FOREWORD BY
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RUSSIA'S PATH TO THE HIGH-TECH BATTLESPACE

The JAMESTOWN FOUNDATION

Russia's Path to the High-Tech Battlespace

By Roger N. McDermott

With Foreword by Lieutenant Colonel Charles K. Bartles

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The Jamestown Foundation's mission is to inform and educate policy makers and the broader community about events and trends in those societies which are strategically or tactically important to the United States and which frequently restrict access to such information. Utilizing indigenous and primary sources, Jamestown's material is delivered without political bias, filter or agenda. It is often the only source of information which should be, but is not always, available through official or intelligence channels, especially in regard to Eurasia and terrorism.

Origins

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The Jamestown Foundation has emerged as a leading provider of information about Eurasia. Our research and analysis on conflict and instability in Eurasia enabled Jamestown to become one of the most reliable sources of information on the post-Soviet space, the Caucasus and Central Asia as well as China. Furthermore, since 9/11, Jamestown has utilized its network of indigenous experts in more than 50 different countries to conduct research and analysis on terrorism and the growth of al-Qaeda and al-Qaeda offshoots throughout the globe.

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Glossary of Terms

A2/AD Anti-Access/Area Denial
AI Artificial Intelligence
ALBM Air-Launched Ballistic Missile
ALCM Air-Launched Cruise Missile
ASU *Avtomatizirovannoy Sistemy Upravleniya* (Automated Command System)
AVN *Akademii Voyennykh Nauk* (Academy of Military Sciences)
AWACS Airborne Warning and Control Systems
BDA Bomb Damage Assessments
BLA/BPLA *Bespilotnyye Letatel'nyye Apparaty* (Unmanned Aerial Vehicles)
BTG Battalion Tactical Group
C2 Command and Control
C3 Command, Control and Communications
C3I Command, Control, Communications and Intelligence
C4ISR Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CAA Combined-Arms Army
CGS Chief of the General Staff
COFM Correlation of Forces and Means
COMINT Communications Intelligence
DNR *Donets'ka Narodna Respublika* (Donetsk People's Republic)
EA Electronic Attack
ECM Electronic Counter Measures
ELINT Electronic Intelligence
EME Electromagnetic Environment
EMS Electromagnetic Spectrum
EP Electronic Protection
ES Electronic Support
EW Electronic Warfare

FSB *Federal'naya Sluzhba Bezopasnosti* (Federal Security Service)
GBRS Ground Based Robotic Systems
GLCM Ground Launched Cruise Missile
GLONASS *Global'naya Navigatsionnaya Sputnikovaya Sistema* (Global Navigation Satellite System)
GOZ *Gosudarstvennaya Oboronnyi Zakas* (State Defence Orders)
GPV *Gosudarstvennaya Programma Razvitiya Vooruzheniy* (State Armaments Program)
GRU *Glavnoye Razvedyvatelnoye Upravleniye* (Main Intelligence Directorate)
GZO/GZLA *Giperzvukovogo Oruzhiya/Giperzvukovyye Letatel'nyye Apparaty* (Hypersonic Weapons)
HGV Hypersonic Glide Vehicles
ICBMs Intercontinental Ballistic Missiles
ISBU *Informatsionnaya Sistema Boyevogo Upravleniya* (Battle Management Information System)
ISR Intelligence, Surveillance and Reconnaissance
IUO *Informatsionno-Udarnaya Operatsiya* (Information-Strike Operation)
IUS *Informatsionno-Udarnaya Sistema* (Information-Strike System)
IW Information Warfare
KRUS *Kompleks Razvedki Upravleniya i Svyazi* (Intelligence Management and Communications Complex)
LACM Land-Attack Cruise Missile
LNR *Luganskaya Narodnaya Respublika* (Lugansk People's Republic)
MASINT Measurement and Signature Intelligence
MD Military District
MDMP Military Decision-Making Process
MLRS (Multiple Launch Rocket System)
MRAU *Massirovannyye Raketno-Aviatsionnyye Udary* (Massed Missile-Aviation Strikes)
MTO *Materialno-Tekhnicheskogo Obespechenie* (Material-Technical Support)

NATO North Atlantic Treaty Organization

NTsUO *Natsionalnogo Tsentra Upravleniya Oboronoy* (National Defense Management Center)

OODA Loop Observe–Orient–Decide–Act Loop

ORBAT Order of Battle

OSK *Obyedinennyye Strategicheskoye Komandovanie* (Joint Strategic Command)

OSU *Operativno-Strategicheskie Ucheniya* Operational-Strategic Exercise

PGW Precision-Guided Weapons

PSYOPS Psychological Operations

PVO SV *Voyska Protivovozdushnoy Oborony Sukhoputnye Voiska* (Ground Forces Air Defense Forces)

PVO *Voyska Protivovozdushnoy Oborony* (Air Defense Forces)

R&D Research and Development

REB *Radioelektronnaya Bor'ba* (Electronic Warfare)

RKhBZ *Radiatsionnoy, Khimicheskoy i Biologicheskoy Zashchity* (Radiation, Chemical and Biological Protection Troops)

RMA Revolution in Military Affairs

ROK *Razvedyvatelno-Ognevoy Kompleks* (Reconnaissance-Fire Complex)

ROO *Razvedyvatelno-Ognevaya Operatsiya* (Reconnaissance-Fire Operation)

ROS *Razvedyvatelno-Ognevaya Sistema* (Reconnaissance-Fire System)

RTK *Robototekhnicheskikh Kompleksov* (Robotic Technical Complexes)

RUK *Razvedyvatelno-Udarnaya Kompleks* (Reconnaissance-Strike Complex)

RUS *Razvedyvatelno-Udarnaya Sistema* (Reconnaissance-Strike System)

RV&A *Raketnyye Voyska i Artilleriya* (Missile and Artillery Troops)

RVSN *Raketnye Voyska Strategicheskogo Naznacheniya* (Strategic Rocket Forces)

SAA Syrian Arab Army
SAM Surface-to-Air Missile
SIGINT Signals Intelligence
SLCM Sea Launched Cruise Missile
SVP *Spetsializirovannaya Vychislitel'naya Podsistema* (Specialized Computing Subsystem)
TsVSI *Tsentr Voyenno-Strategicheskikh Issledovaniy* (Center for Military-Strategic Studies)
TVD *Teatr Voyennykh Deystviy* (Theater of Military Operations)
UAS Unmanned Aerial Systems
UAV Unmanned Aerial Vehicle
UBLA *Udarnyye Bespilotnyye Letatel'nyye Apparaty* Shock/Strike Unmanned Combat Aerial Vehicles
UCAV Unmanned Combat Aerial Vehicle
VDV *Vozdushno-Desantnye Voyska* (Airborne Forces)
VKS *Vozdushno Kosmicheskikh Sil* (Aerospace Forces)
VMF *Voyenno-Morskoy Flot* (Military-Maritime Fleet)
VTO *Vysokotochnoye Oruzhiye* (High-Precision Weapons)
VVS *Voyenno-Vozdushnye Sily* (Air Force)
VVST *Voyennoy i Spetsial'noy Tekhniki* (Military and Special Equipment)
YeRIP Y*edinogo Razvedyvatel'nogo Informatsionnogo Prostranstva* (Single Reconnaissance Information Space)
YeSU TZ *Yedinaya Sistema Upravleniya v Takticheskom Zvene* *(*Unified System for Command and Control at the Tactical Level)

Preface

Research and writing this book preceded and continued during Russia's military buildup on Ukraine's borderlands in 2021–2022. As such, the value of the book—as a contribution to deepening the understanding of Russia's military capabilities, developments in Russian military thought, and the connection of force transformation to modernization, heavily tied to the adoption of high-technology among other features—necessitates defining what this study intends and explicitly noting the areas it is not covering. The book is not intended as a comprehensive analysis of Russian conventional military capability or specifically the Russian way of war fighting. These themes are more than adequately covered in earlier published works including: Niels Bo Poulsen and Jørgen Staun (Eds), *Russia's Military Might: A Portrait of Its Armed Forces*, Copenhagen, 2021; Glen E. Howard and Matthew Czekaj (Eds), *Russia's Military Strategy and Doctrine*, The Jamestown Foundation, 2019; as well as Lester W. Grau and Charles K. Bartles, *The Russian Way of War: Force Structure, Tactics, and Modernization of the Russian Ground Forces*, Mentor, 2016.

Russia's Path to the High-Tech Battlespace, by contrast, examines a range of modernization developments affecting Russian conventional military capability in the long term. It essentially examines the transition from a Soviet legacy force inherited after the dissolution of the USSR in 1991 to a smaller, better trained lethal force that places significantly greater emphasis on the massive exploitation of information and information-centric systems. The following study also analyzes the deeper effort to build conventional military capabilities that can lessen long-term dependence and reliance upon the nuclear deterrent.

Military transformation in Russia is inherently linked to much of its Soviet and imperial Russian history, especially in terms of continuity in military thought. Indeed, Russia's latest military transformation grew most directly out of its experience of small wars in the 1990s and early 2000s, particularly in Chechnya, a process then crystallized by the August 2008 Russian-Georgian war and the systemic military reforms the political leadership in Moscow ordered in that conflict's aftermath. In the interim, Russia's political-military leadership was also influenced by the country's involvement in conflict in Ukraine since 2014 and its limited intervention in Syria, initiated in September 2015. That process did not culminate nor can it be exclusively judged on the basis of the Russo-Ukrainian war in 2022. The fundamentals of the Russian military transformation, with its more recent roots in the reforms that began in 2008–2009, lie in the extent to which Russia's political and military elites finally recognized that the underlying means and methods of modern and future war have dramatically changed—principally as a result of the information era.

In this context, the following book represents a journey deep into the thinking and rationale of the ongoing military transformation in Russia and is therefore rooted in Russian-language material, giving voice to the numerous and eclectic actors involved with reshaping the Russian Armed Forces for the 21st century security environment. This begins by examining the changing character of war and the role played by technology in Russian military thought, linked to views and identifiable trends in future warfare. It considers the recent revolution in military decision-making, which has attended the country's military modernization over more than the past decade. Then it traces the historical and contemporary roots of its transition into network-centric warfare capability with the testing of Lieutenant General Vladimir Slipchenko's (1935–2005) concept of sixth-generation warfare and its pinnacle of non-contact warfare in operations in Syria. The role of hypersonic weapons systems in Russian military thought is considered in the context of a possible emerging concept of preemptively neutralizing emerging threats; while Russia's strengthening electronic warfare (EW) capability is assessed as part of the country's broader military modernization programs. Finally, technologies such as unmanned aerial vehicles (UAV) and unmanned combat aerial vehicles (UCAV) are also of growing importance in the Russian military inventory, a trend that is examined in terms of its drivers and overall purposes.

Russia's Path to the High-Tech Battlespace is neither a primer on nor an assessment of the "military balance" faced by contemporary Russia. Its target audience ranges from specialists in Russian military strategy and capability, inclusive of intelligence professionals, defense analysts, policy and decision-makers, academics and experts, or military historians, to the interested reader regardless of perspective or background. Those with a belief that they "understand" Russia and its military need read no further. In May 2011, this author was present in Moscow at the one-off "military Valdai" event, when a leading Russian general explained to his foreign military expert audience that while many foreigners, including intelligence analysts, try to understand Russia's Armed Forces and ask many interesting questions, "we ourselves don't fully understand even our own structures." It is, of course, always a challenge to make the effort to try to understand another culture—particularly its military culture—and to recognize that other people and peoples can see the world quite differently. So in short, this book is offered to its readership in the intellectual spirit of the words of imperial Russian General Aleksandr Suvorov (1730–1800): "Never despise your enemy, whatever he may be, and know well his weapons, his way of acting and fighting."

Foreword

By US Lieutenant Colonel Charles K. Bartles

Russian Military Modernization and Russia's 2022 Invasion of Ukraine

In recent years, there has been much interest in Russian military modernization due to Russia's 2014 annexation of the Crimean Peninsula and activity in eastern Ukraine, more assertive behavior along its borders, successful bolstering of the Syrian regime, and short deployment to Kazakhstan in January 2022 to quell civil unrest. Given these successes, the Russian military has been proffered as an elite military force filled with Special Operations Forces who were the "polite people" or "little green men" seen on the streets in Crimea in 2014. Perhaps more colloquially put, since 2014, the Russian Armed Forces have been seen as ten feet tall. Understandably, interest in Russia's military modernization is being piqued to new heights due to its 2022 invasion of Ukraine, euphemistically called a *spetsial'naya voyennaya operatsiya* (special military operation), which is unfolding as this introduction is being written.

The daily barrage of information about the campaign has created a situation wherein the specialized vernacular of the Russian military experts, terms such as "Battalion Tactical Groups," can now be readily heard and seen in the mass media, YouTube, and a plethora of blog sites. The use of this terminology and the daily reporting of Russian military failures, including huge equipment losses, weak tactics, flagging morale, and broken logistics, often leads to conclusions and general feelings of certainty that the Russians are failing miserably. If these Ukrainian-friendly sources are taken at face value, one might conclude that all previous Russian military successes have been flukes, and in reality the Russian military is really only four feet tall.

Trying to assess the performance of the Russian Armed Forces based only upon available open source reporting is, at best, very difficult for several reasons. The first is that it is impossible to discern if videos posted on social media are showing exemplars of trends (tip of the iceberg), or are just spotlighting isolated incidents. For example, the Russian military's logistics system may have had widespread failures, but it is speculation at best to just assume so, based solely upon videos posted to social media. Perhaps the biggest hindrance to understanding comes from the fact that information is mostly from Ukrainian-friendly sources. Currently, there are only official Russian pronouncements about the "success" of the campaign or mentions of Ukrainian atrocities, which are, at best, exaggerations and, at worst, blatant lies. We see little, if any, reporting from the Russian mass media (albeit often Russian controlled), independent analysts, and even anything in the usually highly active world of Russian social media and blog sites. These valuable information sources have been uncharacteristically quiet since the war in Ukraine began, and understandably so, as long-standing Russian laws provide stiff prison sentences for those discussing ongoing military operations. In addition, Russia has recently (March 4) passed a new draconian law about spreading "fake news" that can result in a prison sentence of up to 15 years, further stifling public discourse.[1] The net effect of these laws results in little or no public discussion of the campaign, allowing only for reposting or rehashing of the aforementioned government pronouncements.

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[1] Will Oremus, 'In Putin's Russia, 'fake news' now means real news,' *Washington Post* Online, March 11, 2022. https://www.washingtonpost.com/technology/2022/03/11/russia-fake-news-law-misinformation/; Elahe Izadi and Sarah Ellison, 'Russia's independent media, long under siege, teeters under new Putin crackdown,' *Washington Post* Online, March 4, 2022. https://www.washingtonpost.com/media/2022/03/04/putin-media-law-russia-news/.

In addition, there is another serious problem about trying to make premature broad-brush comments about the nature of this conflict. Western intelligence services predicted the Russians could take Kyiv in a few days, leading the media and some analysts to conclude that the Russian military capabilities have been drastically overestimated, while, in fact, the Russian military is quite inept.[2] This, again, may well be true, but at this time it is difficult to determine what portion of Russia's difficulties can be attributed to an "inept Army" as opposed to intelligence and planning failures at the operational and strategic levels. If the Russians did envision an operating environment in which they would encounter little resistance, they likely underestimated not only the total number of personnel required for such an endeavor but also the general scheme of maneuver and required support mechanisms.

Given the Russian propensity to study historical precedent, this underestimation does not seem wholly unfounded. Ukraine's political leadership has fled the country before in times of duress, and considering President Volodymyr Zelenskyy's background as a comedian and actor along with his somewhat lackluster performance before the Russian invasion, the Russian failure to foresee Zelenskyy's decision to stay and fight and his unlikely success as a wartime leader can be understood. Moreover, recent historical precedent of the failures of Western security assistance activities, might have led the

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[2] Barbara Starr, Ellie Kaufman and Jeremy Herb, 'Top US general in Europe says there 'could be' an intelligence gap in US that caused US to overestimate Russia's capabilities,' *CNN* Online, March 29, 2022, https://www.cnn.com/2022/03/29/politics/tod-wolters-intelligence-gap-us-russia-ukraine/index.html; Max Boot, 'Stop overestimating the Russian military and underestimating Ukrainians,' *Washington Post* Online, March 28, 2022, https://www.washingtonpost.com/opinions/2022/03/28/stop-overestimating-russian-military-and-underestimating-ukrainians-one-month-war/; Fred Kaplan, 'No, You're Not Imagining It: Russia's Army Is Inept,' *Slate*, February 28, 2022, https://slate.com/news-and-politics/2022/02/no-youre-not-imagining-it-russias-army-is-inept.html.

Russians to believe that the vast sums of dollars, euros and pounds that were wasted propping up Afghan regime, were being equally wasted in Ukraine. Although the Russians were concerned about the defenders' acquisition of certain weapon systems (such as the various antitank guided missiles), as a whole the quality and resolve of the Ukrainian military may have been perceived to be more at level closer to 2014 than they encountered in 2022.

All things being equal, if Moscow did accurately forecast the operational environment, the course of the campaign may have looked much different. Instead of attempting to achieve all objectives simultaneously to secure a "quick win," a more traditional approach of prioritized objectives may have resulted in more Russian success. The point of this discussion is not to debate the shortcomings of the Russian military and/or its intelligence and planning failures, but instead to illustrate the point that causes of failure or success for military campaigns require more than casual observation. If the West reaches the conclusion that the Russian Armed Forces are inept from just casual observation, this could result in an underestimation of the Russian military akin to how Moscow underestimated the Ukrainians—a potential catastrophe in case the West ever becomes embroiled in a kinetic conflict with the Russian Federation.

In truth, it is far too early to fully grasp the reality and lessons learned from this most recent Russian infringement of Ukrainian sovereignty. This goal will likely not be possible until after the cessation of active hostilities, when operational security procedures are allowed to lapse on both sides of the conflict. If Russia continues the pattern of past conflicts, it will initially declare success but will then perform a critical self-assessment of its military's performance and lessons learned. This was certainly the case after the 2008 Russo-Georgian War. In 2010, the Centre for Analysis of Strategies and Technologies (CAST), a Russian think tank with strong ties to the Russian government, published *The Tanks of August*.[3] The book is a collection of seven essays by prominent authors from the Russian defense and security community. The book meticulously lays out a timeline of the conflict, Russian and Georgian losses, post-war developments, and lessons learned. By almost all accounts, the book provides a critical and well-balanced assessment of the Russian military's performance in the conflict. Although Russia's "New Look" reforms were envisaged well before the 2008 Russo-Georgian War, the Russian military's poor performance in the conflict likely was an impetus to execute those reforms or, at a minimum, lessened institutional resistance. A similar critical look at the Russian military's performance will likely occur after active hostilities in the current operation cease.

Aside from operational security concerns on both sides of the conflict and the general "fog of war," additional difficulties stem from understanding the lessons learned and the "big picture"—simply the scale and duration of the campaign. A military conflict of this size has not been seen in Europe since the Second World War, a complete accounting of the conflict to include its actions on at least five independent axes, phases, many battles, and all other aspects of modern warfare will probably take many years for scholars, analysts, and militaries to fully digest. In terms of analytical assessments, *The Tanks of August* is an excellent account of the 2008 Russo-Georgian War, but it is important to keep in mind that this conflict was comparatively much smaller in terms of personnel, geography and duration, lasting only five days. Due to the scope of Russia's 2022 invasion of Ukraine, and the availability of massive amounts of digital evidence that has surfaced and will continue to surface for years to come, it is doubtful that there will be a single text such as *The Tanks of August* that will be able to encapsulate Russia's 2022 assault on

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[3] M. S. Barabanov, A .V. Lavrov, V. A. Tseluiko, Eds. R. N. Pukhov, *The Tanks of August*
(Moscow, Centre for Analysis of Strategies and Technologies, 2010), pp. 144.

Ukraine. Instead, one can expect many books, articles, thesis/dissertations, papers, etc., drafted about the various aspects of the campaign, in addition to a few works that will provide a general overview.

Perhaps the biggest obstacle in attempting to develop any all-encompassing "lessons learned" about Russia's military modernization and performance in this campaign, at this stage, is the fact that the Russian military is a thinking and adaptable organization. As previously mentioned, there will be a formal review conducted at the end of the campaign, but the Russian General Staff almost certainly already started an impromptu process to make immediate changes, the results of which will presumably become more evident as the campaign transitions from being measured in weeks to months. Therefore, one should be mindful that some lessons learned may be applicable to the whole campaign, while others may just be applicable to certain phases, axes of advance, and/or particular units as the Russian military adapts to its environment, including a learning and adapting Ukrainian force.

Although it is too early for an assessment of Russia's 2022 invasion of Ukraine, Roger N. McDermott's *Russia-s Path to the High-Tech Battlespace* provides an important tool for those interested in studying Russian military modernization and how successful or unsuccessful these efforts have been as evidenced in Ukraine 2022. Many such assessments can be expected in the years to come, but McDermott's contribution permits these assessments to measure Russian military modernization within the context in which it was developed and implemented. As will be described, McDermott couches Russian military modernization as Russian military theorists, planners, and force designers think about it. In particular, Russian military modernization follows the thinking of the late Major General Vladimir Slipchenko, one of Russia's most prominent military theorists, whose theories can be readily seen in Russia's military modernization.

Understanding the Context of Russian Military Modernization

In order to understand the context in which Russian military modernization is being conducted, a short description of how Russian military theorists think about military modernization is required. In Russian military thought, military modernization is considered to be part of the broad field of "military art," the branch of military science that describes the theory and practice (strategy, operational art and tactics) of the preparation and conduct of armed struggle on land, air, sea, and other domains.[4] In order to consider the future of strategy, operational art and tactics, they must first consider what the future of war will look like. This is accomplished by studying the lessons of past wars and factors that will cause war to change, and using this information to forecast what the future operating environment may look like.[5] The most important of these factors is technological development, which is essential for any long-term defense planning involving military doctrine and capability development.[6] Given the importance of technological development to military art, Russian military theorists have long been pondering the impacts of technological change and innovation. One of the best known of these Russian theorists is the aforementioned Major General Vladimir Slipchenko. Slipchenko was keenly interested in the technological developments that characterized the 1991 Desert Storm operation and the 1999 bombing of Yugoslavia by the North Atlantic Treaty Organization (NATO). In his view, these conflicts were characterized

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[4] N. N. Tyutyunnikov, *Military Thought in Terms and Definitions: In Three Volumes (Vol. 1)* (Moscow, Russia: Pero., 2018), p. 129.

[5] T. L. Thomas, 'Russian Forecasts of Future War,' Military Review, Vol. 99, No. 3, May–June 2019, www.armyupress.army.mil/Portals/7/military-review/Archives/English/MJ-19/Thomas-Russian-Forecast.pdf, p. 84.

[6] P. A. Mattsson, 'Russian Military Thinking: A New Generation of Warfare,' *Journal on Baltic Security*, No. 1, Vol. 1, 2015, pp. 61–70, at p. 61, https://doi.org/10.1515/jobs-2016-0013 (accessed October 14, 2021).

by the increasing use of precision-guided munitions (PGM), the growing importance of the informational aspects of war—information/psychological operations; command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR), electronic warfare (EW), cyber warfare, and so on—as well as the decreasing importance of ground elements.

In Slipchenko's view, heavily influenced by Marxist dialectical materialist thinking, as humanity's technological advancement has increased, so has the military's level of technological development, resulting in what Russian theorists describe as different "generations" of warfare; this is the context in which Russian military theorists use the term "new generation warfare." [7] This view proffers that in over four thousand years of human history, there have been five generations of warfare: first generation—edged weapons; second generation—gunpowder weapons; third generation—rifled weapons; fourth generation—automatic weapons; fifth generation—nuclear weapons.[8] The transitions between these generations of warfare are not seen as a binary yes/no proposition. Instead, in step with this theory's underpinnings in dialectical materialism, the world's transition between generations of warfare was viewed as occurring on a spectrum. Belligerents could, and often do, use the means of more than one generation to varying degrees depending on a variety of factors (economy, technological level, etc.). In addition, belligerents could revert to older generations of warfare, or even skip generations of warfare depending on the situation.

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[7] S. G. Chekinov, '*Prognozirovaniye tendentsiy voyennogo iskusstva v nachal'nom periode XXI veka* [Predicting Trends in Military Art in the Initial Period of the 21st Century],' *Military Thought*, Vol. 19, July 2010., 19–33.

[8] M. Gareev and V. Slipchenko, Future War (Fort Leavenworth, KS: Foreign Military Studies Office, 2007), pp. 14–15.

Slipchenko's analysis of the historical development of warfare posited that the world was now entering a new, sixth generation of warfare. The first appearance of this new generation of warfare was evidenced by the first use of over-the-horizon cruise missiles in the 1982 Falklands War, and came to be defined by the 1991 Gulf War and actions against Yugoslavia in 1999. Slipchenko noted that the deceive use of precision-guided munitions in these conflicts is what differentiated them from earlier generations of warfare. In Slipchenko's view, the Western view that the tank, machine-gun, and aircraft were revolutionary military developments was unfounded, as he believed they were simply evolutionary improvements, paling in importance to PGMs.

While it took 4,500 sorties (each aircraft returning many times) and about 9,000 aerial bombs to destroy a railroad bridge over a large river in World War II, a bridge like that was destroyed by about 90 aircraft carrying 200 guided aerial bombs during the Vietnam War. And a single aircraft and one cruise missile destroyed such a bridge in Yugoslavia in 1999. You can see how much progress has been made, to the point where high-precision weapons are replacing many different forces and devices.[9]

Slipchenko postulated that the precision-guided munitions were in fact a revolutionary development, which would require major changes to the way warfare would be thought about and conducted. He believed that once fully realized, sixth-generation warfare would be characterized by the use of a combination of non-nuclear PGMs and informational means to achieve strategic objectives, without the need of a conventional ground force. Since the means used to conduct this type of warfare are long-distance and over-the-horizon in nature, Russians typically refer to sixth-generation warfare as "non-contact" warfare.

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[9] Gareev and Slipchenko, *Future War*, p. 17.

(Left to right) Army General Makhmut Gareyev (1923–2019) former deputy chief of the USSR General Staff and president of the Russian Academy of Military Sciences; Dr. Jacob Kipp (1942–2021), former director of the Foreign Military Studies Office and deputy director of the School of Advanced Military Studies; and Major General Vladimir Slipchenko (1935–2005), a member of the Russian Academy of Military Sciences and author of "Future War" and numerous other publications. At a conference in Fort Leavenworth, KS, in the early 1990s, discussing future war.

This revolution in warfare has many implications of. As the means of sixth-generation warfare become more commonplace, the character of war would also change. In particular, traditional offensive and defensive actions conducted by large combined-arms formations would become less common, as large groupings of forces would become easy targets for reconnaissance-strike systems. The means of sixth-generation warfare would not only deter belligerents from massing large troop formations to conduct operations along a few axes but would also be able to simultaneously attack all axes of a theater of military operations. Sixth-generation warfare shifts the focus from large formations fighting in discrete battlefields to the massive use of precision-guided munitions to destroy the enemy's means of conducting a retaliatory attack, such as their PGMs, key military installations (especially those pertaining to the enemy's reconnaissance-strike systems), electrical power infrastructure, lines of communication, and economically vital assets.

Among the consequences of this change would be that terms such as "front," "rear," and "forward edge of the battle area," would become obsolete as most attacks would transition to the aerospace and informational domains. Another consequence of this change in the character of war relates to military decision-making. Typically, Soviet/Russian military art has drawn sharp lines between strategy, operational art and tactics, but this new way of warfare would blur these lines and reduce military decision making to essentially three commands: "detect," "decide" and "destroy."[10] Due to the "reaches" of sixth-generation means of war, the geography of war would change from discrete regions to a singular global domain. Even the concept of victory itself would change. Furthermore, even the concept of victory would change. Previously, victory was often predicated upon defeating the enemy's military, occupying their territory, destroying their economic means, and finally toppling their political leadership. Eventually, the means of sixth-generation will allow mass attacks directly on the enemy's homeland. Victory in sixth-generation warfare will be determined not on some far-away battlefield, but on the home territories of the belligerents via non-contact means.

Conclusion

It appears likely that Russia will not achieve all of its initial operational and strategic objectives for its 2022 invasion of Ukraine. And Russia may well have made a strategic blunder by underestimating the tenacity and resolve of the Ukrainian political establishment, military, and populace to resist this latest Russian aggression. However, this conflict, whatever its outcome, will provide NATO with a unique look at not only how Russia conducts a partial mobilization and large-scale combat operations, but also how Russia's military modernization has

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[10] S. A. Modestov, '*Strategicheskoye sderzhivaniye na teatre informatsionnogo protivoborstva* [Strategic Deterrence in the Theater of Information Warfare],' *Journal of the Academy of Military Sciences*, Vol. 26, No. 1, 2009, p.35.

progressed. An eventual thorough study will undoubtedly reveal that some Russian military modernization goals have succeeded, others failed, and many were/are still unrealized.

Although in many ways the West and Russia have similar views about the future operational environment, such as: "less large-scale warfare; increased use of networked command-and-control systems, robotics, and high-precision weaponry; greater importance placed on interagency cooperation; more operations in urban terrain; a melding of offense and defense; and a general decrease in the differences between military activities at the strategic, operational, and tactical levels," the two sides are pursuing rather different strategies for modernization.[11]

The content of military operations is changing. Their spatial scope is growing, and their intensity and dynamism are increasing. Time parameters of the preparation and conduct of operations are shortening. There is a transition from successive concentrated actions to continuous distributed actions conducted simultaneously in all spheres of opposition as well as in remote theaters of military action. Demands on troop mobility are toughening. A transition is being made to comprehensive engagement of the enemy based on integrating the efforts of all attack assets and weapons into a single system. The boundaries of theaters of military action are expanding substantially. Areas with facilities of military and economic potential are being encompassed that are at a considerable distance from zones of immediate combat operations.[12]

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[11] C. K. Bartles, 'Getting Gerasimov Right,' Military Review, January-February 2016, Vol.96, No.1, https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/January-February-2016/.

[12] O. Falichev, 'Hotspots of Science: General Staff Denoted Bases of Operation and Lines for Scientists,' *Military-Industrial Courier*, March 27, 2018, https://vpk.name/news/210325_goryachie_tochki_nauki.html.

As opposed to the previously discussed Russian ideas of global sixth-generation war, the United States Army has adopted a wholly different Multi-Domain Operations (MDO) doctrine, one that is region focused. Since the US and Russia are pursuing dissimilar modernization strategies, the success of Russia's military modernization efforts should not be assessed solely through a Western lens, as this was not the context in which they were developed. The chapters of *Russia's Path to the High-Tech Battlespace* provide the necessary blueprint for a complete understanding and assessment.

In 1981, US Army General Donn Starry presented a new "AirLand Battle" concept, which focused on air support for land forces. This concept, and later doctrine, was the bedrock of US/NATO doctrine in later years of the Cold War and was validated by the Coalition's great success in the 1991 Gulf War. General Starry developed this concept from his study of the 1973 Yom Kippur War. This six-month study started in 1977, years after the end of that conflict. Fortunately, General Starry benefitted from having enough time for all necessary information to come to light and sufficient situational understanding to conduct the study. A premature and/or hasty assessment of the 1973 Yom Kippur War might have led to much different conclusions than eventually reached, possibly without the required insights that were the foundations of the "AirLand Battle" concept. When the time comes for a similar type assessment of Russia's 2022 invasion of Ukraine, *Russia's Path to the High-Tech Battlespace* will certainly help provide such situational understanding.

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1.

Russian Military Thought on the Changing Character of War: Harnessing Technology in the Information Age

Russia has a well-established tradition of producing advances in military theory, not simply in an abstract or narrow academic exercise, but in formulating highly important and usable ideas that were developed during periods in Russian and Soviet history when the State faced dangerous crises.[1] This chapter examines the role of high technology in modern Russian military thought, traces its Soviet origins, and follows the intrinsic linkages with analyses and perceptions of the changing character of warfare. The subject matter involved in any analysis of Russian military theory, including its historical and cultural contexts, is understandably vast. This study focuses on the leading military theorists writing on how wars will be fought in the future.[2] At the outset, it is important to note that unlike

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[1] Dima Adamsky, *The Culture of Military Innovation,* Stanford: Stanford University Press, 2010; Makhmut Gareev, '*Itogi Desiatiletnosti Akademii Voennykh Nauk 2001–2005 i Osnovnye Zadachii Akademii*,' *Voyennaya Mysl*, No. 2, 2006.

[2] Makhmut Gareev,'*Problemy Strategicheskogo Sderzhivania V Sovremennykh Usloviakh*,' in *Bezopasnost Rossii - 2010*, ed. R.M. Timoshev, Moskva: Triumfalnaia

Western militaries, Russian military thought has never abandoned its interest in large-scale inter-state warfare, which also features as part of the war types rehearsed and trained for in the annual strategic military exercises. This focus on the potential for large-scale inter-state conventional military conflict equally translates into Russian military thinking about the wars of the future.

Russia's military culture is encapsulated, in terms of military thought, in its national defense interest in military science (*voyennaya nauka*). That is to say, the science of war, and its potential for theoretical and practical input into the whole complexity of future warfare, is bound up within the idea of Russia's military science. In Russian military parlance, this is best defined as:

> A system of knowledge about the laws, military strategy, the nature of war, ways to prevent it, construction and preparation of the Armed Forces and the country for war, laws, principles and methods of warfare. War as a complex social and political phenomenon is studied by many societies, cultures and sciences. The main the subject is armed conflict and it explores the problems of war and peace, taking into account the dependence of its course and outcome on the ratio of economic, moral-political, scientific-technical and military capabilities of the belligerents, its forms, methods of training and strategy, operational and tactical in large-scale, regional, local wars and armed conflicts; composition, organization, technical, equipment; problems of military training and education, preparation of the population and mobilization, resources for war; the content, forms and methods of command and control (leadership) of troops (forces) in peacetime and in war.[3]

Arka, 2009; Boris Cheltsov, Sergei Volkov, '*Setevye Voiny Xx Veka*,' *Vozdushno-Kosmicheskaya Oborona,* 41, No. 4, 2008.

[3] *Voyennyy Entsiklopedicheskiy Slovar'*, https://encyclopedia.mil.ru/encyclopedia/dictionary/details.htm?id=4339@morfDict

Moreover, military science is the essential building bloc in the formulation of operational art and military strategy. In an article in November 2005 in the General Staff journal *Voyennaya Mysl'*, its authors Vice-Admiral Yu. P. Gladyshev and Captain 1st Rank G.V. Ivanov characterize military science as a tool for analyzing and solving challenges stemming from the organizational development, training and role of the Armed Forces, and note the need to examine the character of war. At the time of writing, the authors believed that Russian military science was not in good shape and had largely lost its predictive elements:

> Currently it becomes increasingly obvious that we should look for fundamentally new approaches to the understanding of problems of national, regional and global security. We should also rethink the role and capacities of military force in solving contradictions arising in international relations, and create a generally accepted, efficient scientific tool for probing the problems involved in the organizational development, preparation and employment of the Armed Forces to defend this country's national interests and assure its security.
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> *Military science* is supposed to be *this tool*, it being an integral and non-contradictory system of knowledge on ways and

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ionary, Accessed, July 6, 2021; O. Ragozin, (ed.), *Voyna i mir v terminakh i opredeleniyakh. Voyenno-politicheskiy slovar',* Moscow: Veche, 2017, pp. 111.See: Charles K. Bartles, 'Defining Russian Military Science,' NATO Defense College: Rome, Russian Studies Series 3:21, https://www.ndc.nato.int/research/research.php?icode=705, July 2021. For discussion of key Russian military terms, interpretations of concepts and how these may relate to one another, as well as how they are subject to change over time, see: Michael Kofman, Anya Fink, Dmitry Gorenburg, Mary Chesnut, Jeffrey Edmonds, and Julian Waller, Russian Military Strategy: Core Tenets and Operational Concepts, https://www.cna.org/CNA_files/pdf/Russian-Military-Strategy-Core-Tenets-and-Operational-Concepts.pdf, Research Memorandum, CNA: Arlington, Va, August 2021.

