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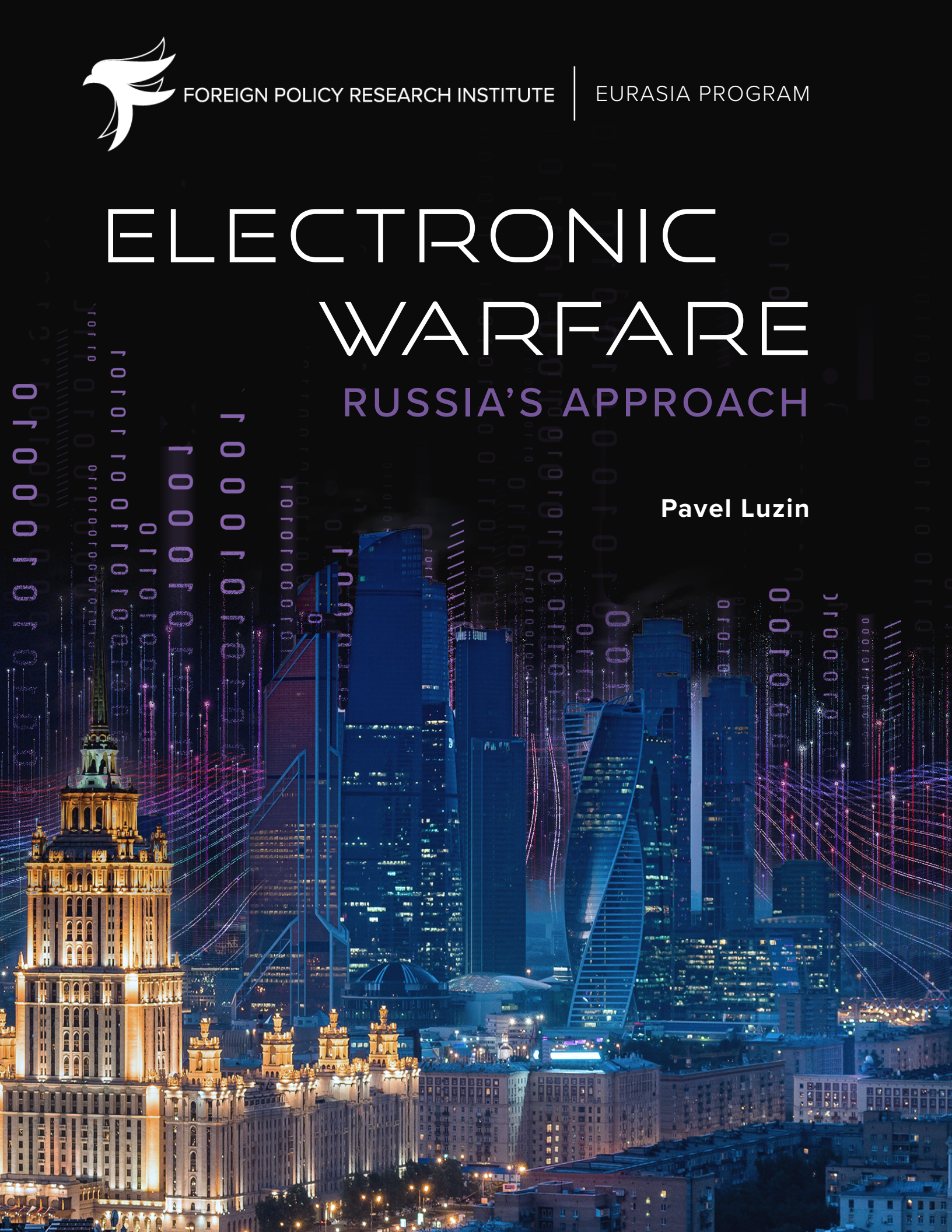
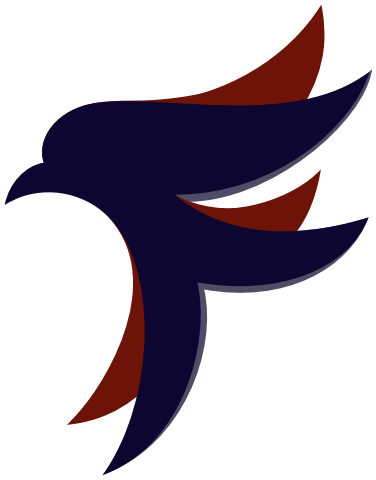
ELECTRONIC WARFARE

RUSSIA'S APPROACH

Pavel Luzin





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EXECUTIVE SUMMARY

Russia considers electronic warfare (EW) one of the key military capabilities in its ongoing confrontation with the West. EW provides a non-nuclear deterrence capability and helps Russia keep its great power status and strategic autonomy while also taking into account its long-term economic and demographic weakness. Russia has made significant advances in EW during the 2010s. However, at the beginning of 2020s, Russia still faces technological, technical, industrial, organizational, and political challenges that prevent Moscow from getting the EW capabilities it wants.

Technological challenges are related to delays in developing air- and space-based EW capabilities, and to the need to unify EW systems. Technical challenges stem from the number of different types of EW systems that must be maintained, the relatively short lifespans of various EW systems, and issues integrating them with other combat systems and units. The last point also indicates why Russia has struggled to transform its quantity of the EW systems into a higher quality of combat capabilities. Industrial challenges are caused by the volatile dynamic of Russia's arms procurements and R&D programs and the capacity of defense corporations to develop and produce advanced EW systems with acceptable costs. The main organizational challenge is that the number of EW troops that has already achieved its objective limit.[1] Now EW troops need to be transformed from combat support into a combat branch. Finally, a political challenge appears in the confrontation between Russia and the West, which is the main driver for efforts related to EW. Russia is unable to compete with the United States and Europe in a symmetric way, and Russia's political system does not allow Moscow to realize a "revolution in military affairs" because the centralized system struggles to implement a net-centric approach to the armed forces in effective way. For that reason, Russia has chosen a classic approach of asymmetric warfare with the goal of disrupting the command and control systems of a superior adversary.

The coming decade promises to be challenging for Russia in terms of electronic warfare. Moscow will need to fix its previous EW efforts, pay more attention to the overall quality of electronic warfare rather than on the quantity of deployed EW systems, and bridge the evident gaps in EW on tactical, theater, and strategic levels. Moreover, after defense spending stabilized and even declined during the late 2010s, Russia has been forced to increase its defense budget again. This means spending for EW will also increase. Russia will try to fill gaps in air- and space-based EW capabilities, with the sea-based component continuing to play a secondary role in Russia's military planning. It is also possible that Russia will chose to extend its ground-based EW infrastructure in Belarus with creation of an EW "chain" from Crimea to Kaliningrad.

1 A.D. Lutsenko, V.A. Orlov, D.M. Byvshikh, "Оценка целесообразности реализации инновационных стратегий техники радиоэлектронной борьбы [Evaluation of purposefulness of innovation strategies in developing electronic warfare systems]", Vooruzhenie i ekonomika, No. 1 (34), 2016, http://www.viek.ru/34/44-52.pdf.

