона)	Rubin Design Bureau (Рубин Конструкторское бюро)	Development prototype	ISR	https://www.interfax.ru/world/519565 and https://tass.ru/armiya-i-opk/8682529

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
UUV	Amulet (Амулет)	Rubin Design Bureau (Рубин Конструкторское бюро)	Development prototype	ISR	https://russian.rt.com/nopolitics/news/657263-robot-rossiya-ekspert and https://tass.ru/armiya-i-opk/8682529
UUV	Marlin-350 (Марлин-350)	Tetris-Pro (АО «Тетис Про»)	Scaled production	ISR	http://robotrends.ru/robopedia/marlin-350 and https://bmpd.livejournal.com/3974875.html
UUV	No official designation given	Okeanos (ЗАО "Научно-производственное предприятие подводных технологий Океанос)	Development prototype	ISR and industrial duties- UUV has a manipulator arm	https://flot.com/2019/%D0%9C%D0%B2%D0%BC%D1%8151/
UUV	Sea Shadow (Glider) (Глайдер (Морская тень)	Sankt-Peterburgskiy Gosudarstvennyy Morskoy Tekhnicheskiy Universitet and Okeanos Bureau (Санкт-Петербургский государственный морской технический университет (СПбГМТУ) и ЗАО "Научно-производственное предприятие подводных технологий Океанос")	Scaled production	ISR	http://robotrends.ru/robopedia/glayder-2.0
UUV	Sarma (Сарма)	ARF and Lazurit (ФПИ и конструкторское бюро "Лазурит")	Fielded prototype	Arctic region ISR and logistics	https://ria.ru/defense_safety/20181024/1531327404.html

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
UUV	Avrora (Аврора)	Avrora Design Bureau (НПО "Аврора")	Development prototype	ISR	https://flotprom.ru/2021/%D0%98%D1%81%D0%BF%D1%8B%D1%82%D0%B0%D0%BD%D0%B8%D1%8F8
UUV	Surrogat (Суррогат)	Rubin Design Bureau (Рубин Конструкторское бюро)	Development prototype-field tests conducted	Mimic friendly or adversary submarines	https://tass.ru/armiya-i-opk/5402375 and https://tass.ru/armiya-i-opk/8682529 and https://tass.com/defense/1166271
UUV	Target unmanned underwater system, no designation given - description is similar to the Surrogat	Russian Navy is overseeing the project	Basic research	Mimic friendly or adversary submarines	https://iz.ru/843010/aleksei-ramm-aleksei-kozachenko/dron-imitator-submarin-vmf-poluchit-slozhnuiu-mishen
UUV	Cephalopod (Цефалопод)	Rubin Design Bureau (Рубин Конструкторское бюро)	Development prototype	Underwater combat operations	https://bmpd.livejournal.com/1595107.html and https://topwar.ru/145141-podvodnyy-bespilotnik-cefalopod-zarubezhnyy-vzglyad.html
UUV	Nerpa (Нерпа)	Rostec (Ростех)	Development prototype	Underwater combat operations – UUV can carry explosives and on-board weapons	http://robotrends.ru/robopedia/podvodnye-voennye-robotizirovannye-apparaty and https://tass.ru/armiya-i-opk/5475917
UUV system	Iceberg (Айсберг)	Rubin Design Bureau and ARF (ФПИ и Рубин Конструкторское бюро)	Development prototype	Arctic region extractive industry, underwater ISR	https://tass.ru/interviews/4572997 and https://tass.ru/armiya-i-opk/8682529

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
UUV	Perspectiva-R (Перспектива "P")	Rubin Design Bureau (Рубин Конструкторское бюро)	Basic research into a development prototype by 2023	Hydroacoustics and ISR UUV with increased autonomy	https://flotprom.ru/2020/%D0%92%D0%BC%D1%8455/
UUV	No official designation given	Far East Federal University (DVFU) and Russian Academy of Sciences (Дальневосточный федеральный университет и РАН)	Basic research	UUV for deep-water operation, including in the Arctic	https://nauka.tass.ru/nauka/6832313
UUV	MSS-3000	MarineGeo (Морское Инженерное Бюро)	Scaled production	Deep-water ISR remote-operated platform	http://mil.today/2019/Navy44/
UUV	No official designation given	"Senorika" NTI Center of Competence and National Research University MIET (Центр компетенций НТИ "Сенсорика"на базе Национального исследовательского университета МИЭТ)	Development prototype	UUV platform that will require need GPS for navigation	https://nauka.tass.ru/nauka/6013638
UUV swarm	Micro UUVs swarm announced in 20919, no official designation given	Multiple domestic vendors	Development prototypes	Micro UUV swarm for ISR operations in the Arctic	https://tass.ru/interviews/4502372