> methods of preventing wars and military conflicts; on the possible character of war, the laws and regularities of warfare; on the armed forces, their organizational development, preparation and peacetime and wartime employment. The contiguous areas of knowledge that help to achieve goals assigned to military science are of importance as well.[4]

Military theory was an area in which the Soviet Union clearly excelled, yielding works and contributions to military science of international and lasting significance. Two examples illustrate this point: from the 1920s—1930s and the 1980s. In the 1920s and 1930s, a small minority of elite Soviet military theorists developed the doctrine of the "deep operation." They accurately forecast the coming war with Germany, and in some cases advocated new approaches to national territorial defense. And in the 1980s, Soviet theorists discussed what later became known as the so-called Revolution in Military Affairs (RMA). Deep operation was championed by among others, Mikhail Tukhachevskii, Vladimir Triandafilov and Georgii Isserson, concentrating on the need to strike deep behind enemy lines to destroy the enemy's ability to defend its own front. In turn, deep operation doctrine also yielded ideas about combined-arms operations and introduced an operational level between the strategic and tactical.[5]

The impact of this on Soviet military thought was profound; it marked a transition from a focus on tactics to a new paradigm based upon operational art. Ultimately, it is this positive contribution that led to the costly Soviet victory against the Wehrmacht. In the 1980s some of the leading Soviet military theorists and top brass were discussing the RMA based on their assessments of developments in Western

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[4] Author's emphasis. Gladyshev Yu. P, Ivanov G.V, '*Voyennaya nauka i voyennaya sistemologiya*,' *Voyennaya Mysl'*, No. 11, 2005.

[5] Author's emphasis.

computer technology and precision weaponry.[6] As the debate on the RMA took hold in the United States, there was clear linkage to the Soviet discussions on this theme. Andrew Marshall, at the Office of Net Assessment (ONA) in the US Department of Defense, began to circulate ideas within the US military that he had borrowed directly from his readings of Soviet military theory in publications such as *Voyennaya Mysl'* (Military Thought), the official journal of Russia's General Staff.[7]

A critical theme in Soviet and Russian military thought is the scientific and analytical tasks associated with forecasting the changing character of war, drawing upon the military intellectual tradition that began with Carl Von Clausewitz (1780–1831), or developing likely models of how wars would be fought in the future. This tied into the fact that many of these Soviet officers shared a common background in the imperial Russian military, with Russia's General Staff model finding

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[6] Shimon Naveh, *In Pursuit of Military Excellence - the Evolution of Operational Theory*, Ed. Gabriel Gorodetsky, The Cummings Center Series, London: Frank Cass, 1997, p. 164; See: Azar Gat, A History of Military Thought, Oxford: Oxford University Press, 2001, pp. 632–639, Andrei Kokoshin, Soviet Strategic Thought 1917–91, Cambridge, Massachusetts: The MIT Press, 1998) pp. 19-40.

[7] Stephen Peter Rosen, 'The Impact of the Office of Net Assessment on the American Military in the Matter of the Revolution in Military Affairs,' *The Journal of Strategic Studies,* Volume 33, Issue 4, 2010, pp. 469–482. Charles Bartles stresses the role of this professional journal: '*Voyennaya Mysl'* (Military Thought) is the Russian Armed Forces oldest and most venerated journal on military theory, intended for senior officers, specialists in Russian Ministry of Defense institutes, faculty and students of military academies, universities and institutes, and the defense industry. The journal's articles are usually authored by senior officers and military academics. Past authors have included leaders and senior officers of the Ministry of Defense, General Staff , Military Districts, Fleets, and Branches of the Armed Forces (Ground Forces, Aerospace Forces, Navy, Airborne Troops, Strategic Rocket Forces), and academics and scientists from military academies and research institutions.' Bartles, 'Defining Russian Military Science,' *Op. Cit.*

its origins in Prussia's General Staff system. The problem of forecasting future warfare is critical to understand in order to assess how these theorists were thinking about this issue beyond mere speculation. What is the scientific basis of the work of Soviet or Russian theorists in this modeling of future warfare? To what extent is Russia's contemporary political-military leadership interested in the area of future warfare, and does this feed into defense planning and procurement?[8]

These complex issues pertaining to Russian military thought, future warfare, and the adoption of high technology are intrinsically linked to the role played by Moscow's strategic threat perceptions. As Jacob W. Kipp, an adjunct professor at the University of Kansas, identified in 2014, Russia's strategic culture is driven mainly by considerations of the information capabilities of its potential adversaries as well as the extent to which advanced information technology has been applied to conventional war-fighting capabilities by the United and many of its allies:

> The core of Russian strategic culture by the second decade of the 21st century focused on two threats: (1) information warfare (*informatsionnoe protivoborstvo*), which embraced information operations designed to destabilize the Russian state, society, and its allies; and (2) the application of advanced information technology to conventional war-fighting in the form of

[8] V.I. Korchmit-Matyushov, '*Teoriya voyn*,' M.:BFRGTZ, Slovo, 2001; S.A. Parshin, Yu.Ye. Gorbachov, Yu.A. Kozhanov, '*Sovremennyye tendentsii razvitiya teorii i praktiki upravleniya v vooruzhonnykh silakh SSHA*,' M.: Lenand, 2009; '*Khochesh' mira, pobedi myatezhevoynu! Tvorcheskoye naslediye*,' Ye.E. Messnera, *Russkiy voyennyy sbornik*, No.21, 2005; V. I. Slipchenko, '*Voyny novogo pokoleniya: distantsionnyye i beskontaktnyye*,' Moscow, OLMA-PRESS obrazovaniye, 2004; M.A.Gareyev, V.I. Slipchenko, *Budushchaya voyna*, Moscow, OGI, 2005; '*Setetsentricheskaya voyna. Daydzhest po materialam otkrytykh izdaniy i SMI*,' – Moscow: VAGSH VS RF, 2010.

> precision-strikes and fires, and C4ISR [command, control, communications, computers, intelligence, surveillance, reconnaissance] as the keystone for network-centric warfare. In this regard, Russia is back into a model that Peter the Great, Dmitri Miliutin and Joseph Stalin would have recognized: catching up with the military innovations that transpired outside Russia in open societies where the exploitation of information across societies is the norm. In the past, Russia's rulers have sought to have the West's transformations without accepting a Western sociopolitical or economic model.[9]

It is clear that the political-military leadership in Moscow has considerable interest in the changing character of war as part of strategic planning, judging from the persistent appeals to the military scientific community to support and develop "strategic foresight," a theme that constantly appears in the speeches of the chief of the General Staff, Army-General Valery Gerasimov.[10] According to an official definition in 1983, military foresight is the "process of cognition regarding possible changes in military affairs, the determination of the perspectives of its future development. The basis of the science of foresight is knowledge of the objective laws of war, the dialectical-materialist analysis of events transpiring in a given concrete-historical context."[11] Numerous Soviet and Russian military

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[9] Jacob W. Kipp, "'Smart' Defense From New Threats: Future War From a Russian Perspective: Back to the Future After the War on Terror,' *The Journal of Slavic Military Studies*, Vol. 27, No.1, 2014, p. 61.

[10] Author's emphasis. See: Steven J. Main, 'You Cannot Generate Ideas by Orders: The Continuing Importance of Studying Soviet Military History—G. S. Isserson and Russia's Current Geo-Political Stance,' *The Journal of Slavic Military Studies*, Vol. 29, No. 1 (2016), pp. 48-72; Valery Gerasimov, "*Tsennost' nauki v predvidenii*," *Voyenno Promyshlennyy Kuryer*, http://vpk-news.ru/articles/14632, February 26, 2013.

[11] *Voyennyy entsiklopedicheskiy slovar'*, Moscow: Voyenizdat, 1983, p. 585.

theorists, however, understood the inherent complexity and challenges of pursuing military foresight. The late Army-General Makhmut Gareev (1923–2019) described this process as "a labor of Sisyphus," since it necessitates continuous assessment of the various issues and processes.[12] Nonetheless, despite the enormous challenges presented in the pursuit of military foresight, as Army-General I. E. Shavrov and Colonel M. I. Galkin observed in 1977, "In its essence, military science is the science of future war."[13]

Conceptually, military systemology (*voyennaya sistemologiya*) plays a conceptual role in Russia's General Staff efforts, as well as within the wider community of Russian military scientists in forecasting future warfare.[14] In June 1997, Jacob W. Kipp identified the increasingly important role played by military systemology within the Russian military scientific community: "Military systemology, a new discipline relying on modeling and cybernetics to establish a 'theory of combat systems,' and other forecasting techniques have their place, but expert opinion and experience are vital to military forecasting. However, this is not a 'hind-bound' view that sees no changes afoot in military art. Evaluation of past combat experience is necessary but insufficient,

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[12] See: Jacob W. Kipp, 'The Labor of Sisyphus: Forecasting the Revolution in Military Affairs During Russia's Time of Troubles', in Thierry Gongora and Harold von Riekhoff, eds., *Toward a Revolution in Military Affairs?*, Westport, CT, Greenwood Press, 2000, pp. 87–104.Gareev's reference to Sisyphus draws on Greek mythology. Sisyphus as founder and king of Ephyra was punished for twice cheating death by rolling an enormous boulder uphill; it rolled downhill every time he neared the top. The modern usage of the 'labors of Sisyphus' refers to futile or laborious tasks. Encyclopedia of Greek Mythology: Sisyphus, www.mythweb.com. Accessed, June 2, 2021 .

[13] I. E. Shavrov and M. I. Galkin, eds., *Metodologiya voyenno-nauchnogo poznaniya,* Moscow: Voyenizdat, 1977, p. 64.

[14] Nikolay Tyutyunnikov, *Voyennaya mysl' v terminakh i opredeleniyakh: v trekh tomakh* (Military Thought in Terms and Definitions: In Three Volumes), Vols. 1,2,3, Pero, 2018.

and foresight is necessary but extremely difficult to develop."[15] Military systemology is essentially a military meta-science, which is formed at the junction of the methodological foundations of general systems theory, the theory of military art, cybernetics, philosophy, operations research, systems engineering and other fundamental and applied sciences.[16]

As Kipp observed, the rise of Russian military systemology in the 1990s was an important element in the search for ways and methods of military forecasting: "Military systemology has become more important as older approaches to techniques have lost their ability to forecast the outcomes of modern combat and operations. The experience of local wars revealed this problem and provided a significant push for applying military systemology to the more dynamic and complex reality of combat. In systemology, the forecaster searches for ways combat systems and subsystems can maintain effectiveness and how enemy combat systems can be disrupted by targeting critical subsystems for destruction, disruption or neutralization."[17] The promotion of this discipline was on the initiative of Captain 1st Rank (retired), Edvard Shevelev, Doctor of Military Sciences, Professor in the AVN. Shevelev worked in the Department of National Security in the Academy of National Economy and Public Administration and collaborated with the Academy of the General Staff.[18] In 2016, on the orders of General Gerasimov, Russian military scientists at military universities and

[15] Jacob W. Kipp, 'Confronting the RMA in Russia,' FMSO: June, 1997.

[16] Shevelev E.G, *Vvedeniye v voyennuyu sistemologiyu*, Moscow: VA GSH, 1993.

[17] Kipp, 'Confronting the RMA in Russia,' *Op.Cit.*

[18] Author's interview with Russian military specialists, Moscow, September 23, 2021. E. G. Shevelev, '*Sistemologiya natsional'noy bezopasnosti na rubezhe vekov: sostoyaniye i perspektivy razvitiya*,' *Vestnik Samarskogo gosudarstvennogo aerokosmicheskogo universiteta*, No. 2, 2004, pp. 47-64.

research centers in the defense ministry collaborated to issue a teaching aid distributed to all relevant organizations and institutions.'[19] In 2016 Sergei Chvarkov, Doctor of Military Sciences and Professor in the AVN, edited this collection on military forecasting: *Osnovy sistemnogo analiza, analiticheskoy raboty i voyennogo prognozirovaniya* (The Basics of Systems Analysis, Analytical Work and Military Forecasting).[20] The systems analysis aspect in the title clearly implies linkage to systemology.

While a detailed discussion and evaluation of the contemporary role of military systemology in Russian military thought lies beyond the scope of this chapter, it is suffice to remind the reader that its existence forms part of a much wider effort to engage in institutionalized analytical thinking about the likely nature of future wars and how they will fought.[21] These complex processes related to forecasting future warfare require much more than the deep understanding and analysis of past conflicts, or identifying critical emerging trends. It is an extremely difficult task that demands constant and ongoing work to sketch out the most likely courses in the development of future warfare. Moreover, Makmut Gareev as the founder of the Academy of Military Sciences (*Akademii Voyennykh Nauk*—AVN) in Moscow,

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[19] Major-General V.V. Krugulov (Reserve), Lieutenant-Colonel V.I. Yakupov, 'Methodology of Prognosticating Armed Struggle,' *Voyennaya Mysl'*, April 2017.

[20] *Osnovy sistemnogo analiza, analiticheskoy raboty i voyennogo prognozirovaniya* (The Basics of Systems Analysis, Analytical Work and Military Forecasting), Ed. S.V. Chvarkov, the Military Academy of the RF AF General Staff Press, Moscow, 2016.

[21] Yesin V.I, '*Primeneniye sistemologii k obespecheniyu strategicheskoy yadernoy bezopasnosti posle okonchaniya kholodnoy voyny*,' *Bezopasnost' Yevrazii*, No.4, 2003; Shevelev E.G, '*Vliyaniye metasistem na natsional'nuyu bezopasnost' i voyny budushchego: (voyennaya sistemologiya*), *Bezopasnost' Yevrazii*, No.4, 2003; Ryabchuk V.D, '*Sistemologiya i sinergetika v taktike upravleniya boyem*,' *Bezopasnost' Yevrazii*, No. 4, 2003.

understood that the process relies above all on the vibrancy of ideas and discussion among military and civilian defense specialists, and one of the purposes of the AVN is to widen such discussions to include civilian input from beyond the governmental and military structures.[22]

Finally, the following chapter offers a consensus-based sketch of Russian military theorists' perspectives on future warfare. Ultimately, the key link in Russian military thought concerning future warfare gives pride of place to the role of modern technology, without advocating technological determinism. Thus, the purpose of this study is to explore the interconnections and antecedents between Russian military thought as well as its influences and origins, views on the changing character of war and its implications for the role and adoption of high technology to shape the future battlespace.[23]

The Continued Influence of Soviet Military Thought

One of the most outstanding Soviet military theorists was Aleksandr Svechin, and it should be noted that his key thoughts on warfare and strategy resonate today with the top brass. Svechin's key ideas or

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[22] V. D. Ryabchuk, '*Problemy Voennoy Hauki I Voennogo Prognozirovaniya v Usloviyakh Intellektual'no-informatsionnogo Protivoborstva* (Problems of Military Science and Military Forecasting under Conditions of an Intellectual-Information Confrontation),' *Voyennaya Mysl'*, No. 5, 2008, pp. 68-69; N. E. Makarov, '*Kharakter Vooruzhennoy Bor'by Budushchego, Aktual'nye Problemy Stroitel'stva i Boevogo Primeneniya Vooruzhennykh Sil RF v Sovremennykh Usloviyakh* (The Character of Future Armed Conflict, Actual Problems of the Development and Deployment of the Armed Forces of the Russian Federation Today),*Vestnik*, No. 2, 2010, p. 19; Makhmut A. Gareev, If War Comes Tomorrow, Frank Cass, London 1998, pp. 52-53.

[23] For a detailed study of the Russian perspectives on network-centric warfare at an early stage in the reform of Russia's Armed Forces, see Roger N. McDermott, *Russian Perspective on Network-Centric Warfare,* (Foreign Military Studies Office), 2010.

quotes frequently appear in speeches by the chief of the General Staff, Army-General Valery Gerasimov. Svechin's key works include, *Strategiya* (*Strategy*), *Evolyutsiya voyennogo iskusstva* (*Evolution of Military Art*) and *Istoriya voyennogo iskusstva* (A History of Military Art). Svechin, however, tended to focus on the strategy of smashing and the strategy of attrition, neither of which took hold in Soviet military art and planning.[24] Like other senior Soviet senior officers in this period, Svechin was subject to Stalin's purges of the officer corps.

During the inter-war period, the most far-sighted Soviet theorists in the area of future warfare were M.V. Frunze, B.M. Shaposhnikov, V.K. Triandafilov, I.I. Vatsetis, A.M. Zayonchkovsky, A.M. Vol'pe, and A.N. Lapchinsky. For example, Frunze wrote in his paper *Front i tyl v voyne budushchego* ("The Front and the Rear in Future Warfare"), "War will assume the nature of a lengthy and cruel contest putting to the test every economic and political basis of the warring parties." I.I. Vatsetis in his work *O voyennoy doktrine budushchego* (On the Military Doctrine of the Future) in 1923 said that new military equipment (aircraft, submarines, radio) unfettered the traditional strategy and expanded to infinity the limits of theaters of war. A.M. Zayonchkovsky arrived at a similar conclusion, seeing future warfare as a coalition in nature involving vast spaces, and "uncompromising in terms of action."[25] Many of these officers fell afoul of Stalin's paranoia. Or their conclusions—namely, regarding the development of defensive military planning for what they accurately forecast as the coming war with Germany—contradicted the Soviet elites' prejudices. Nonetheless, their thoughts on the changing character of war were undoubtedly ahead of their time.

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[24] *Istoriya voyennoy strategiyi Rossiyi*, *Op. Cit.*

[25] I.I. Vatsetis, *O voyennoy doktrine budushchego* (On the Military Doctrine of the Future]) Moscow, 1923, p. 72; A.M. Zayonchkovsky, *Lektsiyi po strategiyi* (Lectures on Strategy), Moscow, 1923; B.M. Shaposhnikov, *Vospominaniya. Voyenno-nauchniye trudy* (Reminiscences. Works on Military Theory), Moscow, 1982, p. 435.

Following the Great Patriotic War (1941–1945), many Soviet works on military theory were issued. These included: *Kharakter sovremennoy voyny i yeyo problemy* (*The Nature of Modern Warfare and Its Problems*, 1953); *Sovremennaya voyennaya nauka* (*Contemporary Military Science*, 1959); *Sovremennaya voyna* (*Modern Warfare* ,1960); *Voyennaya strategiya* (*Military Strategy*, 1961); *Nachalniy period voyny* (*The Initial Stage of War*, 1964); *Strategicheskaya operatsiya na teatre voyennykh deystviy* (*The Strategic Operation at the Theater of War*, 1966); *Voyna i voyennoye iskusstvo* (*War and Military Art*, 1972). In 1980, the fundamental handbook was issued: *Osnovy strategicheskikh operatsiy* (*Basics of Strategic Operations*). In 1966, the M.V. Frunze Military Academy published works in military theory titled *Obshchevoyskovoy boy* (*Combined-Arms Battle*) and *Taktika* (Tactics).[26]

Although Soviet military theory was outstanding in many aspects and forward looking, it was also hampered by the limits of state ideology. As Vorobyov and Kiselyov noted in *Voyennaya Mysl'* in 2013:

> After World War II and until the early 1990s, Russian domestic military theory traveled a complex, fruitful and fairly controversial path in its development. It had known ups and downs, achievements and setbacks. On the whole it developed by leaps and bounds, with a maximum stress on the latest achievements in science and technology. Tremendous breakthroughs in nuclear physics, space and electronic technology followed by fundamentally new capabilities of armed struggle of enormous destructive potential based on those achievements produced a veritable revolution in the views on war and methods of conducting it. Within a mere forty-odd years the Soviet Union saw three to five generations of

[26] *Istoriya voyennogo iskusstva* (A History of Military Art), Voyenizdat Publishers, Moscow, 2006, p. 6.

> conventional arms and military hardware replace one another, and as a result operations and combat activity assumed a qualitatively new image. Research began into laser, beam (neutron), microwave, infrasound and kinetic weapons.[27]

Modern Russian Military Thought on Future Warfare

One of the greatest modern Russian military theorists was Army-General Makhmut Gareev (1923–2019), the long serving president of the Academy of Military Sciences (*Akademii Voyennykh Nauk*—AVN). Gareev wrote extensively on the theme of future warfare, though he was widely known as a conservative in his views, as his thinking on war was largely shaped by his experience of the Great Patriotic War.[28]

One of the most important English-language contributions to understanding modern Russian military theory appeared in an article in 2011 in the *Journal of Strategic Studies*, in which its author, the Norwegian Russia-Ukraine expert Tor Bukkvoll, examines the relationship between Russian theorists and military modernization. Bukkvoll divides modern Russian military theorists into three camps: traditionalists, modernists and revolutionaries. Most importantly Bukkvoll explains,

> It should also be mentioned here that while some Russian military theorists are familiar with, and do refer to current Western or other foreign works, a clear majority do not. This is probably first of all the result of lacking English skills, but it possibly also stems from an idea that the Russian military-

[27] I.N. Vorobyev, V.A. Kiselyov, 'Russian Military Theory: Past and Present,' *Voyennaya Mysl'*, No. 4 2013.

[28] M.A. Gareyev, *Srazheniya na voyenno-istoricheskomfronte* (Battles on the Military History Front), INSAN Publishers, Moscow, 2010.

> theoretical tradition is so rich that it can do without foreign input. Either way, the main point here is that large parts of the Russian debate become very in-house, with all the dangers that this represents for "group think" and reproduction of misperceptions. In particular, that seems to be the case for many of the traditionalists.[29]

Bukkvoll's observation is critical, as he highlights the fact that most Russian military theorists across the spectrum of traditionalists, modernists and revolutionaries are singularly steeped in their own military culture. Thus, the reference to Russian and Soviet military theory and its development is of the utmost value in understanding that most of the sources on future warfare are drawn from Russian sources, with the exceptions of work on hybrid or network-centric warfare, where it seems the Russian theorists draw largely on the work of foreign military experts.[30]

A major recent source for contemporary Russian military theorists writing about future warfare relates to the late Major General Vladimir Slipchenko (1935–2005). In Slipchenko's writings

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[29] Tor Bukkvoll, 'Iron Cannot Fight—The Role of Technology in Current Russian Military Theory,' *Journal of Strategic Studies*, Volume 34, Issue 5, 2011, pp.618–706.

[30] Bukkvoll divides Russian military theorists into three camps: 'Contemporary Russian military theory is dominated by three schools of thought: the 'traditionalists,' the 'modernists' and the 'revolutionaries.' On the role of technology in future warfare, the traditionalists do not recognize budget constraints and therefore argue for both high tech and massive forces at the same time. The modernists are ready to trade manpower for technology, whereas the revolutionaries give technology full priority. Both the traditionalists and the modernists think that Russia, because of the country`s technological lag and limited resources, should respond asymmetrically to the Western technology challenge. The revolutionaries, on the other hand, think Russia must respond in kind. If not, the country will no longer be able to defend its sovereignty. The currently ongoing radical reform of the Russian military is a partial victory for the modernists.' See: Bukkvoll, 'Iron Cannot Fight,' 2011, *Op.Cit.*

examining future warfare, he uses the idea of sixth-generation warfare.

Table 1. Slipchenko's Generations of Warfare

Generation	The Character of War	The Purpose of War
First Generation: 500 BC to 900 AD	Hand-to-hand combat with primitive arms	Destruction of the enemy and take-over of his weapons
Second Generation: 900 to 1700	Firearms, battle at some distance, and sea battles in the littoral	Destruction of the enemy and submission of his territory
Third Generation: 1700 to 1800	Increased firepower and precision, trench warfare and battles at the world oceans	Destruction of the enemy, his economy and political system
Fourth Generation: 1800 to 1945	Automatic weapons, battle tanks and air battles	Destruction of the enemy's military forces, his economy and political system
Fifth Generation: 1945 to 1990	Nuclear weapons and the balance of terror	Political goals unachievable by the use of nuclear weapons
Sixth Generation: 1990 →	Precision weapons and defense against these, information warfare and electronic warfare	Destruction of the enemy's economy with the help of long-distance no-contact warfare

Source: Vladimir Slipchenko, *Voiny Novogo Pokolenia - Distantsionnye i Bezkontaktnye* (Moscow: Olma-Press, 2004), pp. 32–34.

As Bukkvoll notes, Slipchenko ties the idea of sixth-generation warfare to a concept of non-contact or contactless warfare. He conveys the idea that future war between modern states will take place without direct contact. This is rooted in the use of high-precision weapons (*Vysokotochnoye Oruzhiye*—VTO). Yet, as seen in the lower right side of **Table 1**, above, Slipchenko assumes that high-precision strike systems will come into play mostly against civilian targets to destroy the enemy's economy.[31]

Many of the conclusions reached in the various works by Slipchenko permeate contemporary discussions among Russian theorists considering the wars of the future. These are briefly outlined as follows:

- The role and importance attached to nuclear weapons will gradually decline;
- Conventional long-range high-precision strike weapons will grow in importance, as, unlike nuclear weapons, they will be more likely to be used;
- Wars will be shorter than in the past;
- Advanced militaries will restructure their forces from the traditional army, navy and air force to strategic attack forces and strategic defense forces;
- Twenty first century warfare will be marked by conflict at sea, meaning that naval platforms will be used to launch high-precision strike weapons;
- The tactical level of warfare will decline in importance and the strategic level will become the main emphasis in future warfare;
- The main role for land forces in the future will be to support the air force.[32]

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[31] *Ibid.*

[32] Vladimir Slipchenko, '*K Kakoi Voine Dolzhny Gotovitsia Vooruzjennye Sily*,' *Otechestvennye Zapisky*, No. 8, 2002. p. 4; Gareev, Makhmut and Slipchenko, Vladimir, *Budushchaia Voina*, Moscow: Politru O.G.I, 2005.

Slipchenko on Information Confrontation and 'Seventh Generation Warfare'

Like Georgii Isserson (1898–1976) writing in the 1930s, who emerged later as one of the architects of the concept of the "deep operation" that proved so crucial in the Soviet victory over the Wehrmacht in defense of the Soviet Union, it appears that General Slipchenko is one of the leading thinkers on "non-contact" and "sixth-generation" warfare, whose influence is vividly present in more recent studies by Lieutenant General (ret.) Sergei Bogdanov and Colonel (reserve) Sergei Chekinov.[33] However, Slipchenko also worked on the concept of a future "seventh-generation" of warfare, which he forecast could emerge in the 2050s among the most advanced military powers. His work in this area remained unpublished after his death in 2005; but later, in 2013, a version began to circulate among members of the AVN. Numerous aspects of this work, especially in relation to the exponential growth in the importance of information in modern and future warfare are percolating in contemporary Russian defense circles and are strikingly similar to the work of other Russian military specialists. Slipchenko's *Informatsionnyi resurs i informatsionnoe protivoborstv* (Information Resource and Information Confrontation), which appeared in October 2013, advances that,

> Future warfare will undoubtedly include *information confrontation* as a most important element. Information assets will be one of the components of the state's strategic strike and defense forces. Intelligence will also acquire significant development. From a traditional type of support for military

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Gat, Azar. A History of Military Thought. Oxford: Oxford University Press, 2001; V. Slipchenko*, Voiny Novogo Pokolenia - Distantsionnye I Bezkontaktnye*. Moscow: Olma-Press, 2004, p. 51.

[33] See: Richard W. Harrison, *Architect of Soviet Victory in World War II: The Life and Theories of G.S. Isserson,* MacFarland: 2010, pp. 411.

> operations in past generations of warfare, it will turn into a dynamic and active branch and become one of the strike components of precision means of destruction and defense.[34]

In this regard, Slipchenko placed high value on the idea of "information confrontation," rather than "information warfare," as a critical distinction. He linked this to the development of global information networks based on advances in modern information technology: "One of the most important mechanisms of the formation of contemporary views on the conduct of combat operations is the information scientific and technological revolution, which is now going through the stage of formation of information systems on a planetary scale."[35] Slipchenko readily admitted that other generations of warfare co-exist, but noted that a "sudden leap" in the efforts to informationize command and control (C2) through automated systems for military forces would result eventually in another progression to result in information assets involved in the information confrontation becoming a combat category:

> Subsequently, after the transitional period is over, information confrontation will gradually go beyond the bounds of a support category and become a *combat category*, that is, it will acquire an independent nature among the many other forms and methods of struggle. As distinguished from precision-strike weapons, however, which hit a concrete, specifically selected important objective or its critical point, information weapons will be system-destructive, i.e., they will disable whole combat, economic, or social systems. Superiority over an enemy will be achieved through an advantage in the acquisition of various types of information, mobility, and rapidity of reaction; and in

[34] Author's emphasis. V.V. Slipchenko, '*Informatsionnyi resurs i informatsionnoe protivoborstvo*,' *Armeyskiy Sbornik*, No. 10, 2013, pp. 52–57.

[35] *Ibid.*

> precise fire and information effects in real time against numerous structures of his economy, military objectives with the minimum possible risk for one's own forces and means. It is completely obvious that to prepare for conducting non-contact warfare a sovereign state must shift from an industrial to an information society.[36]

Slipchenko, identifies the centrality of information in modern and future warfare, forecasting that its utility would eventually move beyond a combat support role and into the area of essentially a combat arm. Slipchenko undoubtedly drew upon earlier Soviet and Russian analyses on information warfare (IW) as having component elements: information-technological and information-psychological, with the target or objective of IW being the information struggle or "confrontation."[37] Some Russian theorists writing in the 1990s argued that electronic and computer-support systems needed to be factored into operational planning and the adjustment of the correlation of forces and means (COFM) model. It seems clear that Slipchenko understood that the General Staff's COFM could not apply in the information era of modern warfare. Others feared that information "weapons" could in the future become as destructive as weapons of mass destruction. By the mid-1990s Russian military specialists in this area were discussing the impact of the effort to informationize critical systems, including C2, which would result in the electromagnetic sphere becoming a warfare domain.[38] Similarly, professional Russian

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[36] Author's emphasis. *Ibid.*

[37] See: Joe Cheravitch, The Role of Russia's Military in Information Confrontation, CNA: Arlington, Virginia, June 2021, https://www.cna.org/CNA_files/PDF/The-Role-of-Russias-Military-in-Information-Confrontation.pdf.

[38] Lukashkin, A.N., Yefimov. A.I., '*Problema bezopasnosti komp'yuternoy infosfery strategicheskikh oboronnykh sistem*,' *Voyennaya Mysl'*, No. 5, 1995, pp. 48-52.

electronic warfare (EW) specialists argue that in future this will emerge as a combat arm of service.

Thus, for Slipchenko, information superiority is the key to gaining superiority in non-contact warfare based on the following:

- Domination in the information domain of space systems as well as reconnaissance, warning, navigation, meteorological, command and control, and communications assets;
- An advantage in the number of precision missiles and reconnaissance-strike combat systems with elements of ground, sea, air, and space basing and the ability to continuously maneuver these forces and means, and their fire;
- Speed in introducing combat programs into variously based precision missiles;
- The capability of mass and lengthy (with respect to time) employment of variously based precision weapons;
- All-round material and technical support of reconnaissance-strike combat systems;
- Reliable information protection of precision-strike and defensive forces and means on land, in the air, in space, and at sea.[39]

Slipchenko criticized Russian military specialists for their confusion over the ideas of "information warfare" and "information confrontation," arguing that the latter demands continuous exploitation:

> Western sources are trying to state that it will be "information warfare" and not "information confrontation" that will be waged. The concept of "warfare" is, in general, not appropriate

[39] Slipchenko, '*Informatsionnyi resurs i informatsionnoe protivoborstvo,*' *Op.Cit.*

> in this context, because it refers to a more complex socio-political phenomenon. War is a particular condition of society associated with a sharp change in relations between states, nations and/or social groups conditioned by the employment of armed force to achieve political, economic, and other goals.[40]

It is important to identify that in this regard not only was Slipchenko ahead of his time in highlighting information confrontation as a set of tools ultimately including cyber along with the growing role of information in shaping the future battlespace, but that he also forecast this area emerging as a combat arm: which still lies some way off. Slipchenko adds that a new "seventh-generation" warfare could appear in the 2050s:

> The next-generation warfare will undoubtedly leave the operational and even strategic levels and immediately acquire a planetary scale. Using information networks and assets, a planetary aggressor can provoke technogenic catastrophes in large economic regions and sections of the world. It is possible that after 2050, ecological weapons may also be developed for directed effects against countries' mineral and biological resources, local areas of a biosphere (atmosphere, hydrosphere, lithosphere), and climate resources in local areas of the Earth. It is important to mention that in next-generation warfare, starting with the sixth, *man will not be the main target of a strike*. He will be *defeated indirectly*, through other *structures and systems* associated with his life support.
>
> The great interest in information confrontation in future warfare is not by chance, because this is associated with the fact that information is becoming a weapon, just like missiles, bombs, torpedoes, etc., It is already clear now that *information*

[40] Author's emphasis. *Ibid.*

> *confrontation* is becoming the factor that will substantially influence future warfare itself—its *beginning, course, and outcome.*
>
> Possession of information assets in future warfare is becoming as indispensable an attribute as possession for forces and means, arms, munitions, transport, etc. was in past wars. Winning an information confrontation in future non-contact warfare will, in fact, result in the achievement of the strategic and political goals of wars, which will be enough to defeat an enemy's armed forces, capture his territory, destroy his economic potential, and overthrow his political system.[41]

Slipchenko's thinking on future warfare ties sixth and seventh generations together in their avoidance of directly targeting enemy manpower, and instead focusing the fight on the adversary's systems using modern and advanced capabilities including the exploitation of information assets. This conflict capability, in his estimation, will transform warfare beyond the strategic level to reach truly global scales. He identified information as a future weapon in war similar to the destructive effect of kinetic systems, and suggested that this would influence war in its entirety from beginning to conflict termination. It is clear that the reform and modernization of the Armed Forces that the political leadership ordered in late 2008 utilizes many of the concepts encapsulated in Slipchenko's military thinking, to include sixth-generation and non-contact warfare as its highest form. Moreover, Slipchenko's influence still finds expression in the influential studies of leading Russian General Staff military theorists such as Bogdanov and Chekinov.

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[41] Author's emphasis. *Ibid.*

Gerasimov on Modern Russian Military Science

Since Russia's political leadership ordered the reform and modernization of the country's Armed Forces in late 2008, the General Staff has persistently appealed to the military scientific community to meet the challenges stemming from these complex processes. An essential ingredient in this public discussion is the focus on future warfare as part of national defense strategy to encourage greater attention to strategic foresight. Chief of the General Staff Gerasimov has pressed this issue heavily in his public speeches and articles since his appointment in November 2012. This is especially the case in his annual speeches to the AVN. In March 2019, Gerasimov outlined a new approach of limited actions that conceptualizes Russia's approaches to warfare in its interests beyond its borders—as witnessed in its actions especially in Syria.[42] Gerasimov also raised the issue of future warfare. These views offer insights into how Russian defense specialists see future warfare and consequently some of the driving factors in Moscow's strategic posture.

General Gerasimov characterizes responding to the potential threat posed to the Russian Federation by the United States, referring to the "preemptive neutralization of threats." Gerasimov declared,

> The basis of "our response" is the "strategy of active defense," which, with consideration of the defensive nature of the Russian Military Doctrine, envisages a set of measures for preemptive neutralization of threats to national security. It is the substantiation of measures being developed that must comprise the scientific activity of military scientists. This is one of the priority directions for ensuring national security. We must

[42] Valery Gerasimov, 'Vektory razvitiya voyennoy strategii,' *Krasnaya Zvezda*, March 4, 2019, http://redstar.ru/vektory-razvitiya-voennoj-strategii/.

> preempt the enemy in the development of military strategy and be "a step ahead."[43]

The Russian chief of the General Staff also noted the urgency to upgrade nuclear and non-nuclear systems. In particular he highlighted VTO capability and a number of these high-precision strike systems currently under development: "serial production of new models of armaments and outfitting of the Armed Forces with them have begun. The Avangard [hypersonic glide reentry vehicle], Sarmat [intercontinental ballistic missile], and the newest Peresvet [laser cannon] and Kinzhal [air-launched hypersonic missile] weapons have shown their high effectiveness, and the Poseidon [autonomous, nuclear-armed torpedo] and Burevestnik [nuclear-powered, nuclear-armed cruise missile] complexes are going through successful tests. Scheduled work is proceeding on creation of the Tsirkon hypersonic sea-launched [cruise] missile."[44]

On the theme of a strategy of limited actions, Gerasimov outlined some of its areas for development. The first is integration of command, control, communications, computers, intelligence, surveillance and reconnaissance—C4ISR. This is aimed at the "detection, issue of target designation, and delivery of selective strikes against critically important targets in near-real time by strategic and operational-tactical non-nuclear weapons. Subsequently, military science needs to develop and substantiate a system for comprehensive engagement of the enemy." Another priority is to exploit robotic complexes and unmanned aerial vehicles (UAV), as well as developing a system to counter UAVs and VTO. Gerasimov stressed the importance of a number of issues for military science to develop "digital technologies, robotics, unmanned systems, and electronic

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[43] *Ibid.*

[44] *Ibid.*

warfare."[45] The centrality of the technologically-centered theme should be noted.