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POLITICAL AND ECONOMIC CONTEXT FOR RUSSIAN EW

Since the early 1990s, Russia has worked with inherited Soviet electronic warfare technologies and deployed systems that were aimed at electronic intelligence and field radio interference and jamming. Russia also inherited a theoretical framework for modern warfare based on advanced command, control, and communication systems, satellite navigation, intelligence, and high-precision conventional weapons. Watching the American experience in Iraq in 1991 confirmed the accuracy of this framework.[2]

The collapse of the Soviet Union did not mean that Russia abandoned its claims to great power status. On the contrary, Russia's emerging domestic political and economic order — as well as the positions of the Russian elite — became highly dependent on Russia's status in foreign affairs. Russia's strategic goal was to remain one of a few leading military powers in the world, relying on both nuclear weapons and advanced conventional capabilities to guarantee its ability to project power abroad.

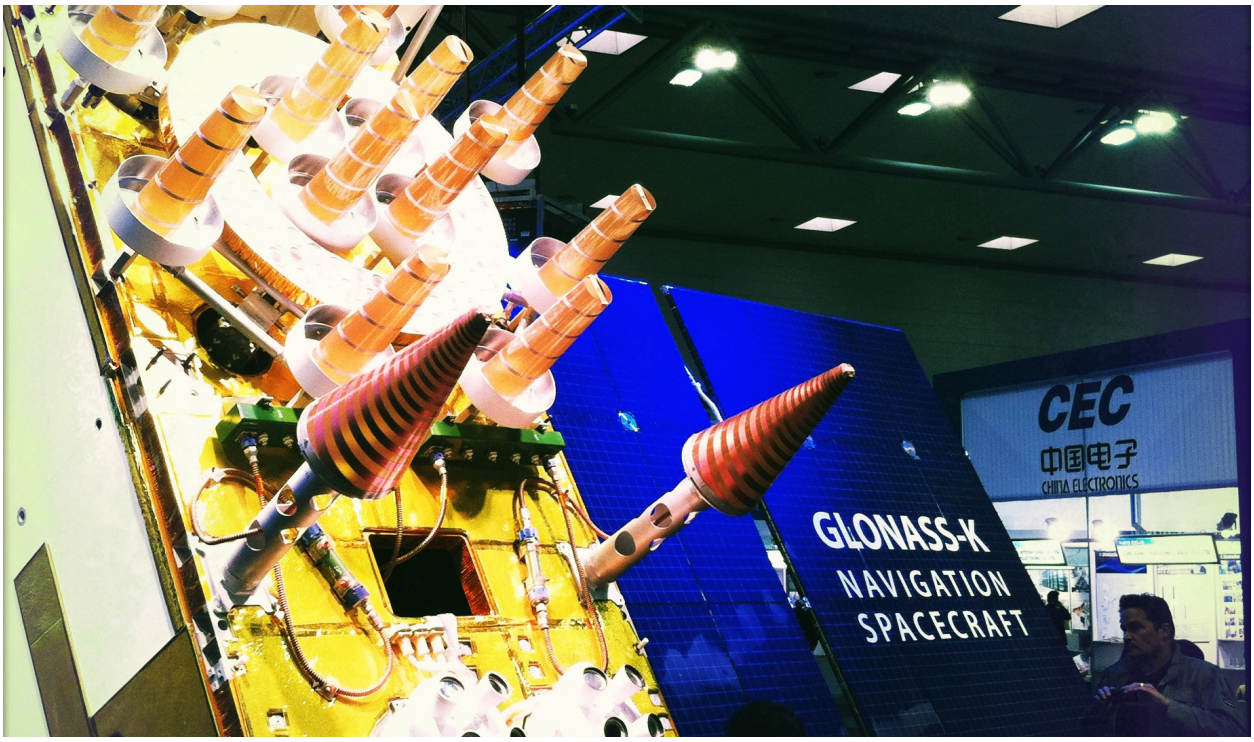
However, Russia faced a crucial deficit of resources, military difficulties in Chechnya, and a crisis within the defense industry during the 1990s and was not able to realize its own "revolution in military affairs."[3] Even rapid economic growth from the export of mineral resources in the 2000s did not allow Russia's authorities to solve the problem. Despite increasing defense spending and consolidating the defense industry into several state-owned corporations, the industry remained economically inefficient because of the cost-plus inflation and the deficit of human capital, technologies, and industrial equipment.

Generally, along with restoring centralized control over the domestic economy and political field, Russia's political elite was concerned after NATO's operation against Slobodan Milosevic's regime in Yugoslavia in 1999 and after the democratic revolutions in Georgia and Ukraine in 2003 and 2004, respectively. The elite held a political and economic monopoly at home and had the long-term goal of restoring Russia's dominance over the former Soviet republics, but this did not mean that the United States — the only global superpower — and the whole West would recognize Russia's monopoly over its near abroad. As a result, Russia turned more and more to anti-American and anti-Western policies.

The war against Georgia in August 2008 and the world economic crisis were game changers for Russia. On the one hand,

2 See, for example: 1) V.V. Krysanov, "К вопросу о радиоэлектронизации сил и средств [On the radiolectronification of forces and equipment]," Voennaya mysl', No. 5, 1991, http://militaryarticle.ru/voennaya-mysl/1991-vm/8394-k-voprosu-o-radiojelektronizacii-sil-i-sredstv; 2) A.G. Fubtikov, V.A. Kuznetsov, V.I. Popov, and V.Y. Kaminskiy, "Проблемы метрологического обеспечения операций (боевых действий) [Issues of metrological support of combat operations (warfare)]," Voennaya mysl', No. 9, 1991, http://militaryarticle.ru/voennaya-mysl/1991-vm/8434-problemy-metrologicheskogo-obespechenija-operacij.

3 On the nature of the revolution in military affairs, see: 1) *Keeping the Edge: Managing Defense for the Future*, edited by Ashton B. Carter and John P. White. MIT Press, 2001; 2) Dima Adamsky, *The Culture of Military Innovation: The Impact of Cultural Factors on the Revolution in Military Affairs in Russia, the U.S., and Israel*, Stanford University Press, 2010.



Produced during former President Medvedev's modernization program, a model of a Russian Glonass-K Satellite used for their GPS alternative is displayed during a 2011 trade show.
(flickr/PaGn)

military reform and a huge rearmament program became urgent for Moscow. Without the reforms, it was no longer capable of claiming to possess incontestable dominance over its neighbors and global great power status. On the other hand, the existing model of faster economic growth and redistribution of increasing export and tax revenues reached a deadlock. It required either a systemic modernization of institutions (as was attempted unsuccessfully during the presidency of Dmitry Medvedev in 2008–2012) or the further consolidation of political and economic power, with some technical improvements in governance and moves to increase the share of state-owned entities in Russia's economy and political life. This strategy has been implemented since 2012.