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
UUV-UAV complex	No official designation given	Institute for Management Problems. V.A. Trapeznikov at the Russian Academy of Sciences (RAS) (Институт проблем управления им. В.А. Трапезникова РАН (ИПУ РАН)	Fielded prototype	A UUV capable of launching its own multi-rotor UAV for ISR and communications	https://iz.ru/791262/mariia-nediuk/podvodnyi-dron-shpion-v-rossii-sozdan-sovmeshchennyi-s-kopterom-bespilotnik
UUV	Part of the "Geo-information systems. The Yenisei - the Arctic" project	Siberian State University of Sciences and Technologies (Сибирского государственного университета науки и технологий, Институт космических исследований и высоких технологий)	Fielded prototype	River exploration platform	http://tass.com/defense/1039955
Unmanned underwater antennae	No official designation given	Russian Navy is conducting T&E	Development prototype	ISR and underwater ASW	https://iz.ru/759689/nikolai-surkov-aleksei-ramm/rossiiskie-korabli-poluchili-antennu-robota
USV	No official designation given	Almaz Design Bureau and Sredne-Nevsky Shipbuilding (ЦКБ "Алмаз" и Средне-Невский судостроительный завод)	Development prototype	ISR and anti-mine warfare	https://rg.ru/2019/02/27/reg-ufo/bespilotnyj-kater-dlia-vmf-ispytaiut-v-chernom-moreispytaniia.html
USV	CyberBoat-350 (КиберБоат-330)	St. Petersburg Polytechnic University (Санкт-Петербургский	Development prototype	Patrolling shallow Caspian Sea waters	https://flot.com/2020/%D0%A4%D0%BE%D1%80%D1%83%D0%BC%D0%90%D1%80%D0%BC%D0%B8%D1%8F128/

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
		политехнический университет)			
USV	Falco	Morteh LLC (Мортех)	Development prototype	Modular boat for combat and logistics	https://flotprom.ru/2020/%D0%A4%D0%BE%D1%80%D1%83%D0%BC%D0%90%D1%80%D0%BC%D0%B8%D1%8F182/
USV	Iskatel (Искатель)	Research and Production Enterprise "Aviation and Marine Electronics" (NPP AME) (О «Научно-производственное предприятие «Авиационная и морская электроника» (НПП АМЭ)	Development prototype	ISR and anti-mine warfare	https://bmpd.livejournal.com/2725709.html
USV	Skanda (Сканда)	Mnev and Co. Shipbuilding (ООО "ПКФ "Мнев и К" (Санкт-Петербург)	Development prototype	Anti-mine operations	https://bmpd.livejournal.com/3294327.html
USV	Buk-600 (Бук-600)	Peter the Great St. Petersburg Polytechnic University (Санкт-Петербургский политехнический университет)	Development prototype	Patrol and ISR	https://flotprom.ru/2018/%D0%9C%D0%B2%D0%BC%D1%813/
USV	Ratsionalizator-1 (Рационализатор-1)	Telecommunications University (Институт телекоммуникаций)	Development prototype into fielded prototype	ISR complex for Rosgvardiya (National Guard)	https://flotprom.ru/2019/%D0%98%D1%81%D0%BF%D1%8B%D1%82%D0%B0%D0%BD%D0%B8%D1%8F16/ and https://flotprom.ru/2018/%D0%A4%D0%BE%D1%80%D1%83%D0%BC%D0%9