Gerasimov's addresses and appeals to Russia's military science community builds upon the speeches of his predecessor, Nikolai Makarov, and further draws on the works and ideas of various leading Russian and Soviet military theorists. In his much misunderstood address to the AVN in February 2013, which led some commentators to allege it formed the basis of a "Gerasimov doctrine," he appealed to the country's leading military scientists to aid the General Staff in developing *strategic foresight*, part of which was to remain open to new ideas and deeper understanding of identifiable trends in modern warfare. Indeed, his entire speech to the AVN in February 2013 was permeated with the theme of the changing character of war. In many of Gerasimov's subsequent speeches and articles, he cites one of the most outstanding Soviet military theorists, for example, Aleksandr Svechin (1878–1938). Likewise, in 2013, he reminded the AVN of Svechin's well-known dictum: "The situation of war [...] is extremely difficult to foresee. For each war, it is necessary to develop a special line of strategic behavior, each war is a special case that requires the establishment of its own special logic, and not the application of any template." Highlighting the uniqueness of each armed conflict or war, Gerasimov called for military science to provide insight into the likely shape of future warfare, or risk becoming irrelevant to the state.[46]

Gerasimov also appealed to military science to learn from the example of Georgii Isserson (1898–1976), who was able in the pre-war era in the 1930s to forecast the likely contours of the coming conflict. Gerasimov referred to Isserson's 1940 work *Novye Formy Bor'by: Opyt Issledovaniia Sovremennykh Voin* (*New Forms of Combat: An Essay*

[45] *Ibid.*

[46] Valery Gerasimov, '*Tsennost' nauki v predvidenii*,' *Voyenno Promyshlennyy Kuryer*, February 26, 2013, http://vpk-news.ru/articles/14632.

Researching Modern Wars). Isserson had predicted mobilization and concentration of forces occurring imperceptibly and conflict commencing with pre-deployed forces. Isserson had also warned about the need to monitor the buildup of forces on a shared border to avoid becoming a victim of strategic surprise (*strategicheskaia vnezapnost'*).[47]

Similarly, in his address to the AVN in March 2017, Gerasimov again appealed to the legacy of Aleksandr Svechin and other leading Soviet military theorists who had made important contributions to military science. He referred to a supporter of Svechin, Andrei Snesarev (1865–1937), who not only helped develop the science of war, but was one of the country's leading Asia scholars. On Snesarev and Svechin, Gerasimov noted that the main themes of their research were the key trends in warfare resulting from political, economic and social factors.[48]

Gerasimov told his audience that modern warfare is characterized by the Armed Forces directing both military and non-military means of waging war. He also noted the continued importance of achieving surprise: "By acting quickly, we must preempt the enemy by our preventive measures, identify his vulnerable places in a timely manner, and create threats of inflicting unacceptable damage on him. This ensures seizure and maintenance of the strategic initiative." He followed this with a reference to Russian military leader Aleksandr Suvorov (1730–1800)—"Theory without practice is dead"—which,

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[47] *Ibid.*

[48] Valery Gerasimov, '*Mir na granyakh voyny*,' *Voyenno Promyshlennyy Kuryer*, March 13, 2017, https://www.vpk-news.ru/articles/35591.

according to Gerasimov, means, "It is impossible to imagine practical activity of military strategy without its scientific substantiation."[49]

It is equally worth tracing and noting other references to Soviet military theorists in the speeches by Gerasimov. In November 2018, Colonel General (ret.) Leonty Shevtsov authored a review article in *Voyenno Promyshlennyy Kuryer,* examining a book by Major General (ret.) Aleksandr Vladimirov. The second edition of Vladimirov's book *Osnovy obshchey teorii voyny* (*The Basics of the General Theory of War*) was examined in detail. In one section of the review, Vladimirov's use of Soviet and Russian military theorists was outlined, many of whom are frequently referred to in Gerasimov's speeches. In particular, Vladimirov based much of his thinking about modern warfare on Aleksandr Svechin, Andrei Snesarev and Yevgeny Messner. He refers to Snesarev, "The solution to the question of the future of war—positive or negative—remains a matter of faith, not a scientifically proven fact." He also noted that Messner had forecast, "We must stop thinking that war is when people fight, and peace when they are not fighting. You can be in war without fighting."[50]

It is also notable that the Soviet theorists cited by Gerasimov fell afoul of the regime: they were executed or internally exiled, their views were underestimated by the political-military leadership. While Gerasimov uses this to frame his appeals to contemporary military scientists and to provide strategic insight for the benefit of the General Staff, significantly he admits the comparison with the pre-war military theorists does not reflect well on modern experts. Thus, in his 2013 AVN speech, he asserted, "The state of Russian military science today

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[49] Valery Gerasimov, '*Vektory razvitiya voyennoy strategii*,' *Krasnaya Zvezda*, March 4, 2019, http://redstar.ru/vektory-razvitiya-voennoj-strategii/.

[50] Colonel-General (retired) Leonty Shevtsov, '*Novyy vzglyad na national'nuyu voyennuyu strategiyu*,' *Voyenno Promyshlennyy Kuryer*, https://vpk-news.ru/articles/46263, November 28, 2018.

cannot be compared with the flowering of military-theoretical thought in our country on the eve of World War II."[51]

Despite the constant appeals from the General Staff to the wider community of Russia's military scientists to meet the challenges of developing strategic foresight and offer concrete ideas to feed into policy planning for future warfare, Gerasimov reaches a damning, if rather obvious conclusion by reminding his audience that they are a pale shadow of the intellectual depth and foresight available in the pre–World War II period. In February 2020, Sergei Chvarkov, a doctor of military sciences and a professor at the Academy of Military Sciences, published *Nauka o voyne—neobkhodimost' ili dan' mode?* (The Science of War: a Necessity or a Fashion?) in *Nezavisimoye Voyennoye Obozreniye*. The article examined the role of the science of war (*nauki o voyne*) and sought to determine its contemporary value. Chvarkov noted that since the Kremlin initiated the reform and modernization of Russia's Armed Forces in late 2008, the defense ministry and General Staff set specific tasks for the military scientific community. These are as follows: efforts to integrate the existing body of knowledge about war; analysis of the key trends in the development of military thought around the world; trends in global development and in Russia's development; and assessing the national interests of the Russian Federation and its allies and how this geopolitical context impacts on the evolution of the science of war.[52]

The author follows Russian elite security thinking, as he presents the case that the international security system has been degrading since the end of the Cold War and the conflicts in the Balkans in the 1990s. Chvarkov then argues on this basis,

[51] Gerasimov, '*Tsennost' nauki v predvidenii*,' *Op.Cit*.

[52] Sergei V. Chvarkov, '*Nauka o voyne – neobkhodimost' ili dan' mode*?' *Nezavisimoye Voyennoye Obozreniye*, http://nvo.ng.ru/concepts/2020-02-20/1_1082_war.html, February 20, 2020.

> It must be developed as the theory and practice of a special period in the life of the state, society, people, international community, taking into account the laws and principles of the international struggle, on which the historical fate of Russia and its people depends. However, such an approach requires everyday study and generalization of advanced military, political, economic, and sociological thought, since this is precisely what can provide an answer to the question of concern to the layman: 'Are we ready for the wars of the future?' Modern military thought is based on three pillars of the strategy of world-military relations:
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> - Timely and reliably identify the enemy, evaluate his combat power, military, economic and industrial potential, quickly reveal the growth of threats and assess the possibility of their development in danger, if possible, prevent this, and even more so aggression;
> - Organize an adequate preparation of the country and the armed forces for possible conflicts, while not missing the initiative to promptly address the growing threats, regardless of the scope of their occurrence and application, to find ways and possibilities of an asymmetric response to forces and means, but adequate and sufficient in effect;
> - Form as friendly a coalition as possible, ensuring sustainable coordination and interaction between allied states, and above all between military and civilian institutions within the state.[53]

On the role of military science, Chvarkov states,

[53] *Ibid.*

> In addition, it should be borne in mind that the variability of the image of war as a socio-political phenomenon has now acquired an extremely dynamic character. As a result, this requires a detailed approach to determining the logic of the development of conflicts and evaluating their genesis, goals and means of future warfare, opening new or modifying existing laws and principles of war. It should be remembered that science explains phenomena and processes, but it does not give ready-made recipes for victories. Science provides an understanding of the role and significance of the properties of all components that, to one degree or another, determine the growing threat of war.[54]

Chvarkov also refers to works by the leading Soviet or imperial Russian military theorists to advance the assertion that there is no commonly agreed definition of "war," as such. It is worth noting that among the theorists he refers to, most of these feature directly or indirectly in the annual address to the AVN by General Gerasimov. Chvarkov notes,

> Unfortunately, the philosophy of this problem is as the basis of the theory of war after the works of N. V. Medem [1796–1870] (founder of the national military strategy), A. A. Svechin [1878–1938], A.E. Snesarev [1865–1937], N. N. Golovin [1875–1944], [and] E.I. Messner [1891–1974] in domestic theory and practice has not received proper development. In addition, neither in international nor in domestic science is there sufficient practical knowledge required by practice regarding the wars of the future and the genesis of their development.[55]

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[54] *Ibid.*

[55] *Ibid.*

He links the study of past wars to the concept of forecasting future warfare but states categorically that "war in the future will not resemble the wars of the past."[56]

In 2016, on the orders of General Gerasimov, military scientists at military universities and research centers of the Russian defense ministry pooled their efforts to issue a teaching aid sent to relevant organizations and institutions.[57] In 2016 Sergei Chvarkov edited this collection on military forecasting, referred to by Kruglov and Yakupov: *Osnovy sistemnogo analiza, analiticheskoy raboty i voyennogo prognozirovaniya* (The Basics of Systems Analysis, Analytical Work and Military Forecasting).[58] One critical element in Chvarkov's article worth highlighting is his overview of where the defense leadership takes its views on future warfare from: "the Academy of Military Sciences, the Institute of Military History, the Department of Strategy and the Center for Military Strategic Studies of the General Staff Military Academy," then adding "which have been conducting mostly initiative research for several years, the problems of future wars after the war remains in the shadow zone."

Chvarkov eschews technological determinism in forecasting the likely contours of future warfare, arguing that modern war is a complex socio-political-economic phenomenon requiring

> Passion for only technological aspects, such as forms, methods, techniques, [and] methods of using troops and weapons, the

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[56] *Ibid.*

[57] V.V. Krugulov and V.I. Yakupov, 'Methodology of Prognosticating Armed Struggle,' *Voyennaya Mysl'*, April 2017.

[58] *Osnovy sistemnogo analiza, analiticheskoy raboty i voyennogo prognozirovaniya* (*The Basics of Systems Analysis, Analytical Work and Military Forecasting)*, Ed. S.V. Chvarkov, the Military Academy of the RF AF General Staff Press, Moscow, 2016.

> development of highly effective weapons systems, [as well as] systems and means of reconnaissance, command and support, will only help build up the combat power of the armed forces and the state and the military budget. However, this will not lead to the leveling of the problem of war; since ancient times, the appearance of a new sword has led to the development of a more advanced shield and vice versa. Today it is quite difficult to say which weapon system is defensive and which one is offensive. One way or another, it depends on the situation, conditions, goals and consequences of its application. In this regard, the most obvious task of science is to equip the military-political leadership of the state with a complex of tools to level threats, and not only relying on military and non-military measures to deter and repel aggression. First of all, [it must develop] technologies and signs of anticipatory opening of these threats in various conditions, fields and environments.[59]

Although Chvarkov suggests that military science must equip the "military-political leadership" with the set of tools to deal with threats, he does not seek to outline or specify the nature of these.[60] However, Chvarkov and other Russian military specialists thinking about and analyzing the changing character of war form part of a wider and diverse military scientific community.

Returning to the theme of interstate conflict as a centrifugal force in Russian military thought on future warfare the Chief of the Academy of the General Staff, Colonel-General Vladimir Zarudnitskiy,

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[59] *Ibid.*

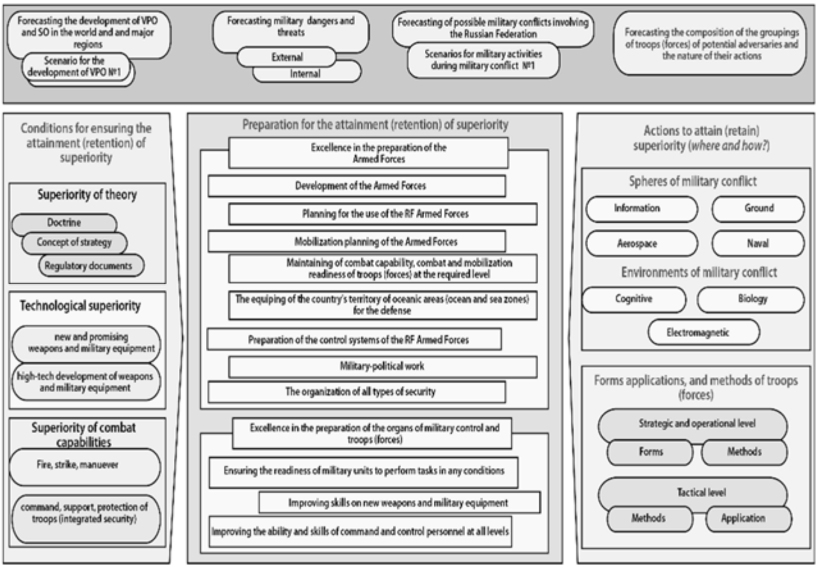
[60] *Ibid*; V.V. Ivanov, G.G. Malinetsky, *Rossiya: XXI vek. Strategiya proryva: Tekhnologiyi. Obrazovaniye. Nauka*, LENAND Publishers, Moscow, 2016; I.N. Vorobyev, V.V. Kruglov, A.I. Suptelya, *Voyennaya futurologiya*, RF MOD Press, Moscow, 2000; V.V. Kruglov, '*Voyennoye prognozirovaniye: sostoyaniye, vozmozhnosti i realizatsiya rezul'tatov*,' *Voyennaya Mysl'*, No. 4, 2016, pp. 80–86.

explored a number of related elements in the General Staff approaches to contemporary and future military conflicts. Zarudnitskiy's article was published in the August 2021 issue of *Voyennaya Mysl', 'Faktory dostizheniya pobedy v voyennykh konfliktakh budushchego,'* (Victory Factors in Future Military Conflicts).[61] His article touched upon a number of interconnected themes that dominate contemporary Russian military discourse on modern warfare, these included High-Precision Weapons (*Vysokotochnoye Oruzhiye* –VTO) and their growing role in deterrence and potential military operations, exploitation of UAV technology, electronic warfare (EW), artificial intelligence (AI) and military robotics. Zarudnitskiy focused on the theoretical aspects of gaining and maintaining superiority over an adversary in modern and future wars. "Undoubtedly, accurately predicting the nature and content of future wars is difficult, but it is also difficult to define theoretical approaches to achieving superiority over the enemy which is quite possible and necessary now in the interests of high-quality preparation for the use of the Armed Forces in the interests of ensuring military security of the Russian Federation."[62] Zarudnitskiy encapsulated the key features in this complex process of gaining superiority over an adversary, and as seen below (**Figure 2**) this is predicated upon military forecasting.

[61] V.B. Zarudnitskiy, '*Faktory dostizheniya pobedy v voyennykh konfliktakh budushchego*,' *Voyennaya Mysl'*, No. 8, 2021, pp, 34-47.

[62] *Ibid*, p.35.

Figure 2: General Approach to Gaining Superiority Over the Enemy[63]



In Zarudnitskiy's graphic, military forecasting is placed as central in the overall paradigm. The forecast elements divide into four. The development of VTO; forecasting dangers and threats both external and internal; forecasting military conflicts involving the Russian Federation; forecasting the likely force groupings of the potential adversary and their operational actions. Zarudnitskiy sees the effort to gain and maintain superiority over the enemy as being inter-linked in achieving this in the areas of theory, technology and combat capabilities. The author also details a number of factors in the preparation of gaining superiority and then divides the domains of military conflict into: information, ground (land), aerospace (air and

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[63] V.B. Zarudnitskiy, '*Faktory dostizheniya pobedy v voyennykh konfliktakh budushchego*,' *Voyennaya Mysl'*, No. 8, 2021, pp, 34-47.

space), and naval (maritime); while describing as "environments of military conflict," cognitive, biology and electromagnetic.[64]

Similarly, other researchers in the Academy of the General Staff see future warfare involving a reduction in the spatial, temporal and information gaps in C2 due to advances in information technologies, increased non-contact methods exploiting robotics and AI and the gradual blurring of the distinctions between strategic, operational and tactical levels of warfare, as well as in offensive or defensive operations.[65]

Modern Russian Military Theorists on Future Warfare

Another Western Russia specialist who has written extensively on Russian perspectives on future warfare is US Lieutenant-Colonel (retired) Timothy L. Thomas. His contributions in this area are simply outstanding. In order to frame this study and move from a Western perspective on the future of warfare to a more grounded Russian view, it is useful for the reader to see a glimpse of Thomas outlining the theorists working on this field. He sketches their articles to gain some sense of what is available in the Russian literature. Thomas groups the Russian theorists on future warfare and presents some of their writings as follows:

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[64] *Ibid.*

[65] V.I. Ostankov, '*Kharakter sovremennykh voyennykh konfliktov i yego vliyaniye na voyennuyu strategiyu*,' *Vestnik*, No. 2, 2019. At the time of the article's publication Lieutenant-General Vladimir Ostankov was the leading researcher in the Academy of the General Staff. He had also served in the elite General Staff think tank the Center for Military-Strategic Research (*Tsentr Voyenno-Strategicheskikh Issledovaniy Generalnogo Shtaba Vooruzhennykh Sil' Rossiyskoy Federatsii*—TsSVI GSh).

The specific individuals (officers in important official positions and well-respected theoretical writers) behind the concepts associated with the development of future war theory and changing nature of warfare differ in experience, creativity, and authority. They are divided into four groups in the paper.

Group one includes three individuals, General of the Army Makhmut Akhmetovich Gareev, President of the Academy of Military Science, creator of the operational maneuver group concept, and veteran of World War II; General Valeriy V. Gerasimov, Chief of the Russian General Staff; and Colonel-General A. V. Kartapolov, the former head of the Main Operations Directorate and now head of the Western Military District. [Now deputy defense minister of the Russian Federation—Chief of Main Directorate for Political-Military Affairs of the Russian Armed Forces.] They are listed here for their experience and official positions.[66]

[66] Thomas lists these as follows: 'Group one: "On Several Characteristic Aspects of Future War," Military Thought, 6/2003, pp. 52–59, M. A. Gareev; "Strategic Deterrence: Problems and Solutions," Krasnaya Zvezda (Red Star), No. 183, 8 October 2008, p. 8, M. A. Gareev, Eastview.com download, 17 March, 2010; "Lessons and Conclusions Drawn From the Experience of the Great Patriotic War for Building Up and Training the Armed Forces," Military Thought, 5/2010, pp. 10–25, M. A. Gareev; "Anticipate Changes in the Nature of War: Every Era Has its Own Kind of Military Conflict, its Own Constraints, and its Own Special Biases," Voyenno-Promyshlennyy Kuryer Online (Military-Industrial Courier Online), 5 June 2013, M. A. Gareev; "How Does One Develop a Modern Army?" Krasnaya Zvezda Online, 11 March 2016, unattributed report summarizing Gareev's speech; "The Value of Science is in Foresight: New Challenges Demand Rethinking the Forms and Methods of Carrying Out Combat Operations," Military-Industrial Courier, 26 February 2013, V. V. Gerasimov; "The Role of the General Staff in the Organization of the Country's Defense in Accordance with the New Statute on the General Staff," Bulletin of the Academy of Military Science, 1/2014, pp. 14–22, V. V. Gerasimov; "New Forms of Confrontation Employed by Western Countries Will Be Considered when Developing Russia's Defense Plan," Army Journal, No. 3, 2015, no page numbers (introductory comments), V. V. Gerasimov; "The Syrian Experience. Hybrid Warfare Requires High-Tech Weapons and Scientific Substantiation," Military Industrial Courier Online, 9–15 March 2016, V. V. Gerasimov; "Lessons of

Group two includes two people, Colonel S. G. Chekinov and Lieutenant-General (retired) S. A. Bogdanov (there is also one entry for Bogdanov and V. N. Gorbunov). They are recognized for their focus on two issues in particular, strategy and future war. They have contributed several important discussions regarding future war and its components over the past six years.[67]

Group three also is composed of two people, V. A. Kiselov and I. N. Vorobyev, who write on a variety of topics. While much of their focus is at the tactical and operational level of conflict, they also write on war's changing nature, to include the concepts of network-centric operations, indirect actions, cyberspace, and

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Military Conflicts and Prospects for the Development of Means and Methods of Conducting Them, Direct and Indirect Actions in Contemporary International Conflicts," Bulletin of the Academy of Military Science, 2/2015, pp. 26–36, A. V. Kartapolov.

[67] Listed as: 'Group two: "On the Character of Armed Confrontation in the Twenty-First Century," Military Thought, 3/2009, pp. 2–14, S. A. Bogdanov and V. N. Gorbunov; "Asymmetrical Actions to Maintain Russia's Military Security," Military Thought, 3/2010, pp. 13–22, S. G. Chekinov and S. A. Bogdanov; "Strategy of the Indirect Approach: Its Impact on Modern Warfare," Military Thought, 6/2011, pp. 3–13, S. G. Chekinov and S. A. Bogdanov; "The Initial Period of War and its Influence on the Preparation of the Country for Future Wars," Military Thought, 11/2012, pp. 14–27, S. G. Chekinov and S. A. Bogdanov; "The Nature and Content of a New-Generation War," Military Thought, 10/2013, pp. 13–24, S. G. Chekinov and S. A. Bogdanov; "Military Futurology: Its Origin, Development, Role, and Place within Military Science," Military Thought, 8/2014, pp. 19–29, S. G. Chekinov and S. A.Bogdanov; "The Art of War in the Early 21st Century: Issues and Opinions," Military Thought, 1/2015, pp. 32–43, S. G. Chekinov and S. A. Bogdanov; "Forecasting the Nature and Content of Future Wars: Problems and Opinions," Military Thought, 10/2015, pp. 41–49, S. G. Chekinov and S. A. Bogdanov; "Modern Military Art in the Context of Military Systematology," Military Thought, 11/2015, pp. 23–33, S. G. Chekinov and S. A. Bogdanov.

deception, among other topics. Only future war references are considered here.[68]

Finally, **group four** basically includes everyone else, and there are many authors who discuss directly the topic of future war or issues related to it. In all, 45 articles were considered and some summarized.[69]

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[68] Listed as: 'Group three: "The New Strategy of the Indirect Approach," Military Thought, 9/2006, pp. 2–5, I. N. Vorobyov and V. A. Kiselev; "Transition of the Ground forces to a Brigade Structure as a Phase in the Development of their Maneuver Capabilities," Military Thought, 2/2010, pp. 18–24, I. N. Vorobyov and V. A. Kiselev; "Russian Military Schools," Military Thought, 3/2010, pp. 43–49, I. N. Vorobyov and V. A. Kiselev; "Light Armed Formations in the System of Modern Combined Arms Operations (Battle)," Military Thought, 5/2010, pp. 26–34, I. N. Vorobyov and V. A. Kiselev; "The Role of Military Science in the Formation of a New Version of Russia's Armed Forces, Military Thought, 2/2011, pp. 40–48, I. N. Vorobyov and V. A. Kiselev; "Commentary on the Article 'Warfare Today and in the Future,'" Military Thought, 5/2011, pp. 54–58, I. N. Vorobyov and V. A. Kiselev; "From Modern Tactics to the Tactics of Network-Centric Actions," Military Thought, 8/2011, pp. 19–27, I. N. Vorobyov and V. A. Kiselev; "The Present Stage of Military Theory in Russia," Military Thought, 9/2011, pp. 74–78, I. N. Vorobyov and V. A. Kiselev; "Cybernetics in the System of Network-Centric Actions," Military Thought, 4/2012, pp 17–25, I. N. Vorobyov and V. A. Kiselev; "New Trends in the Development of Tactical Reconnaissance," Military Thought, 5/2013, pp. 54–63, I. N. Vorobyov and V. A. Kiselev; "Russian Military Theory: History and Today," Military Thought, 8/2013, pp., 28–42, I. N. Vorobyov and V. A. Kiselev; "Strategies of Destruction and Attrition: A New View," Military Thought, 3/2014, pp. 45–57, I. N. Vorobyov and V. A. Kiselev; "Trends in the Development of Network-Centric Actions," Military Thought, 5/2014, pp. 10–17, I. N. Vorobyov and V. A. Kiselev; "Indirect Warfare in Cyberspace," Military Thought, 12/2014, pp. 21–28, I. N. Vorobyov and V. A. Kiselev; "Hybrid Operations as a New Form of Military Confrontation," Military Thought, 5/2015, pp. 41–48, I. N. Vorobyov and V. A. Kiselev.

[69] And listed as: 'Group four: "The Probable Character of Future Warfare," Bulletin of the Academy of Military Science, 2/2005, pp. 126–129, P. A. Dul'nev and E. A. Bryuzgin; "Development and Use of Nonmilitary Measures to Reinforce the Military Security of the Russian Federation," Military Thought, 5/2009, pp. 2–12, V. I. Lutovinov; "Warfare Today and in the Future," Military Thought, 2/2011, pp. 3-12, E. O. Novozhilova; "Technosphere Warfare," Military Thought, 7/2012, pp. 22–

Thomas, based on these articles, observes the following:

> Several of the articles in *Military Thought* were the first article in the edition, indicating their importance, and the others were either close to the top or put alone in the middle of an edition so that they stood out. Thus, the importance of these concepts was obvious to all in Russia, but perhaps not to foreign analysts. Few focused-on nonmilitary, indirect and asymmetric operations over the past decade as the Russians have. This is understandable, since each nation has its own set of analysts and experts who see things from their own perspective and terms (hybrid, gray, etc.).[70]

Prior to articulating alternative approaches to defining the identity and influence of Russian officers working on future warfare, it is worth sketching the areas of interest in the above Russian articles as outlined by Colonel Thomas:

31, V. V. Bukharin and S. S. Semonov; "Tendencies in the Changing Character of Armed Struggles in Military Conflicts in the First Half of the 21st Century," Military Thought, 11/2012, pp. 40–46, S. V. Kuralenko; "The Future is being Laid Today: Armed Forces Structure Theory Must Correspond to the Nature of Future Wars to the Maximum Extent Possible," Military-Industrial Courier, March 2013, Oleg Falichev; "Information Resource and Information Confrontation: their Evolution, Role, and Place in Future War," Armeyskiy Sbornik (Army Journal), No. 10 2013, pp. 52–57, Vladimir Slipchenko; "A War of the Future," Russia in Global Affairs, 4/2013, p. 131, Andrei Baklanov; "Information is the Best Defense. Scientists Call for Sixth Technological Generation to Be Adopted into the Armory," Military-Industrial Courier, June 2014, Konstantin Sivkov; "Political Engineering of Color Revolutions: Ways to Keep Them in Check," Military Thought, 9/2014, pp. 3–11, A. N. Belsky and O. V. Klimenko; "Principal Changes in the Nature of Armed Struggle in the First Third of the 21st Century," Bulletin of the Academy of Military Science, 1/2015, pp. 44–51, P. A. Dul'nev and V. I. Orlyanskiy.

[70] See: Timothy L. Thomas, "Thinking Like a Russian Officer: Basic Factors and Contemporary Thinking on the Nature of War," FMSO, Kansas, April 2016.

> Lessons drawn from the Great Patriotic War; the specific nature and context of each and every conflict; the need to develop strategic foresight; new forms of confrontation including indirect contact; lessons drawn from Russia's more recent experience of military conflict; network-centric warfare; asymmetrical warfare; new generation warfare; information warfare; cyber warfare, hybrid warfare, the initial period of war; military futurology; brigades and the development of maneuver; non-military measures; countering color revolutions.[71]

Casting the net still wider and further into Russian military publications across the past twenty years, the following feature heavily: Vladimir Andreyev, Dmitriy Borisov, Vladimir Chebakov, I. Chernishev, Ivan Chichikov, Makhmut Gareev, A. Kondratyev, I. G. Korotchenko, Vladimir Kozhemyakin, V. V. Kruglov, S. Leonenko, Yevgeniy Lisanov, D. A. Lovtsov, N. E. Makarov, Gennadiy Miranovich, Sergei Modestov, P. Peresvet, Nikolay Poroskov, A. A. Proxhozhev, Mikhail Rastopshin, V. D. Ryabchuk, Vladimir Shenk, I. D. Sergeev, N. A. Sergeev, N. I. Turko.[72] These authors cover a broad range of future warfare-linked themes:

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[71] *Ibid.*

[72] V. D. Ryabchuk, '*Problemy Voennoy Hauki I Voennogo Prognozirovaniya v Usloviyakh Intellektual'no-informatsionnogo Protivoborstva* (Problems of Military Science and Military Forecasting under Conditions of an Intellectual-Information Confrontation),' *Voyennaya Mysl'*, No. 5, 2008, pp. 68-69; N. E. Makarov, '*Kharakter Vooruzhennoy Bor'by Budushchego, Aktual'nye Problemy Stroitel'stva i Boevogo Primeneniya Vooruzhennykh Sil RF v Sovremennykh Usloviyakh* (The Character of Future Armed Conflict, Actual Problems of the Development and Deployment of the Armed Forces of the Russian Federation Today), *Vestnik Akademii Voennykh Nauk*, No. 2, 2010, p. 19; Makhmut Gareev, 'Concepts: The Experience of the Victors in the Great War Cannot Become Obsolete. We Need to Find the Roots of Future Victories in the Past,' *Nezavisimoye Voyennoye Obozreniye*, March 12, 2010; Makhmut A. Gareev, *If War Comes Tomorrow*, Frank Cass, London 1998, pp. 52-53; M. A. Gareev, '*Strategicheskoe Sderzhivanie: Problemy i Resheniya* (Strategic Deterrence: Problems and Solutions),' *Krasnaya Zvezda*, October 8, 2008; Sergei Modestov, '*Prostranstvo Budushchey Voyny* (The Space of Future War),'

> Military science and military forecasting; the character of future conflict; rooting future warfare in the lessons of the past; strategic deterrence and strategic foresight; network-centric warfare; war in space; deep defense in information warfare; asymmetric warfare; psychotronic weapons; climate weapons; reflexive control; and nanotechnologies.[73]

Vestnik Akademii Voennykh Nauk, No. 2, 2003, p. 65; Sergei Modestov, '*Strategicheskoe Sderzhivanie Na Teatre Informatsionnogo Protivoborstva* (Strategic Deterrence in the Theater of Information Warfare),' *Vestnik Akademii Voennykh Nauk*, No. 1, 2009, p. 35; Sergei Modestov, '*Kontseptsiya Glubokoy Oborony v Informatsionnom Protivoborstve* (A Concept for Deep Defense in Information Warfare),' *Informatsionnaya Bezopasnost' Rossii* (Information Security of Russia), Moscow 1998; I. G. Korotchenko, '*Tendentsii razvitiya sovremennogo operativnogo iskusstva* (Tendencies in the Modern Development of Military Art),' *Voyennaya Mysl'*, No. 1, 1999, p. 11; I. D. Sergeev, '*Osnovnyi Faktory, Opredelyayushchie Voenno-Tekhnicheskuyu Politiku Rossii Nakanune XXI Veka* (The Main Factors which Determine Russia's Military-Technical Policy on the Eve of the 21 st Century),' *Krasnaya Zvezda*, No. 259, 9 December, 1999; Mikhail Mikhaylovich Rastopshin, '*V Labirinte Asimmetrichnykh Otvetov* (In the Labyrinth of Asymmetric Responses),' *Nezavisimoye Voyennoye Obozreniye*, No. 17, June 1, 2007.

[73] Gennadiy Miranovich, '*Voennaya Reforma: Problemy i suzhdeniya. Geopolitika i bezopasnost' Rossii* (Military Reform: Problems and Judgment. Geopolitics and Russian Security),' *Krasnaya Zvezda*, July 31 1999; V. V. Kruglov, '*O Vooruzhennoy Bor'be Budushchego* (On Future Armed Conflict),' *Voyennaya Mysl'*, September-October 1998, No. 5, pp. 54-58; N. A. Sergeyev and D. A. Lovtsov, '*O probleme 'organizatsionnogo oruzhiya'* (On the Problem of the 'Organization Weapon'),' *Voyennaya Mysl'*, No. 1, 1999, p. 34; I. Chernishev, '*Polychat li poveliteli 'zombi' blast' nad mirom* (Can a Ruler Make 'Zombies' Out of the World),' *Orientir*, February 1997, pp. 58-62; Vladimir Grigoryevich Andreyev, '*Novye Tendentsii Razvitiya Sredstv Protivoborstva: Netraditsionnoe Oruzhie Mozhet Okazat' Reshayushchee Vliyanie na Iskhod 'Voyny Budushchego'* (New Trends in the Development of Weapons: Non-traditional Weapons May Have a Decisive Influence on the Outcome of the 'War of the Future'),' *Nezavisimoye Voyennoye Obozreniye*, 26 February-4 March 1999; Dmitry Borisov and Vitaliy Koreshkov, '*Voyny Menyayut Oblik: v Sposobakh Vedeniya Boevykh Deystviy Vozrastaet Rol' Nesmertel'nogo Oruzhiya,*' (Wars are Changing their Look: The Growing Role of Non-lethal Weapons in Methods of Combat Operations)," *Nezavisimoye Voyennoye Obozreniye*, 26 February-4 March 1999; S. Leonenko, '*O Refleksivnoe upravlenie protivnikom* (On Reflexive Control of the Enemy),' *Armeyskiy Sbornik*, No. 8, 1995,

As noted, the annual speech to the AVN by the chief of the General Staff witnesses a wider appeal to the Academy to produce useful ideas for the General Staff, especially in the areas of *strategic foresight* and *future warfare*. In addition to these sources of organizational support and credibility in this search for ideas on future warfare, there are the aforementioned military educational establishments and research centers; all play a role in formulating such ideas, but pride of place and influence seems to lie in the hands of the Center for Military-Strategic Research Under the General Staff (*Tsentr Voyenno-Strategicheskikh Issledovaniy Generalnogo Shtaba Vooruzhennykh Sil' Rossiyskoy Federatsii*—TsSVI GSh). On future warfare among other issues. Lieutenant General (ret.) Sergei Bogdanov is professor and chief researcher at the TsVSI, and his colleague at the center Colonel (reserve) Sergei Chekinov is a professor and leading Researcher as well

p. 28; A. A. Proxhozhev and N. I. Turko, '*Osnovy Informatsionnoy Voyny* (The Basics of Information Warfare)*,' in Analiz Sistem na Poroge XXI Veka: Teoriya i Praktika: Tom Chetvertyy* (Systems Analysis on the Threshold of the 21 st Century: Theory and Practice: Volume Four), Moscow February 1996; N. I. Turko and S. A. Modestov, '*Refleksivnoe Upravlenie Razvitiem Strategicheskikh Sil Gosudarstva Kak Mekhanizm Sovremennoy Geopolitiki* (Reflexive Control in the Development of Strategic Forces of States as a Mechanism of Geopolitics),' in *Analiz Sistem na Poroge XXI Veka: Teoriya I Praktika: Tom Chetvertyy* (Systems Analysis on the Threshold of the 21 st Century: Theory and Practice: Volume Four), Moscow February 1996; Vladimir Chebakov, '*Kto Tut 'Shmel'? Leninskuyu Premiyu Emu…* (Who's the Shmel Here? Give Him the Lenin Prize),' *Armeyskiy Sbornik*, No. 3, 2003; Yevgeniy Lisanov, '*Proyti Nad Propast'yu i Ne Svalit'sya* (Pass Over the Abyss without Falling In),' *Krasnaya Zvezda*, June 4, 2008; Yevgeny Lisanov, '*Predvidenie Uchenykh—Voennomu Delu* (Foresight of Scientists—Military Affairs),' *Nezavisimaya Gazeta*, No. 193, 10 September 2008; Kondratyev, A, Shchukin, M, '*Razvedyvatel'noe obespechenie boevykh deistvii sukhoputnyhk voisk SShA v gorodskikh usloviiakh,*' (Intelligence Support for the Military Operations of US Ground Troops), *Zarubezhnoe Voennoe Obozrenie*, No. 9, September, 2008; Kondratyev, A, '*Obshchaia kharakteristika setevykh arkhitectur, primwniaemykh pri realizatsii perspectivnykh setetsentricheskikh kontseptsii vedushykh zarubezhnykh stran*,' (General Characteristics of the Web Architecture, Used in the Process of Applying the Perspective of Network-Centric Concepts of Leading Foreign Countries), *Voyennaya Mysl*, No. 12, December 2008.

as serves on the editorial board of *Voyennaya Mysl'*. According to the author's Russian interlocutors, these among other TsVSI researchers are at the top of the pecking order of influence, to include retired staffers such as Lieutenant General (ret.) Vladimir Ostankov.[74]

Chekinov and Bodgdanov, in their 2015 article in *Voyennaya Mysl'*: *Razvitiye sovremennogo voyennogo iskusstva s tochki zreniya voyennoy sistemologii* (The Development of Modern Military Art in Terms of Military Systemology), examine the evolution of military art in the early years of the 21st century and make projections about the kind of military threats likely to rise 30–50 years ahead, changes in the substance of future wars and in the principles of military art, as well as new tasks facing military science.[75]

On the likely shape of future wars, the authors assert,

> Forecasts of the possible content of future warfare involving the use of arms suggest that it will be conducted with the use of unconventional arms causing earthquakes, typhoons, sustained heavy downpours leading to erosion of the economies and intensification of sociopsychological tensions in the warring countries. These unconventional arms will certainly set off development of new forms and methods of conduct of military operations [and] changes in the pattern of military operations at the tactical, operational, and strategic levels.
>
> Beyond a doubt, new weapons and military hardware have always produced a strong effect on what fighting was all about. In future wars, their nature and substance will be impacted by

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[74] Author researcher interviews, via VTS, Moscow, June 7–8, 2021.