Nevertheless, it became evident that Russia's long-term opportunities for rearmament still were limited, for several reasons: in defense manufacturing, Moscow could rely neither on private initiative nor on well-developed industrial cooperation with Europe and the U.S.; after 2012, Russia's annual GDP growth was lower than the world's average; and the gap in human capital, technologies, and the industrial base between Russia and the West remained unbridgeable. Russia's defense industry faced troubles even with reverse-engineering advanced European and

American technologies.[4] So, Russia could not develop its armed forces in the same way as the United States and other NATO allies.

Concerning the growing military competition with the West that finally transformed into open confrontation as early as 2014, Moscow was forced to rely mostly on Anti-Access/Area Denial (A2/AD) systems and other asymmetrical warfare measures. Electronic warfare systems and EW troops were supposed to play a key role in this, from improving Russia's non-nuclear deterrence capabilities to neutralizing NATO's superiority in command, control, communications, navigation, and technical intelligence systems.

In 2009–2011, together with the military reform started soon after the war against Georgia, Russia began its reconsideration of the combat role of electronic warfare. In January 2009, separate electronic warfare units of the Russian armed forces were combined into the electronic warfare troops, as another type of combat support. In January 2012, an electronic warfare policy lasting through 2020 was issued by President Dmitriy Medvedev. Though this document is classified, the main goal of the policy is to develop an effective interagency, multifunctional system of electronic warfare, and one of the key priorities alongside development of EW technologies and their procurement is integrating electronic warfare systems with other national security systems.[5]

In addition, the Russian armed forces planned to increase the combat effectiveness of their electronic warfare systems during military operations — defined as the amount of successful combat tasks — from 30–35% to 80–90% by the 2020s.[6] The strategy demonstrates that the Russian leadership recognized a crucial deficit in EW capabilities decade ago. The deficit led to a quantity-oriented approach that was dominant until the end of 2010s. This, in turn, caused Russia's current challenge in the field of electronic warfare. The quantity of EW systems has not been transformed into a higher quality of combat capabilities that would allow Russia to disrupt the command and control systems of a superior adversary.

4 For reference see: 1) E. Pokataeva and E. Petrovskaya, "Импортозамещение и обеспечение качества [Import substitution and quality assurance]," Elektronika: Nauka, Tekhnologiya, Biznes, No. 3 (174), 2018, http://www.electronics.ru/files/article_pdf/6/article_6616_528.pdf; 2) Pavel Luzin, "Russia's Defense Industry: Between Political Significance and Economic Inefficiency", Foreign Policy Research Institute, April 3, 2020, https://www.fpri.org/article/2020/04/russias-defense-industry-between-political-significance-and-economic-inefficiency/.

5 M.V. Doskalov, "Перспективы развития системы радиоэлектронной борьбы Российской Федерации на период до 2020 года [Prospects of development electronic warfare system of the Russian Federation for 2020]," Federal Guidebook – Defense Industry of Russia, Volume 9, 2013, http://federalbook.ru/projects/opk/structura-9.html.

6 Ibid.

INDUSTRIAL BASE AND PROCUREMENTS OF EW SYSTEMS

Russia's efforts to develop electronic warfare systems rely on a research and industrial base. The main research and educational center that works on theory of combat using EW systems and requirements for their further development is the Air Force Academy in Voronezh.[7] The 46th Central Research and Development Institute of the Ministry of Defense in Moscow also contributes to the development of EW systems.[8] The EW troops themselves have a small research unit, the 9th scientific company, which is based at the joint-force EW training center in Tambov and conducts some applied research.[9] However, the main R&D activity is concentrated within the defense industry. Two major players here are the *Rostec* and *Almaz–Antey* state-owned defense corporations.

Rostec has two subsidiary corporations that develop and produce up to 80% of Russia's EW systems: *KRET* (ground-, air- and sea-based EW systems) and *Sozvezdie* (ground-based EW systems).[10] In turn, subsidiaries of *Almaz-Antey* (especially *NTC REB*, *Academician A.I. Berg Central Research and Development Radio Engineering Institute*, *Ratep*, and *NNIIRT*) develop and produce ground-based EW systems for air and missile defense, as well as, presumably, space-based EW systems.

Detailed data on the EW systems procurements made by Russia in this decade are classified, but even fragmentary data makes some estimates possible. From 2013–2017, EW troops got more than 600 new and modernized EW systems of different types.[11] The majority of these systems were designed to defend tactical units of ground forces and single aircraft and surface ships against the adversary's radar and precision-guided munitions, as well as to conduct tactical electronic surveillance

7 Военный учебно-научный центр военно-воздушных сил "Военно-воздушная академия имени профессора Н.Е. Жуковского и Ю.А. Гагрина" [Military education and research center of air forces 'Air forces academy named in honor of Professor N.E. Zhukovskiy and Y.A. Gagarin']," https://vva.mil.ru

8 :46 Центральный научно-исследовательский институт Министерства обороны Российской Федерации [46th Central research and development institute of the Ministry of Defense of the Russian Federation]," https://ens.mil.ru/science/SRI/information.htm?id=11391@morfOrgScience. The leading role of the 46th institute in EW development is confirmed also by this statement: "Россия начала работу над оружием для поражения спутников [Russia started work on weapon against satellites]," Interfax, November 30, 2017, https://www.interfax.ru/russia/589740

9 "9 научная рота (войск РЭБ) [9th scientific company (electronic warfare troops)]," Mil.ru, https://recrut.mil.ru/for_recruits/research_company/companies/9nr.htm.

10 "Эволюция радиоэлектронной борьбы [Evolution of electronic warfare]," Rostec, February 27, 2018, https://rostec.ru/analytics/evolyutsiya-radioelektronnoy-borby/.

11 "Шойгу: Доля современной техники в войсках РЭБ к 2021 году вырастет до 70% [Shoigu: Share of modern weapons in EW troops will increase to 70% by 2021]", TASS, February 26, 2018, https://tass.ru/armiya-i-opk/4988935.

and intelligence collection.[12] *KRET* reportedly supplied 62 advanced EW systems in 2017: nine Moskva-1 electronic intelligence and jamming stations, eight Krasukha-2 and 15 Krasukha-4 electronic intelligence and jamming stations, 20 Rtut'-BM tactical mobile electronic intelligence and jamming stations, and 10 Mi-8 jamming helicopters equipped with the Rychag-AV system.[13] However, this was the peak of EW equipment supplies. After 2017, procurement of EW systems declined, according to the *Rostec* annual report of 2018, as the State Armament Plan for 2011–2020 concluded and the new State Armament Plan for 2018–2027 had to deal with maintenance and modernization of the EW systems supplied during the 2010s, as well as with procurements of sophisticated new systems.[14]

Combining these numbers with *KRET*'s fragmentary financial data (see Table 1) and considering the 60% stake of *KRET* in manufacturing of the EW systems, Russia's annual procurements of ground-, air-, and sea-based EW systems during the past decade can be estimated as changing from 20 billion rubles in 2012 to almost 45 billion rubles in 2016, with some decline in recent years. If this estimate is correct, procurement of EW systems was no less than 31–40 billion rubles in 2018–2020.