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
					0%D1%80%D0%BC%D0%B8%D1%8F62/
USV-UUV complex	No official designation given	Shirshov Institute of Oceanology of the Russian Academy of Sciences and the "Underwater Robotics" company (Институт океанологии имени Ширшова РАН и российская компания "Подводная робототехника")	Development prototype	Increased autonomy allows an operator to command both a USV catamaran and an on—board UUV platform	https://ria.ru/20190503/1553238265.html
USV-UUV complex	Shadow (Тень)	St. Petersburg State marine Technical University (Санкт-Петербургский государственный морской технический университет)	Basic research	Increased autonomy (up to 6 months), modular construction allows the vehicle to operate both above and below water	https://nauka.tass.ru/nauka/6077199
Humanoid android UUV	No official designation given	Sevastopol State University, United Shipbuilding Corporation and NPO “Androidnaya Tekhnika” Севастопольский государственный университет (СевГУ) и Андроидная Техника)	Development prototype	Tele-operated humanoid platform for deep-water exploration	https://nauka.tass.ru/nauka/6241679
UGV	Udar (Удар)	Rostec (Ростех)	Fielded prototype	Autonomy for combat operations	https://russian.rt.com/russia/article/831267-rossiya-armiya-udar-robot

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
UGV	Marker (Маркер)	ARF (ФПИ)	Fielded prototype	Experimental autonomy and ISR as a test bed for UGV technology	https://fpi.gov.ru/press/news/marker-preodolel-30-kilometrov-po-peresechennoy-mestnosti-v-avtonomnom-rezhime/?fbclid=IwAR3abfzNJG3b0X1fCEWwWgLrp_aDk4xxJhGJowa4DhLLyGGjEfx1K2rnOjc
UGV	Uran-6 (Уран-6)	Rostec (Ростех)	Scaled production	Deming operations	https://iz.ru/1115129/anton-lavrov/voina-na-udalenke-armiia-massovo-zakupaet-boevykh-robotov
UGV	Uran-9 (Уран-9)	Rostec (Ростех)	Scaled production	Combat operations	https://iz.ru/837551/2019-01-24/boevoi-robot-uran-9-postupil-na-vooruzhenie-rossiiskoi-armii
UGV	Uran-14 (Уран-14)	Rostec (Ростех)	Scaled production	Demining and IEX clearance	https://iz.ru/1115129/anton-lavrov/voina-na-udalenke-armiia-massovo-zakupaet-boevykh-robotov
UGV	Soratnik (Соратник)	Kalashnikov (Rostec) (Ростех)	Fielded prototype	Combat operations, MUM-T testing platform	https://radiosputnik.ria.ru/20200414/1570028041.html
UGV	Nahlebnik (Нахлебник)	Kalashnikov (Rostec) (Ростех)	Fielded prototype	ISR and combat operations	http://www.vesti.ru/doc.html?id=2853609
UGV	Nerehta (Нерехта)	Degtyaryov plant and ARF (заводом имени В.А. Дегтярева совместно с Фондом перспективных исследований)	Development prototype in limited production with Kungas UGV system	Guard duties, combat operations	https://xn--b1aga5aadd.xn--p1ai/2019/%D0%A0%D0%BE%D0%B1%D0%BE%D1%82%D1%8B2/ This UGV is now part of Kungas UGV complex.

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
UGV	Shturm (Штурм)	Uralvagonozavod (УралВагоноЗавод)	Development prototype	Urban warfare combat operations	https://andrei-bt.livejournal.com/949786.html
UGV	Kungas (Кунгас)	Special Engineering Design Bureau (Специальное инженерное конструкторское бюро)	Fielded prototype	Combat ISR and logistics operations	https://tass.ru/armiya-i-opk/7189865
UGV	Paladin (Паладин)	Rostec (Ростех)	Development prototype	Combat and logistics.	http://tass.ru/armiya-i-opk/6504329 Unveiled in 2019, it is unclear if Paladin and Udar are the same project, but a different designation, or a separate UGV project also based on a BMP-3 armored vehicle.
UGV	Argo	Central Design Institute of Robotics and Technical Cybernetics, modified Canadian design (Центральный проектный институт робототехники и технической кибернетики)	Fielded prototype	Logistics and transportation	http://robotrends.ru/robopedia/argo
UGV	Mars A-800 (МАРС А-800)	Avrora Design Bureau (Конструкторское бюро "Аврора")	Fielded prototype	Logistics	http://военное.рф/2017/%D0%98%D1%81%D0%BF%D1%8B%D1%82%D0%B0%D0%BD%D0%B8%D1%8F7/
UGV	Scarab (Скарабей)	CET-1	Scaled production	ISR for demining forces	https://www.set-1.ru/