[75] S.G. Chekinov and S.A. Bodgdanov, 'Razvitiye sovremennogo voyennogo iskusstva s tochki zreniya voyennoy sistemologii, (The development of modern military art in terms of military systemology)', *Voyennaya Mysl'*, No.6, 2015.

> weapons designed on new physical principles. The nature and substance of future wars will be changed radically by space-based attack weapons, orbiting battle space stations (platforms), new weapons of improved destructive power, range, accuracy, and rate of fire, greater capabilities of reconnaissance and robot-controlled assets, automated weapons control, communication, and information warfare systems.
>
> Naturally enough, a forecast of future warfare drives us to the conclusion that wars will be resolved by a skillful combination of military, nonmilitary, and special nonviolent measures that will be put through by a variety of methods and forms and a blend of political, economic, informational, technological, and environmental measures, primarily by taking advantage of information superiority. Information warfare in the new conditions will be the starting point of every action now called the new type of warfare (a hybrid war) in which broad use will be made of the mass media and, where feasible, the global computer networks (blogs, various social networks, and other resources).
>
> Looking ahead to the course and outcome of future wars, we can assume that the new information techniques based on new technologies as components of information weapons will be capable of paralyzing the barely protected computer systems used to control troops and weapons and depriving the enemy of information transmission functions. It is not an exaggeration at all either to say that the computer will turn into a strategic weapon in future wars.[76]

Chekinov and Bogdanov argue here that warfare in the future will see the use of "unconventional arms" to cause climactic disasters and, thus, break the will of the enemy to fight. In turn, this technological

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[76] *Ibid.*

breakthrough will again change the means and methods of conducting warfare and gradually erode the distinction between strategic, operational and tactical levels. Like other authors dealing with future warfare, they assume the development of new weapons "designed on new physical principles." These will also carry warfare into space, with the development of space-based attack systems and orbiting battle-platforms. Weapons will be designed with greater destructive power and robotics, and information systems will feature as component parts of warfare. The authors argue that the use of military and non-military means will be further refined in the future to exploit information superiority, finally resulting in a stage where the computer becomes a *de facto* strategic weapon. Chekinov and Bogdanov then lay out a short summary of future warfare:

> In their forecast of what future wars will be centered around, these authors want to make the point that future wars will begin with an operation that will be launched by electronic warfare forces and will blend with a strategic operation to be set off by the Armed Forces and an aerospace operation that is a part of it. The Armed Forces' and aerospace operations must be augmented by a massive launch of cruise missiles from all realms—space, air, land, and sea, and space-based strike weapons—and reconnaissance outfits capable of delivering strikes and fires at targets they detect, and by remotely guided and piloted vehicles and robots. The armed forces involved in this operation will be assigned the primary task of winning overwhelming superiority in all realms—in the aerospace, on land, at sea, and in the information environment.[77]

Clearly, the authors see a significant role to be played by the use of EW and high-precision strike systems. They continue with a more detailed series of insights:

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[77] *Ibid.*

We have found, through our forecasts, that there will be evolution of forms and methods of employment of joint task forces in operations and engagements. The adversary will be defeated and destroyed by massive fire strikes by high-precision weapons (HPW) on the basis of new technologies, by aerospace systems, EW forces, electromagnetic, informational, and infrasonic weapons against his retaliation forces, his economic facilities, government and military control systems, and energy generation centers through the full depth of the adversary's country. The combat command and information management systems of the global and regional level will serve as centers for strike-capable combat reconnaissance systems to be built around. There will no longer be any need to mount varying scale operations to overrun the adversary's territory devoid of economic facilities, and his political system pushed into the corner will collapse under its own weight.

Prediction of what future wars will be in substance gives us an insight into adjustments likely to be made in the laws and rules of warfare, and in the substance of the behavioral patterns of joint task forces in the theaters of operations (strategic areas). The main distinctions of future wars are listed briefly below:

- weapons designed on new technological principles—high-precision weapons based on several platform varieties, aerospace attack weapons, strike-and fire-capable reconnaissance systems, remote-controlled and piloted aerial vehicles, and robot-controlled weapons—will have an overwhelming superiority;
- nuclear weapons will have their significance reduced where strategic and political objectives will have to be attained and their functions taken over by conventional high-precision weapons, weapons on new physical principle, and other types of conventional weapons;

- strategic operations by armed forces will become the principal form of strategic task fulfillment; and
- a unified system will be deployed to collect and process information by integrating space, aerial, and ground reconnaissance capabilities for target allocation and designation in real time.[78]

Entirely consistent with Slipchenko's writings, Chekinov and Bogdanov believe that future warfare will witness the erosion of the deterrence value of nuclear weapons, and that there will be further development and exploitation of C4ISR approaches to combat. The authors conclude:

> Forecasting is a way to gain an insight into a situation in which employment of weapons based on new physical properties, new weapons having greater destructive power, longer range, higher accuracy and rate of fire, broader capabilities of reconnaissance and robot-controlled assets, automated weapons control, communication, and information warfare, and closer integration of space-based, aerial, and ground reconnaissance systems in target designation and acquisition in real time will have a significant impact on the fast pace of future wars. It can be expected, therefore, that future wars will each consist of an opening and a closing period.
>
> The opening period of a future war will last for approximately a month. The length of this period will depend on the strength and combat power of the armed forces of the country that comes under attack, the strength or weakness of its economy, its technological development, its size and geographic position, and several other less significant contributing factors.

[78] *Ibid.*

The authors are certain that the opening period of future wars will really be the principal and decisive stretch that will begin with an EW operation that will merge cohesively with the armed forces' strategic operation that will include an aerospace operation and massive launches of cruise missiles from various platforms. These operations will be supported and reinforced by operations of strike-and fire-capable reconnaissance units, and remote-controlled and piloted aerial vehicles to the full depth of the country under attack to deny the defender the ability to check the aggression.

The closing period of future wars must be as short as possible. Its length will depend on the combat power of the surviving forces, the morale of the losing country's military and political leaders, and their readiness to capitulate.

It can be assumed, then, that the transformation of views on the nature of threats to the country's military security, changes in the principles of conduct of wars in the future and in the laws of warfare, in the forms and methods of conduct of war by joint interagency and cross-service task forces, and new areas of military art development will raise the need for changes to be made in the substance of tasks that will face military science and for new tasks to crop up.

Above all, military science will be hard-pressed to explore changes in the substance of future wars and in their principles and in the principles of military art. The results of the exploration findings must be used to probe for new forms and methods of conduct of military operations in the future, to effectively counter new threats and challenges, and to identify points where modifications will have to be made in the fundamental documents and strategies related to controversial

> aspects of the country's national security maintenance and its Military Doctrine, to keep the peace.[79]

It is worth noting here the emphasis the authors place upon the initial period of war and the closing period, with heavy stress on the use of EW, high-precision strike systems and further evolution of C4ISR.[80] It seems that these researchers are more representative of the modernist or revolutionary schools of thought in Russian military theory; and given the current emphasis placed by the political-military leadership on EW, cyber and information warfare, C4ISR, and high-precision strike systems, these views apparently carry weight in defense-policy planning and are set to continue to do so for the foreseeable future.

It is also worth noting, despite the high-level interest in the exploitation of non-military assets in the hard/soft power mixture of modern Russian military capability that Chekinov and Bogdanov see future war as remaining, by definition, war: "Despite the assertions of some military scientists about the need for a fundamental review of the essence and content of the war and the loss of priority in it by military force, it is the mandatory use of armed forces that is the main criterion that distinguishes the war as a special period of interstate confrontation. *The war of the future will still remain a war*."[81]

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[79] *Ibid.*

[80] Some of these views are even echoed in a recent publication from Gareev, recognizing, for instance, the increased role played in modern warfare by the use of non-military measures, as well as the growing role played by high-precision strike systems. M. A. Gareev, E. A. Derbin, N. I. Turko, '*Diskurs: Metodologiya I Praktika Sovershenstvovaniya Strategicheskogo Rukovodstva Oboronoy Strany s Uchetom Kharaktera Budushchikh Voyn i Vooruzhennykh Konfliktov*,' *Vestnik*, No. 1, 66, 2019.

[81] Author's emphasis. S. Chekinov, S. Bagdanov, '*Evolyutsiya sushchnosti i soderzhaniya ponyatiya 'voyna,' v XXI stoletii*,' *Voyennaya Mysl*', No. 1, 2017, p. 42.

Indeed, other Russian military theorists place high value on the potential for domestic military science to yield long-term strategic results. For example, typical of this approach, Captain 1st Rank (ret.) Lennor Olshtynsky, a professor and full member of the AVN and a veteran of the Great Patriotic War, encapsulated this in an article in *Voyennaya Mysl'* in April 2020: "The development of domestic military science urgently requires the use of all theoretical principles to study not only the centuries-old combat experience, but above all the achievements of the Soviet military science, which historically proved its superiority over the Western one."[82] Olshytynsky, referencing the history of recent military conflicts in the 20th and early 21st centuries, echoes the ideas of Chekinov and Bogdanov that, essentially, wars of the future will remain "wars," categorizing warfare types as subordinate to the overall use of armed force:

> *It is inappropriate to use such definitions as "economic war," "psychological warfare," "guerrilla war," "cyber war," "information war," and the like*. These are *areas of the struggle*, which do not stop in peacetime and become even more intense in *wartime*. War, as a whole, includes the armed struggle as its main content, as well as the struggle in other spheres of social life, which were used both in preparation for war and in its conduct. Nonmilitary types of struggle can include economic struggle, foreign policy struggle and organization of active forms of internal political struggle of the opposition forces in the opposing state ("color revolutions"), subversive activities of "agents of influence" and direct agents against the opposing state. The arsenal of nonmilitary types of struggle should include informational, ideological, and psychological struggle, intelligence and counterintelligence and dissemination of false information, electronic struggle in electronic control systems

[82] Lennor Olshtynsky, '*Nauka o voyne: preyemstvennost' i sovremennoye razvitiye*,' *Voyennaya Mysl'*, No.4, 2020, pp. 115–123.

> and communication systems, acts of sabotage, and political terror. All these types of struggle, combined with the use of armed forces, are what Americans call "network warfare." It is, therefore, important to use the concept of, and the term "war" only in conjunction with an armed struggle of the appropriate scale and purpose.[83]

Olshtynsky is cautious in latching on "new" types of warfare as providing necessary insight into the wars of the future, and sees such sub-categories as elements or features of modern and future military conflicts. Moreover, in a seminal work published in Moscow in 2018, Major General (ret.) Stepan Tyushkevich assesses the historical developments of the laws of war in the context of military theory and methodology, arguing the laws of war vary in each historical epoch. In 2018, Tyushkevich, as a veteran of the Great Patriotic War and already 100 years old, was also the leading researcher in the Institute of Military History at the General Staff Academy in Moscow. Tyushkevich's book, *O zakonakh voyny: Voprosy voyennoy teoriyi i metodologiyi* (*The Laws of War: Issues of Military Theory and Methodology*), attracted a great deal of attention in Russian military scientific circles.[84]

Tyushkevich argues that Russian military science must pay more attention to the importance of technological and scientific revolution and its role in determining the success or failure of states in future wars: "Against the background of social changes, the scientific and technological revolution, the transformation of science into an important factor of social progress and its increasingly deep

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[83] Olshtynsky, '*Nauka o voyne: preyemstvennost' i sovremennoye razvitiye*,' *Voyennaya Mysl'*, *Op. Cit*. Emphasis in the original.

[84] Stepan A. Tyushkevich, *O zakonakh voyny: Voprosy voyennoy teoriyi i metodologiyi* (*The Laws of War. Issues of Military Theory and Methodology*), Progress Publishers, Moscow, 2018, pp. 352.

penetration into all spheres of social life—ensuring the *superiority in scientific potential becomes extremely important for determining the outcome of war*."[85] Tyushkevich conceives of the "laws of war" as playing a primary role in achieving success in the modern battlespace: "The laws of war, the laws of armed struggle are a system of essential dependencies to which war is subordinated. […] The scientific and practical significance of the laws of war is enormous. Correctly learned, they allow a better understanding of the ways to achieve victory and the means to prevent failures and defeats."[86]

Conclusion

The elements of Soviet military thought influencing Russia's contemporary military transformation have also been highlighted by Dmitry Adamsky, a professor in the School of Government, Diplomacy and Strategy at the IDC Herzliya, in Israel. Adamsky's analysis of Russian information-technological warfare argues that this finds it roots firmly in Soviet military thought. He traces these origins to three specific aspects of Soviet military theoretical research focuses: the first is the Soviet RMA thinking, which stressed the disruption of the adversary's decision-making systems by targeting its C4ISR, the second stems from *maskirovka* (measures to deceive, disinform or conceal, aimed at influencing the enemy's understanding of the battlespace), and finally the third source is Soviet cybernetics.[87]

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[85] Emphasis in the original. Tyushkevich, *O zakonakh voyny: Voprosy voyennoy teoriyi i metodologiyi*, *Op.Cit*, p. 65.

[86] *Ibid*, p. 75.

[87] See: Dmitry (Dima) Adamsky, 'Cross-Domain Coercion: The Current Russian Art of Strategy,' *Proliferation Papers*, No. 54, November 2015. See also: Dima Adamsky, 'Through the Looking Glass: The Soviet Military-Technical Revolution and the American Revolution in Military Affairs,' *Journal of Strategic Studies*, Vol. 31, No. 2, 2008, pp. 257–294; Dima Adamsky, *The Culture of Military Innovation: The Impact of Cultural Factors on the Revolution in Military Affairs in Russia, the USA, and Israel*, Stanford: Stanford University Press, 2010; Dima Adamsky, 'From Moscow

Likewise, although there are no specific Russian military specialist theorists focusing exclusively on the theme of future warfare, the General Staff's continued interest in this area draws upon a diverse and large body of military scientific knowledge, which provides a pool from which defense planners are able to formulate modernization priorities. This area has been purposefully encouraged and expanded in recent years by the General Staff leadership.

As noted, recent Russian military thought concerning the changing character of warfare over the past twenty years has highlighted numerous areas to include: the lessons drawn from the Great Patriotic War; the specific nature and context of each and every conflict; the need to develop strategic foresight; new forms of confrontation including indirect contact; lessons drawn from Russia's more recent experience of military conflict; network-centric warfare; asymmetrical warfare; new generation warfare; information warfare; cyber warfare; hybrid warfare; the initial period of war; military futurology; brigades and the development of maneuver; non-military measures; and countering color revolutions.[88] Also, Russian military science has considered the following in this wider context: military science and military forecasting; the character of future conflict; rooting future warfare in the lessons of the past; strategic deterrence and strategic foresight; war in space; deep defense in information warfare; psychotronic weapons; climate weapons; nanotechnologies.[89]

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with coercion: Russian deterrence theory and strategic culture,' *Journal of Strategic Studies*, Vol. 41, No. 1–2, 2018, pp. 33–60.

[88] Thomas, 'Thinking Like a Russian Officer: Basic Factors and Contemporary Thinking on the Nature of War,' *Op.Cit.*

[89] Borisov and Koreshkov, '*Voyny Menyayut Oblik: v Sposobakh Vedeniya Boevykh Deystviy Vozrastaet Rol' Nesmertel'nogo Oruzhiya*,' *Op.Cit*; Leonenko, '*O Refleksivnoe upravlenie protivnikom*,' *Op.Cit;* Lisanov, '*Predvidenie Uchenykh—Voennomu Delu*,' *Op.Cit*; Kondratyev, '*Razvedyvatel'noe obespechenie boevykh deistvii sukhoputnyhk voisk SShA v gorodskikh usloviiakh*,' *Op.Cit*; Kondratyev, '*Obshchaia kharakteristika setevykh arkhitectur, primwniaemykh pri realizatsii*

Some Russian civilians are also working on future warfare, such as Andrei Kokoshin or Alexei Arbatov, although this is not the exclusive focus of their work. Kokoshin is undoubtedly Russia's greatest civilian military theorist, who most consistently has written about future war, as the titles of a selection of his most prominent publications indicate: *O Politicheskom Smysle Pobedy v Sovremennoi Voine* (*On the Political Understanding of Victory in Current War*, 2004), *Politilogia i Sotsiologia Voennoi Strategii* (*Political Science and Sociology in Military Strategy*, 2005), *O Revoliutsii v Voennom Dele v Proshlom i Nastoiashchem* (*On the Revolution in Military Affairs in History and Today*, 2006), and *Innovatsionnye Vooruzhennye Sily i Revoliutsia v Voennom Dele* (*Innovative Military Forces and the Revolution in Military Affairs*, 2008).[90]

Kokoshin has argued strongly in favor of Russia's military adopting C4ISR capabilities rooted in network-centric approaches toward modern and future warfare. Like Chvarkov, however, Kokoshin has warned against technological determinism as part of this transformation in military capabilities.[91] Kokoshin also recognizes that the adoption of C4ISR places new and challenging demands on military personnel, including recruitment, training and education,

perspectivnykh setetsentricheskikh kontseptsii vedushykh zarubezhnykh stran,' *Op.Cit*; Shenk, '*Stikhiey—po Vragu: Klimaticheskoe Oruzhie Voydet v Arsenal Sovremennykh Armiy*,' *Op.Cit*; Chichikov, '*Nanovoina: Masshtab Ugrozy*,' *Op.Cit*.

[90] Andrei Kokoshin, *O Politicheskom Smysle Pobedy V Sovremennoi Voine,* Moscow: URSS, 2004; Andrei Kokoshin, *Politilogia I Sotsiologia Voennoi Strategii,* Moscow: URSS, 2005; Andrei Kokoshin, *O Revoliutsii V Voennom Dele V Proshlom I Nastoiashchem,* Moscow: URSS, 2006; Andrei Kokoshin, *Innovatsionnye Vooruzhennye Sily I Revoliutsia V Voennom Dele,* Moscow: URSS, 2008.

[91] Andrei Kokoshin, *Innovatsionnye Vooruzhennye Sily I Revoliutsia V Voennom Dele*. p. 5;

Alexandr Kondratyev, *'Borba Za Informatsiu Na Osnove Informatsii,'* *Nezavisimoe Voennoye Obozrenie*, October 24, 2008.

while also highlighting the potential cultural stumbling block in relation to the reluctance of the Russian officer corps to delegate authority to the lower ranks.[92] Equally, the corollary of this observation lies in the need to allow officers operating at tactical level to access information at operational and strategic levels.[93]

In essence, therefore, there is strong evidence of continuity in contemporary Russian military thought, planning, force structure and its linkages into the adoption of C4ISR and the transformation of the country's military rooted in its transition to the information age. Of course, areas of divergence and innovation exist. However, a unifying factor in these complex processes is an underlying need to harness high-technology in order to successfully modernize Russia's Armed forces to meet the state's potential security challenges in the 21st century. In conceptual terms, as the intellectual beneficiaries of Ogarkov and the Soviet RMA theory, Russian military theorists such as General Vladimir Slipchenko conceptualized these advances in capability in terms of the generations of warfare.[94] In this regard, Russia has come later into the sphere of sixth-generation warfare, and

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[92] Jacob W. Kipp traces and assesses the influences of Soviet and Russian military theorists on the thinking and analyses of Kokoshin to include: Aleksandr Svechin, Mikhail Tukhachevsky, Vasily Sokolovsky, Nikolai Ogarkov, Sergei Akhromeyev, and Makhmut Gareev; Jacob W. Kipp, 'Forecasting Future War: Andrei Kokoshin and the Military-Political Debate in Contemporary Russia Andrei Kokoshin: Scholar and Bureaucrat,' Foreign Military Studies Office, Fort Leavenworth, Kansas, https://fas.org/nuke/guide/russia/agency/990100-kokoshin.html, January 1999.

[93] Andrei Kokoshin, *Innovatsionnye Vooruzhennye Sily i Revoliutsia v Voennom Dele*, pp. 198–199;

See: A.E Kondratev, '*Problemnye Voprosy Issledovania Novykh Setetsentricheskikh Konseptsii Vooruzhennykh Sil Vedushchikh Zarubezhnykh Stran*,' *Voyennaya Mysl'*, No. 11, 2009, p. 63.

[94] Slipchenko, *Voiny Novogo Pokolenia - Distantsionnye i Bezkontaktnye, Op.Cit;* Slipchenko, '*K Kakoi Voine Dolzhny Gotovitsia Vooruzjennye Sily*,' *Op.Cit.*

it still maintains and relies upon fifth-generation (nuclear) means for strategic deterrence—while also adding conventional "pre-nuclear" deterrence into this mixture. It visibly tested elements of its sixth-generation and non-contact warfare capabilities during its military operations in Syria.[95] And its continued conventional military modernization and transformation lies deeply intertwined with the adoption of network-centric warfare capability; though it appears aimed at offering warfighting means and methods principally against a high-technology peer adversary. Slipchenko's far-sighted analysis of the potential to develop a new seventh generation warfare capability may be closer in timescale that he envisaged in the early 2000s.[96]

The origins of network-centric approaches to modern and future warfare are rooted in the RMA, championed by Marshal Nikolai Ogarkov in the 1980s. As he predicted, modern and future inter-state warfare will be short and sharp, no longer envisaging a period of mobilization or "follow-on" forces. Russia's contemporary General Staff understands that the key to securing political-military objectives in such a scenario depends on gaining the advantage in the information space and utilizing its speed of decision-making through improved automated command and control. As such, Russian military strategists and policymakers have consciously sought to move

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[95] M. Y. Shepovalenko, *Siriyskiy Rubezh,* Moscow: *Tsentr Analiza Strategiy i Tekhnologiy (CAST)*, 2016, pp.112–113; Igor Semenchenko, '*Ni razu ne promazali Na siriyskom TVD poluchen unikal'nyy opyt*,' *Voyenno Promyshlennyy Kuryer*, https://vpk-news.ru/articles/40474, December 19, 2017; Alexei Ramm, '*Shestnadtsat' udarnykh dney Kratkiye itogi deystviy rossiyskoy voyennoy aviatsii*,' *Voyenno Promyshlennyy Kuryer*, https://www.vpk-news.ru/articles/27621, October 20, 2015; Konstantin Bogdanov, '*Rossiyskaya operatsiya v Sirii: voyennyye i politicheskiye aspekty*,' *Natsional'naya Oborona*, https://oborona.ru/includes/periodics/geopolitics/2017/1221/144623069/detail.shtm , No.11, 2020; Ivan Safronov, '*Khronika pikiruyushchikh bombardirovshchikov*,' *Kommersant*, https://www.kommersant.ru/doc/3094571, September 26, 2016,

[96] Slipchenko, '*Informatsionnyi resurs i informatsionnoe protivoborstvo*,' *Op.Cit.*

away from the country's traditional reliance upon mass mobilization to forming leaner and more capable forces. After many years of analysis, discussion and planning, the Russian military is now well on the path toward the fuller formation of a network-centric capability that will present challenges for any potential adversary. Thus, Russia's Armed Forces, together with their numerous technological advances, are confidently entering the high-tech battlespace.[97]

Over the past decade, Moscow has prioritized harnessing high technology to transform military decision-making. This has involved reforming and simplifying command and control, introducing new structures in order to ingrate C2, digitizing the technologies involved in facilitating decision-making, and designing and procuring modern automated C2 systems.[98] These developments in advancing Russia's

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[97] N. Tyutyunnikov, *Voyennaya mysl' v terminakh i opredeleniyakh: v trekh* (Vol. 3), Moscow, Russia: Pero, 2018, p. 160; V. Burenok, '*Bazis setecentricheskih voyn – operezhenie, intellect, innovacii* (Basis for Network-Centric Wars: Anticipation, Intellect, Innovations),' *Nezavisimoye Voyennoye Obozreniye*, April 2, 2010; V. Burenok, A. Kravchenko and S. Smirnov, '*Kurs – na stetsentrcheskuiu sistemu vooruzheniia*,' *Vozdushno Kosmicheskaia Oborona*, May 2009; A. V. Kopylov, '*K voprosu o kritike kontseptsii setetsentricheskikh voyn (operatsiy) v amerikanskikh SMI*,' http://www.milresource.ru/Kop—NCW.html, July 8, 2013; O. V. Belenkov, '*Realizatsiya tekhnologii setetseitricheskogo upravleniya v ASU voyskami i oruzhiyem na baze GIS Karta-2011*,' http://www.gisinfo.ru/item/91.htm, July 8, 2013; V. M. Burenok, A. Yu. Kravchenko, S.S. Smirnov, '*Budushcheye za setetsentricheskoy sistemoy vooruzheniy*,' *Poslezavtra: internet-gazeta*, http://poslezavtra.com.ua/budushee-za-setecentricheskoj-sistemoj-vooruzhenij/, November 21, 2009; V. M. Burenok, A. A. Ivlev, V. Yu. Korchak, '*Razvitiye voyennykh tekhnologiy XXI veka: problemy, planirovaniye, realizatsiya*,' Tver': Izdatel'stvo OOO KUPOL, 2009.

[98] Sergei Batyushkin, *Podgotovka i vedeniye boyevykh deystviy v lokal'nykh voynakh i vooruzhennykh konfliktakh Podgotovka i vedenie boevykh deistvii v lokalnikh voinakh i vooruzhennykh konfliktakh*, (Preparation and Conduct of Military Actions in Local Wars and Armed Conflicts), Moscow: KnoRus, 2017, pp. 438; Yu. Bobkov and N. Tyutyunnikov, *Kontseptual'nyye Osnovy Postroyeniya ASU Sukhoputnymi Voyskami VS RF,* Moscow: Paleotip, 2014; Dmitry Kandaurov, '*Komp'yuteru davno pora priyti na smenu karandashu v rukakh shtabnogo ofitsera*,' *Nezavisimoye*

conventional military capabilities are closely tied to its pursuit of network-centric approaches to modern and future warfare, adopting command, control, communications, computers, intelligence, surveillance and reconnaissance—C4ISR—rooted in harnessing high technology to achieve these aims. In the area of military decision-making, a revolution has occurred, making the new system in place barely recognizable compared to the C2 apparatus it has displaced.

While considerable interest among Western analysts of Russia's military modernization has focused on the speeches and published articles of the chief of the General Staff, Army General Valery Gerasimov, his comments on the role of the military in operations in Syria since September 2015 are replete with an emphasis on the "limited" application of hard power, culminating in articulating this as an emerging "strategy of limited actions" in such conflicts. Gerasimov has also referred to "non-contact" warfare and the employment of high-precision weapons systems. Moscow has tried and tested this nascent "non-contact" warfare capability in its operations in Syria, it did so in ways to support ongoing complex operations as well as to test and refine the use of these systems.[99]

Many of the elements in Gerasimov's thinking on future warfare are naturally reflected in the writings of the Chief of the Academy of the General Staff Colonel-General Vladimir Zarudnitskiy. For example, in Zarudnitskiy's article in *Voyennaya Mysl'* in January 2021,

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Voyennoye Obozreniye, http://nvo.ng.ru/armament/2010-11-12/10_computer.html, November 12, 2010; Dmitry Kandaurov, '*Glavnyye resursy v rasporyazhenii ASUV – informatsiya i vremya*,' *Nezavisimoye Voyennoye Obozreniye*, http://nvo.ng.ru/concepts/2010-10-08/6_asuv.html, October 8, 2010.

[99] Valery V. Gerasimov, '*Razvitie voennoi strategii v sovremennykh usloviiakh. Zadachi voennoi nauki*,' *Vestnik* 67, No. 2, 2019, pp. 6–11; Valery V. Gerasimov, '*Vliianie sovremennogo kharaktera vooruzhennoi bor'by na napravlennost' stroitel'stva i razvitiia Vooruzhennykh Sil Rossiiskoi Federatsii. Prioritetnye zadachi voennoi nauki v obespechenii oborony strany*,' *Vestnik*, 62, No. 2, 2018, pp.16–22.

Kharakter i soderzhaniye voyennykh konfliktov v sovremennykh usloviyakh i obozrimoy perspektive (The Nature and Content of Military Conflicts in Present-day Conditions and in the Foreseeable Future), which examines the likely contours of future wars, he draws heavily upon ideas contained in public speeches by Gerasimov, such as the "strategy of active defense," and measures for the "preemptive neutralization of threats" to state security. Moreover, Zarudnitskiy identifies eighteen trends in military-technical development influencing long-term planning and thinking about future warfare. Military and special equipment (*voyennoy i spetsial'noy tekhniki* — VVST) will evolve around the following trends:

- Accelerated creation of the newest UAVs, with a broadening of their executable functions and of the air means of destruction;
- Increase in missile flight speed to hypersonic;
- Reduction of the conspicuousness of VVST models;
- Improvement of automated systems of C2 carriers and weapons;
- Increase in the range of target detection and destruction (without entry into the enemy's air defense zone);
- Development of space-based reconnaissance and C2 systems;
- Formation of a unified information and C2 domain, with the help of space resources;
- Robotic space systems will conduct anti-satellite struggles and service space systems; weapons based on new physical principles will be created for space defense. This will shift space operations from support to combat;
- Robotization of all spheres of armed struggle;
- Development of AI for robotic systems, broadening the spectrum of their executable tasks and ability to operate autonomously;
- Shift from the principle of "command and control of a robot" to the principle of "assigning tasks to a robot:"

- Introduction of technologies for employing robotic military systems in groups;
- Improvement of various precision, control, and self-homing means of destruction and intelligence, targeting, radio-electronic warfare, air defense systems, and systems for the struggle against cruise missiles and UAVs;
- Increase in the level of automation of VVST;
- Shift from fire destruction of an enemy to the use of comprehensive effects against opponents;
- Equipping combat ships with long-range "ship-to-shore" and "ship-to-ship" precision weapons;
- Creation of underwater robotic military systems, including strategic systems and systems for situational awareness;
- Introduction of AI units capable of self-learning and analysis of large amounts of information for employment in various fields—from reconnaissance and C2 of weapons to strategic forecasting and decision-making.[100]

Zarudnitskiy on this basis offers a vision of future warfare that incorporates many of the themes in Russia's contemporary military modernization, with its emphasis on the automation of C4ISR, UAV development, hypersonic missile technology and the further development and exploitation of AI. However, his comments concerning the development of space-based assets to be elevated to a combat function rather than restricted to combat support, combined with the idea of AI to extend into self-learning systems and contribute to military decision-making and into the sphere of "strategic forecasting," is potentially revolutionary if the state adopts the necessary measures to implement such ideas. Indeed, this would

[100] Cited in: Timothy Thomas, Harold Orenstein, 'Russia Discusses the Nature of Future Conflict: is This an Opening Discussion of Russia's New Military Doctrine?' Mitre: McLean: Va, May 2021, pp. 6–7. The original article: V.B. Zarudnitskiy, '*Kharakter i soderzhaniye voyennykh konfliktov v sovremennykh usloviyakh i obozrimoy perspektive*,' *Voyennaya Mysl*', No. 1, 2021, pp. 34–44.

transcend the arguments as to how much continuity and change persists in Russian military thought, as these measures would swing the pendulum towards innovation with less tangible origins in Soviet military thought.[101]

Moreover, by successfully deploying and exploiting such high-precision strikes in a conflict, the political leadership was further persuaded of the need for additional and consistent state investment in these capabilities. Those added investments include the development of hypersonic cruise missiles in the State Armaments Program to 2027, reportedly capable of overcoming any adversary's air defenses. Equally, these precision weapons play a pivotal role in the conventional hard-power dimension of the 2014 Military Doctrine—the commitment to developing "non-nuclear" or "pre-nuclear" deterrence. Thus, Russia's dedication to diversifying and deepening the role of high-precision strike weapons in its military inventory is assured a long-term place in Moscow's defense planning and procurement priorities.[102]

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[101] Zarudnitskiy, '*Kharakter i soderzhaniye voyennykh konfliktov v sovremennykh usloviyakh i obozrimoy perspektive*,' *Op. Cit.*

[102] Evgeny Podzorov, '*Yuvelirnaya tochnost' Russkiye Kalibry unichtozhayut IGIL v Sirii*,' *Russkiya Vesna*, https://rusvesna.su/news/1498853824,https://rusvesna.su/news/1498853824,July 1, 2017; Andrei Kokoshin, *O sisteme neyadernogo sderzhivaniya v oboronnoi politike Rossii,* Moscow: Moscow University Press, 2012; V. I. Poletayev and V. V. Alferov, '*O neyadernom sderzhivanii, ego roli i meste v sisteme strategicheskogo sderzhivaniya*,' *Voyennaya Mysl'*, No. 7, July 2015, pp. 3–10; A. N. Bel'skiy, D. A. Pavlov, O. B. Klimenko, '*Aktual'nye voprosy obezpecheniya voyennoy bezopasnosti Rossiiskoy Federatsii*,' *Voyennaya Mysl'*, No. 1, January 2015, pp. 3–10; *Voyennaya Doktrina Rossiiskoy Federatsii'* (Military Doctrine of the Russian Federation), 2014, https://rg.ru/2014/12/30/doktrina-dok.html, Section 12, point G; and Section 21, point M; V. A. Sobolevskiy, A. A. Protasov, V. V. Sukhorutchenko, '*Planirovanie primeneniya strategicheskikh vooruzhenii*,' *Voyennaya Mysl'*, No. 7, July 2014, pp. 9–27; A. V. Nedelin, V. I. Levshin, M.E. Sosnovsky, '*O primenenii iadernogo oruzhiya*

Russia's Armed Forces have long struggled to locate and fix enemy targets and follow up with precision strikes. After reshaping Soviet-era concepts through technology to close the time gap between reconnaissance and precision strikes or fires, Moscow has implemented a network-centric approach to combat and operations. This has been realized in the creation of an integrated Reconnaissance-Fire System, trialed and tested in military exercises and during operations in Ukraine and Syria. The new Reconnaissance-Fire System allows combat units to conduct operations in real time and greatly increases the speed and accuracy of Russian fires on the future battlefield. This process has already made significant progress, with its future development earmarked as a high priority in Moscow's defense planning. The ROS is a network-centric capability offering vastly enhanced target acquisition and strikes across the range of Russian systems capable of targeting ground targets, and especially benefits artillery systems.[103]

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dlya deeskalastii voennikh dyestvii," *Voyennaya Mysl'*, No. 3, May–June 1999, pp. 34–37.

[103] A. V. Anan'yev and S. V. Filatov, '*Obosnovaniye neobkhodimosti sozdaniya mezhvidovogo razvedyvatel'noudarnogo kompleksa bespilotnykh letatel'nykh apparatov malogo klassa dlya aviatsionnogo formirovaniya*,' *Vozdushno-Kosmicheskiye Sily: Teoriya i Praktika*, No.13, 2020; '*O sozdanii razvedki i ognya kompleks s BPLA Orlan-10 dlya vypolneniya osobo otvetstvennykh zadach*,' *Tsentr Spetsial'nykh Tekhnologiy Voyennoy Artilleriyskoy Akademii Rossiyskoy Federatsii*, St.Petersburg, 2017; M. M. Matveevsky, M. A. Saronov, '*Organizatsiya i vedeniye razvedki v interesakh boyevogo primeneniya raketnykh voysk i artillerii v sovremennykh operatsiyakh*,' *Voyennya Mysl'*, https://vm.ric.mil.ru/Stati/item/117170/,October 2017; O. Yu. Kashirina, Ye. I. Kashirina, V. V. Kulakov, V. A. Shamanov, '*Osnovnyye napravleniya razvitiya perspektivnykh avtomatizirovannykh kompleksov v interesakh Sukhoputnykh voysk*,' *Izvestiya Instituta inzhenernoy fiziki*, No. 4, 54, 2019; A. V. Polyanskov, M. S. Spirin, '*Sistemnyye napravleniya razvitiya razvedyvatel'no-informatsionnogo obespecheniya podsistemy upravleniya raketnymi voyskami i artilleriyey yedinoy sistemy upravleniya takticheskogo zvena*,' *Nauka i Voyennaya Bezopasnost'*, No.3, 2015.