This trend correlates with the estimation of governmental R&D expenditures on EW during the period of 2015–2018 (see Table 3). State-owned defense corporations also invest in R&D for EW, and some necessary technologies and components for EW systems — such as electronics, command and control systems, and materials — are developed within other programs. Together, the tables presented here indicate that Russia's leadership tried to revise its approach toward EW after 2016–2017.

There were several reasons why such a revision was necessary. First, EW troops got more than 20 different types of EW systems during the 2010s,[15] and many of them duplicate each other. The main cause of this was an approach in which defense companies (their design bureaus and plants) developed special systems for any separate combat task using different technologies and components. In addition, the limited production capacities and different economic conditions of each plant meant that it was impossible to scale manufacturing of EW systems. So it was much easier to develop and supply new or modernized/improved EW systems every couple of years

12 For more information on the specifications of some Russian EW systems see: 1) "Чем Россия может "ослепить" и "подавить" противника [What allows Russia 'to blind' and 'to neutralize' an enemy]," TASS, April 15, 2019, https://tass.ru/armiya-i-opk/6328905; 2) "ТК-25Э: Корабельный комплекс радиоэлектронного подавления [TK-25E: Ship-borne EW system]", Rosoboronexport, http://roe.ru/catalog/voenno-morskoy-flot/korabelnye-radioelektronnye-sistemy/tk-25e/; 3) "Многофункциональный комплекс радиоэлектронной борьбы/подавления (РЭБ/РЭП) ОКР "Хибины" [Multifunctional jamming EW system of R&D project "Khibiny"]", BGTU Voenmeh, http://library.voenmeh.ru/jirbis2/files/materials/ifour/book3/book_on_main_page/14.14.htm; 4) A.V. Lenshin, "Бортовые комплексы радиоэлектронной борьбы: Учебное пособие [Onboard electronic warfare systems: Training book]," Sozvezdie, Voronezh, 2016, https://www.sozvezdie.su/uploads/science/2016%20=%20Леньшин%20АВ%20=%20Бортовые%20комплексы%20радиоэлектронной%20борьбы.pdf; 5) "Тактика военно-воздушных сил: Учебное пособие [Tactics of Air forces: Training book]," MIREA, 2015, https://files.mai.ru/site/unit/institute-of-military-science/tvvs/data/g4/4-2-2.html.

13 "Эволюция радиоэлектронной борьбы [Evolving of electronic warfare]," Rostec, February 27, 2018...

14 "Годовой отчет государственной корпорации "Ростех" за 2018 год [State-owned corporation Rostec: Annual Report 2018]," Rostec, September 30, 2019, https://rostec.ru/upload/iblock/587/587257de247709537226335c9b40b76a.pdf.

15 "Интервью с генерал-лейтенантом Юрием Ласточкиным, начальником войск РЭБ ВС РФ [Interview with Lt. Gen. Yuriy Lastochkin, chief of the electronic warfare troops of the Russian Armed Forces]," Krasnaya Zvezda, April 15, 2020, http://redstar.ru/strazhniki-efira-na-pravilnom-puti/.

Table 1: Total revenue of KRET and share of the EW systems supplied for the RAF in revenue, in billions of rubles

	2011[1]	2012[2]	2013[3]	2014[4]	2015[5]	2016[6]	2017[7]	2018[8]	2019[9]	2020[10]
Total Revenue	65.5	75.9	77.3	105	98	93.5	115.1	121.1	132.5	200
EW systems	N/A	11.6	15.3	17.1[11]	21.3	26.7[12]	N/A	N/A	N/A	N/A

1“В 2012 году КРЭТ увеличил выручку на 15,8% — до 75,9 млрд рублей [KRET increased revenue on 15,8% — to 75,9 billion rubles in 2012],” Novosti VPK, May 30, 2013, https://vpk.name/news/90478_v_2012_godu_kret_uvelichil_vyruchku_na_158_do_759_mlrd_rublei.html.

2 “КРЭТ увеличил выручку [KRET revenue grew up]”, Rostec, May 29, 2013, https://rostec.ru/news/2044/.

3 “Выручка КРЭТ в 2013 году от продаж систем и средств радиоэлектронной борьбы превысила 15 млрд рублей [KRET revenue from EW systems exceeded 15 billion rubles in 2013],” Russian Engineering Union, April 15, 2014, https://soyuzmash.ru/news/companies-news/vyruchka-kret-v-2013-godu-ot-prodazh-sistem-i-sredstv-radioelektronnoy-borby-prevysila-15-mlrd-ruble/.

4 “КРЭТ огласил итоги [KRET announced its annual results],” Comnews.su, February 3, 2015, https://www.comnews.ru/content/89886.

5 “Годовой отчет КРЭТ за 2015 год [KRET Annual Report 2015],” KRET Annual Report 2015, https://web.archive.org/web/20170802193554/http://cret.layout.su/finance.

6“Годовой отчет государственной корпорации “Ростех” за 2016 год [State-owned corporation Rostec: Annual Report 2016],” Rostec, March 20, 2017, http://ar2016.rostec.ru/operational/aviation/.

7 “Годовой отчет государственной корпорации “Ростех” за 2017 год [State-owned corporation Rostec: Annual Report 2017],” Rostec, June 1, 2018, http://report2017.rostec.ru/operational-review/aviation/.

8 “Годовой отчет государственной корпорации “Ростех” за 2018 год [State-owned corporation Rostec: Annual Report 2018],” Rostec, September 30, 2019, https://rostec.ru/upload/iblock/587/587257de247709537226335c9b40b76a.pdf.

9 “Интервью с Сергеем Чемезовым, генеральным директором корпорации “Ростех” [Interview with Sergei Chemezov, director general of Rostec],” Vedomosti, July 12, 2021, https://www.vedomosti.ru/partner/characters/2021/07/12/877735-mi-sozdaem-polnotsennogo-igroka-mirovoi-aviatsionnoi-areni.

10 Ibid.

11 “КРЭТ поставил Минобороны РФ новейшие комплексы РЭБ на 17 млрд руб” [KRET supplied newest EW systems to the Ministry of Defense for 17 billion rubles],” RIA Novosti, February 3, 2015, https://ria.ru/20150203/1045642876.html.

12 “Россия увеличивает производство комплексов РЭБ [Russia increases manufacturing of EW systems],” RIA Novosti, May 11, 2017, https://ria.ru/20170511/1494105210.html?in=t.