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
UGV	Sphera (Сфера)	CET-1	Scaled production	ISR for demining forces	https://www.set-1.ru/
UGV	Scorpion (Скорпион)	CET-1	Fielded prototype based on Scarab	ISR and demining operations, based on the Scarab model	https://topwar.ru/170747-ot-skorpiona-do-prohoda-robototehnicheskie-kompleksy-pomogajut-saperam.html
UGV	Platforma-M (Платформа-М)	NITI Progress (ОАО "НИТИ "Прогресс")	Fielded prototype	ISR and combat operations	http://robotrends.ru/robopedia/katalog-nazemnyh-voennyh-robotov-razlichnogo-naznacheniya
UGV	Prohod-1 (Проход-1)	High Precision Weapons JSC («НПО «Высокоточные комплексы»)	Fielded prototype	Demining operations	https://www.npovk.ru/produktsiya/kompleksy-vooruzheniya-bronetankovoy-tekhniki-boevye-otdeleniya-legkobronirovannoy-tekhniki/prokhod-1/
UGV	Kapitan (Капитан)	Central Research and Development Institute of Robotics and Technical Cybernetics (TsNII RTK)	Development prototype	ISR and demining operations	https://rtc.ru/solution/kapitan/
UGV	MRK-15	SKTBR (ООО «СКТБ ПР»)	Scaled production	Engineering and ISR	http://sktbpr.ru/robot/mrk-15-modernizirovannyy
UGV	МРК-002-БГ-57 Volk	Izhevsky Plant and Uralvagonozavod	Limited scaled production	Deigned to guard Topol-M and Yars strategic forces	http://www.army-guide.com/rus/product5525.html
UGV	МРК-27-БК	Special Design and Technology Bureau of Applied Robotics (Центральный научно-исследовательский и	Scaled production	Engineering and ISR	http://sktbpr.ru/robot/mrk-27-modernizirovannyy

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
		опытно-конструкторский институт робототехники и технической кибернетики)			
UGV	KRMM-06 (KPMM-06)	Resurs-AVTO (ООО «Ресурс-Авто»)	Scaled production	ISR for engineering forces	https://tvzvezda.ru/news/2021121355-7AAFP.html
UGV	Kobra-1600 (Кобра-1600)	Research Institute of Special Mechanical Engineering, Moscow State Technical University Bauman (НИИ Специального машиностроения МГТУ им. Баумана)	Scaled production	ISR for engineering forces	https://topwar.ru/170747-ot-skorpiona-do-prohoda-robototehnicheskie-kompleksy-pomogajut-saperam.html
UGV	Evakuatsiya (Эвакуация-Р)	The Russian MOD requested the development of this complex	Basic research into development prototype	Casualty evacuation robots	https://ria.ru/20200626/1573501487.html
UGV	No official designation given	The Russian MOD requested the development of this complex	Development prototype	This UGV will be used for CBRN duties	https://tass.ru/armiya-i-opk/10398663
Swarm technology	No official designation given - products discussed as a system of systems	Southern Federal University (Южный федеральный университет)	Development prototype	Swarm application for air and ground drones	https://www.sfedu.ru/www2/web/press-center/news/62523

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
Humanoid android	Fedor (Федор)	ARF and Android Technologies (ФПИ и Андроидная Техника)	Fielded prototype	Android system operating in dangerous environments, including space	https://iz.ru/924138/2019-09-22/razrabotchiki-dopustili-vozvrashchenie-robota-fedor-na-mks
Humanoid android	Teledroid (Теледройд)	ARF and Android Technologies (ФПИ и Андроидная Техника)	Development prototype	Android system operating in dangerous environments, including space	https://ria.ru/20200727/1574881940.html
AI and autonomy in military platforms					
Naval vessel	Project 22160 (Проект 22160)	Zelenodolsk and Zaliv shipyards ((Зеленодольский ССЗ и Залив ССЗ)	Development prototype	Reducing crew through automation and AI. This vessel class will get its own USVs	https://iz.ru/787909/roman-kretcul-aleksei-ramm/korabli-roboty-modulnye-korvety-vozmut-pod-okhranu-novorossiisk and https://iz.ru/706601/sergei-valchenko-aleksei-ramm-evgenii-dmitriev/korvety-nevidimki-usiliat-otriadami-morskikh-dronov
Tank	T-14 Armata (Армата)	Rostec (Ростех)	Development prototype headed into scaled production	Autonomy for combat operations and a test bed for unmanned tank technology	https://ria.ru/20210225/armata-1598859233.html and https://ria.ru/20200824/armata-1576231396.html
Mines	Surface (Поверхность)	*MOD developer not specified*	Development prototype	Sea-based autonomy for identifying and striking targets	https://iz.ru/841783/aleksei-ramm-aleksei-kozachenko/khoroshaia-mina-pri-morskoi-igre-flot-poluchit-