Contemporary Russian military thought on the changing character of war and implications for future warfare contains features that appear "futuristic," but the political-military leadership supported by mainstream Russian military theorists' work on future warfare envisages the modernization of the hard power elements of conventional military capability to form the core of that long term vision. This will involve maintaining elements of fourth generation capability, modernizing its fifth generation (nuclear), consolidating and continued development of sixth generation and movement towards a new seventh generation capability. Moreover, Moscow's continued exploitation of advanced technology in pursuit of its military modernization extends into further developing EW, UAV strike and reconnaissance systems and hypersonic strike capability, as well as low-yield nuclear warheads. In short, Russian military thought on the changing character of war, drawing on its Soviet heritage, has come of age and, with the support and investment of the political leadership, has entered the sixth-generation warfare era to exploit high technology to shape the future battlespace.

2.

The Revolution in Russian Military Decision-Making

Russia's military modernization and reform of its conventional Armed Forces since 2008 has resulted in the formulation of a credible and potent set of military capabilities.[1] Moscow's experience of military conflict in the 1990s and early 2000s, largely tied to counter-insurgency operations in Chechnya, gradually convinced the political-military leadership of the futility of maintaining Cold War–era structures, doctrines, arms and equipment, and force structures. The Russia-Georgia War of August 2008 proved pivotal in shifting the political-military leadership away from concepts such as "mass mobilization" and toward a force structure capable of embracing modern information-era forms of warfare: massive numbers of deployed forces gave way to broadly exploiting the information space to change the way the Russian military conducts battlefield operations. At the heart of this transformation was the adoption and use of high technology to exponentially enhance the speed and efficiency of military decision-making. This has revolutionized how

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[1] The author is grateful to Major Charles Bartles for the graphics used in this chapter for illustrative purposes.

these processes are handled by senior commanders on down to the tactical levels of combat operations. Russia's Armed Forces have their own distinctive military culture and approaches to the entire panoply of military issues. This is especially the case when it comes to the complex processes involved in military decision-making, as it includes the structures of the Armed Forces, military personnel, as well as increased reliance upon and use of modern technologies. In the early 2000s, for example, the Russian Armed Forces were unable to generate digital communications through the command-and-control (C2) structures and had to reply upon a paper-bound process.[2] This is no longer the case, as the modernization of C2 has since markedly progressed. Russia's current military decision-making process is, therefore, clearly distinctive, and not only reflects their unique military culture but also the changing nature of modern combat operations in an information-centric era.

The following chapter examines the complex contours of the processes of decision-making in the Russian military as well as the various influences involved and how Russia's experience has differed, at times vividly, from the approaches or standard methods within North Atlantic Treaty Organization (NATO) militaries. The chapter purposefully avoids examining the theory of military decision-making and concentrates on the practicalities of who is involved and how this intricate process is handled. It is aimed at informing defense planners and military decision-makers within NATO to better understand the nature of this process in Russia's Armed Forces. In particular, the following study seeks to identify the areas in which Russia's Armed Forces are making marked progress to improve the *speed and*

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[2] Aleksey Leonkov, '*Nash asimmetrichnyy otvet na amerikanskiye setetsentricheskiye voyny*,' *Zvezda Weekly*, https://zvezdaweekly.ru/news/t/20181041654-460kh.html, October 16, 2018.

effectiveness of military decision-making, as well as to explore some of the challenges and vulnerabilities still facing Moscow.[3]

Consequently, the chapter divides into three parts. In the first, the Russian military decision-making architecture is outlined, identifying the core elements of the state and its military machinery as well as assessing which of these are involved in or influence the decision-making process. The second part considers how this process unfolds or is handled at the various levels, from strategic to operational to the tactical. The third part examines the critical role played by the transition of the Russian Armed Forces into the information era, specifically the pivotal function of automated C2 systems. In order to avoid misrepresenting the extent to which advances have been made in this area, primarily as a result of the reforms in Armed Forces initiated in late 2008, some of the challenges and vulnerabilities facing Russian military decision-making will also be assessed.

The 18th century Russian military leader Alexander Suvorov (1729–1800) rightly identified the importance of *speed and time* in achieving success on the battlefield: "One minute can decide the outcome of the battle, one hour the outcome of the campaign, and one day the fate of empires." This truism is even more accentuated in modern approaches to the conduct of warfare, reflecting the fact that its *means and methods* have radically changed by utilizing advanced technologies in the information era. Indeed, it is the central driving force behind Moscow's effort to introduce high technology into its C2, and its wider adoption of command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR): speeding up the process of decision-making and C2 for the singular purpose of acting faster than the future adversary. This has compelled shifts in how modern militaries assess, use, and try to manipulate time

[3] Yu. Bobkov and N. Tyutyunnikov, *Kontseptual'nyye Osnovy Postroyeniya ASU Sukhoputnymi Voyskami VS RF,* Moscow: Paleotip, 2014.

and space factors in their planning processes. Russia's political-military leadership has also recognized this evolution in modern warfare and, as a result, applied systemic changes to its Armed Forces' structures, as well as introduced modern technologies and approaches to the conduct of combat operations. A crucial driving factor in these efforts to reform and modernize Russia's military is the focus on enhancing the speed and efficiency of the C2 bodies in order to achieve the aim of improving decision-making and the timely execution of decisions. In short, their aim is to be able to act faster than the potential adversary.[4]

The complexity of describing and assessing this process in Russia's Armed Forces partly stems from an issue of terminology. Many of the terms used by the militaries of the United States or its NATO allies do not quite fit the Russian context. For example, the term anti-access/area denial (A2/AD) is a familiar one to Western militaries. However, when the term features in Russian military publications, it is always used to refer to foreign armed forces and their approaches to this concept. Nonetheless, there is clearly a set of capabilities in existence in the Russian military, which, when combined, does, in fact, constitute an A2/AD capability.[5] Similarly, in US and NATO parlance, the term Military Decision-Making Process (MDMP) is not only common, but military personnel are expected to be familiar with the constituent parts of both the long and shortened versions of the

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[4] Sergey Valchenko, Aleksey Ramm, '*Siriyskiy opyt prodlit zhizn' Gvozdik*,' *Izvestia*, https://iz.ru/668996/sergei-valchenko-aleksei-ramm/siriiskii-opyt-prodlit-zhizn-gvozdik, November 17, 2017.

[5] Author video teleconference (VTC) with retired Russian officers, Moscow, November 2020; '*Rossiyskiye 'Iskandery' vpervyye perebrosili na ucheniya v Tadzhikistan,*' *Nezavisimoye Voyennoye Obozreniye*, http://www.ng.ru/news/582227.html, May 25, 201; Arkadiy S. Borzov, '*VKO: pora prekratit' terminologicheskiye diskussii,*' *Vozdusho-Kosmicheskaya Oborona*, http://www.vko.ru/koncepcii/vko-pora-prekratit-terminologicheskie-diskussii, No. 4, August 4, 2010.

MDMP. In Russian military publications, the term again is always used to describe how foreign militaries conduct the MDMP. It is not a term in use within the Russian Armed Forces; though such a process evidently exits.[6] This author has no access to current Russian military regulations, since these are classified and accessible primarily to serving military personnel. However, apart from the wider body of military publications, the term MDMP cannot be found in *Voyennaya Entsiklopediya* (*Military Encyclopedia*) or *Voyennyy Slovar* (*Military Dictionary*).

Nonetheless, the concept of an MDMP undoubtedly exists within the Russian Armed Forces, along with its algorithm and checklist. Indeed, it is the main element in the formal procedure of battle-order (*boyevoy prikaz*) development. According to *Voyennyy Slovar*, *boyevoy prikaz* development follows a set pattern. It sets tasks for subordinate forces during the preparation and conduct of combat operations. These should be "brief, extremely clear, excluding the possibility of different interpretations." It includes an overview of the force grouping command element and the likely nature of the ensuing actions, delineates the combat mission, plans the combat operation, sets priorities, and distributes the tasks and objectives to the relevant force elements. The orders can then be issued in written form or orally.[7]
Since there is an absence of a "go to" source to describe and assess the Russian MDMP, a different approach is needed to discover its outlines. This author deduces some of the elements of that process through analysis of the post-reform command structures for combat

[6] Author VTC with retired Russian military officers, Moscow, December 2020.

[7] *Voyennyy Slovar'*, https://encyclopedia.mil.ru/encyclopedia/dictionary/details_rvsn.htm?id=3549@morfDictionary, Accessed, May 3, 2019.

operations.[8] An additional method is to examine how the Russian General Staff and military planners and commanders view the strategic, operational, and tactical levels of operations and how this influences their MDMP. Arguably, the transition toward network-centric approaches to warfare, with the introduction of automated C2 and, indeed, the wider adoption of C4ISR, plays a unifying role in this process, which is designed to maximize both speed and efficiency. Therefore, the sources for this chapter are almost exclusively Russian military publications and professional Russian military journals.

The Russian Military Decision-Making Architecture

The military decision-making process in Russia's Armed Forces must be understood in the context of its military reform and modernization since 2008 and, in particular, the conceptual shift that has attended these developments. As already noted, the decision-making process until these reforms were initiated was largely paper-bound. The transformation in Russia's Armed Forces over the past decade has been driven by transitioning the force structures into the modern information era. Conceptually, Moscow placed C4ISR capability and the introduction of network-centric approaches to warfare at the epicenter of its Armed Forces transformation and modernization drive since 2008.[9] It is a unifying theme in the transformation and underpins the defense industry's support for modernization. Moreover, it guides and shapes experimentation with force structure, manpower and the application of network-enabled operations in an informationized combat environment. Therefore, while initially used

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[8] See: Lester Grau, Charles Bartles, 'The Russian Way of War,' Military Mentor, 2018.

[9] A. Garavskiy, '*Svyaz reshaet vse*,' *Krasnaya Zvezda,* 4 June, 2010; B. Cheltsov, I. Zamaltdinov, S. Volkov, 'NATO and Western Countries' Work on 'Network-Centric' Warfare and Russia's Slowness in This Area,' *Vozdushno kosmicheskaya oborona,* June 21, 2009.

as a mechanism to promote reform and modernization, within the past several years this process has matured and moved significantly to implementation and working out its implications for future force development.[10]

This process has resulted in numerous practical experiments, advances in capability, and the slow but highly important step of developing and procuring automated command, control and communications (C3) systems. Progress is also evident in introducing improved surveillance and reconnaissance capability, combined with vigorous efforts to upgrade and innovate in terms of electronic warfare, which Russian defense planners see as symbiotic with progress in network-centric capability. Some of these unifying features in Russia's ongoing military transformation provide pointers as to the likely shape and extent of its future conventional military capability. This is a capability that will prove to be more important for Russia's military planners as a tool set to indirectly or directly challenge the US and NATO or other powers on Russia's periphery, depending on the nature of possible conflicts. By adopting network-centric approaches to modern warfare, Russia's General Staff sought to use this as a means to enhance the speed of C2 and, therefore, to greatly improve the overall efficiency of its military decision-making.[11]

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[10] V. I. Korchmit-Matyushov, '*Teoriya voyn*,' M.:BFRGTZ, *Slovo*, 2001; S. A. Parshin, Yu. Ye. Gorbachov, Yu. A. Kozhanov, '*Sovremennyye tendentsii razvitiya teorii i praktiki upravleniya v vooruzhonnykh silakh SShA*,' Moscow: LENAND, 2009; '*Khochesh' mira, pobedi myatezhevoynu! Tvorcheskoye naslediye*,' *Ye. E. Messnera/russkiy voyennyy sbornik*, No.21, 2005; V. I. Slipchenko, '*Voyny novogo pokoleniya: distantsionnyye i beskontaktnyye*,' M., OLMA-PRESS obrazovaniye,' 2004; M. A. Gareev and V. I, Slipchenko, *Budushchaya voyna*, Moscow, OGI, 2005; '*Setetsentricheskaya voyna. Daydzhest po materialam otkrytykh izdaniy i SMI*,' Moscow. VAGSH VS RF, 2010.

[11] V. D. Dobykin, A. I. Kupriyanov, V. G. Ponomarov, L. N. Shustov, *Radioelektronnaya bor'ba. Silovoye porazheniye radioelektronnykh sistem,* M.: Vuzovskaya kniga, 2007; A. I. Paliy, *Ocherki istorii radioelektronnoy bor'by*, M.:

Russia's intervention in Ukraine revealed little that was network-centric in essence. However, there were experiments with network-centric warfare during Russian military operations in Syria, which most strikingly has shown an absence of massed artillery fires in favor of greater use of precision strikes and unmanned aerial vehicles (UAV) used for immediate bomb damage assessment (BDA). Nonetheless, most of the Russian operations in Syria have involved non-precision-guided weapons; and certainly, network-centric-based experimental operations constitute a much smaller fraction of the total. [12] It remains difficult to gauge the extent of progress in this area, but the general picture of advancing toward fuller network-centric warfare capability is consistent with progress in areas such as C2 and especially in electronic warfare and the wider theme of "informationizing" the Armed Forces. Russian specialists anticipate continued progress in developing network-centric capability so long as the state continues to provide sufficient financial investment in this endeavor. A critical element of this process is the transformation of the military decision-making by utilizing modern advanced technologies.[13]

In the writings of Russian military scientists, there is a deep understanding of and body of knowledge on Western approaches to

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Vuzovskaya kniga, 2006; *Sovremennaya radioelektronnaya bor'ba. Voprosy metodologii*, M.: Radiotekhnika, 2006; V. V. Tsvetnov, V. P. Demin, A. I. Kupriyanov, *Radioelektronnaya bor'ba. Radiomaskirovka i pomekhozashchita,* M.: MAI, 1999, T. 1; V. V. Tsvetnov, V. P. Demin, A. I. Kupriyanov, *Radioelektronnaya bor'ba. Radiorazvedka i radioprotivodeystviye*, M.: MAI, 1998, T. 2; Chernavin V. N., *Voyenno-morskoy slovar'*, M.: Voyenizdat, 1990; *Entsiklopediya 'Oruzhiye i tekhnologii Rossii. XXI vek'* Tom 13, '*Sistemy upravleniya, svyazi i radioelektronnoy bor'by*.'

[12] O. V. Tikhanychev, '*O roli sistematicheskogo ognevogo vozdei'stviia v sovremennykh operatsiiakh*,' *Voyennaya Mysl'*, No. 11, November 2016, pp. 16–20.

[13] Author interviews with Russian SMEs, December 2016.

network-centric warfare; they tend to analyze the operational experience of such operations and draw conclusions concerning the relative strengths and weaknesses of such approaches. Additionally, Russian specialists have sought to study and draw lessons from examples of Western militaries (such as Sweden) that tried but later abandoned efforts to introduce network-centric warfare—in order to avoid these pitfalls in Russia. Russian analysis of US/NATO network-centric warfare is also closely linked to how Russia's military intelligence (GRU) specialist officers follow, assess and understand the concept and the key trends involved.[14] Many of these specialists were writing on network-centric warfare and what this may mean for Russian C2 in an overall search for ways and means to enhance both military capabilities and the speed of decision-making.[15] A major area of concern was how to learn from the foreign operational experience of network-centric operations and adapt this to fit Russia's military culture.[16]

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[14] Jacob W. Kipp, 'Promoting the New Look for the Russian Armed Forces: the Contribution of Lieutenant-Colonel Aleksandr Kondratyev,' *Eurasia Daily Monitor*, Volume 7, Issue 113, The Jamestown Foundation, June 11, 2010, https://jamestown.org/program/promoting-the-new-look-for-the-russian-armed-forces-the-contribution-of-lieutenant-colonel-aleksandr-kondratyev/.

[15] A. Kondratyev, '*Problemy organizatsii aviatsionnoi podderzhki operatsii sukhoputnykh voisk SShA*,' *Zarubezhnoe Voennoe Obozrenie*, No. 9, November, 2009; A. Kondratyev and A. Medin, '*Doroga SShA k novomu obliku sukhoputnykh voisk,*' *Voyenno Promyshlennyy Kuryer*, October 14, 2009; A. Kondratyev, '*Edinaia razvedka evrosoiuza: byt ili ne byt?*' *Voyenno Promyshlennyy Kuryer,* February 25, 2009.

[16] A. Kondratyev, '*Problemnye voporsy issledovaniia novykh setetsentricheskikh kontseptii vooruzhennykh sil vedushikh zarubezhnykh stran*,' *Voyennaya Mysl*, No. 11, November, 2009, pp.1–74; V. V. Kvochkov, Y. A. Martsenyuk, 'On the Character of Wars and Armed Conflicts With the Participation of the Russian Federation,' *Voyennaya Mysl*, No. 2, 2002.

Despite these issues, the idea of network-centric warfare has been preserved as one of the key drivers in conventional military modernization.[17] For the top brass and defense planners in Russia, this means they rely upon "learning by doing," and, therefore, they pay closer attention to the experimental use of networked operations in the Syrian theater to better understand how this may be furthered in future planning and subsequent shaping of the internal military structures as well as modernization priorities.

Indeed, recent work by Russian military theorists acknowledges that the adoption of network-centric capability in Russia's Armed Forces will involve a change in the outlook of the military leadership at all levels, forming the automated infrastructure, operating in a single information space, further developing modern means of surveillance and reconnaissance to fill the modernized telecommunications networks, and populating the Armed Forces with a "sufficient number of high-precision weapons."[18] Clearly, this involves long-term and systemic work on the part of Russian defense planners to integrate combat platforms into such an information network, accommodating this type of change to appropriate measures related to military manpower and training.[19] Such processes are heavily influencing and transforming approaches toward military decision-making.

Thus, following several years of experimentation with network-centric approaches and what this means for force structure, education,

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[17] Yu. Ye. Donskov, S. V. Golubev, A. V. Mogilev, '*Model' podgotovki spetsialistov radioelektronnoy bor'by k vypolneniyu zadach po informatsionnomu obespecheniyu voyennykh (boyevykh) deystviy*,' *Voyennaya Mysl'*, No. 4, 2015.

[18] '*Iranskiy BLA, Khamashekh vpervyye prinyal uchastiye v uchebnykh manevrakh KSIR*,' *Voenno-Tekhnicheskoe Sotrudnichestvo*, April 2016; Dmitriy Litovkin, 'A*rmiya perekhodit na elektronnyye pasporta*,' *Izvestia*, July 26, 2016.

[19] Anatoliy Isayenko, '*Nastupayet Era Tsifrovogo Mirotvortsa*,' *Nezavisimoye Voyennoye Obozreniye*, November 13, 2015.

training and operational tactics, Russian top brass and theorists are in broad agreement that the concept in the Russian context may be used to inspire, shape and drive the defense industry's work to modernize the country's Armed Forces. Network-centrism is not an end in itself, avoiding what some theorists describe as a "mental trap," but a method to achieve an additional "force multiplier" in the state's future war fighting capability.[20]

The Elements of the Military Decision-Making Apparatus

In the Russian military decision-making process, the distinctive culture and military traditions of the country's Armed Forces are necessary to understand in order to recognize the extent to which this process does not simply mirror US/NATO approaches to and methods of conducting the MDMP. In the Russian context, the roles played by certain structures are important, as is the significance of personality and the abilities and competences of commanders in the field. First, the constituent parts of the reformed Russian military chain of command for combat operations must be outlined, since it is into this context that the Russian MDMP is also conducted. This framework for the overall approach to the MDMP has emerged over the past decade as Moscow carried out widespread structural reorganization of the Armed Forces and its C2. As noted, this is designed to improve efficiency and speed in C2, as well as to position the Armed Forces to conduct operations in an information-driven operational environment.

A three-tiered simplified C2 structure was followed, in June 2010, by a declared target of forming four new military districts/joint strategic commands (*Obyedinennyye Strategicheskoye Komandovanie*—OSK)

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[20] V. Kovalov, G. Malinetskii, Y. Matviyenko, '*Kontseptsiya 'setetsentricheskoy" voyny dlya armii Rossii: 'mnozhitel' sily' ili mental'naya lovushka?' Vestnik, Akademii Voyennykh Nauk*, No.1, (50), 2015.

by December 1, 2010. The new districts/commands were formed on four strategic axes: West (headquarters in St. Petersburg), East (headquarters in Khabarovsk), Central (Yekaterinburg) and South (Rostov-on-Don). The Western MD/OSK was based on the Moscow and Leningrad MDs, and the Baltic and Northern Fleets. The Eastern MD/OSK comprised the former Far East MD, the eastern part of the Siberian MD and the Pacific Fleet. The Central MD/OSK included the western part of the Siberian MD and the Volga-Urals MD. And the Southern MD/OSK merged the North Caucasus MD and the Black Sea Fleet and the Caspian Flotilla.[21] In April 2019, the defense ministry set the target of December 2019 to upgrade the status of the Northern Fleet to that of an OSK.[22]

These command elements are essentially dual hatted, drawing from Western, Southern, Central and Eastern MDs/OSKs. On December 1, 2015, a fifth OSK was formed: the Northern OSK. Also, by December 1, 2014, a new integrating structure was established in Moscow: the National Defense Management Center (*Natsionalnyy Tsentr Upravleniya Oboronoy*—NTsUO), aimed at inter-connecting the leadership and direction of defense and security structures in real time.[23] In peacetime, these commands function as MDs; they transition to OSKs during military operations. The high-command elements of the Ground Forces, Aerospace Forces (*Vozdushno Kosmicheskikh Sil*—VKS) as well as the Military-Maritime Fleet (*Voyenno-Morskoy Flot*—VMF) are, in effect, structural subunits of

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[21] Grigoriy Maslov, 'They Will Divide the Russian Armed Forces by the Compass,' *Infox.ru*, April 30, 2010.

[22] Aleksey Ramm, Aleksey Kozachenko, Bogdan Stepovoy, '*Polyarnoye vliyaniye: Severnyy flot poluchit status voyennogo okrug*a,' *Izvestia*, April 19, 2019, https://iz.ru/869512/aleksei-ramm-aleksei-kozachenko-bogdan-stepovoi/poliarnoe-vliianie-severnyi-flot-poluchit-status-voennogo-okruga.

[23] '*Natsional'nyy tsentr upravleniya oboronoy RF zastupit na boyevoye dezhurstvo 1 dekabrya*,' *TASS*, October 26, 2014, http://tass.ru/armiya-i-opk/1533288.

the General Staff. And the command process was simplified by reducing the number of stages orders pass through from 16 to 5.

An additional change to the military district system was introduced on January 1, 2021, with the Northern Fleet upgraded to the status of an MD, as part of a reorganization of the overall structure of MDs. According to the *ukaz* (decree) signed by President Vladimir Putin on December 21, 2020, the purpose in this upgrade was "[t]o consider the Northern Fleet an inter-specific strategic territorial association of the Armed Forces of the Russian Federation, performing the tasks of a military district." This is rationalized in the *ukaz* by linking it to measures to protect the integrity and inviolability of the Russian Federation and to defend the country's northern borders as well as Moscow's evolving interests in the Arctic.[24]

Moreover, in June 2020, Putin signed an *ukaz* giving the Northern Fleet the status of a separate military-administrative unit. Some parts of the Western MD/OSK were cut and subordinated to the new Northern Fleet MD/OSK: the Komi Republic, the Arkhangelsk and Murmansk regions, as well as the Nenets Autonomous District. The former commander of the Northern Fleet, Admiral Vyacheslav Popov, explained, "From January 1, 2021, the Northern Fleet will *de jure* perform the tasks of the military district, which exist *de facto*. This, in particular, involves the solution of issues of mobilization, conscription, interaction with authorities, [and] the creation and

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[24] '*Severnyy Flot Rossii Poluchil Status Voyennogo Okruga,*' *Interfax*, https://www.interfax.ru/russia/743819,January 1, 2021, https://www.interfax.ru/russia/743819; '*Severnyy Flot s 1 Yanvarya Budet Vypolnyat' Zadachi Voyennogo Okruga,*' *Izvestia*, December 21, 2020, https://iz.ru/1102711/2020-12-21/severnyi-flot-s-1-ianvaria-budet-vypolniat-zadachi-voennogo-okrug.

development of the infrastructure of the Northern Sea Route."[25] The change to the status of the Northern Fleet is a departure from the system created in 2010, as the original concept was to subordinate all military and security units and assets within the MD to the OSK commander (with the exception of units and assets under the direct control of the General Staff). By contrast, the updated system places all units in each arm and branch of service as well as security agencies within the geographical area of the Northern Fleet MD/OSK, directly under the control of the commander of the Northern Fleet, Admiral Aleksandr Moiseev. That change effectively makes the commander of the Northern Fleet "dual hatted," in charge of this key naval fleet in the VMF while simultaneously commanding the MD/OSK.

[25] Yury Gavrilov, '*Flot Ukhodit v Avtonomku Severnyy Flot Rossii Priravnyali k Voyennomu Okrugu*,' *Rossiyskaya Gazeta*, December 22, 2020, https://rg.ru/2020/12/22/severnyj-flot-rossii-priravniali-k-voennomu-okrugu.html.

Figure 1: Russia's Military Districts/Joint Strategic Commands (January 2021)[26]

The NTsUO will eventually be fully connected to subordinate command centers linking strategic-operational and tactical levels; this will likely be implemented by 2027, with further technological refinements to follow. It will link the OSKs and army group levels.[27] At tactical levels, the ground forces are overcoming automated C2 problems and implementing network-centric warfare capabilities through a variety of new technologies. This broadly fits the procurement and modernization priorities into a much broader network-centric framework.[28] These include: new tactical radios, a

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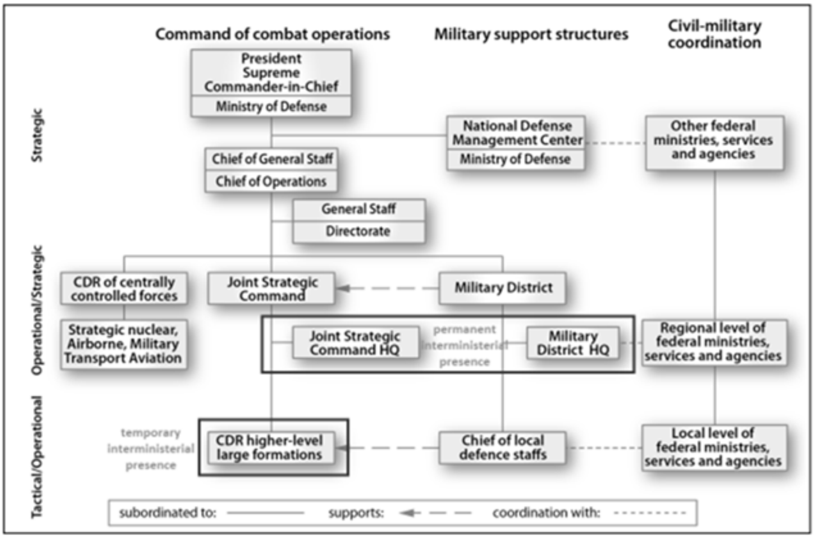
[26] Based on the structure of MDs/OSKs displayed on the Russian defense ministry website, accessed on January 7, 2021.

[27] Ye. O. Ostroovskiy and A. S. Sizov, '*Podkhod k modelirovaniyu kognitivnoy sfery ob'yektov operativnoy razvedki*,' *Voyennaya Mysl'*, No. 2, 2016.

[28] '*Ukazatel' Statey, Opublikovannykh V Zhurnale 'Morskoi' Sbornik*,' *Morskoi' Sbornik*, No. 12, 2015.

tactical digital mobile subscriber system (military digital cell phone and data system), tactical laptops and tablets, as well as a secure military intranet.

Figure 2: Assessed Chain of Command for Combat Operations[29]



In terms of the changes made to the MD/OSK system, the role of the commander of the MD/OSK has been greatly boosted. The commander of the OSK during combat operations has control over all military and uniformed services in the OSK, apart from strategic-level assets placed under the General Staff, such as the Airborne Forces (*Vozdushno-Desantnye Voyska*—VDV) or military intelligence special forces (GRU Spetsnaz). In addition to this change, the

[29] This graphic is based upon one shown in Gudrun Persson (Ed.), "Russian Military Capability in a Ten-Year Perspective—2016," *Swedish Defense Research Agency* (*FOI*), December 2016. The original graphic does not depict the National Security Council, which consists of various military officers and civilian ministry and agency heads. These members of the National Security Council serve in senior positions at the operational and strategic levels in the boxes shown above.

introduction of the NTsUO is also important, as it brings together many of the key decision-makers to interact in real time and oversee, guide, and fine-tune the MDMP. It is no doubt calculated to aid network-centric approaches to combat operations, but it remains a work in progress and will take time to fully integrate all the various nodes in the Russian military system. The NTsUO is also surely intended to overcome the traditional stove-piping in the Russian military decision-making system; but this will also take time and effort to overcome institutional inertia.

The roles of the General Staff and the Russian Security Council as elements influencing, at times indirectly, the overall architecture for military decision-making are outlined by Major Charles Bartles in an important article examining how Russia might create a framework to conduct large-scale military operations:

> In the Russian system, the General Staff is responsible for operational-strategic-level planning. Russia has a fairly nuanced view of the differences between the tactical, operational, and strategic levels of military science. The difference between these levels is based upon the scope of mission, not simply the size of the unit. For example, a brigade fighting under an army group would be considered a tactical asset, but the same brigade fighting independently in a different situation could be considered a tactical-operational asset. Generally speaking, the General Staff's operational planning duties typically involve the operational and operational-strategic level, or, in Russian parlance, "operational art." Proponency for strategic planning resides with the Russian Security Council, which is an inter-ministerial body that is chaired by high-level officials, weighted heavily with the intelligence and security services. Although the Russian Security Council is the main proponent of Russian strategy, the chief of the Russian General Staff does sit on the

> council, bridging operational art to the national security strategy.[30]

As Bartles also notes, it is equally important to understand what the General Staff does not do. It has no operational control over forces. Operational control was removed from the service chiefs and placed in the hands of the OSK commanders. Therefore, in combat, war-fighting assets are under the control of the appropriate field commanders rather than the General Staff.[31] Thus, the role of *individual commanders* in the Russian MDMP is more pronounced than in Western militaries.

Strategic, Operational and Tactical Levels

Many of these structural themes and unique aspects of Russian military approaches to the reformed C2 system feed directly into the Russian variant of the MDMP. A close linkage exists between these structures and the focal point of commanders within the system across strategic, operational and tactical levels. In short, the Russian MDMP seems predicated on the commander being competent and having strong leadership skills, supported by a relatively weak staff. In this system and within the Russian variant of the MDMP, the personalities of the commanders in the field and, at strategic levels, the OSK commanders play a highly significant role. It is also clear that in the future, the NTsUO will play an increasingly crucial function in smoothing out some of the problematic issues involved in conducting operations using automated C2 as well as in efforts to integrate and streamline the issues facing the future development of the MDMP.

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[30] Charles K. Bartles, 'Russian Force Structure for the Conduct of Large-Scale Combat Operations,' *Military Intelligence Professional Bulletin*, January 2019.

[31] *Ibid.*

In terms of command and control at the strategic level, the commander-in-chief will most likely play a critical and "hands-on" role. This might change in the future, in the aftermath of the Putin era, but it seems the system in which the overall Russian MDMP occurs is designed to be "top heavy," and that is unlikely to change in the foreseeable future. A good illustration of this was offered by Army General Valery Gerasimov, the chief of the General Staff (CGS). Gerasimov noted that in terms of Russia's military operations in Syria, Putin had involved himself in the planning on a regular basis as well as in setting operational aims. Asked about Putin's involvement in overseeing Russia's military operations in Syria, Gerasimov said,

> I usually report to the minister of defense on a daily basis, morning and evening, on the state of affairs and the progress in mission performance, and he reports to the president. Once or twice a week, the minister reports to the president in person, presenting the requisite documents, maps and video materials. Sometimes, the Supreme Commander-in-Chief himself comes to see me; sometimes, the defense minister and I go to him to report. The president identifies the targets, the objectives; he is up to speed on the entire dynamic of the combat operations. And in each sector—moreover. And of course, he sets the objectives for the future.[32]

An additional "work in progress," already alluded to is the theme of fuller integration of C4ISR and automated C2 to produce a more joined-up approach toward planning and coordinating military operations. Here, a significant role is assigned to the NTsUO, which, as more technologies are introduced and flaws in the "stove piping" are resolved, will play an enhanced role in overseeing operations in

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[32] Viktor Baranets, '*Nachal'nik Genshtaba Vooruzhennykh sil Rossii general armii Valeriy Gerasimov: 'My perelomili khrebet udarnym silam terrorizma,''* *Komsomolskaya Pravda*, December 26, 2017, https://www.kp.ru/daily/26775/3808693.

real time. The interface between the national political leadership, General Staff, defense ministry and OSKs down to temporary mobile HQs during military operations would be the NTsUO. Next in the chain is the OSK leadership, which means that during wartime, the OSK commander has overall control of military forces within his OSK, including the non-defense ministry forces, except for some strategic assets under General Staff control, such as the Strategic Rocket Forces (*Raketnye Voyska Strategicheskogo Naznacheniya*—RVSN), Airborne (VDV) and GRU Spetsnaz units. Then in the order of command would be the assets under the command of the OSK: for example, in terms of the Western MD/OSK, these are the 6th and 20th combined arms armies and the 1st Tank Army.[33]

The recent history of Russia's operational-strategic exercises reveals that the political-military leadership places great emphasis upon internal strategic mobility, and so it is highly likely that units would move from other OSKs in the pre-conflict phase. Equally, there is almost no possibility of the General Staff attempting to use the approach seen in southeastern Ukraine to assemble forces for large-scale conflict for two critical reasons. First the operational environment would differ as the adversary also differs in scope and capability, and the use of Battalion Tactical Groups (BTG), which Russia's General Staff associates with local wars and armed conflicts, is not the tactical means to be used in large-scale inter-state warfare.

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[33] Oleg Vladykin, '*Zapad-2017 natselen na zashchitu Vostoka*,' *Nezavisimoye Voyennoye Obozreniye*, September 15, 2017, http://nvo.ng.ru/realty/2017-09-15/1_965_west2017.html; '*Pochemu Zapad-2017 vyzval isteriyu na Zapade*,' *Nezavisimoye Voyennoye Obozreniye*, September 8, 2017, http://nvo.ng.ru/gpolit/2017-09-08/2_964_nvored.html; Ivan Dragomirov, '*Soldatam – udachi!*' *Voyenno Promyshlennyy Kuryer*, September 19, 2017, https://www.vpk-news.ru/articles/39002; '*Sily PVO Zapadnogo voyennogo okruga razvernulis' v novykh rayonakh na ucheniyakh Zapad-2017*,' *TASS*, September 16, 2017, http://tass.ru/armiya-i-opk/4567491; 'Baltic Fleet corvettes destroy air, sea and coastal targets during Zapad-2017 drills,' *TASS*, September 17, 2017; Zapad 2017, Livejournal, September 20, 2017, https://bmpd.livejournal.com/2857093.html.

That is to say, the structure would be: OSKs–army groups–divisions/regiments–brigades, and not focused on BTGs. The BTGs are not intended for use in this level of operation.[34] The flexible army groups with their tactical maneuver assets (divisions and brigades) would be the main constituent parts of the *obyedineniya* (i.e., army groups, fronts, Strategic High Command).

Western and Russian analyses of Vostok 2018, for example, tended to be somewhat overshadowed by Moscow's decision to invite China to send forces to that exercise. However, in referring to that year's annual operational-strategic exercise (*Operativno-Strategicheskie Ucheniya*)[35]—Vostok 2018—CGS Gerasimov used the phrase *strategicheskiye manevry* (strategic maneuvers), adding that Russia needs more of these exercises. It is unclear how Gerasimov understood the elevation of terms or whether the presence of People's Liberation Army (PLA) units served as the reason to claim a "new level" in the annual exercise.[36] Vostok 2018 focused on five combined-arms and four air-defense training grounds in the Eastern and Central MDs/OSKs. It also involved the VKS, VDV, and the Northern and Pacific fleets. The commander of the Central MD/OSK, Lieutenant General Alexander Lapin, noted the "unprecedented" scale of the exercise would entail "new forms and methods of combat" based on lessons drawn from Russia's operations in Syria. But he made no

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[34] Popov, '*Faktor mobil'nosti v sisteme boyevoy gotovnosti Vooruzhennykh Sil*,' *Op. Cit.*

[35] The terms *operativno-strategicheskikh ucheniy* (operational-strategic exercise) and *strategicheskiye komandno-shtabnyye* (strategic command staff [exercise]) are frequently used interchangeably in Russian military literature, though the latter implies fewer forces used or deployed for the exercise.