Table 2: Russia's arms procurements, in billions of dollars

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
₽	710	920	1280	1680	1770	2110	1460	1500	1850	1600
$	24.2	29.6	40.2	43.7	28.9	31.4	25	23.9	28.6	22.2

Table 3: Direct governmental R&D expenditures on EW systems, billion rubles[1]

2015	2016	2017	2018
1.5	1.6	0.8	0.99

1 R.S. Anosov, Y.E. Donskov, S.G. Zelenskaya, and V.A. Orlov, "Современные военно-экономические условия развития системы вооружения радиоэлектронной борьбы ВС РФ [Modern military-economic conditions of developing the electronic warfare armament system of the Russian armed forces]," Voennaya mysl', No. 9, 2021, https://cyberleninka.ru/article/n/sovremennye-voenno-ekonomicheskie-usloviya-razvitiya-sistemy-vooruzheniya-radioelektronnoy-borby-vs-rf.

than to realize a full-scale production of multirole ones from the very beginning. The problem of duplication was evident to the Russian military leadership from the very beginning, but it remains urgent.[16]

Nevertheless, further increasing the quantity of EW systems was impossible due to the limits on personnel and financial resources.[17] Once Russia filled the gap in its electronic warfare capabilities through the purchase of a significant quantity of EW systems, it was forced to work on maintaining them, further developing them, and unifying and integrating them with other combat systems. All this inevitably led to difficulties transforming the quantity of EW systems into better overall quality for the whole armed forces.[18] In other words, the increasing number of new EW systems undoubtedly gave the Russians good results (for instance, Russia actively used EW systems in Ukraine and Syria), but these results did not reach the level of original expectations. Achievements on the tactical level in local conflicts did not give a significant advantage against a superior adversary during a full-scale clash — for example, one with the U.S. and NATO, an event that was considered possible and even probable.

Secondly, requirements for the modernization of deployed EW systems appeared early within their operating periods. Russian ground-based EW systems formally have 10–12 years[19] or 600–900

16 Y.I. Lastochkin, "Строительство войск РЭБ Вооруженных сил Российской Федерации и задачи оборонно-промышленного комплекса по их техническому оснащению [Development the electronic warfare troops of the Russia armed forces and goals for the defense industry regarding their equipment]," Federal Guidebook – Defense Industry of Russia, Volume 8, 2012, http://federalbook.ru/projects/opk/structura-8.html.

17 See: 1) Y.L. Koziratskiy, R.S. Anosov, and D.M. Byvshikh, "Обоснование технологий развития системы радиоэлектронной борьбы. Применение морфологических методов [Technology validation of developing electronic warfare system. Implementation of morphological methods]," Vooruzhenie i ekonomika, No. 1(34), 2016, http://www.viek.ru/34/33-43.pdf; 2) A.D. Lutsenko, V.A. Orlov, and D.M. Byvshikh, "Оценка целесообразности реализации инновационных стратегий техники радиоэлектронной борьбы [Evaluation of the purposefulness of innovation strategies in developing electronic warfare systems]," Vooruzhenie i ekonomika, No. 1(34), 2016, http://www.viek.ru/34/44-52.pdf.

18 See: 1) A.D. Lutsenko and T.V. Radzievskaya, "Регулирование рационального типажа средств радио-, радиотехнической разведки в интересах разведывательно-информационного обеспечения радиоэлектронной борьбы [Regulation of rational types of electronic intelligence systems for intelligence information support of electronic warfare]," Vooruzhenie i ekonomika, No. 2(44), 2018, http://www.viek.ru/44/37-44.pdf; 2) Y.E. Donskov, D.V. Kholuenko, Y.N. Yarygin, and D.M. Byvshikh, "Обоснование направлений развития системы вооружения радиоэлектронной борьбы сухопутных войск: методическое обеспечение [Validation of development of electronic warfare systems of ground forces: methodology]", Voennaya mysl', No. 2, 2019, https://cyberleninka.ru/article/n/obosnovanie-napravleniy-razvitiya-sistemy-vooruzheniya-radioelektronnoy-borby-suhoputnyh-voysk-metodicheskoe-obespechenie; 3) A.D. Lutsenko, V.A. Orlov, and D.M. Byvshikh, "*Технология обоснования и формирования системы целевых программ по реализации стратегий развития системы вооружения радиоэлектронной борьбы* [Technology of validation and formulation of purpose-oriented programs for implementation of strategy of developing electronic warfare systems]", Gosudarstvennoe upravlenie. Elektronnyi vestnik, No. 60, 2017, https://cyberleninka.ru/article/n/tehnologiya-obosnovaniya-i-formirovaniya-sistemy-tselevyh-programm-po-realizatsii-strategiy-razvitiya-sistemy-vooruzheniya; 4) Y.L. Koziratskiy, R.S. Anosov, and D.M. Byvshikh, "Обоснование технологий развития системы радиоэлектронной борьбы. Применение законов развития технических систем [Technology validation of an developing electronic warfare system. Implementation of developmental laws of technical systems]", Vooruzhenie i ekonomika, No. 2(35), 2016, http://www.viek.ru/35/38-52.pdf.

19 For example: 1) A.D. Lutsenko and A.Y. Bozhkov, "Применение стратегий выхода изделий техники РЭБ в капитальный ремонт по 'техническому состоянию' и 'нормам расхода ресурса' при обосновании предложений в государственный оборонный заказ в части капитального ремонта техники РЭБ" [Implementation of 'technical condition' and 'formal usage rate' strategies for the complete overhaul of EW systems during the planning of state defense order regarding the complete overhaul of EW systems]," Vooruzhenie i ekonomika, No. 1(30), 2015, http://www.viek.ru/30/12-22.pdf; 2) R.S. Anosov, A.Y. Bozhkov, and D.M. Byvshikh, "Методический подход к планированию мероприятий по капитальному ремонту средств радиоэлектронной борьбы [Methodology of planning complete overhaul of EW systems]", Vooruzhenie i ekonomika, No. 1(51), 2020, http://www.viek.ru/51/65-73.pdf.

Krasukha-2, a mobile, ground-based, EW system, produced by KRET, in the Rostec group. (Wikimedia / Vitaly V. Kuzmin)

hours[20] of work before overhaul, but they needed modernization after 4–5 years in service because of obsoletion due to rapid changes in the communications environment, as well as in EW technologies and counter-measures. In this way, for instance, the Divnomorie-U system was developed by the end of 2010s with the goal of replacing the Moskva-1, Krasukha-2, and Krasukha-4 systems.[21] That means the Russian authorities faced the problem of searching for a balance between the cost of developing and procuring new EW systems with higher levels of unification and modularity, and the increasing costs of the EW systems delivered early.