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
					boepripasy-s-iskusstvennym-intellektom
Soldier gear	Sotnik (Сотник)	Rostec (Ростех)	Development prototype	System automation that connect different Sotnik soldier combat gear elements	https://tvzvezda.ru/news/opk/content/2019241713-CfokY.html
Aircraft	Su-57 (Су-57)	Sukhoi (Ростех)	Scaled production	AI-enabled on-board information management and possible remote-piloting	https://rg.ru/2018/08/28/iskusstvennyj-intellekt-rasshirit-vozmozhnosti-istrebitelia-su-57.html
Aircraft	Su-35S (Су-35С)	Sukhoi (Ростех)	Scaled production	On-board information management	https://www.sukhoi.org/products/samolety/256/ and https://bmpd.livejournal.com/3047341.html
Aircraft	MiG-31 (МиГ-31)	MiG-OAK (МиГ-ОАК)	Development prototype	AI-enabled on-board information management	https://iz.ru/873658/aleksei-ramm-aleksei-kozachenko/vzgliad-sverkhu-istrebitel-mig-31bm-prevratiat-v-shtab-ataki
Aircraft	MiG-35 (МиГ-35)	MiG-OAK (МиГ-ОАК)	Development prototype	AI-enabled on-board information management, target recognition	https://russian.rt.com/russia/article/8514Russian lawyers asked the authorities not to let AI into "dangerous" areas72-istrebitel-mig-35-intellekt

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
Aircraft	MiG-41 (МиГ-41)	MiG-OAK (МиГ-ОАК)	Development prototypes	On-board information management	https://russian.rt.com/russia/article/422319-istrebitel-iskusstvennyi-intellekt
Aircraft	Su-25SM3((Су-25М3)	Sukhoi (Ростех)	Development prototypes	AI-enabled targeting and combat system for greater autonomy	https://tass.ru/armiya-i-opk/6410976
Aircraft	Mil-28H (Ми-28Н)	Russian Helicopters (Вертолёты России)	Development prototype	AI-enabled targeting and combat system for greater autonomy	https://tass.ru/armiya-i-opk/6141703
Aircraft	Ka-52M (Ка-52М)	Russian Helicopters (Вертолёты России)	Development prototype	UAV command and control system	https://iz.ru/1023859/anton-lavrov-bogdan-stepovoi/ot-vinta-do-drona-rossiiskie-vertolety-budut-upravliat-bespilotnikami
Artillery	MSTA-SM (МСТА-СМ)	Rostec (Ростех)	Scaled production	Targeting automation	https://iz.ru/1092597/anton-lavrov-alekseiramm/kromeshnaia-msta-na-iug-rossii-pridut-robotizirovannye-artustanovki
Air Defense	TOR (Тор)	Almaz-Antey (Алмаз-Антей)	Scaled production	Targeting automation	https://ria.ru/20190405/1552408001.html
Artillery	Koalitsiya-SB (Коалиция-СВ)	Burevestnik (ЦНИИ «Буревестник»)	Scaled production	Targeting automation	https://tass.ru/armiya-i-opk/5490500
Truck	Kamaz truck (Камаз)	Kamaz (Камаз)	Scaled production	Driver assist navigation and endurance	www.robotics.innopolis.university
Anti-personnel mine	POM-3 "Medallion"	NIII (Научно-исследовательский	Fielded prototype	Autonomous target identification and activation	https://topwar.ru/86566-perspektivnaya-protivopehotnaya-mina-pom-3-medalon.html and