[36] '*V Rossii podoshla ochered' provodit' strategicheskiye manevry, zayavil Gerasimov*,' *RIA Novosti*, September 9, 2018, https://ria.ru/defense_safety/20180906/1527948289.html.

mention of the rehearsal of large-scale inter-state warfare, even though it clearly featured in the exercise.[37]

Gerasimov provided an outline of the scenario. The exercise was held from September 11 to 17, with the first two days devoted to planning. The second active phase was staged over five days, and its novelty lay in extending the exercise beyond one MD/OSK to include both the Eastern and Central MDs/OSKs, as well as the participation of the PLA. The General Staff appears to use such strategic-level exercises to asses, among other features, the speed and efficiency of the MDMP. The main action would still focus on combined-arms training grounds in the Eastern MD, at four VKS and air-defense training facilities, and in the Okhotsk and Bering seas. Again, noting the scale of the exercise, Gerasimov noted the presence of advanced weapons systems, such as the Iskander operational-tactical system. He said that in the second active phase of the exercise, participating forces would rehearse the repulsion of a "massive air strike" while simultaneously practicing repelling cruise missile attacks, involving VKS air-defense and naval platforms in the Sea of Okhotsk and the northwestern Pacific Ocean. The exercise also envisaged conducting offensive and defensive operations using land, air and sea power. The joint operations conducted with the PLA at the Tsugol training ground rehearsed combined-arms action against a hypothetical opponent; this response was coordinated between Russian forces, PLA units and a small number of troops from Mongolia. A complex range of targets reportedly allowed commanders to form a "front" 24 kilometers in

[37] '*V masshtabnom uchenii Vostok-2018 budut zadeystvovany osnovnyye sily Tsentral'nogo voyennogo okruga*,' *Rambler.ru*, August 30, 2018, https://news.rambler.ru/middleeast/40685993-v-masshtabnom-uchenii-vostok-2018-budut-zadeystvovany-osnovnye-sily-tsentralnogo-voennogo-okruga/; Dmitry Sergeyev, '*Vostok-2018: kakova tsel' samykh masshtabnykh za postsovetskiye gody manevrov voysk*,' *Tvzvezda.ru*, August 21, 2018, https://tvzvezda.ru/news/forces/content/201808210722-xsmd.htm.

length and 8 kilometers deep.[38] On the basis of this detail, some analysts conclude that Vostok 2018 was a rehearsal for large-scale warfare. Yet it also fits a series of conflict types built into an overall scenario to rehearse conflict escalation control.

Such exercises illustrate the Russian approaches to strategic, operational and tactical levels of combat operations, and offer insight into how they seek to fit these together in accordance with the requirements of the exercise scenario vignettes. While the Russian General Staff avoids applying models to its operational planning (as represented in its military exercises), they also believe that the US and NATO do conduct operations based upon templates. Equally, they see the US/NATO MDMPs as fixed and easy to predict in terms of their stages and possible weaknesses.[39] This is evident in Russian military coverage of NATO operations and the interest in countering a massive air attack/campaign; that information is factored into most Russian operational-strategic exercises, with emphasis on countering cruise missile attacks and responding to air sorties.[40] Moreover, when the

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[38] Ivan Dragomirov, '*Vostok – delo gromkoye Bol'shiye vostochnyye manevry proshli ot Zabaykal'skogo kraya do beregov Severnogo Ledovitogo okeana i tikhookeanskogo poberezh'ya Rossii Dragomirov,*' *Voyenno Promyshlennyy Kuryer*, September 18, 2018, https://www.vpk-news.ru/articles/45052; Il'ya Kramnik, '*Vostok s oglyadkoy na zapad: chem interesny ucheniya Vostok-2018 Dlya chego nuzhny samyye krupnyye s sovetskikh vremon manovry*,' *Izvestia*, September 17, 2018, https://iz.ru/789818/ilia-kramnik/vostok-s-ogliadkoi-na-zapad.

[39] The United States' version of the MDMP differs from those of other NATO members. However, sufficient levels of similarity are retained in order to ensure military interoperability within the Alliance.

[40] Oleg Vladykin, '*Zapad-2017 natselen na zashchitu Vostoka*,' *Nezavisimoye Voyennoye Obozreniye*, September 15, 2017, http://nvo.ng.ru/realty/2017-09-15/1_965_west2017.html; "Pochemu Zapad-2017 vyzval isteriyu na Zapade," *Nezavisimoye Voyennoye Obozreniye*, September 8, 2017, http://nvo.ng.ru/gpolit/2017-09-08/2_964_nvored.html; Ivan Dragomirov,

Russian Ground Forces and other arms and branches of service train to fight, they have an enemy in mind. Unlike the US military, which is capability based, the Russian Ground Forces are combat trained to fight based on the General Staff's assessment of the likely threats to the Russian state. This is likely to give the Russian Ground Forces a long-term training edge over their US and NATO counterparts as well as reinforce their conviction that conflict will only occur close to Russia's borders.[41]

Following Vostok 2018, a command-staff exercise was held in October 2018 in the Southern MD featuring large-scale force-on-force maneuvers. The exercise featured elements from the 8th, 49th and 58th combined arms armies, the 22nd Army Corps, the Caspian Flotilla, the Black Sea Fleet, the 4th Air Force and Air Defense Army, military units subordinate to the Southern MD, as well as some Spetsnaz units. Colonel General Aleksandr Dvornikov, the commander of the Southern MD/OSK, stated, "For the first time in exercises of this level, the opposed forces principle was implemented, in which troops in two

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'*Soldatam – udachi!*' *Voyenno Promyshlennyy Kuryer*, September 19, 2017, https://www.vpk-news.ru/articles/39002.

[41] Vladislav A. Morenko and Andrei N. Tezikov, '*Istoricheskiy aspekt razvitiya ASU PVO,*' *Vozdusho-Kosmicheskaya Oborona*, No.1, February 7, 2015, http://www.vko.ru/oruzhie/istoricheskiy-aspekt-razvitiya-asu-pvo; Igor M. Kuptsov, '*Bor'ba s giperzvukovymi letatel'nami apparatami (GZLA): Novaya Zadacha i trebovaniya k sisteme vozdushno-kosmicheskoy oborony (VKO),*' *Voyennaya Mysl'*, No. 1, January 2011, pp.10–17; Anton Balagin, '*Ispytaniya zenitnoy sistemy S-500 nachnutsya do kontsa goda*,' *Russkoye Oruzhiye*, February 1, 2016, http://rg.ru/2016/02/01/s500-site-anons.html; 'S-500 Prometheus," Missile Threat,' April 26, 2013, http://missilethreat.com/defense-systems/s-500/; '*S-500 budet sposobna odnovremenno porazhat' 10 ballisticheskikh tseley s pochti pervoy kosmicheskoy skorost'yu – glavkom VVS,*' *TASS*, December 24, 2012, http://tass.ru/politika/654566; 'ZRK S-400 'Triumf': obnaruzheniye – dal'neye, soprovozhdeniye – tochnoye, pusk – porazhayushchiy,' *Vozdusho-Kosmicheskaya Oborona*, June 3, 2008, http://www.vko.ru/oruzhie/zrs-s-400-triumf-obnaruzhenie-dalnee-soprovozhdenie-tochnoe-pusk-porazhayushchiy.

operational directions conducted combat operations against each other… Prior to the command staff exercise, the troops of the military district conducted just company and battalion tactical exercises." The exercise, as a rehearsal for large-scale force-on-force warfare, did not feature the use of any BTGs but instead rehearsed operations using divisions/regiments and brigades on opposing sides. The General Staff also decided to use units to face off against one another rather than forming an opposing force (OPFOR) to represent the adversary.[42] And, again, with such an emphasis placed upon training for large-scale conflict, this undoubtedly involved testing, refinement and experimentation with the MDMP.

Military Planning and the Russian MDMP

The likely development of the Russian Armed Forces' conventional capability in the period to 2030, providing that sufficient levels of defense spending are maintained in this period, envisages greater force integration and adoption of C4ISR capability, with an array of related capabilities, including precision-guided weapons (PGW), cyber operations and electronic warfare (EW). This has clear implications for the future development of C2 and automated C2, as well as the challenges for commanders in coordinating and executing the MDMP. As noted, the General Staff has factored into the operational-strategic military exercises the concept of fighting large-scale inter-state war. But how does this differ from the Soviet approach involving multiple echeloned armies and fronts, and what

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[42] '*Soyedineniya armii Yuzhnogo voyennogo okruga (YuVO), dislotsirovannyye v Volgogradskoy i Rostovskoy oblastyakh prinimayut uchastiye v dvukhstoronnem komandno-shtabnom uchenii,*' Ministry of Defense of the Russian Federation, October 1, 2018, https://tvzvezda.ru/news/forces/content/201810011602-mil-ruj6tgf.html; '*Chetyre divizionnykh i brigadnykh takticheskikh ucheniya proydut v ramkakh KSHU sgruppirovkami voysk YuVO*,' Ministry of Defense of the Russian Federation, September 18, 2018, https://function.mil.ru/news_page/country/more.htm?id=12195952@egNews.

might these differences mean given the need for the General Staff to plan operations according to the specific demands of the local operational environment? In 2017, Major General Sergei Batyushkin (ret.) published *Podgotovka i vedeniye boyevykh deystviy v lokal'nykh voynakh i vooruzhennykh konfliktakh Podgotovka i vedenie boevykh deistvii v lokalnikh voinakh i vooruzhennykh konfliktakh* (Preparation and Conduct of Military Actions in Local Wars and Armed Conflicts).[43]

This lengthy work offers detail on Russian approaches to military planning and is especially important for explaining the distinction between large-scale warfare and "local wars and armed conflicts [*lokalnykh voynakh i vooruzhennykh konfliktakh*]."[44] Batyushkin reminds his readers that the Soviet Armed Forces were trained and prepared to fight a conventional war in Europe using means and methods including mass mobilization that will never happen. He distinguishes, in terms of definition, local wars and armed conflicts from large-scale inter-state warfare; and in this regard, Batyushkin's work is also important in showing how Russia's Armed Forces would approach operations other than large-scale conflict. It is highly likely that the MDMP in use varies according to the scale, nature and mission goals of any particular combat operation.

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[43] Major General (ret.) Sergei Batyushkin graduated from the Frunze Military Academy (now called the Combined Arms Academy of the Armed Forces of the Russian Federation) with a prestigious "gold medal" for academic excellence and was later an instructor at the institution. He is also a Doctor of Military Sciences, and a member of the Russian Academy of Military Science. Batyushkin's impressive credentials make him a suitable authority on these issues.

[44] Sergey Batyushkin, *Podgotovka i vedeniye boyevykh deystviy v lokal'nykh voynakh i vooruzhennykh konfliktakh Podgotovka i vedenie boevykh deistvii v lokalnikh voinakh i vooruzhennykh konfliktakh*, (Preparation and Conduct of Military Actions in Local Wars and Armed Conflicts), Moscow: KnoRus, 2017, pp. 438.

In an address to the Academy of Military Sciences in January 2016, the then-commander of the Southern MD/OSK, Colonel General Aleksandr Galkin, discussed the challenges of C2 of integrated force groupings in a theater of military operations. He referred to the US Department of Defense concept of "joint force," forming forces along with allies and civilian organizations to conduct operations on the ground, in the air, at sea and in the information space. Noting the term "global integrated operation," he also told his audience that a practical example of this approach began in August 2014, when the US and coalition partners deployed forces to the Middle East to combat the Islamic State. Galkin explained, "The basis for C2 systems is the global information network of the US Department of Defense, which supports all types of communications. Characteristically, due to this advanced communication system, the command-and-control points were deployed at a significant distance from each other on the territories of various states (Jordan, Iraq, Bahrain, Qatar)." He said that such developments compelled revisions to approaches to conducting operations on the part of Russia's General Staff. In passing, referring to NATO operations in Yugoslavia, Afghanistan and Libya, he said that "now the application of military force is preceded by a long period of political, economic, and informational pressure with a gradual escalation to military conflict."[45]

During the same conference, similar C2 themes were addressed by Major General I. A. Fedotov, a senior researcher at the Center for Military-Strategic Studies of the General Staff Academy (*Tsentr Voyenno-Strategicheskikh Issledovaniy*—TsVSI). He prefaced his lecture by referring to defense sufficiency and its impact on forming force groupings: "In the new military-political and military-strategic conditions, the demands of the principle of defense sufficiency

[45] A. V. Galkin, 'Forms of the Application of Military Force and the Organization of Command and Control of Integrated Armed Force Groupings in the Theater of Military Activity,' *Vestnik*, Academy of Military Sciences 2(55) 2016, pp. 51–54.

[*oboronnaya dostatochnost*] apply not to the Armed Forces in general but only to the combat strength of the functional components, including force groupings [*gruppirovka voysk*] deployed along strategic axes to repel an attack and eventually destroy the enemy with the required level of effectiveness."[46] Despite the enormous progress made in restructuring C2 and introducing automated C2 since the reform of the Armed Forces initiated in late 2008, General Fedotov attacked the limited nature of actual integration and castigated the persistence of stove piping:

> In our view, one of the main reasons for the unsustainability of the current command-and-control system is the retention of stereotypes in the structural elements of command, which at one time were designed to conduct strictly defined tasks and consisted of four functional command stovepipes: joint force *obyedineniya* [i.e., army groups, fronts, Strategic High Command], *soyedineniya* [i.e., army, division or brigade] and combat units; *soyedineniya*-level units of the branches of arms [i.e., motor rifle, tank, artillery, air defense] and specialty branches [i.e., reconnaissance, signals, EW, engineers, NBC, logistics/supply] of the Ground Forces; branches of operational and combat support; and comprehensive support branches.
>
> In accordance with the approaches of that time to the forms of employing the Armed Forces, the system of front command and control was necessarily built up with command-and-control stovepipes (Air Force, Air Defense Forces, Navy in coastal or greater maritime areas) that carried out, in general, supporting roles in the interests of the Ground Force groupings.

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[46] I. A. Fedotov, 'Trends in the Development of the Operational-Strategic Command of the Military District at the Present Stage of Developing the Structure of the Armed Forces of the Russian Federation,' *Vestnik*, 4 (57) 2016, pp. 65–69.

> The command-and-control system was oriented toward detailed planning and control of a Ground Force grouping. Planning for the employment of, and command and control of force groupings of other branches (Air Force and Navy) was carried out by relevant commanders from their own command-and-control locations.
>
> Modern approaches to the forms of employing the Armed Forces are critical for the employment of a force grouping. The significant increase in the number of tasks that are required of the command and control of joint actions of a force grouping in the theater of military activity along a strategic axis demands a correction of the structural levels of command and control.[47]

Despite Fedotov highlighting ongoing issues and challenges related to more fully integrating C2 to avoid the type of stove piping still present within the overall C2 structures, he inadvertently highlights the approximate layout of a force grouping (*gruppirovka voysk*) that could be formed in any strategic direction. Therefore, large-scale inter-state conflict involving Russia's Ground Forces acting in concert with support from other branches and arms of service would involve: "joint force *obyedineniya* [i.e., army groups, fronts, Strategic High Command], *soyedineniya* [i.e. army, division or brigade] and combat units; *soyedineniya*-level units of the branches of arms [i.e., motor rifle, tank, artillery, air defense] and specialty branches."[48] Combined with Galkin's observation that the initial period of war includes a buildup and preparation phase, a rough picture emerges as to how the Russian General Staff would plan and a form a *gruppirovka voysk,* to include Ground Forces, for large-scale operations.

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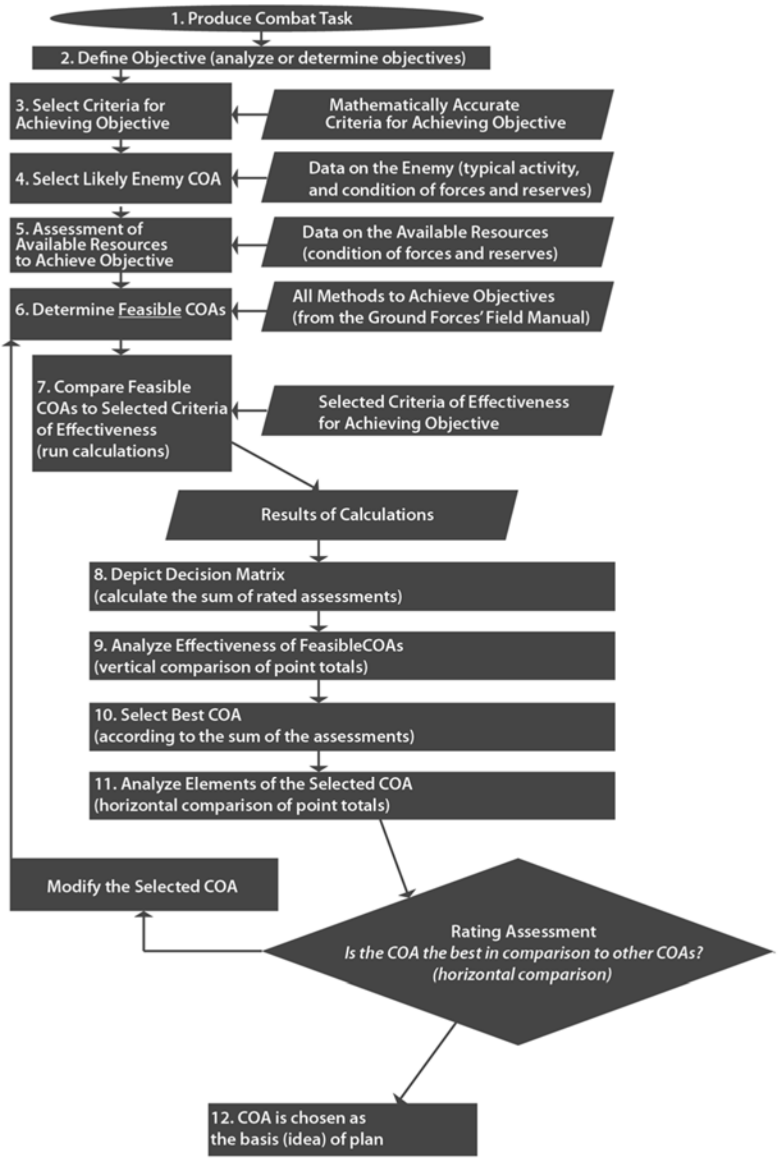
[47] Fedotov, 'Trends in the Development of the Operational-Strategic Command,' pp. 65–69.

[48] *Ibid.*

It is into this complex command-and-control structure, with its numerous command nodes, as well as the Russian approaches to strategic-, operational- and tactical-level missions that the MDMP actually fits. But it is evidently designed differently from Western militaries' approaches to such processes. In the United States' military, for example, the MDMP is divided into long and shortened versions, with commanders and personnel involved in the process being well trained, and well-versed in the use of each version. In the US Army, there are seven stages in the MDMP: receipt of mission, mission analysis, followed by five course-of-action steps, being development, analysis, comparison, approval and orders production. The Russian variant of this system is shown in **Figure 3**.[49]

[49] Department of the Army, Field Manual 101-5, Staff Organization and Operations (Washington, DC: U.S. Government Printing Office, 31 May 1997), 5-1.

Figure 3: The Algorithm of the Russian MDMP[50]



[50] Dragon_first_ru, http://dragon-first-ru.livejournal.com/36850.html, accessed January 12, 2021.

Although there may be a similar step-by-step process in the Russian military, there appear also to be some critical differences in how it approaches the MDMP. According to US and Western officers that have interacted with their Russian counterparts during peacetime support operations in the Balkans, there seem to be four main distinctions in the Russian approach to MDMP. Though admittedly, there may additionally be differences in how Russians approach the MDMP depending on the mission type.[51] First, they appear to use a shortened, but largely informal MDMP. Second, they intentionally hold off until the last possible moment before making a decision. Russian commanders wait until they are confident they have gathered as much information as needed before they commence the MDMP. Third, the personality of individual commanders plays a major role within the Russian MDMP. And finally, the Russian system, as noted, is designed to support a highly capable commander and a weaker staff. This raises questions concerning the effectiveness of the MDMP if the commander on the ground lacks such competence.

Some aspects of these differences are worth highlighting. The military cultures and systems in the US, NATO or Russian militaries reflect the individual and distinctive approaches to standards and methods designed to fit their own systems. In the US or NATO militaries, individual initiative and problem solving as well as delegated authority play a much more prominent role, especially at the tactical levels of the process. Therefore, as the information flow starts, a US or NATO commander will also begin the MDMP with his or her staff. However, their Russian counterpart at this stage will not do so. The Russian commander, as observed, begins the MDMP only once the

[51] Major Donald R. Baker, 'Military Decision-making in the First Russian Peacekeeping Separate Airborne Brigade,' *Military Review*, September–October, 2003, pp. 46–50.

information is assembled.[52] In the Russian military system, the initiative and problem-solving skills are higher up in the system, with less need for this at tactical levels. In some circumstances, especially in a future conflict between network-centric militaries, with each side targeting the information systems of the other side, it is likely to impact on Russian commanders more than US or NATO counterparts. Hypothetically, some Russian commanders in these circumstances would not be trained to initiate the decision-making process in an operational environment where the information flow is disrupted. And the commanders willing or capable of doing so, commencing the decision-making in the absence of the necessary information, most likely would perceive themselves to be engaging in decision-making in effect partially blinded.

The Importance of Automated C2 Systems

Russia's military decision-making architecture, and its approaches to this process at strategic, operational and tactical levels, is particularly tied into the development in recent years of automated command-and-control systems as well as the wider efforts in its military modernization to transition into the information era. The unifying theme in these efforts both to streamline the C2 system itself and to introduce automated systems is the focus upon speed: speed in *decision-making* and speed of *action* in military conflict.[53] The Soviet Union, and later the Russian Federation, has attempted to field a modern network-centric C2 system, though lack of the technical means to implement it resulted in many delays. This situation has changed rapidly in the last few years, as Russia bolstered its information technology sector, with military industries developing and fielding new technologies. Moscow, as noted above, has

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[52] Author discussions with US military officers and defense officials, Washington, DC, November 2018.

[53] Author's emphasis.

established a national defense management center that will connect to subordinate command centers at the joint strategic command (military district) and army group levels.[54]

In 2000, President Putin ordered the Russian defense industry to design and develop a Unified System for Command and Control at the Tactical Level (*Yedinaya Sistema Upravleniya v Takticheskom Zvene*—YeSU TZ). The task was contracted to Sozvezdiye Concern, which oversees a group of domestic defense-industry companies involved in the project.[55] The process intensified following the Russia-Georgia War in August 2008 and the ensuing military reforms, which transitioned the Ground Forces to a brigade-based structure. In particular, the General Staff concentrated on enhancing the speed of military decision-making, which would be facilitated by the YeSU TZ, and grappled with network-centric approaches tied to improving speed in other areas, including strategic and tactical mobility. The base of **Figure 4** (below) implies the failure of the process to result in a *fully* integrated system, and it suggests timeframes and possible approaches toward fixing this issue (discussed in more detail below).[56]

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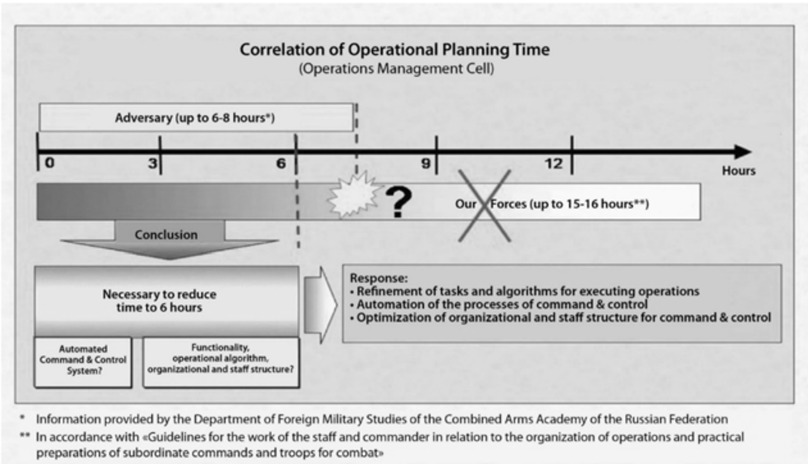
[54] Ye. O. Ostrovskiy and A. S. Sizov, '*Podkhod k modelirovaniyu kognitivnoy sfery ob'yektov operativnoy razvedki,*' *Voennaia mysl'*, No. 2, 2016.

[55] G. I. Metlitsky and Yu. E. Zaitsev, '*Sovershenstvovanie sistemy upravleniya voinskimi chastyami*,' (On the Improvement of the Command-and-Control System), *Voyennaya Mysl',* April 4, 2008, pp. 18–22, http://www.mil.ru/files/vm4_2008.pdf; E. A. Perov and A. V. Pereverzev, '*O perspectivnoi cifrovoi sisteme svyazi Vooruzhennih Sil Rossiiskoi Federatsii*,' (On the Prospective Digital Communication Network of the Russian Federation Armed Forces), *Voyennaya Mysl'*, No. 3, March 2008.

[56] Author's emphasis. See: Dmitry Kandaurov, '*Komp'yuteru davno pora priyti na smenu karandashu v rukakh shtabnogo ofitsera,*' *Nezavisimoye Voyennoye Obozreniye*, November 12, 2010, http://nvo.ng.ru/armament/2010-11-12/10_computer.html; Dmitry Kandaurov, '*Glavnyye resursy v rasporyazhenii ASUV – informatsiya i vremya*,' *Nezavisimoye Voyennoye Obozreniye*, October 8, 2010, http://nvo.ng.ru/concepts/2010-10-08/6_asuv.html; A valuable insight into characteristic flaws in Russian defense planning can be found in: Carolina Vendil,

Figure 4: Russian Operational Planning Time



Discussion among Russian military theorists, specialists in network-centric warfare and the top brass, in the period 2008–2012, focused largely on the need to improve the time needed to generate orders for the conduct of an operation.[57] They saw the YeSU TZ as a means to close the gap in this regard with leading NATO militaries. The speed required at the earliest phase in this process is illustrated in **Figure 4**. The diagram is taken from a Russian military publication in 2013,[58] but it shows how thinking developing in this area since the General Staff carried out its lessons learned from the Russia-Georgia War in

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Russian Military Reform: A Failed Exercise in Defense Decision Making, Routledge: London, 2009.

[57] Nikolay Palçhikov, '*Povestke – sud'bonosnyy vybor*,' *Krasnaya Zvezda*, November 6, 2015; V. I. Vladimorov and V. I Stuchinskiy, '*Obosnovaniye boyevogo primeneniya aviatsionnykh nositeley sredstv radioelektronnoy bor'by v operativnoy glubine dlya zavoyevaniya informatsionnogo prevoskhodstva*,' *Voennaia Mysl*, No. 5, 2016.

[58] S. Skokov, '*Otsenka obstanovki v voyennom dele – chast' vtoraya [general'naya liniya]*,' October 2013, http://general-skokov.livejournal.com/2691.html.

2008; one of its main lessons related to the ineffective nature of the existing command, control and communications system.[59]

Russian military analysts, as well as specialists on automated C2 systems, note the evolution of such technological developments and improvements to C2 in the United States' and other foreign militaries as well as the course of such efforts within Russia. In the 1950s, for example, the US military developed automated systems to provide C2 for artillery units (TACFIRE) and air-defense units (Missile Monitor). By the late 1990s, the US military sought to exploit the internet to enhance C2. In 2003, the US Department of Defense launched the Future Combat Systems (FCS) program. However, after encountering technical issues, this was phased out, with fresh focus instead on improving more compact programs, such as the Brigade Combat Team Modernization. Russian analysts also note the development of automated C2 in the militaries of the United Kingdom, Israel, France and Turkey. Early efforts, in the 1960s, by the Soviet Union to develop and introduce automated C2 witnessed its appearance in the strategic missile forces, and a set of automation assets was created for the air-defense forces (Almaz-2) and for the Air Force (Vozdukh-1M ACCS). In 1964, the Soviet government set the ambitious task of creating an automated C2 system for use by frontline conventional armed forces, but only by the latter part of the 1980s were elements of the Manevr C2 system finally introduced.[60]

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[59] Interview with CGS Makarov, *Voyenno Promyshlennyy Kuryer*, February 1, 2011, https://vpk-news.ru/articles/7058; Aleksandr Postnikov, "Time 'Automated' War," *Nezavisimoye Voyennoye Obozreniye*, January 14, 2011, http://nvo.ng.ru/realty/2011-01-14/1_automate.html.

[60] L. V. Savin, '*Setetsentrichnaya i setevaya voyna. Vvedeniye v kontseptsiyu*,' Moscow: *Yevraziyskoye dvizheniye*, 2011; Igor Sheremet, '*Komp'yuterizatsiya kak put' k pobede v vooruzhennoy bor'be*,' *Nezavisimoye Voyennoye Obozreniye*, November 11, 2005, http://nvo.ng.ru/concepts/2005-11-11/4_computers.html; Yury Gorbachev, '*Borba v elektronnom prostranstve usilivaetsya*,' *Nezavisimoye Voyennoye Obozreniye*, January 30, 2015, http://nvo.ng.ru/concepts/2015-01-30/6_cyber.html; B. N. Kotiv, I. M. Samokhvalov, V. I. Badalov, A. V. Goncharov, V.

Moscow-based military analyst Petr Nikolayev, noting the long journey undertaken by the Russian defense ministry and defense industry to create the YeSU TZ, explained some of the underlying reasons for the delayed timescale and the design complexities involved in the process:

> The most important task was the systematization of the basic requirements for control-and-communications equipment, complexes, and systems at the tactical level and the interconnection of the ongoing research and development for their creation. As a result, in August 2000, Russian Federation President Vladimir Putin approved the Concept of Creating a Unified Command and Control System for Troops (Forces) and Weapons at the Tactical Level—YeSU TZ. More than 50 industrial enterprises were involved in its implementation. The Voronezh-based Sozvezdiye Concern became the lead contractor. This integrated structure includes 17 enterprises expected to ensure the functioning of the full life cycle of the system, from development to disposal. The delay in the development of the YeSU TZ within the framework of the Sozvezdiye-2015 project is partly due to the complexity of the system and the delay in the development of its individual components in previous decades. But while deliveries of various types of machinery and equipment were formerly carried out by different factories according to separate plans, the Sozvezdiye Concern took over coordination this time around. It also delivers

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V. Severin, V. A. Reva, Y. N. Petrov, '*Voenno-polevaya khirurgiya v nachale XXI veka*,' *Voenno-Medichinskii Zhurnal*, May 31, 2016; P. A. Sharikov, '*Rossiiskii vector amerikanskoi informacionnoy politiki, SShA – Kanada, ekonomika, politika, kultura*,' September 30, 2015; V. Litvinenko, '*Perspektivy razvitiya artilleriiskogo vooruzheniya i boepripasov dlya sukhoputnykh voisk*,' *Armeiskiy Sbornik*, July 2015; V. Babich, "*Yazyk' do Kieva dovedet*," *Armeiskiy Sbornik*, September 2015.

> on a turnkey basis the entire range of technical solutions, including their service.[61]

These complexities in the design and production of the YsSU TZ, from field testing to interaction with senior officers and defense ministry officials, slowed the complex work of the Sozvezdiye Concern. The company is a powerful research and production structure, the successor to the Scientific Research Institute of Communications, established in 1958, which was well known in the Soviet period. The Institute was a component of the USSR Council of Ministers Committee on Electronics. Today, it employs 5,500 personnel, including 2,000 hardware and software developers. Another 1,500 specialists are involved in production.[62]

Sozvezdiye Concern defines the purpose of development of the YeSU TZ and details the main tasks of the system. Accordingly, the YeSU TZ is developed "[t]o increase the effectiveness of using tactical-level military formations on the basis of: coordination of actions of unified (interdepartmental) formations as a single military organism in any conditions of the situation; [and] increasing controllability, mobility, and survivability through provision with modern communications and automation equipment and software." Nikolayev offers a more concise and practical definition: "The purpose of the introduction of the new system is to improve command and control of troops and increase their combat effectiveness. In other words, if you are ahead

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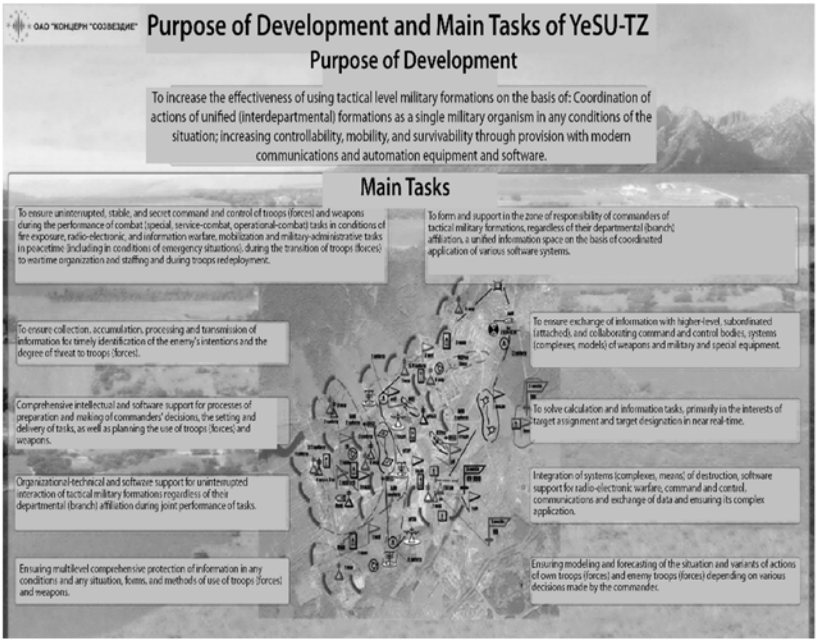
[61] Petr Nikolayev, '*Boy. Upravleniye. Pobeda Dlya Rossiyskoy armii sozdayut ASU takticheskogo Zvena,' Armystandard.ru*, https://armystandard.ru/news/202012231642-IPIrh.html,December 24, 2020, https://armystandard.ru/news/202012231642-IPIrh.html.

[62] Around 90 percent of the production volume is manufactured in the interests of the Russian Federation Ministry of Defense and other security agencies. Nikolayev, '*Boy. Upravleniye. Pobeda Dlya Rossiyskoy armii sozdayut ASU takticheskogo Zvena,' Op. Cit.*

of the enemy in making a well-grounded decision, then you have already achieved superiority in real combat.”[63]

Figure 5: Purpose and Development and Main Tasks of the YeSU TZ



According to the Sozvezdiye Concern, the key tasks for the YeSU TZ are as follows:

- To ensure uninterrupted, stable, and secret command and control of troops (forces) and weapons during the performance of combat (special, service-combat, operational-combat) tasks in conditions of fire exposure, radio-electronic, and information warfare, mobilization and military-administrative tasks in peacetime (including in

[63] *Ibid.*

conditions of emergency situations), during the transition of troops (forces) to wartime organization and staffing and during troop redeployment;

- To form and support in the zone of responsibility of commanders of tactical military formations, regardless of their departmental (branch) affiliation, a unified information space on the basis of coordinated application of various software systems;
- To ensure collection, accumulation, processing and transmission of information for timely identification of the enemy's intentions and the degree of threat to troops (forces);
- To ensure exchange of information with higher-level, subordinated (attached), and collaborating command-and-control bodies, systems (complexes, models) of weapons, and military and special equipment;
- To establish comprehensive intellectual and software support for processes of preparation and making of commanders' decisions, the setting and delivery of tasks, as well as planning the use of troops (forces) and weapons;
- To solve calculation and information tasks, primarily in the interests of target assignment and target designation in near real-time;
- To create organizational-technical and software support for uninterrupted interaction of tactical military formations regardless of their departmental (branch) affiliation during joint performance of tasks;
- To integrate systems (complexes, means) of destruction, software support for radio-electronic warfare, command and control, communications and exchange of data, and to assure its complex application;
- To ensure multi-level comprehensive protection of information in any conditions and any situation, forms, and methods of use of troops (forces) and weapons;

- To ensure modeling and forecasting of the situation and variants of actions of own troops (forces) and enemy troops (forces) depending on various decisions made by the commander.