The issue of import substitution of electronics should be also considered here. On the one hand, all military systems rely on previous generations of electronics and do not require significant miniaturization of it (though space electronics is exception here), so, in theory, Russia is able to produce most of its needed defense electronics by itself. On the other hand, even processors developed by Russian companies and used in military systems are produced by TSMC in Taiwan. Moreover, the command, control, and information systems of electronic warfare need to be more effective to remain relevant to the complicated communication environment of modern warfare. In this way, Russia continues to rely on imported electronic components and will do so for the foreseeable future. Maintaining stores

20 The approximate estimation is based on data for some countertypes of EW systems produced in Belarus. See the archived version of KB Radar website: 1) “Станция помех VHF/UHF/SHF диапазона “Гроза-6” [“Groza-6” interference station for VHF/UHF/SHF band],” KB Radar, April 10, 2021, http://web.archive.org/web/20210411000418/https://kbradar.by/products/radioelektronnaya-borba/stantsii-i-kompleksy-radiopodavleniya-radiosvyazi/110/; 2) “Комплекс радиотехнической разведки “Кираса-У” [Electronic intelligence system “Kirasa-U”],” KB Radar, April 10, 2021, http://web.archive.org/web/20210411001813/https://kbradar.by/products/radioelektronnaya-borba/sredstva-i-kompleksy-passivnoy-radiolokatsii/318/.

21 “Война невидимая и эффективная [Invisible and effective warfare],” VPK, August 24, 2021, https://vpk-news.ru/articles/63516.

of such components is still the main way for Russia to compensate for this dependency.

Moreover, Russia still has relatively few advanced air-based EW systems. Besides several dozen old-fashioned Su-24MR reconnaissance aircrafts that may be used for tactical electronic intelligence, some jamming helicopters, and some Leer-3 EW systems based on Orlan-10 tactical UAVs, Russia received only three Il-22PP electronic warfare aircraft in 2016 (a modernized and reequipped version of Il-22 command and control aircraft) and two Tu-214R electronic/signals intelligence aircraft.[22] Both the planned development of an EW aircraft based on the Tu-214[23]commercial jet plane and the supply of another Tu-214R[24] were delayed indefinitely. Perhaps the main challenge here is achieving electromagnetic compatibility between the EW equipment and onboard electric and electronic systems.

The situation was even more complicated for ground-based EW systems aimed at countering an adversary's space assets and space-based systems aimed at electronic intelligence and jamming. The Russian authorities and defense industry paid enough attention to satellite jamming during the 2000–2010s.[25] By the end of 2010s, Russia finally was able to develop the EW ground-based system Tirada-2S (and its modified version, the Tirada-2.3) that conducts jamming of satellite communications at the area of deployment.[26] This system was first supplied to the Central Military District in 2019 or 2020.[27] Nevertheless, there were still some significant technical and technological issues with manufacturing the Tirada systems as of 2018. For instance, the design documentation for the Tirada-2.3 had to be updated after testing, and the substitution

22See: 1) "Минобороны РФ в ближайшее время получит три самолета для постановки помех Ил-22ПП [Russian Ministry of Defense will get three EW aircrafts Il-22PP soon]," TASS, October 21, 2016, https://tass.ru/armiya-i-opk/3723977; 2) "Поставить помеху ракете: Как новый "Порубщик" заглушит противника [Jamming against a missile: How new "Porubschik" will black out an enemy]," TASS, July 11, 2018, https://tass.ru/armiya-i-opk/5362505.

23 See: 1) "Комплекс РЭБ "Порубщик" будет устанавливаться на самолеты Ту-214 с 2018 года [The "Porubschik" EW system will be installed on Tu-214 from 2018]," TASS, March 5, 2015, https://tass.ru/armiya-i-opk/1809357; 2) "Помеха сверху. Новый российский самолет "ослепит" противника [Interference from above: New Russian aircraft will 'blind' the enemy]", RIA Novosti, July 10, 2018, https://ria.ru/20180710/1524259379.html.

24 "Кадровый компромисс: Юрий Слюсарь поднял статус директора Казанского авиазавода [Staff compromise: Yuri Slyusar raised status of the director of the Kazan aircraft plant]," Realnoe vremya, June 30, 2016, https://realnoevremya.ru/articles/35688.

25 See, for example: 1) "Патент No. RU 2420760: Способ оценки эффективности радиоподавления сигнала спутниковой связи путем воздействия помехами на приемные системы ретрансляторов и устройство для его реализации [Patent No. RU 2420760: Method of evaluation of satellite signal radio suppression after interference on receiver systems of onboard relay stations, and device for its implementation]," Moskovskiy innovatsionnyi klaster, June 10, 2011, https://i.moscow/patents/RU2420760C2_20110610; 2) "Патент No. RU 2581613: Способ радиоподавления несанкционированного канала космической радиолинии "Земля – космический аппарат" и система для его реализации [Patent No. RU 2581613: Method of radio suppression of unauthorized communication channel 'Earth – spacecraft,' and system for its implementation]", Moskovskiy innovatsionnyi klaster, April 20, 2016, https://i.moscow/patents/RU2581613C1_20160420; 3) "Патент No. RU 2677261: Метод радиоподавления спутниковых каналов управления [Patent No. RU 2677261: Method of satellite circuits radio suppression]," Moskovskiy innovatsionnyi klaster, January 16, 2019, https://i.moscow/patents/RU2677261C1_20190116; 4) "Способ мониторинга космической радиолинии [Patent No. RU 2685538 S1: Method of monitoring a space radio link]," Elibrary.ru, April 22, 2019, https://elibrary.ru/item.asp?id=38145153&.

26 "Россия испытала системы для подавления спутников [Russia tested systems for satellite jamming]," Interfax, October 27, 2018, https://www.interfax.ru/russia/635313.

27 See: 1) "Новейшие комплексы РЭБ "Палантин" и "Тирада-2С" поступят на вооружение ЦВО в 2019 году [The newest EW systems "Palantin" and "Tirada-2S" enter service in Central Military District in 2019]," Mil.ru, December 17, 2018, https://function.mil.ru/news_page/country/more.htm?id=12208471@egNews; 2) "Противоспутниковый комплекс "Тирада" будет впервые представлен на "Армии-2020" в Екатеринбурге [Anti-satellite system "Tirada" will be demonstrated at first time during the "Army-2020" forum in Yekaterinburg]", TASS, August 24, 2020, https://tass.ru/ural-news/9272817.

of imported high voltage power modules for the Tirada-2S failed and was canceled.[28] Despite this, Tirada may be considered Russia's attempt to create a counterpart of the U.S.-made Counter Communication System that was first introduced in 2004.[29]

Simultaneously, Russia paid attention to developing and modernizing its space surveillance infrastructure. The space surveillance centers across Russia's territory belong to the air and space forces (VKS), and their funding is part of the Russian space budget. However, they are crucially needed as much for strategic electronic intelligence and warfare purposes as for the Russian civil and defense space programs. Without this infrastructure, it would be hard to plan, deploy, or use ground-based EW systems, including the Tirada, in a proper way. However, this program's realization has been slow because the highest priority during the 2010s was developing an early warning system with radar and satellites. Russia deployed one laser optical space surveillance system in 2016 that is meant to identify trajectories and to get images of spacecraft and planned to deploy 12 more systems by 2025[30] (three of them would be also laser optical[31] and the other systems would be radio radar), but as of fall 2021, Russia is still only planning to deploy these 12 systems.[32] Consequently, Russia may face significant challenges with its space awareness and still cannot claim to have complete counter-space EW capabilities, including protection from satellites of technical reconnaissance (ELINT, optical electronic, and radar imaging).