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
	(ПОМ-3 «Медальон»)	инженерный институт (НИИИ)			https://zen.yandex.ru/media/technic/pom3-medalon-russkie-miny-s-iskusstvennym-intellektom-5d40196580879d11ed5a34a3
Mines	Surface (Поверхность)	MOD developer not specified	Development prototype	Autonomy for identifying and striking targets	https://iz.ru/917299/aleksei-kozachenko-aleksei-ramm/chaika-nositel-samolety-be-12-vooruzhat-umnymi-minnymi-kompleksami
Missiles	X-250	Tactical Rocket Systems (Тактическое ракетное вооружение")	Basic research into development prototype	Onboard data management and proposed self-learning systems	https://iz.ru/621844/2017-07-20/v-rossii-sozdadut-raketu-s-iskusstvennym-intellektom and https://ria.ru/20170811/1500169864.html?fbclid=IwAR1Zx0Ct5Y4plUW1JpaKTxembmDF7pcb0OYCc75MH-F7UrpVeLNLBAhhGIM
Combat module	Combat module	Kalashnikov (Калашников)	Development prototype-fielded platform	Neural network technologies that enable the module to identify targets and make decisions	https://tass.com/defense/954894
Combat module	Epoha (Эпоха)	Sheglovsky Val (Щегловский вал)	Development prototype	Automated targeting system	https://www.tsn24.ru/news/armiya-i-opk/tulskiy-boevoy-modul-epokha-mozhet-pereyti-pod-upravlenie-iskusstvennogo-intellekta/ and https://vpk.name/library/f/epoha-bm.html

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
C-UAS	Kupol (Купол)	Rostec (Ростех)	Fielded prototype into scaled production	Automated command and control system	https://ria.ru/20200824/armiya-1576259567.html
Information management and decision making					
National-level C2	National Defense Management Center (НЦУО)	Ministry of Defense (Министерство Обороны)	Fielded prototype	Monitoring of Russian forces and international geopolitical situation, predictive analysis and decision-making assistance	https://regnum.ru/news/polit/2836730.html
Maritime	AquaHranitel (АкваХранитель)	Formosa System (Формоза-Сервис)	Development prototype	Maritime domain oversight	https://rg.ru/2020/10/19/reg-cfo/v-stolice-protestirovali-sistemu-monitoringa-chs-na-vode.html
Military C2	ACS of the Russian Military (АСУ)	Ministry of Defense (Министерство Обороны)	Development prototype	System of systems utilizing AI for managing battlefield information	https://vm.ru/science/861589-pulya-bolshe-ne-dura
Aircraft management system	Kasatka (Касатка)	RadarMMS (РадарММС)	Fielded prototype	System for greater autonomy in aircraft, helicopters and drones.	https://tass.ru/interviews/5488433 and https://radar-mms.com/product/kompleksy-aviatsionnogo-bazirovaniya/poiskovo-pritselnyy-kompleks-kasatka/ppk-kasatka/
Text analysis	Text Analysis	MSU and RAS (МГУ и РАН)	Development prototype	Information operations - identifying extreme	

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
				or inappropriate content	
EW system	Bylina (Былина)	Ruselektronics (Rostec) (Росэлектроника, Ростех)	Fielded prototype headed for possible scaled production	ISR, IO and Autonomy for electronic warfare operations	https://iz.ru/1000101/aleksei-ramm-bogdan-stepovoi/vidit-tcel-bylina-smozhet-atakovat-protivnika-bez-uchastiia-operatora
Early warning and air defense					
Air defense	Derivatsiya (Деривация)	Burevestnik Central Research Institute (ЦНИИ «Буревестник»)	Scaled production	Autonomy for air defense operations	https://tvzvezda.ru/news/opk/content/201912171726-Obd9Z.html
Air defense	Pantsir-S (Панцирь-С)	KBP Instrument Design Bureau (АО «КБП)	Scaled production	Autonomy for air defense operations	https://iz.ru/948322/aleksei-ramm-bogdan-stepovoi/odin-na-vsekh-zrk-pantcir-unichtozhit-protivnika-bez-ekipazha
Air defense	ResonanceNE (РезонансНИ)	Rezonans (Резонанс)	Fielded prototype	System automation	https://dfnc.ru/en/journal/2017-1-43/rezonans-ne-new-generation-cognitive-integrated-radar-system/
Air defense	Penicillin (Пенициллин)	Rostec (Ростех)	Scaled production	ISR, C2, system autonomy for detecting adversary assets	https://ria.ru/20210122/kompleks1594109718.html and https://tass.ru/armiya-i-opk/10521623
Early warning	*No official designation available*	MOD developer not specified	Development prototype	AI-enhanced ballistic missile early warning	https://tass.com/defense/1256603