The automated control system for combined arms and support for military formations at the tactical level provides the following main characteristics, in comparison with the existing standards (without automation):

- Reduction of troops' command-and-control cycle—three-fold;
- Reduction of weapons' command-and-control cycle—three-fold;
- Increase in data relevance: for enemy troops by five-fold; for own troops by three-fold;
- Solution of following tasks with 0.95 probability; collection and mapping of data—not to exceed 10 minutes;
- Setting of combat tasks to subordinates—not to exceed 5 minutes;
- Processing of a combat report, within a time period not to exceed 5 minutes;
- Making of the decision to fight and plotting it on a topographic map—not to exceed 60 minutes;
- Identification of one's own location and the location of vehicles of subordinate subunits (commanders)—not to exceed 1 minute.[64]

Finally, Nikolayev describes the attributes and advantages of the YeSU TZ as follows:

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[64] *Ibid.*

> The "tactical level" in the title speaks for itself. The YeSU TZ provides automated and non-automated control of combined arms and supports military formations, ranging from an individual serviceman and further to a squad, platoon, company, battalion, regiment, brigade and division. Its range of application includes both direct combat operations and participation in joint special and counter-terrorist operations and in the elimination of consequences of emergency situations. The range of functional problems that can be solved with the help of the YeSU TZ is very extensive. The system collects and processes information about its own and enemy troops and displays it on electronic topographic maps. This allows for a quick resolution of planning and combat control tasks. The system prepares and transmits commands, signals, and information for notification, identification, interaction and target designation. During the command-and-control process, it receives, registers, stores, and processes current information and combat documents. And finally, which ultimately determines the end result—[it] ensures the coordinated use of combat arms, systems, and means of combat command and control, reconnaissance, navigation, and communications in a changing operational-tactical situation.[65]

It should be noted how the adoption and introduction of automated C2 dramatically increases the speed and efficiency of Russian military decision-making during combat operations. By investing in and prioritizing the successful completion of the YeSU TZ and its various subsystems, Moscow has substantially increased the speed and functioning of C2: moving toward a more fully formed capability to operate in a unified information space. Suvorov's emphasis upon *speed and time* in achieving success in battle—"One minute can decide the outcome of the battle, one hour the outcome of the campaign, and one day the fate of empires"—has finally been achieved through the

[65] *Ibid.*

introduction of high-technology assets to bring Russia's military C2 into the twenty first century and harness information and automation assets. Despite such advances, a number of challenges remain.[66] And these are likely to present ongoing issues as Russia struggles in the future to balance its wider economic development against the need for continued military transformation and modernization. It is not as simple as exploiting high-technology assets for military purposes; it also demands improvements and adjustments to the training and education of officers and enlisted personnel as well as the attraction of higher-caliber individuals to seek access to military careers, which in turn raises issues about military recruitment policy.

While the defense ministry and defense industry struggled with the numerous issues involved in developing and introducing automated command-and-control systems for the Armed Forces, the complex nature of such a system functioning in the information space has also presented many additional problems and challenges.[67] In professional Russian military publications, two themes that stand out are the problems of interoperability and matters related to information conflict (*informatsionnoye protivoborstvo*). These issues are frequently represented as being closely interconnected with Russia's military adopting and pursuing network-centric warfare capability, as noted above. If there is conflict between militaries with network-centric capabilities, then it would also involve the information space. But the

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[66] Yu. Bobkov and N. Tyutyunnikov, *Kontseptual'nyye Osnovy Postroyeniya ASU Sukhoputnymi Voyskami VS RF,* Op. Cit.

[67] S. V. Morozov and O. A. Kudrenko, '*O podkhode k sozdaniyu yedinoy statsionarnomobil'noy avtomatizirovannoy sistemy upravleniya voyskami i oruzhiyem obyedinyonnogo strategicheskogo komandovaniya*,' *Voyennaya Mysl'*, No. 1, 2013, pp. 126–134; A. A. Protasov, V. A. Sobolevsky, V. V. Sukhorutchenko, '*Planirovaniye primeneniya strategicheskikh vooruzheniy*,' *Voyennaya Mysl'*, No. 3, 2014, pp. 42–62; O. A. Kudrenko and S. V. Morozov, '*Uchyot morfologicheskikh, sintaksicheskikh i stilisticheskikh osobennostey operativnykh dokumentov pri sozdaniyi ASU spetsnaznacheniya*,' *Voprosy Radioelektroniki,* No. 2, 2013, pp. 23–31.

interoperability problem is also one that weighs heavily in Russian military thinking and planning. It is addressed in detail in a 2017 article by A. Ya. Oleynikov and I. I. Chusov, in *Vestnik*, the official publication of the Academy of Military Sciences (*Akademii Voyennykh Nauk*).[68]

The authors highlight that while NATO standards on interoperability are encapsulated in a document, in Russia no such document exists. They then turn to explore interoperability challenges in the context of the information era and the Russian military's adoption of network-centric approaches to warfare. Oleynikov and Chusov assert,

> At the same time—again, judging from open sources—work is not being done for now on a similar document in the RF [Russian Federation] Armed Forces. If this is so, the conclusion can be drawn that under conditions of network-centric warfare, the RF Armed Forces will be unable to oppose a potential enemy and loss of command and control is possible, which means a threat to defense capability and, in the final account, to national security. Interoperability also is important in peacetime to ensure information interaction of RF defense ministry structures with state authorities and with industry.[69]

The authors also note the absence of addressing the problem of standardization for creating a unified information space, which clearly has implications for Russian military decision-making. The importance of standardization for the information space is contained in the latest iteration of Russia's Military Doctrine (2014), the Concept of Forming and Developing a Unified Information Space of Russia

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[68] A. Ya. Oleynikov and I. I. Chusov, '*Voyenno-organizatsionnoye: razvitiye Problema vzaimodeystviya v Vooruzhennykh Silakh Rossiyskoy Federatsii,' Vestnik, Akademii Voyennykh Nauk,* No 1 (61), 2017, pp 61–68.

[69] *Ibid.*

and Corresponding State Information Resources, the RF Military Doctrine (approved by President Putin on December 26, 2014), and the Information Security Doctrine (2016). However, these security documents do not address how to resolve the complex issues involved in standardization. While elsewhere, the full measures needed are outlined. For example, the Russian Federation State Program for Information Society 2011–2020 (adopted April 2014), provides a list of measures to include the "formation of open standards of interaction of information systems, including the development and support of an open standards profile of architecture of state information systems, formats, and data exchange protocols, ensuring the compatibility of state information systems and their components."[70]

Oleynikov and Chusov draw the conclusion that "high-level Russian conceptual documents, such as the aforementioned ones, give attention to questions of interoperability based on use of ICT [information communication technology] standards, but we will note that this is a declarative level. At the same time, it is well-known that the level of work on ICT standardization in the Russian Federation is significantly lower than it is abroad."[71] In this sense, it seems the standardization issue and problems of interoperability impact on military decision-making, in addition to the complex challenges of unifying and fitting together multiple automated C2 systems.[72] It is, therefore, important to place Russian military decision-making in the context of the information space architecture and the Russian conceptualization of interoperability. Oleynikov and Chusov outline this as follows:

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[70] *Ibid.*

[71] *Ibid.*

[72] A. A. Kupriyanov, '*Kompleksnaya avtomatizirovannaya sistema upravleniya silami (voyskami), oruzhiyem i sredstvami,*' *Avtomatizatsiya protsessov upravleniya*, # 2 (20), 2010, pp. 62–70.

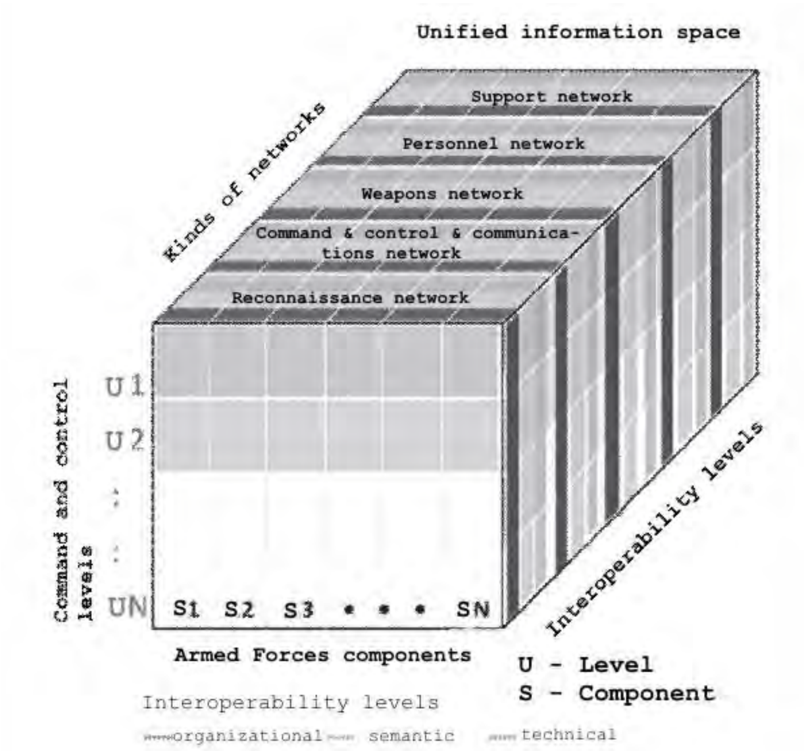
> The Concept of Interoperability in the Russian Federation Armed Forces follows directly from the Military Doctrine (2014), from the provision that combat operations must be conducted based on the network-centric warfare concept. The network-centric warfare concept envisages an increase in the combat power of a grouping of joint forces through the formation of a unified information space that joins together information (reconnaissance) sources, command-and-control entities, means of destruction (suppression), and the real-time communication of valid and complete information about the situation to all participants of operations. The concept proposes the conversion of advantages inherent to individual ICTs into a competitive advantage through unification in a stable network of informationally sufficient, well supported, geographically distributed forces. The RF Armed Forces' unified information space must encompass all functional components (reconnaissance, command, weapons), all levels of command and control, and all branches and combat arms. It is common knowledge that command-and-control levels include the strategic level, operational level, and tactical level.[73]

The Russian military views the information space as an architecture with three dimensions (see **Figure 6**). The constituent parts of the Armed Forces (combat arms and branches of service) are shown along the horizontal axis, while the levels of C2 (strategic to tactical) lie along the vertical axis. The performance profile (*funktsionalnyy razrez*) is displayed on the third axis: reconnaissance network, command and control and communications network, weapon engagement network, as well as the personnel network and support network. According to the network-centric warfare concept, each part (cell or node) in this information space must have the property of

[73] Oleynikov and Chusov, '*Voyenno-organizatsionnoye*,' *Op. Cit.*

interoperability in relation to any other cell or node within this information space.[74]

Figure 6: The Unified Information Space[75]



[74] I. I. Bystrov, B. V. Tarasov, A. A. Khoroshilov, S. I. Radomanov, V. M. Gukasov, '*Ontologiya i komp'yuternaya lingvistika v avtomatizirovannykh informatsionnykh sistemakh,*' *Meditsina i Vysokiye Tekhnologiyi*, # 4, 2015, pp. 31–38; A. V. Palagin, S. L. Krivoy, N. G. Petrenko, '*Znaniye-oriyentirovanniye informatsionniye sistemy s obrabotkoy yestestvenno-yazykovykh obyektov: osnovy metodologiyi i arkhitekturno-strukturnaya organizatsiya,*' *Upravlyayushchiye Sistemy i Mashiny*, # 3, 2009, pp. 42–57.

[75] A. Ya. Oleynikov and I. I. Chusov, '*Voyenno-organizatsionnoye: razvitiye Problema vzaimodeystviya v Vooruzhennykh Silakh Rossiyskoy Federatsii,*' *Vestnik*, Akademii Voyennykh Nauk, No 1 (61), 2017, pp 61–68.

Thus, Russian military decision-making takes place within the context of the network-centric warfare concept, and planning and conducting operations occur in the information space. The Russian Armed Forces' unified information space represents a supercomplex system (system of systems), which necessarily includes a large number of subsystems.[76] This suggests it is challenging to make due with a single profile and that there must be a hierarchy within the overall taxonomy.

Oleynikov and Chusov stress that achieving technical interoperability is clearly necessary but insufficient alone to ensure effective interaction. For interoperability to be achieved more fully, it must be done at higher levels and, crucially, it has to be systemic, which is enormously complex. As they note, "These include methods of decision-making theory, methods of integration of unstructured information, graph theory, and so on that are reflected in numerous publications." Moreover, since interoperability is vital in the military decision-making process, it is also important to note that in a conflict between network-enabled militaries, they will target each other's information systems. As the authors highlight, in an information conflict each side will target and try to disrupt the enemy's use of the information space and degrade interoperability: "It is rather obvious that objects ensuring interoperability, the so-called 'key interfaces,' should be the targets of cyberattacks, and accordingly reliable protection must be provided for these objects where possible. This

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[76] I. I. Bystrov, V. N. Kozichev, B. V. Tarasov, '*Kontseptual'niye osnovy avtomatizirovannoy obrabotki nestrukturirovannoy informatsiyi v perspektivnykh sistemakh Upravleniya*,' *Sistemy i sredstva informatiki*, Informatics and Management Center Press, RAS, Moscow, Vol. 26, # 4, 2016, pp. 162–170; A. M. Shcherbin, '*Sovremenniye bortoviye informatsionno- upravlyayushchiye sistemy avtomobilnoy tekhniki,*' *Issledovaniya, konstruktsiyi, tekhnologiyi*, # 3 (92), 2015, pp. 26–29.

means that the makeup of the interoperability profile must include standards of protection and information security."[77]

Conclusion

Russia's MDMP fits into its wider military cultural and distinctive context, shaped and heavily influenced by the reform and modernization of the Armed Forces conducted since 2008. The transition of the Armed Forces into the information era, the adoption of network-centric warfare capability, continued experiments with C2 and adjustments to force structure, as well as lessons learned from these initiatives and, indeed, from its operational experience in Ukraine and Syria and strategic-level military exercises, has resulted in a complex system. That wider system, which involves the command structures and the order of battle, automated C2 and the adoption of C4ISR, continues to lay great stress on the competence of *individual commanders*, rather than competent staffs.[78]

The Russian MDMP is less formalized than what may be familiar to its Western counterparts. Russian commanders, in many cases, will wait until they are confident that all information is gathered, and only then do they commence the MDMP. While the presence of automated C2 systems and subsystems is designed to speed up the decision-making process, there are clearly challenges both with the integration of those automated systems and also in terms of the training and

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[77] Oleynikov and Chusov, '*Voyenno-organizatsionnoye*,' *Op. Cit.*

[78] L. V. Savin, '*Setetsentrichnaya i setevaya voyna. Vvedeniye v kontseptsiyu*,' Moscow: *Yevraziyskoye dvizheniye*, 2011; I. A. Sheremet, '*Kontseptsiya 'setetsentrichnoy voyny' i osobennosti yeyo prakticheskoy realizatsii*,' *Nezavisimoye Voyennoye Obozreniye*, November 11, 2005, http://nvo.ng.ru/concepts/2005-11-11/4_computers.html.

educational standards of the end user.[79] Areas also exist where the decision-making process naturally slows, mainly at the strategic level, while the commanders in the field would face deep challenges if executing their MDMP in an information-challenged operational environment.

The introduction of network-centric approaches to modern warfare certainly has profound implications for the Russian Armed Forces, especially in the area of the MDMP. In fact, it inadvertently increases the need for more highly trained and competent commanders in the field with an ability to make decisions quickly and to also delegate authority and responsibility—a challenge that is traditionally unfamiliar within the Russian military system. But part of the transition to C4ISR capability has been the overall structural changes in the C2 over the Armed Forces, flattening out and simplifying these as well as introducing high-technology based systems; these initiatives have a direct bearing upon the speed and efficacy of the MDMP.[80] Critical in the coordination of the process in the future will be the extent to which the NTsUO can be exploited as a mechanism through which traditional stove-piping may gradually erode and result in greater speed and coordination in setting the framework for the MDMP in real time during combat operations.

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[79] Baker, U.S. Army, 'Military Decision-making in the First Russian Peacekeeping Separate Airborne Brigade,' *Op. Cit.*

[80] Yury Gorbachev, '*Borba v elektronnom prostranstve usilivaetsya*,' *Nezavisimoye Voyennoye Obozreniye*, January 30, 2015, http://nvo.ng.ru/concepts/2015-01-30/6_cyber.html; B. N. Kotiv, I. M. Samokhvalov, V. I. Badalov, A. V. Goncharov, V. V. Severin, V. A. Reva, Y. N. Petrov, '*Voenno-polevaya khirurgiya v nachale XXI veka,*' *Voenno-Medichinskii Zhurnal*, May 31, 2016; P. A. Sharikov, '*Rossiiskii vector amerikanskoi informacionnoy politiki,*' *SShA – Kanada, ekonomika, politika, kultura,* September 30, 2015; V. Litvinenko, '*Perspektivy razvitiya artilleriiskogo vooruzheniya I boepripasov dlya sukhoputnykh voisk,*' *Armeiskiy Sbornik*, July 2015; V. Babich, 'Yazyk do Kieva dovedet,' *Armeiskiy Sbornik*, September 2015.

Strategic, operational and tactical levels of military operations are viewed differently within the culture of Russia's defense planning community compared to its US or NATO counterparts. And the MDMP probably functions differently in the Russian system according to the scale and mission of each type of combat operation.[81] However, the Russian MDMP seems less formalized and shorter than in NATO militaries and appears to offer more scope for flexibility.

Nevertheless, there are a number of challenges facing Russian military planners in seeking to maximize the speed of the MDMP in future combat operations. These relate primarily to the issue of fully integrating the existing automated control system (*avtomatizirovannoy sistemy upravleniya*—ASU), further developing the capacity of the NTsUO, as well as, in the future, completing the wider equipping of the military with the ASU from the strategic to the tactical levels. Only part of the overall force structure has access to and

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[81] V. I. Kovalev, E. S. Larina, N. A. Sergeev, 'The psychological factor of warfare,' *Information War*, No.2, (30), 2014; V. V. Kruglov, 'On the Armed Struggle of the Future,' *Military Thought*, No. 5, 1998, pp.54–58; N. I. Turko and S. A. Modestov, 'Reflexive Control and the Development of Strategic Forces, the Mechanism of Modern geopolitics,' Conference Report 'Systems Analysis on the Threshold of the 21st Century: Theory and Practice,' Moscow, February 1996, p. 366; V. Kruglov and D. Lovtsov, 'The Concept of Information-Strike Operations in Modern Warfare,' http://old.nasledie.ru/oboz/N12_99/12_14.html; M. D. Ionov, 'Psychological Aspects of Managing an Adversary in Antagonistic Conflict (Reflexive Control),' *Applied Ergonomics*, Special issue No.1, 1994; Viktor Ryabchuk, '*Voyennaya Teoriya i Praktika*,' *Voyennaya Mysl*', No. 6, 2001, pp. 32–36, http://militaryarticle.ru/voennaya-mysl/2001-vm/9117-voennaja-teorija-i-praktika-9; 'Interview with Retired Major-General Vladimir Dvorkin, the former head of the RF MoD 4th Central Scientific Research Institute (1993–2001),' *Svobodnaya Pressa*, June 5, 2014; Andrei Kokoshin, *Ensuring Strategic Stability in the Past and Present: Theoretical and Applied Questions*, (Cambridge, Mass.: Belfer Center for Science and International Affairs, Harvard Kennedy School, June 2011).

is equipped with the capabilities associated with the ASU technology; in the longer term, this will likely reach a larger proportion of units.[82] The equipping of the Armed Forces with the ASU has experienced multiple delays and faced a crisis in its development in 2012. Work in this area is progressing, but it will be sometime before all these issues are addressed and fuller procurement occurs for the Armed Forces. The Russian military has made marked progress in transitioning into the information era and adopting network-enabled capabilities. And yet, were conflict to erupt with another network-enabled opponent, the Russian Armed Forces will still face the challenge of how to adequately manage their MDMP in an information challenged operational environment. It appears, for the time being, that this issue is not being addressed in Russia's operational-strategic exercises. This may give rise to revising training for officers and attempting to forge a new generation of commanders both at the levels of the OSK and commanders in the field. Yet by the consistent efforts to design and introduce advanced high-technologies into this critical area, Russia's military has revolutionized its decision-making process, not least by digitizing and automating the C2. As a result, Russia's Armed Forces are exponentially more combat capable than the military that was sent south through the Roki tunnel to invade Georgia in August 2008.

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[82] Vladislav A. Morenko and Andrei N. Tezikov, '*Istoricheskiy aspekt razvitiya ASU PVO*,' *Vozdusho-Kosmicheskaya Oborona*, No.1, February 7, 2015, http://www.vko.ru/oruzhie/istoricheskiy-aspekt-razvitiya-asu-pvo; Igor M. Kuptsov, '*Bor'ba s giperzvukovymi letatel'nami apparatami (GZLA): Novaya Zadacha i trebovaniya k sisteme vozdushno-kosmicheskoy oborony (VKO),*' *Voyennaya Mysl'*, No. 1, January 2011, pp.10–17; Igor Pristupyuk and Nikolai Somko, '*Ustoyat' pod udarami VTO*,' *Vozdusho-Kosmicheskaya Oborona*, No. 4, July 12, 2007, http://www.vko.ru/koncepcii/ustoyat-pod-udarami-vto.

3.

Tracing Russia's Path to Network-Centric Military Capability

Following the collapse of the Soviet Union in 1991, Russia's conventional Armed Forces experienced difficult times, suffering from chronic under funding, and were widely regarded in Western policy circles as posing little threat in comparison to Moscow's military power during the Cold War. This conventional military weakness has been largely rectified in recent years—though clearly not on the Soviet scale—via sustained modernization and force transformation. Yet the contours and policy implications of this process of rebuilding a credible conventional force capability has had limited traction within policy circles in the United States or the North Atlantic Treaty Organization (NATO).[1]

Since Russia's annexation of Crimea in 2014, much attention among policymakers has focused on issues around so-called "gray zone" operations. Nevertheless, Russia's military modernization program

[1] Colonel General Yury Baluyevskiy, "*Geopoliticheskiye problemy i vozmozhnosti ikh resheniya v kontekste obespecheniya bezopasnosti rossii*," *Voyennaya bezopasnost' rossiyskoy federatsii v xxi veke: sbornik nauchnykh statey*, Ed. Colonel General Yu. Baluyevskiy, TsVSI: Moscow, 2004, pp. 10–25.

increasingly focuses on providing the state with enhanced military capability rooted in the adoption of high-technology assets; these fit into a broader framework of a drive to modernize the conventional Armed Forces along command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) lines.[2] This increasing emphasis placed on the adoption, integration and role of high-technology assets in Russia's Armed Forces is presently underestimated in both Washington and NATO, with many of their policymakers still accustomed to perceiving Russia's conventional military as comparatively weaker. However, much of the focus of Moscow's introduction of high-technology assets and approaches to modern war fighting is aimed at equipping its military with the capacity to counter peer adversaries in potential conflicts on the country's periphery, which has long-term, policy-relevant importance for the US and its transatlantic allies.[3]

The following chapter explores Russia's lengthy path toward the adoption of high-technology approaches to modern and future warfare, placing this within the conceptual framework of network-centric capability. At the same time, it links the quantum leap in Russia's conventional military capability of recent years to its origins

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[2] Korchmit-Matyushov V.I. '*Teoriya voyn*,' Moscow: BFRGTZ, Slovo, 2001; Parshin S.A., Gorbachov Yu.Ye., Kozhanov Yu.A. '*Sovremennyye tendentsii razvitiya teorii i praktiki upravleniya v vooruzhonnykh silakh SShA*,' M.: Lenand, 2009; '*Khochesh' mira, pobedi myatezhevoynu! Tvorcheskoye naslediye*,' Ye.E. Messnera/russkiy voyennyy sbornik, No.21, 2005; Slipchenko V. I., '*Voyny novogo pokoleniya: distantsionnyye i beskontaktnyye*,' M., Olma-Press obrazovaniye, 2004; Gareyev M.A., Slipchenko V.I, '*Budushchaya voyna*,' M., OGI, 2005; '*Setetsentricheskaya voyna. Daydzhest po materialam otkrytykh izdaniy i SMI*,' – M. VAGSH VS RF, 2010; Sergey Osipov, Aleksandr Kolesnichenko, Vitaly Cheplyaev, '*Nam est chem gorditsya*,' *Argumenty i Fakty*, http://www.aif.ru/society/army/nam_est_chem_gorditsya_na_parade_pobedy_pokazali_novinki_voennoy_tehniki, May 13, 2015.

[3] Johan Norberg, 'Training to Fight– Russia's Major Military Exercises 2011–2014,' FOI: Stockholm, 2015, p. 61.

in the military thought of the late Soviet era. It is not coincidental that the current Russian defense leadership constantly presents the innovative culture of Soviet military theorists as an example when it frames its appeals to the military-scientific community to support the development of strategic thought and military modernization.[4] This study also ties the most recent development to the reform initiated in late 2008, which allowed the exploration and adoption of the later high-technology supported conventional warfare capability. Equally, it touches on advances in automated command and control, improving the speed of decision-making, as well as some of the challenges facing the ongoing process of wider and deeper force integration through C4ISR.[5]

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[4] V. I. Kovalev, E. S. Larina and N. A. Sergeev, 'The Psychological Factor of Warfare, Information War,' No. 2, (30), 2014; V. V. Kruglov, 'On the Armed Struggle of the Future,' *Military Thought*, No. 5, 1998, pp. 54–58; N. I. Turko and S. A. Modestov, 'Reflexive Control the Development of Strategic Forces, the Mechanism of Modern Geopolitics,' Conference Report 'Systems Analysis on the Threshold of the 21st Century: Theory and Practice,' Moscow, February 1996, p. 366; V. Kruglov and D. Lovtsov, 'The Concept of Information-Strike Operations in Modern Warfare,' http://old.nasledie.ru/oboz/N12_99/12_14.html; M. D. Ionov, 'Psychological Aspects of Management Adversary in Antagonistic Conflict (Reflexive Control),' Applied Ergonomics, Special issue No.1, 1994; Viktor Ryabchuk, '*Voyennaya Teoriya i Praktika*,' *Voyennaya Mysl*', No. 6, http://militaryarticle.ru/voennaya-mysl/2001-vm/9117-voennaja-teorija-i-praktika-9, 2001, pp. 32–36; 'Interview with retired Major General Vladimir Dvorkin, the former head of the RF MoD 4th Central Scientific Research Institute (1993–2001),' *Svobodnaya Pressa*, June 5, 2014; Andrei Kokoshin, *Ensuring Strategic Stability in the Past and Present: Theoretical and Applied Questions*, Cambridge, Mass.: Belfer Center for Science and International Affairs, Harvard Kennedy School, June 2011.

[5] Sergey Batyushkin, *Podgotovka i vedeniye boyevykh deystviy v lokal'nykh voynakh i vooruzhennykh konfliktakh Podgotovka i vedenie boevykh deistvii v lokalnikh voinakh i vooruzhennykh konfliktakh*, (*Preparation and Conduct of Military Actions in Local Wars and Armed Conflicts*), Moscow: KnoRus, 2017, pp. 438.

Reforming the Armed Forces

In the aftermath of the August 2008 Russia-Georgia War, the Russian government under the leadership of then–president Dmitry Medvedev and prime minister Vladimir Putin authorized a long-planned reform of the Armed Forces.[6] The reform that ensued not only involved systemic force restructuring and transitioning from a Soviet legacy force to a more flexible, lethal and capable military, it placed at its epicenter a modernization process that has since been sustained.

Prior to setting this reform in motion, Russia's leading military strategists had for decades been aware of the technological gap that had opened with the country's potential state-level adversaries and their consequent conventional military weaknesses vis-à-vis these powers.[7] Since Moscow initiated genuine reform and modernization of the Armed Forces in 2008, many Russian military strategists advocated pursuing *setetsentricheskaia voina* (network-centric warfare) capability as a vital force enabler and force multiplier and as a means to instigate deeper and more meaningful military transformation.[8] The origins of such thinking, of course, lie in late-

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[6] Roger N. McDermott, 'The Restructuring of the Modern Russian Army,' *Journal of Slavic Military Studies*, Vol. 22 (4), 2009, pp. 485–501; Olga Bozhyeva, Festival '*Novaya Voina*,' *Moskovskiy Komsomolets*, http://www.mk.ru/editions/daily/article/2009/10/08/364473-festival-novaya-voyna.html, October 17, 2009; Viktor Litovkin, '*So Strategicheskim Razmahom Rossiya Sozdaet Glubokoeshelonirovannie Oboronitelnie Strukturi na Evropeiskih Teatrah Voennih Deistvii*,' *Nezavisimoye Voyennoye Obozreniye*, November 9, 2009; Vladimir Mukhin, '*Strane Skomandovali 'v rug'e!*'' *Nezavisimaya Gazeta*, September 17, 2009.

[7] V. Baulin and Aleksandr Kondratyev, '*Realizatsiia kontseptsii 'setetsentricheskaia voina v VMS SShA*,' *Zarubezhnoe Voyennoye Obozreniye*, No. 6, June 2009.

[8] An extensive body of literature exists on the development and formulation of network-centric warfare in English-language studies pertaining to its introduction within the US or other NATO militaries; many of these are studied by Russian

defense specialists and are cited in their sources. See the following examples: Vice Admiral Arthur K. Cebrowski, US Navy, and John J. Garstka, 'Network-Centric Warfare: Its Origin and future,' Proceedings, January 1998; Thomas P.M. Barnett, 'The Seven Deadly Sins of Network-Centric Warfare,' Proceedings, January 1999; Edward A. Smith, Jr., 'Network Centric Warfare: Where's the Beef?' C4ISR Cooperative Research Program (CCRP), February 2000; John J. Garstka, 'Network-Centric Warfare,' Phalanx, Military Operations Research Society, December 2000; 'Network-Centric Warfare,' Report to Congress, Department of Defense, April 2002; Paul Murdock, 'Principles of War on the Network-Centric Battlefiled: Mass and Economy of Force,' Parameters, Spring 2002; Jeffrey R. Cares, Raymond J. Christian, Robert C. Manke, 'Fundamentals of Distributed, Net-worked Military Forces and Engineering of Distributed Systems,' NUWC-NPT Technical Report, May 2002; John J. Garstka, 'Network-Centric Warfare Offers War Fighting Advantage: Datalinks are the New Weapon of the Information Age,' Signal, May 2003; Gregory M. Maguire, 'Concept of a Dynamic Organizational Schema for a Network-Centric Organization,' Naval Post Graduate School, June 2003; John Arquilla, David Ronfeldt, 'Swarming: The Next Face of Battle,' Aviation Week & Space Technology, 29 September 2003; Michael Sirak, 'Pentagon Commissions Net-Centric Studies,' Jane's Defence Weekly, October 29, 2003; Henry S. Kenyon, 'Tactical Operations: Tactical Web Takes Shape,' Signal, November 2003; Col. Alan D. Campen, USAF (ret.), 'Look Closely at Network-Centric Warfare: Technology Can Both Aid and Dominate the War Fighter,' Signal, January 2004; Daniel Gonzales, Michael Johnson, Jimmie McEver, Dennis Leedom, Gina Kingston, Michael Tseng, 'Network-Centric Operations Case Study: The Stryker Brigade Combat Team,' RAND, 2005; 'The Implementation of Network-Centric Warfare,' Department of Defense, Office of Force Transformation, January 2005; John Luddy, 'The Challenge and Promise of Network-Centric Warfare,' Lexington Institute, February 2005; Henry S. Kenyon, 'Modular Devices Weave Tactical Networks,' Signal Magazine, March 2005; Lt. Col. Steven G. Zenishek, David Usechak, 'Net-centric Warfare and its Impact on System of Systems,' Defense Acquisition University, April 2005; Nancy J. Wesensten, Gregory Belenky, Thomas J. Balkin, 'Cognitive Readiness in Network-Centric Operations,' Parameters, Spring 2005; Lt. Col. David Schmidtchen, 'Network-Centric Warfare: the Problem of Social Order,' Working Paper No.125, Land Warfare Studies Center, June 2005; Melissa A. Schilling, Col. Christopher Paprone, 'Modularity: an Application of General Systems Theory to Military Force Development,' Defense Acquisition Review Journal, August-November 2005; Col. Stuart A. Whitehead, 'Battle Command: Toppling the Tower of Babel,' Military Review, September-October 2005; Greg Grant, 'Network-Centric Warfare Experts Look to Improve Communications,' The Journal of Net-Centric Warfare, 11 October 2005; Brian L. Gilman, 'Distributed Operations: Translating Tactical Capabilities Into Effects,' Naval War College, February 2006;

Soviet and Russian military theory, particularity with the proponents of the *Revolyutsiya v Voyennom Dele*—the Revolution in Military Affairs (RMA).[9]

Russian military understanding and use of the term *setetsentricheskaia voina* (network-centric warfare) is important to define within the Russian context and how it is used in the analytical and defense circles in common parlance. A solid and clear definition from a reliable Russian military source places emphasis upon information superiority:

> Network-centric war—A concept of military operations oriented toward the achievement of information superiority that provides for an increase in combat power through the creation of an information and communication network linking sensors (data sources), decision makers and assets, which ensures that the participants of operations have situational awareness, accelerating command and control as well as increasing the pace of operations, effectiveness of defeating enemy forces, survivability of troops, and level of synchronization.[10]

David S. Alberts, Richard E. Hayes, 'Understanding Command and Control,' Command and Control Research Project, March 2006; Network Centric Operations Case Study, Department of Defense, February 27, 2007; Clay Wilson, 'Network-Centric Operations: Background and Oversight Issues for Congress,' Congressional Research Service, March 2007; 'The Evolution of NATO Network-Enabled Capabilities,' Network Centric Operations Case Study, Department of Defense, August 6, 2007.

[9] V. Burenok, '*Bazis setecentricheskih voyn – operezhenie, intellect, innovacii,'* (Basis for Network-Centric Wars: Anticipation, Intellect, Innovations), *Nezavisimoye Voyennoye Obozreniye*, April 2, 2010; V. Burenok, A. Kravchenko and S. Smirnov, '*Kurs – na stetsentrcheskuiu sistemu vooruzheniia*,' *Vozdushno Kosmicheskaia Oborona*, May 2009.

[10] Tyutyunnikov, N, *Voyennaya mysl' v terminakh i opredeleniyakh: v trekh* (Vol. 3), Moscow, Russia: Pero, 2018, p. 160.

The seismic shift that has occurred since 2008 in the capabilities of Russia's conventional Armed Forces owes to the fact that the Russian political-military leadership finally acted on these theoretical approaches toward future warfare, sympathetic as it was to alternative perspectives on how information technology and high-technology changes the battlespace. Consequently, Moscow has invested in the necessary modernization program, and that trend is likely to continue for decades. Russian military theorists and planners have a lengthy history of interests in the areas of assessing the plausible patterns or scope of future warfare and in the possibility of forming new capabilities. These views and discussions lead into numerous areas, but they also share some unifying themes.[11]

Modernization plans since 2008–2009 have certainly paid attention to such ideas, with reference to robotics, nanotechnologies and even to further developing or refining the "non-military means" elements in the Russian hard/soft power mix. Critically, there are constant references to "developing weapons of new physical principles" Many observers assume this phrase indicates some breakthrough using unique technologies; but in fact, in Russian "military art," it only refers to possessing weapons and systems better or with stronger capability than those used by an adversary. In this sense, a "weapon of new physical principles," as a historical example, would be the medieval long bow, since it could strike further and with greater damaging impact than any contemporary medieval archer could match.[12]

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[11] Bozhyeva, O, '*Festival* '*novaya voina*," *Moskovskiy Komsomolets*, October 17, 2009.

[12] Author's discussions with retired Russian military officers, Moscow, October 2011.

As a result of these complex processes, Moscow has placed C4ISR capability and network-centric approaches to warfare at the epicenter of the Armed Forces' transformation and modernization drive since 2008–2009.[13] That dual focus is indeed the sole unifying theme in the transformation: it underpins the defense industry's support for modernization as well as guides and shapes experimentation with force structure, manpower and the application of platform-based operations in an increasingly high-technology informationized combat environment. In October 2010, the intellectual "father of the military reform," Colonel (ret.—died 2011) Vitaly Shlykov explained that although the level of understanding of network-centric warfare concepts among senior Russian officers and in the political establishment was not advanced, it was sufficient to use it as a means to "light a fire under" the domestic defense industry and provide an overall aim for the reform process.[14] So while this process was initially used as a means to promote reform and modernization, over the past decade it has moved significantly toward implementation and working out its implications for future force development and procurement requirements.[15]

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[13] A. Garavskiy, '*Svyaz reshaet vse*,' *Krasnaya Zvezda*, June 4, 2010; B. Cheltsov, I. Zamaltdinov and S. Volkov, 'NATO and Western Countries' Work on 'Network-Centric' Warfare and Russia's Slowness in This Area,' *Vozdushno Kosmicheskaya Oborona*.

[14] Author's interview with Vitaly Shlykov, Moscow, October 2010.