From 2009–2021, Russia orbited a constellation of 4 Lotos-S1 electronic intelligence satellites and the first (June 2021) of two Pion-NKS radar and electronic intelligence satellites with the goal of surveilling an adversary's naval forces and the command, control, and communication centers of its ground and air forces.[33] Both types of satellites make up the Liana electronic intelligence and targeting space system.[34] That allows Moscow to realize its strategic approach toward electronic warfare at least partly, despite that fact that the Liana system faced many delays in previous years and still is incomplete. At the same time, Russia plans to develop and deploy a space-based electro-optical space surveillance system that, among other things, would

28 "ОАО "Владимирский завод "Электроприбор": Годовой отчет за 2018 год [JSC 'Vladimirsky zavod Elektropribor': Annual report 2018]," Interfax–CRKI, May 27, 2019, https://e-disclosure.ru/portal/files.aspx?id=16566&type=2.

29 See: 1) "Counter Communication System," L3Harris, https://www.l3harris.com/all-capabilities/counter-communications-system; 2) "Counter Communication System Block 10.2 achieves IOC, ready for the warfighter," Spaceforce.mil, March 13, 2020, https://www.spaceforce.mil/News/Article/2113447/counter-communications-system-block-102-achieves-ioc-ready-for-the-warfighter/.

30 "В России до 2025 года развернут 12 лазерно-оптических комплексов для контроля космоса [Russia to deploy 12 laser-optic complexes for space tracking and surveillance by 2025]," TASS, October 4, 2021, https://tass.ru/armiya-i-opk/12567063.

31 "Интервью с Виталием Горючкиным, главным конструктором российской СККП [Interview with Vitaly Goryuchkin, chief designer of the Russian space surveillance system]," Interfax, October 25, 2021, https://www.interfax.ru/interview/798803.

32 "4 октября в Вооруженных силах Российской Федерации отмечают День Космических войск [October 4 is marked as Space Forces Day in the Armed Forces of the Russian Federation]," Mil.ru, October 4, 2021, https://function.mil.ru/news_page/country/more.htm?id=12386803@egNews.

33 "Дотянулась до космоса: завершается создание системы разведки "Лиана" [Reached the cosmos: The deployment of the 'Liana' space intelligence system is to be completed soon]," Izvestiya, March 6, 2021, https://iz.ru/1133265/anton-lavrov/dotianulas-do-kosmosa-zavershaetsia-sozdanie-sistemy-razvedki-liana.

34 ""Лиана" оплетет моря и сушу ['Liana' will cover seas and lands]," VPK, July 20, 2021, https://vpk-news.ru/articles/62996.

General Director of the Roscosmos State Corporation for Space Activities Dmitry Rogozin speaks with Russian President Vladimir Putin at the Vostochny Space Launch Centre in September, 2021. (Kremlin.ru)

provide information for EW systems.[35] There is also some official evidence that Russia is trying to develop an electronic warfare spacecraft.[36] However, it is not clear if Russia will be successful in the last two projects, taking into account the economic inefficiency of the Russian defense industry and persistent deficits in technology and human capital.

The sea-based component of Russia's electronic warfare capability consists of onboard systems for the defense of vessels and 18 special electronic intelligence ships of different types and ranges. Most of the ELINT ships were built during the Soviet era, and some of them were modernized during the 2010s. There are only two electronic intelligence ships (medium-range project) that were commissioned in 2014 and 2018. Another two ships from project 18280 were delayed and are currently planned for release by the second half of the 2020s.[37] Consequently, sea-based EW systems will continue to play a secondary support role in Russia's military planning. This correlates with the reality of the relative weakness of the Russian naval conventional forces overall.

35 "Интервью с полковником Сергеем Сучковым, начальником Главного центра разведки космической обстановки [Interview with Col. Sergei Suchkov, chief of the Main space situation reconnaissance center of the Russian Aerospace Forces]," Krasnaya Zvezda, March 27, 2020, http://redstar.ru/nablyudat-za-zvyozdami-i-garantirovat-bezopasnost-strany/?attempt=2.

36 For example: 1) "Концерн Радиоэлектронные технологии участвует в создании специальной аппаратуры для перспективного спутника РЭБ [KRET participates in development of special electronic equipment for future electronic warfare satellite]", Interfax-AVN, February 20, 2015, https://www.militarynews.ru/story.asp?rid=3&nid=367398&hashtag=AERO%20INDIAshow&lang=RU; 2) "Интервью с Игорем Насенко, генеральным директором КРЭТ [Interview with Igor Nasenkov, director general of KRET]," RIA, April 28, 2015, https://ria.ru/20150428/1061131478.html; 3) G.V. Konstantinov, A.V. Chizhankov, and I.A. Shishechkin, "Развитие теории применения формирований радиоэлектронной борьбы в интересах противовоздушной обороны войск и объектов [Development of the theory of application of electronic warfare formations for the purposes of air defense forces and facilities]," Voennaya mysl', No. 10, 2019, https://cyberleninka.ru/article/n/razvitie-teorii-primeneniya-formirovaniy-radioelektronnoy-borby-v-interesah-protivovozdushnoy-oborony-voysk-i-obektov.

37 "Разведка подождет [Intelligence will wait]," Kommersant, May 17, 2017, https://kommersant.ru/doc/3298411/.

ISSUES FOR DEVELOPING EW BY 2030

The current number of Russian EW troops is estimated to be 9,000–12,000 officers, NCOs, and soldiers.[38] These troops consist of formations, military units, and subunits of services and branches of the armed forces, military districts, and several EW formations and military units of central subordination.[39] However, the rearmament programs, together with technical and economic issues, raise the question of relevant organizational changes in electronic warfare. One of the main discussion points among the Russian political and military leadership today is the possibility of transforming EW troops from combat support into a separate branch of the armed forces.[40]

Both the current variety of EW systems and the different subordination of EW units require a sophisticated combination of systems and coordination. Moreover, the idea of turning EW troops into specialized forces may be considered evidence that the actual level of combat effectiveness of the Russian EW systems and EW units is still not enough for current military planning. At the least, the problem of misalignment between them is significant.[41]

The main reason for the discussion derives from the military tasks that are allotted to EW troops today. Besides electronic intelligence, jamming the adversary's communication channels in theater (including fire-command chains and weapons guidance systems), and the protection of their own forces from the adversary's technical reconnaissance[42] and electronic warfare, Russian EW troops are meant to disrupt the adversary's command, control, and communication systems overall and consequently to disorganize its forces and weapon systems. The important thing is that the adversary is presumed to be superior in air and space capabilities as well

38 "Солдаты РЭБ на страже эфира [EW soldiers on guard of electronic communications]," Krasnaya Zvezda, April 15, 2019, http://redstar.ru/soldaty-reb-na-strazhe-efira/.