Type	Name	Manufacturer	Development Status	AI/Autonomy Aspect	Link
Early warning and detection	*Harmony (Гармония)*	Spetstroi Federal Agency (СПЕЦСТРОЙ)	System partially fielded	Maritime identification system capable of identifying aerial, surface and subsurface objects	https://nplus1.ru/news/2016/11/25/net *and* https://iz.ru/news/647107
Logistics, training, and military manufacturing					
Quantum computing	*No official designation available*	Rosatom (Росатом)	Basic research	Quantum computing	
Steel inspection system	*No official designation available*	RT-techpriemka (Rostec) (РТ-Техприемка – Ростех)	Basic research into development prototype	Logistics- managing steel quality in defense enterprises	https://www.cnews.ru/news/line/2020-11-26_iiproekt_rttehpriemki
Engine manufacturing	*No official designation available*	Rostec and Zyfra (Ростех и Цифра)	Basic research into development prototype	Logistics - managing engine production quality at defense enterprises	https://xn--b1aga5aadd.xn--p1ai/2020/%D0%A0%D0%BE%D1%81%D1%82%D0%B5%D1%857/

Source: CNA. Derived from open source reporting.

Figures

Tables

Abbreviations

ABM	anti-ballistic missile
ACS	automated control systems
AI	artificial intelligence
APEC	Asia-Pacific Economic Cooperation
ARF	Advanced Research Foundation (Russia)
ASVN	military automated system
BRICS	Brazil, Russia, India, China, and South Africa
C2	command and control
CCTV	closed-circuit television
CCW	UN Convention on Certain Conventional Weapons
CNA	Center for Naval Analyses
COVID	coronavirus disease
DARPA	Defense Advanced Research Projects Agency (US)
DOD	US Department of Defense
ESU TZ	Unified Tactical Control System (Russia)
EU	European Union
EW	electronic warfare
FCS	US Future Combat System
FPRI	Foreign Policy Research Institute
FSB	Federal Security Service of the Russian Federation
GDP	gross domestic product
GII	Global Innovation Index
GLONASS	Global Navigation Satellite System (Russia)
GPS	Global Positioning System
IADS	integrated air defense system
ICBM	intercontinental ballistic missile
IHL	international humanitarian law
IISS	International Institute for Strategic Studies
IoT	internet of things
IP	intellectual property
ISR	intelligence, surveillance, and reconnaissance
IT	internet technology
JADC2	US DOD Joint All-Domain Command and Control
JAIC	US DOD Joint Artificial Intelligence Center
KAIROS	Knowledge-directed Artificial Intelligence Reasoning Over Schemas

KRUS	intelligence, command and communication complex
LAWS	lethal autonomous weapons systems
MIPT	Moscow Institute of Physics and Technology
MIT	Massachusetts Institute of Technology
MOD	Russian Ministry of Defense
MSU	Moscow State University
NATO	North Atlantic Treaty Organization
NDMC	National Defense Management Center (Russia)
NLP	natural language processing
OECD	Organisation for Economic Co-operation and Development
PPP	purchasing power parity
QS	Quacquarelli Symonds
R&D	research and development
RANEPA	Russian Presidential Academy of National Economy and Public Administration
RD&T	research, development and technology
RF	Russian Federation
RUB	Russian ruble
S&T	science and technology
STEM	science, technology, engineering and mathematics
T&E	training and education
TERCOM	terrain contour matching
THE	Times Higher Education
TIGER	Technology, Industry, Growth, Ecosystem, Reliability
TSU	Tomsk State University
UAE	United Arab Emirates
UAV	unmanned aerial vehicle
UCAV	unmanned combat aerial vehicle
UGV	unmanned ground vehicle
UN	United Nations
US	United States
USD	United States dollar
USSR	Union of Soviet Socialist Republics (Soviet Union)
USV	unmanned surface vehicle
UUV	unmanned underwater vehicle

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