39 See: 1) "Управление начальника войск радиоэлектронной борьбы Вооруженных Сил Российской Федерации [Directorate of chief of electronic warfare troops of the Russian Armed Forces]," Mil.ru, https://structure.mil.ru/structure/ministry_of_defence/details.htm?id=9713@egOrganization; 2) The Military Balance 2021, the International Institute for Strategic Studies, 2021.

40 Y.I. Lastochkin, "Перспективы развития войск радиоэлектронной борьбы Вооруженных Сил Российской Федерации [Prospects for the development of electronic warfare troops of the Russian armed forces]," Voennaya mysl', No. 12, 2020, https://cyberleninka.ru/article/n/perspektivy-razvitiya-voysk-radioelektronnoy-borby-vooruzhennyh-sil-rossiyskoy-federatsii.

41 The probability of success is evaluated to be 30–60% less than planned due to this misalignment: Viktor Anokhin, Dmitriy Kholuenko, and Nataliya Gromyko, "Оценка влияния рассогласования в применении разнородных сил и средств на эффективность дезорганизации информационно-управляющих систем противника [Evaluation of influence of misalignment between multiple-type forces on effectiveness of disorganization of adversary's net-centric command, control and information systems]," Voennaya mysl', No.8, 2021, https://cyberleninka.ru/article/n/otsenka-vliyaniya-rassoglasovaniya-v-primenenii-raznorodnyh-sil-i-sredstv-na-effektivnost-dezorganizatsii-setetsentricheskih.

42 V.M. Vatutin, L.S. Kovalenko, and S.A. Kruglov, "Возможности обеспечения радиоэлектронной защиты районов на поверхности Земли от несанкционированного наблюдения [Technical opportunities for the electronic protection of Earth's surface areas from unauthorized space observation]," Raketno-kosmicheskoe priborostroenie i informatsionnye sistemy, No. 4, Vol. 6, 2019, https://docplayer.com/172466083-Vozmozhnosti-obespecheniya-radioelektronnoy-zashchity-rayonov-na-poverhnosti-zemli-ot-nesankcionirovannogo-nablyudeniya.html.

Russian Defence Minister Sergei Shoigu and military leaders meeting with defense industry heads in November, 2021. (kremlin.ru)

as in command, control, communication, and intelligence systems.[43] The discussion about further organizational development of Russian EW troops is therefore defined mostly by the ongoing confrontation with the West.

Moreover, Russian EW theorists generally believe that the struggle for information superiority during a campaign is based on the struggle for superiority in EW command and control systems and units. Along with electronic warfare itself, this struggle presumes fire strikes and cyberattacks against the adversary's EW command and control systems. Only this way of action creates an opportunity for the actor with lesser resources to achieve military victory.[44] Consequently, the current level of integration between electronic warfare troops and other combat branches and services is not considered strong enough in the event of a conflict with superior adversary. That means Russia will try to fill this gap during the next decade.

Another issue derives from the delays in developing sea-, air-, and space-based EW systems. Without positive achievements in these fields, it would be hard to claim success in strategic operations, as well as projection power abroad above the scale seen in Ukraine and Syria. Moreover, because naval EW surface ships continue to play secondary role, Russia will presumably focus its efforts on the air- and space-based components of its electronic warfare capabilities. Taking into account the geography of the European theater, Russia may also choose to deploy ground-based EW facilities in Belarus instead of an old-fashioned Volga early warning radar and/or naval communication center there, with the goal of creating an EW "chain" from Crimea to Kaliningrad, which would cover Ukraine, the Baltic states, and part of Poland.

It is not clear how far the Russian defense industry was able to advance in previous years on other types of electronic warfare systems, such as offensive electromagnetic pulse munitions for aviation and rocket artillery or advanced combat laser systems for EW purposes. The original plans presumed that the armed forces would get these weapons in sufficient quantities by 2025, but the actual statements of the industrial base and current efforts remain unclear.[45] Some R&D projects are being conducted, but these types of EW systems are unlikely to become operational in coming decade.

43 Y.I. Lastochkin, "Перспективы развития войск радиоэлектронной борьбы Вооруженных Сил Российской Федерации [Prospects for developing the electronic warfare troops of the Russian Armed Forces]," Voennaya mysl', No. 12, 2020...

44 Sergei Kozlitin, Yuriy Koziratskiy, and Sergei Budnikov, "Моделирование совместного применения средств радиоэлектронной борьбы и огневого поражения в интересах повышения эффективности борьбы за превосходство в управлении [Modeling of the joint use of electronic warfare and fire systems for increasing the effectiveness of the struggle for superiority in command and control capabilities]," Voennaya mysl', No. 1, 2020, https://cyberleninka.ru/article/n/modelirovanie-sovmestnogo-primeneniya-sredstv-radioelektronnoy-borby-i-ognevogo-porazheniya-v-interesah-povysheniya-effektivnosti.

45 Y.I. Lastochkin, "Приоритетные задачи оборонно-промышленного комплекса по развитию технической основы войск РЭБ Вооруженных сил Российской Федерации [Priority goals of the defense industry toward the development of technical bases of the electronic warfare troops of the Russian armed forces]," Federal Guidebook – Defense Industry of Russia, Volume 10, 2014, http://federalbook.ru/projects/opk/structura-10.html.

CONCLUSION

The current decade promises to be challenging for Russia in terms of electronic warfare. Moscow will need to address issues with its previous EW efforts, focus more on the quality of electronic warfare systems than on the quantity, and bring together EW capabilities on the tactical, theater, and strategic levels.[46] Moreover, after the stabilization of defense spending during the late 2010s, Russia was forced to increase its defense budget again. That means the spending on EW will also increase, even if its share in total Russia's arms procurements remains the same (2.1–2.2%). Russia will try to fill gaps in air- and space-based EW capabilities, and sea-based EW will continue to play a secondary role. Russia may also choose to extend its ground-based EW infrastructure in Belarus with creation of an EW "chain" in Eastern Europe.

46 Besides what was mentioned above, the existence of these gaps is confirmed also by some of the recent military exercises. For example, see: "На спецучении подразделения РЭБ ЮВО примут участие в радиоэлектронном ударе стратегической системы радиопомех ВС РФ [The EW units of the Southern Military District take part in an electronic warfare strike with strategic radio interference system of the Russian Armed Forces during a special exercise]," Mil.ru, August 10, 2020, https://function.mil.ru/news_page/country/more.htm?id=12306262@egNews.

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OFFERING IDEAS

In an increasingly polarized world, we pride ourselves on our tradition of nonpartisan scholarship. We count among our ranks over 100 affiliated scholars located throughout the nation and the world who appear regularly in national and international media, testify on Capitol Hill, and are consulted by U.S. government agencies.

EDUCATING THE AMERICAN PUBLIC

FPRI was founded on the premise that an informed and educated citizenry is paramount for the U.S. to conduct a coherent foreign policy. Through in-depth research and extensive public programming, FPRI offers insights to help the public understand our volatile world.

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