[15] Korchmit-Matyushov V.I. '*Teoriya voyn*,' M.:BFRGTZ, Slovo, 2001; Parshin S.A., Gorbachov Yu. Ye., Kozhanov Yu. A. '*Sovremennyye tendentsii razvitiya teorii i praktiki upravleniya v vooruzhonnykh silakh SShA*,' Moscow: LENAND, 2009; '*Khochesh' mira, pobedi myatezhevoynu! Tvorcheskoye naslediye*,' Ye.E. Messnera/russkiy voyennyy sbornik, No.21, 2005; Slipchenko V. I., '*Voyny novogo pokoleniya: distantsionnyye i beskontaktnyye*,' M., OLMA-PRESS obrazovaniye,' 2004; Gareyev M.A., Slipchenko V.I, '*Budushchaya voyna*,' Moscow, OGI, 2005;

This process has involved practical experiments, advances in capability and the slow but highly important step of developing and procuring automated command, control and communications (C3) systems. Progress is also evident in introducing improved intelligence, surveillance and reconnaissance (ISR) capability, combined with vigorous efforts to upgrade and innovate in terms of electronic warfare (EW) assets, which Russian defense planners see as symbiotic with progress in network-centric capability.[16] Some of these unifying features in Russia's military transformation provide pointers as to the likely shape and extent of the country's future high-technology based conventional military capability. This is a capability that will prove to be more important for Russian military planners as a tool set to indirectly challenge the US and NATO on Russia's periphery than will the contemporary Western preoccupation with Russia's "hybrid warfare" or any of its subsequent variants. In short, the trends in Russia's conventional warfare capability are deeply embedded in adopting C4ISR and network-enabled capability, utilizing high-technology to enhance precision strike and greatly increase the accuracy of fires.[17]

'*Setetsentricheskaya voyna. Daydzhest po materialam otkrytykh izdaniy i SMI*,' – Moscow: VAGSH VS RF, 2010.

[16] Kopylov A.V, '*K voprosu o kritike kontseptsii setetsentricheskikh voyn (operatsiy) v amerikanskikh SMI*,' http://www.milresource.ru/Kop—NCW.html, July 8, 2013; Belenkov O.V, '*Realizatsiya tekhnologii setetseitricheskogo upravleniya v ASU voyskami i oruzhiyem na baze GIS Karta-2011*,' http://www.gisinfo.ru/item/91.htm, July 8, 2013; Burenok V.M, Kravchenko A.Yu., Smirnov S.S, '*Budushcheye za setetsentricheskoy sistemoy vooruzheniy*,' Poslezavtra: internet-gazeta, http://poslezavtra.com.ua/budushee-za-setecentricheskoj-sistemoj-vooruzhenij/, November 21, 2009; Burenok V.M., Ivlev A.A., Korchak V.Yu, '*Razvitiye voyennykh tekhnologiy XXI veka: problemy, planirovaniye, realizatsiya*,' Tver': Izdatel'stvo OOO KUPOL, 2009.

[17] Oleg Vladykin, '*Zapad-2017 natselen na zashchitu Vostoka*,' *Nezavisimoye Voyennoye Obozreniye*, http://nvo.ng.ru/realty/2017-09-15/1_965_west2017.html, September 15, 2017; '*Pochemu Zapad-2017 vyzval isteriyu na Zapade*,' *Nezavisimoye Voyennoye Obozreniye*, http://nvo.ng.ru/gpolit/2017-09-08/2_964_nvored.html,

Moscow's surge in interest in network-centric warfare stems from three preoccupations. First is Russia's threat perception of potentially facing network-enabled forces in its Western strategic direction. Second is the emergence on its eastern flank of a network-centric capability in the Chinese People's Liberation Army (PLA). And third is Russia's lag in military technology compared to other advanced powers. After the collapse of the Soviet Union in 1992, the Russian state's attempts to address the imbalance in its conventional forces compared to the world's leading militaries resulted in a lengthy period of over-reliance upon nuclear deterrence to compensate. Nonetheless, this is equally consistent with the well-known Russian military preoccupation with the Great Patriotic War (1941–1945) and the

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September 8, 2017; Ivan Dragomirov, '*Soldatam – udachi!*' VPK, https://www.vpk-news.ru/articles/39002, September 19, 2017; '*Sily PVO Zapadnogo voyennogo okruga razvernulis' v novykh rayonakh na ucheniyakh Zapad-2017*,' TASS, http://tass.ru/armiya-i-opk/4567491, September 16, 2017; 'Baltic Fleet corvettes destroy air, sea and coastal targets during Zapad-2017 drills,' TASS, September 17, 2017; Zapad 2017, Livejournal, https://bmpd.livejournal.com/2857093.html, September 20, 2017;'*Chislo batal'onnykh grupp, sostoyashchikh iz kontraktnikov, v rossiyskoy armii cherez dva goda dostignet 125 - nachal'nik Genshtaba VS RF*,' http://militarynews.ru/story.asp?rid=1&nid=425709, September 14, 2016; '*Kompleks upravleniya Sozvezdiye ispytan na uchenii Kavkaz-2016*, https://topwar.ru/100528-kompleks-upravleniya-sozvezdie-ispytan-na-uchenii-kavkaz-2016.html, September 11, 2016; '*Tsentr 2015*,' http://politrussia.com/vooruzhennye-sily/tsentr-sily-510/, September 16, 2015; '*Krupneyshiye ucheniya Tsentr-2015 startovali na poligonakh TsVO*,' TVZvezda, https://tvzvezda.ru/news/forces/content/201509141042-3qno.htm, September 14, 2015; See: RIA Novosti, 'Tsentr 2015,' RIA Novosti, https://ria.ru/trend/exercise_centre_russia_19092015/, September 19, 2015; Oleg Vladykin, '*Tsentr-2015 nikomu ne ugrozhayet*,' *Nezavisimoye Voyennoye Obozreniye*, http://nvo.ng.ru/forces/2015-09-11/1_center2015.html, September 11, 2015; Yury Gavrilov, '*Prikaz po Tsentru*,' https://rg.ru/2015/09/14/ucheniya-site.html, *Rossiyskaya Gazeta*, September 14, 2015; Oleg Vladykin, '*Ucheniye Tsentr-2015 zavershilos' udarno*,' *Nezavisimoye Voyennoye Obozreniye*, http://www.ng.ru/armies/2015-09-21/2_uchenie.html, September 21, 2015; '*V khode ucheniy Tsentr-2015 voyska REB otrabotayut naneseniye radioelektronnogo udara*,' Vesti.ru, http://www.vesti.ru/doc.html?id=2664568, September 15, 2015.

lasting impact it has had on modern military-security culture, nurturing chronic fears of a sudden attack from the western flank.[18]

At the same time, the Russian political-military leadership pays close attention to the "initial period of war," when the Armed Forces are tasked by the political leadership with shaping the battlespace to suit and facilitate the achievement of desired political or strategic ends. Given the political-military elite's perspectives on the roots of the power disparity and perceived injustice in Russia's treatment by the US and NATO, the Russian interest in network-centric warfare is closely tied to a professed need to develop additional tools and capabilities to challenge and disrupt Western military operations rapidly and in real time—without risking conflict escalation or elongating the timescale for nuclear first use.[19]

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[18] Savin L.V, '*Setetsentrichnaya i setevaya voyna. Vvedeniye v kontseptsiyu*,' Moscow: Yevraziyskoye dvizheniye, 2011; Sheremet I.A, '*Kontseptsiya 'setetsentrichnoy voyny' i osobennosti yeyo prakticheskoy realizatsii*,' *Nezavisimoye Voyennoye Obozreniye,* November 11, 2005, http://nvo.ng.ru/concepts/2005-11-11/4_computers.html. Valetskiy O.V, '*Novaya strategiya SShA i NATO v voynakh v Yugoslavii, Irake, Afganistane i yeyo vliyaniye na razvitiye zarubezhnykh sistem vooruzheniya i boyepripasov*,' Moscow: Arktika 4D, 2008.

[19] V. I. Kovalev, E. S. Larina and N. A. Sergeev, 'The Psychological Factor of Warfare, Information War,' No.2, (30), 2014; V. V. Kruglov, 'On the armed struggle of the future,' *Military Though*t, No. 5, 1998, pp.54–58; N.I. Turko and S. A. Modestov, 'Reflexive Control, the Development of Strategic Forces, the Mechanism of Modern Geopolitics,' Conference Report 'Systems Analysis on the Threshold of the 21st Century: Theory and Practice,' Moscow, February 1996, p. 366; V. Kruglov and D. Lovtsov, 'The Concept of Information-Strike Operations in Modern Warfare,' http://old.nasledie.ru/oboz/N12_99/12_14.html; M. D. Ionov, 'Psychological Aspects of Management Adversary in Antagonistic Conflict (Reflexive Control),' *Applied Ergonomics*, Special issue No.1, 1994; Viktor Ryabchuk, '*Voyennaya Teoriya i Praktika*,' *Voyennaya Mysl'*, No. 6, http://militaryarticle.ru/voennaya-mysl/2001-vm/9117-voennaja-teorija-i-praktika-9, 2001, pp. 32–36; 'Interview With Retired Major General Vladimir Dvorkin,' *Svobodnaya Pressa*, June 5, 2014; Andrei Kokoshin, 'Ensuring Strategic Stability in

The process itself, marked by force restructuring and advances in military modernization, reached a crisis during the operational-strategic exercise Kavkaz 2012, after which Russia's General Staff recommended terminating the contract with the defense company group tasked with designing and manufacturing the automated *komandovaniye i upravleniye* (command and control—C2) system. Political support for the scheme returned after the intervention of then–deputy defense minister Dmitry Rogozin, permitting a stay of execution for the companies working in this area.[20] Since that crisis, progress on automated C2 has been extensive, and this trend will likely continue over the next decade and beyond. Kavkaz 2016, for example, which marked the next major test for automated C2, demonstrated that significant improvement was achieved, with the signals chief reporting similar advances in further digitizing military communications systems.[21] Not only did the exercise prove the efficacy of newly developed technologies, it also showed that officers and enlisted personnel were sufficiently well trained, indicating progress toward a force structure increasingly well versed in network-enabled systems and their uses.

Russia's military modernization also betrays consistent efforts to introduce new assets and platforms exploiting network-centric

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the Past and Present: Theoretical and Applied Questions,' Cambridge, Mass.: Belfer Center for Science and International Affairs, Harvard Kennedy School, June 2011.

[20] Roger McDermott, 'Kavkaz 2012 Rehearses Defense of Southern Russia,' *Eurasia Daily Monitor*, Volume: 9 Issue: 174, The Jamestown Foundation September 25, 2012.

[21] 'Interview with Major General Aleksandr Viktorovich Galgash by General Staff Program Host Igor Korotchenko: 'They Will Equip Army Brigades with Redut. They Are Conducting Trials of the New Communications System at Exercises," *Moscow Life*, October 23, 2016.

approaches, as revealed in the ongoing agenda to "integrate systems"[22] and further strengthen mobile field communications as well as to markedly improve the levels of training required for personnel. According to top brass sources, the old analogue systems of signals/communications have been removed from all fixed command posts, and work is continuing to replicate this in mobile communications points.[23] This will only expand and be consolidated by 2027–2030.

Russia's intervention in Ukraine revealed little that was network-centric in essence; however, there have been experiments with network-centric warfare during the Russian military operations in Syria. The latter campaign showed a remarkable absence of massed artillery fires in favor of greater use of precision strikes and unmanned aerial vehicles (UAV) used for immediate bomb damage assessments (BDA).[24] Nonetheless, most of the Russian operations in Syria still involved non-precision guided ordinance, with network-centric-based experiments constituting a small fraction of the total operations.[25]

Russian specialists anticipate progress in developing network-centric capability provided that the state continues to invest sufficiently in this endeavor.[26] In turn, the military uses the apparent emergence of this technology-centered capability to convince Russia's political leadership of the need for continued high levels of defense spending

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[22] Author's emphasis.

[23] Galgash Interview, *Op. Cit.*

[24] This will the subject of a future chapter.

[25] O. V. Tikhanychev, '*O roli sistematicheskogo ognevogo vozdei'stviia v sovremennykh operatsiiakh*,' *Voyennaya Mysl'*, No. 11, November 2016, pp. 16-20.

[26] Author interviews with Russian SMEs, December 2018.

in the non-nuclear sphere. In the decades ahead, as the various interested parties strive to maintain comparatively high defense spending or to push their respective service's interests, investment in C4ISR will attract funding on levels that eclipse other transient areas.

The Role of Reviving Russia's Military Science

In a lengthy article in 2018, published in Russia's official journal of the General Staff, *Voyennaya Mysl* (*Military Thought*), Major General (ret.) Kharis I. Saifetdinov assessed the contribution to the development of Russian military science in the early 20th century by Aleksandr Svechin (1878–1938). Svechin's key work, *Strategiya* (*Strategy*, 1927), foresaw many of the features of the coming war with Germany (1941–1945). And though, like many of his peers, Svechin fell victim to Joseph Stalin's purges of the Soviet officer corps, the current leadership of Russia's General Staff frequently appeals to his legacy as an outstanding military theorist. Saifetdinov drew a number of lessons from Svechin's legacy, notably:

> Lesson number one has to do with the fundamental problem of military science, i.e. the chance of foreseeing the nature of future warfare. Aleksandr Svechin largely foresaw the nature of the armed struggle of the future, and many of his forecasts came true during the Second World War. A major condition of foreseeing the nature of armed struggle is a creative atmosphere in the area of military-science thought and tolerance for different views. As Academician Pyotr Kapitsa used to say, in the absence of debates and comparison of opinions in science, the latter can only go to the cemetery, to attend its own funeral. The only thing that can ensure continuity in the development of military art theory and the correctness of decisions taken is objectivity of research into the likely nature of future warfare, a formulation of conclusions and estimates based not on pure theory but on analysis of reality. Whereas previously it was impossible to construct a modern

> army without military science, nowadays, given inadequate funding, science is the one thing that can rescue it.
>
> Lesson number two, stemming from the legacy of Alexander Svechin, answers the question about the ratio between politics and military strategy. Aleksandr Svechin firmly and consistently defended the stand of the prerogative of politics with regard to strategy. At the same time, the scholar stressed that political decisions, too, should conform to the strategy and military potential, that a politician had to pay heed to the opinions of military professionals and be aware of the way the military machine was working as well as of what the state's military mobilization mechanism was like. Therefore, defining the goals of war and preparing state decisions in the military area should be done jointly by politicians, economists, the military and other experts. This is especially important today, when threats to Russia's national security are assuming a new nature and are implemented with fairly intricate means and methods, chiefly politico-diplomatic, economic, information, and other non-military means and methods.[27]

In this historical context, it is unsurprising that since launching the reform and modernization of the conventional Armed Forces in 2008, the incumbent chief of the General Staff (CGS) has used the platform of his annual address to the Academy of Military Sciences (*Akademii Voyennykh Nauk*—AVN) in Moscow to stimulate research on future warfare and encourage Russian military scientists to examine and discuss a range of strategic ideas. Army General Nikolai Makarov (CGS, 2007–2012) and Army General Valery Gerasimov (appointed in 2012) have expounded and promoted such themes. Thus, appeals to the traditions and contributions to military thought from leading

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[27] Major General (ret.) Kharis I. Saifetdinov, '*Aleksandr Svechin: vydayushchiysya voyennyy myslitel' XX veka*,' *Voyennaya Mysl'*, No. 8, 2018.

Soviet and Russian military theorists aim to stimulate today's Russian military scientists to similarly contribute to the process of modernization.[28]

While Soviet and Russian military theorists have reputations for their interest in and analyses of the theme of future war, the upsurge in this area that followed the reform and modernization of the Armed Forces since 2008 naturally resulted in numerous publications examining these issues. One illustration of such thinking is found in a 2017 article in *Voyennaya Mysl* by Colonel (ret.) S. G. Chekinov and Lieutenant General (ret.) S. A. Bogdanov. The main distinctions of future wars are listed briefly below:

- weapons designed on new technological principles—high-precision weapons based on several platform varieties, aerospace attack weapons, strike- and fire-capable reconnaissance systems, remote-controlled and piloted aerial vehicles, and robot-controlled weapons—will have an overwhelming superiority;
- nuclear weapons will have their significance reduced where strategic and political objectives will have to be attained and their functions taken over by conventional high-precision weapons, weapons on new physical principles, and other types of conventional weapons;
- strategic operations by armed forces will become the principal form of strategic task fulfillment; and
- a unified system will be deployed to collect and process information by integrating space, aerial, and ground reconnaissance capabilities for target allocation and designation in real time.

[28] Army General Valery Gerasimov, '*Vektory razvitiya voyennoy strategii*,' *Krasnaya Zvezda*, http://redstar.ru/vektory-razvitiya-voennoj-strategii/, March 4, 2019; Army General Valery Gerasimov, '*Mir na granyakh voyny*,' *Voyenno Promyshlennyy Kuryer*, https://www.vpk-news.ru/articles/35591, March 13, 2017; Charles K. Bartles, 'Getting Gerasimov Right,' *Military Review*, January–February 2016.

As we look at the present trends in the development of new technologies to produce the latest models of weapons and specialized military hardware, we can assume that the timeframe of fast-running wars of the future will be set by information technologies operating in the nanosecond format. Speed, synchronization and concurrency will be the decisive factors (principles) behind the success of military operations. Joint task forces and their fire strikes will be controlled in real time with reliance placed on the capabilities of computers, telecommunications and satellite communications.

In the authors’ view, strategic operations in future wars will achieve their objectives in these conditions if the armed forces are fully supplied with their needs in weapons, ammunition, materials and other logistics. The scope and quality of logistics will, in turn, depend on several circumstances, primarily the country’s readiness to engage its adversary in a future war.

Forecasting is a way to gain an insight into a situation in which employment of weapons based on new physical properties—new weapons having greater destructive power, longer range, higher accuracy and rate of fire, broader capabilities of reconnaissance and robot-controlled assets, automated weapons control, communication, and information warfare, and closer integration of space-based, aerial, and ground reconnaissance systems in target designation and acquisition in real time—will have a significant impact on the fast pace of future wars. It can be expected, therefore, that future wars will each consist of an opening and a closing period.[29]

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[29] Colonel (ret.) S. G. Chekinov and Lieutenant General (ret.) S. A. Bogdanov, ‘*Evolyutsiya sushchnosti i soderzhaniya ponyatiya voyna v XXI stoletii*,’ *Voyennaya Mysl*’, No. 1, 2017, pp. 30–43.

The authors firmly root their outline of future warfare capability to "high-precision weapons based on several platform varieties, aerospace attack weapons, strike-and fire-capable reconnaissance systems, remote-controlled and piloted aerial vehicles, and robot-controlled weapons." Chekinov and Bogdanov assess that this high-technology exploitation of conventional firepower will eventually reduce the role and significance of nuclear weapons. The "unified system" the authors describe is consistent with network-centric approaches to shaping the battlespace, integrating "space-, aerial-, and ground-reconnaissance capabilities for target allocation and designation in real time." Significantly, the authors draw attention to the trends in developing "new technologies" to modernize weapons and hardware that will result in utilizing "information technologies" operating at high speed: "Joint task forces and their fire strikes will be controlled in real time with reliance placed on the capabilities of computers, telecommunications, and satellite communications." Again, the portrait offered of future Russian military operations appears rooted in adopting high technologies to facilitate conducting network-centric combat in real time by improving and harnessing C4ISR.[30]

Indeed, in 2013, the same authors analyzed the developments and implications of foreign military network-centric warfare capability. They concluded that its adoption in the United States military had envisaged the concept applied to bringing all information, communications systems combined with military forces and weapons into one unified system:

> Advanced countries already use the new strategy for preparing and conducting new-generation warfare that differs significantly from war strategies of the 20th century. The changes that have since occurred in all things military have compelled the US

[30] *Ibid.*

armed forces to develop a new concept—Network-Centric Warfare, or NCW. In substance, the NCW concept is not a system of views on the conduct of a modern-day war (armed conflicts) as such; rather, it is a concept of control over combat operations as a new way of directing armed forces in 21st-century operations.

The network-centric warfare concept arose immediately in the wake of rapid advances in information technologies and development of high-precision weapons and weapons based on new physical principles. Armed with the NCW concept, American planners want to use information attack at the outset of a new-generation war to disable all elements of the adversary air-defense system—control posts, communication centers, radar stations, anti-aircraft missile batteries, and the air-defense aircraft control system. In their estimates, a loss of up to 50 percent of control-system capabilities would have an adverse effect on the enemy's strategy and force him to discontinue resistance—the end goal of the NCW concept.

In a network-centric warfare environment developing on the guidelines of the NCW concept, US forces' operations at any level (tactical, operational and strategic) will be directed regardless of where the forces are deployed across the world, whatever combat missions they fulfill, whatever strength they have, and however they are structured. Actually, a "network-centric environment" comprises information and communication elements bringing the armed warfare forces and weapons into one system.[31]

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[31] Colonel (ret.) S. G. Chekinov, Lieutenant-General (ret.) S. A. Bogdanov, '*Priroda i soderzhaniye voyny novogo pokoleniya*,' *Voyennaya Mysl'*, No. 10, 2013, pp. 13–24.

The Revolution in Military Affairs and Ogarkov's Legacy

A particularly close linkage exists between Russian military theory and its evolution of network-centric warfare. This is due to the origins of the RMA in the latter Soviet era, combined with persistent Russian interest and analysis of how this was adapted and introduced by the US and other NATO militaries. The RMA, US approaches to networking warfare, operational analyses of the First Gulf War (1991) and other factors stimulated high interest among Russian military scientists. Colonel General Vladimir Slipchenko (deceased) wrote extensively in the 1990s on so-called "sixth-generation warfare" and argued that Russia had to take note of this fundamental advance in the means methods of conducting warfare or pay a heavy price later. Slipchenko set in motion a tradition among Russian advocates of network-centric warfare to study these developments within foreign militaries.[32]

In 2013, the Norwegian researcher Henrik Olsen Nordal highlighted the relatively long recent history of the RMA concept, its far-reaching influences, and its consequences for the evolution of modern approaches to combat operations:

> The origins of the RMA concept we use today has its roots in the Soviet military thinking of the 1960s. Later, in the early 1970s, it appeared in the title of a major Soviet book of military theory.[33] This book dealt primarily with the strategic and operational exploitation of nuclear firepower. However, by the early 1980s

[32] V. I. Slipchenko, *Voyna Budushchego*, Scientific Reports edition 88 (Moscow: Social Science Foundation), 1999.

[33] Carl W. Reddel, 'A Step Toward Understanding the Soviet View of Modern Warfare,' *Air University Review*, September–October 1975, www.airpower.maxwell.af.mil/airchronicles/aureview/1975/sepoct/reddel.html#reddel.

> the Soviet General Staff developed the concept of what many today call the information revolution in military affairs. What they saw was advanced data processing and communications technology applied to hi-tech conventional firepower potentially increasing the US and NATO conventional capabilities.[34]

This overview of the origins and influences of the RMA in Russian military thought illustrates the transition in such thinking from nuclear issues to how information systems and technologies would revolutionize conventional warfare. Commenting on Marshal Nikolai Ogarkov's significance in the development of the RMA concept in the 1980s, as well as the Soviet general's lasting importance in the transformation of Russia's modern Armed Forces into a force structure rooted in high-technology approaches to modern and future warfare, Michael Kofman, the director for Russia/Eurasia at the Center for Naval Analysis, Arlington, Virginia, notes:

> The most recent decade of military transformation would be better known as the 'Ogarkov reform inheritance,' since it represents the successful implementation of a vision he had for the Soviet armed forces in the early 1980s, which was only partly realized during his tenure. Looking across the changes implemented in the Russian armed forces, from the flattening of the command and control structure, to the execution of complex exercises with combined or inter-service groupings from different military districts, the deployment of recon-strike and reconfire loops, the integration of combat branches and arms around strategic operations in the theater of military operations, and the increasing emphasis on non-nuclear strategic deterrence, we can see that Ogarkov's intellectual children have

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[34] Henrik Olsen Nordal, 'Thinking of Revolution in Military Affairs (RMA): Towards a Common Understanding of RMA,' Master's Thesis, University of Oslo, 2013.

> come home. This is not to dismiss the lasting influence of Mikhail Tukhachevsky, Alexander Svechin or Georgii Isserson, whose writing is also used to underpin modern military thought. But none of those men lived through the Cold War, and many of the current ideas or concepts take their heritage from the Ogarkov period.
>
> Ogarkov was a technologist at heart, arguing for a revolution in military affairs in 1982, to reshape the Soviet armed forces with a new generation of technology. Many of the latest weapon systems deployed in the Russian military date back to the 1980s in terms of design, and were conceived as answers to the capabilities then being deployed by NATO. More important, though, is the doctrinal thought that the Russian General Staff has visibly inherited from him, which drives the development of capabilities and concepts of operations for their employment, i.e. the Russian way of war. The goal is to establish a balanced force, consisting of general purpose forces for warfighting, a non-nuclear conventional deterrent, a capable non-strategic nuclear force for escalation management, and a credible strategic nuclear deterrent.[35]

Kofman is entirely justified in characterizing the military transformation in Russia's Armed Forces over the past decade as the "Ogarkov reform inheritance," since it has largely implemented Marshal Ogarkov's vision for the Soviet Armed Forces. By acting upon these ideas, investing in modernization and conducting force restructuring, Russia's General Staff placed at the heart of this process the adoption of C4ISR and network-centric warfare capability. Indeed, this has come to encapsulate "the Russian way of war." As

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[35] Michael Kofman, 'The Ogarkov Reforms: The Soviet Inheritance Behind Russia's Military Transformation,' *Russia Military Analysis*, https://russianmilitaryanalysis.wordpress.com/?s=ogarkov, July 11, 2019.

Kofman concludes, "The goal is to establish a balanced force, consisting of general purpose forces for warfighting, a non-nuclear conventional deterrent, a capable non-strategic nuclear force for escalation management, and a credible strategic nuclear deterrent."[36] The heightened Russian interest in and study of network-centric warfare notwithstanding, some skepticism persisted among the top brass and in the military scientific community. For simplicity, Russian military theorists writing in the post-1992 period can be divided loosely into three groups: traditionalists, modernists and revolutionaries. The traditionalists generally argued in favor of conservative approaches to warfare, stressing the continued need to study the Soviet experience of World War II while trying to adapt its lessons to modern conflict settings. Modernists favored a modification of this approach that would allow a general modernization of the doctrine, tactics, and weapons and equipment inventory to suit modern conflicts Russia might face. Whereas, revolutionaries argued that entirely new approaches and schemes were needed, and they were open to a complete overhaul of the Russian Armed Forces.[37]

These areas could often overlap. Chief among the traditionalists is Army General (ret.; deceased in 2019) Makhmut Gareev, widely considered one of Russia's greatest military theorists. Gareev was highly skeptical of US advances in network-centric warfare and argued against its adoption in Russia.[38] However, with the onset of the reform of the Armed Forces in 2008, the modernizers and

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[36] *Ibid.*

[37] Tor Bukkvoll, 'Iron Cannot Fight-The Role of Technology in Current Russian Military Theory,' *Journal of Strategic Studies*, XXXIV, No. 5, 2011.

[38] Makhmut Gareev, 'For the army of the 21st Century: a local war is first of all a war,' *Krasnaya Zvezda*, October 31, 2010; Makhmut Gareev, '*Opyt pobeditelei v velikoi voine ne mozhet ustaret*,' *Nezavisimoye Voyennoye Obozreniye*, March 12, 2010.

revolutionaries gained ascendency, both pushing the defense ministry, top brass and political leadership to pay closer attention to C4ISR and the adoption of network-centric warfare capability.[39] This trend continued under Sergei Shoigu (appointed defense minister in November 2012), with the political-military leadership remaining committed to network-centric warfare and the modernization of the Armed Forces along C4ISR lines. This complex theoretical environment presents multiple sources of contradiction and makes establishing the longer-term shape of Russian military capability exceedingly difficult.[40] Gareev, for example, frequently wrote against C4ISR, which was met with varying degrees of sympathy from the political-military leadership.

In addition, these efforts have proven sensitive to Russian military traditions and culture; thus, the transformation in progress must be understood and assessed in this historical, cultural and distinctive setting. The network-centric capability transformation is not about copying or mirroring the US and leading NATO militaries, since their approaches are unlikely to fit within the Russian system. Nevertheless, the top bass is evidently entertaining substantive changes.[41] Moreover, Russian military terms, as in other cases, do not quite fit or complement how their Western counterparts use or understand them. This is especially evident in the case of "C4ISR." In Russian military parlance, the key developmental and conceptual terms since the 1990s were the "reconnaissance-strike complex" (*razvedyvatelno-udarnaya kompleks*—RUK) or the "reconnaissance-fire complex"

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[39] Gavrilov, Y, Interview with General Staff Chief Makarov, *Rossiyskaya Gazeta*, March 23, 2010.

[40] S. P. Stolyarevskiy, D. V. Sivoplyasov, '*Problemy realizatsii federal'nykh gosudarstvennykh obrazovatel'nykh standartov vysshego obrazovaniya v podgotovke ofitserskikh kadrov*,' *Voyennaya Mysl'*, No. 3, 2016.

[41] S. Melkov and O. Zabuzov, '*Initiativa v onlaine i offlaine. Virtualnie voini i realnie problem*,' *Nezavisimoye Voyennoye Obozreniye*, July 16, 2010.

(*razvedyvatelno-ognevoy kompleks*—ROK). During the early 2000s, Russian military scientists added the "reconnaissance-strike system" (*razvedyvatelno-udarnaya sistema*—RUS), the "reconnaissance-fire system" (*razvedyvatelno-ognevaya sistema*—ROS), and the "reconnaissance-fire operation" (*razvedyvatelno-ognevaya operatsiya*—ROO) to augment the RUK and ROK concepts. By 2009, two additional concepts were appended: the "information-strike system" (*informatsionno-udarnaya sistema*—IUS) and the "information-strike operation" (*informatsionno-udarnaya operatsiya*—IUO).[42] While all these encapsulate specific elements of a C4ISR approach, there is, in fact, no direct Russian equivalent of overarching "network-centric warfare" as such. Indeed, when Russian experts have used the term, it first and foremost referenced such developments in US and NATO contexts or, more recently, was employed to grapple with its adoption in the Russian setting. The closest Russian military term to network-centric warfare is the above-mentioned reconnaissance-fire system (ROS).[43]

Equally, it is critical to understand the frequent appeals made to modern Russian military science by CGSs Makarov and Gerasimov because an examination of post-war Soviet military theory confirms a culture of exploiting the latest scientific and technological developments. This included breakthroughs in nuclear physics, space and electronic technology. Since World War II, Soviet military theory also examined laser, neutron beam, microwave, infrasound and

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[42] S. N. Razin'kov, Ye. A. Reshetnyak, A. M. Chernniy, '*Radioelektronno-informatsionnoye obespecheniye voysk radioelektronnoy bor'by Vooruzhennykh Sil Rossiyskoy Federatsii*,' *Voyennaya Mysl'*, No. 12, 2015; Andrey Yevdokimov, Narine Karapetyan, Mikhail Rutman, Mikhail Yakovlev, '*Strelyayem moshchno. no chasto mimo*,' *Zashchita i bezopasnost'*, June 30, 2016; Sergey Osipov, Aleksandr Kolesnichenko, Vitaliy Tseplyayev, '*Nam yest' chem gordit'sya!*' *Argumenty i fakty*, May 13, 2015.

[43] Author interviews with retired Russian military officers by VTC, July 13-14, 2020.

kinetic weapons technology. Many of these themes were expressed in the leading works from the post-war era: *Kharakter sovremennoy voyny i yeyo problem* (*The Nature of Modern Warfare and its Problems*, 1953); *Sovremennaya voyennaya nauka* (*Contemporary Military Science*, 1959); *Sovremennaya voyna* (*Modern Warfare*, 1960); *Voyennaya strategiya* (*Military Strategy*, 1961); *Nachalniy period voyny* (*The Initial Stage of War*, 1964); *Strategicheskaya operatsiya na teatre voyennykh deystviy* (*The Strategic Operation at the Theater of War*, 1966); and *Voyna i voyennoye iskusstvo* (*War and Military Art*, 1972). In 1980, a key handbook, *Osnovy strategicheskikh operatsiy* (*Basics of Strategic Operations*), was issued. Earlier, in 1966, the M. V. Frunze Military Academy published two crucial works in military theory, titled *Obshchevoyskovoy boy* (*Combined-Arms Battle*) and *Taktika* (*Tactics*).[44]

In addition to this rich wealth and variety of theoretical works, the Soviet General Staff experimented and closely assessed the course of operational-strategic military exercises such as Tempest (1962), Typhoon (1963), Dnieper (1967), Neman (1968), Spring Thunder (1968), East (1969), West (1969), North (1970) and Ocean (1970). Between 1971 and 1980, nine operational-strategic exercises were conducted in the west, seven more in the east, two in the south, plus four operational-strategic exercises for the air-defense troops, three for the Air Forces (*Voyenno-Vozdushnye Sily*—VVS), and two strategic exercises for the navy, the Military-Maritime Fleet (*Voyenno-Morskoy Flot*—VMF).[45] It is the nexus between theory rooted in Russian analysis of military conflicts on the one hand and experimentation in operational-strategic exercises on the other hand

[44] *Istoriya voyennoy strategiyi Rossiyi*, Kuchkovo pole publishers, Moscow, 2000.

[45] *Ibid,* p. 406.

that served to propel the drive to introduce C4ISR and exploit high-technology assets in a network-enabled environment.[46]

Military Science and the Ogarkov Reform Inheritance

The network-centric concept has been widely and deeply assessed and analyzed in the body of articles in Russia's professional military journals since the formation of Russia's Armed Forces in 1992, following the disintegration of the USSR in 1991. In an article published in *Voyennaya Mysl*, in 2013, examining the history of Soviet and Russian military theory, Major General (ret.) I. N. Vorobyov and Colonel (ret.) V. A. Kiselyov noted the transformation in approaches to modern warfare denoted by network-centric capability:

> At present, increasingly close attention is being paid to research into information (cybernetic) warfare. And this is perfectly right. In the 20th century, humanity mastered all the three domains that make up nature on planet Earth (the land, water and aerospace), having turned them into spheres of armed struggle. At the same time, the fourth dimension, on-air space [i.e., the electromagnetic spectrum], was also vigorously explored. But on-air warfare, as it was known at the time, was not exactly a strategic resource, nor was it all-embracing, and frequently it was merely sporadic.
>
> The 21st century became the age of IT [information technology] triumph. Progress in the information sphere started influencing the forms and methods of fighting. Characteristically, information acts at once as the target, resource and means of

[46] Oleg Vladykin, '*Ucheniye Tsentr-2015 zavershilos' udarno*,' *Nezavisimoye Voyennoye Obozreniye*, http://www.ng.ru/armies/2015-09-21/2_uchenie.html, September 21, 2015; '*V khode ucheniy Tsentr-2015 voyska REB otrabotayut naneseniye radioelektronnogo udara*,' Vesti.ru, http://www.vesti.ru/doc.html?id=2664568, September 15, 2015.

combat. Information confrontation is even now becoming a form of armed struggle in its own right, taking on a global, multidimensional nature, in space, on land, at sea and on-air. As local wars show, armed struggle is shifting toward the information sphere, and spatial characteristics of combat activity expand owing to active use of on-air space.

The concept of informational superiority over the enemy in operations fits organically in the currently developed concept of network-centric operations, which constitutes a system of views on the methods of controlling armed forces in 21st-century operations involving a single integrated information space formed in near-real time and based on three integrated nets—a global information-controlled network, an intelligence and surveillance network, and a destruction weapons network. Informational superiority within this system acts as the first and essential stage in achieving superiority in troops and weapons control, and it becomes a dominant factor of combat potential.

As one can see, information is now a species of weapon. It does not simply complement fire, strikes, [or] maneuvers but transforms and unites all of those. Among the new forms of informational confrontation are the electronic strike, the electronic information blockade, [and] the comprehensive electronic and energy impact on the enemy. Computer science expands the scope for contactless battles, and the battlefield structure gets more complex; its parameters are no longer just constants (width, depth, height), but also the invisible virtual space. Summing up, let us say that achieving superiority in the information sphere, along with winning fire supremacy over the enemy and achieving dominance in the air, is getting to the

> forefront of the network-centric environment of combat actions.[47]

Vorobyov and Kiselyov present an important Russian understanding of operations conducted in a network-enabled operational environment, representing this as "a system of views on the methods of controlling armed forces in 21st-century operations involving a single integrated *informatsionnoye prostranstvo* (information space) formed in near-real time and based on three integrated nets—a global information-controlled network, an intelligence and surveillance network, and a destruction weapons network." In this force multiplier way of war, information itself becomes a weapon: "It does not simply complement fire, strikes, [or] maneuvers, but *transforms and unites* all of those." Thus, as Vorobyov and Kiselyov note, network-centric warfare prioritizes the information sphere: "achieving superiority in the information sphere, along with winning fire supremacy over the enemy and achieving dominance in the air, is getting to the forefront of the network-centric environment of combat actions."[48]

Analysis of professional Russian military journals over the past 20 years reveals high levels of attention to network-centric warfare and related high-technology themes heavily tied to interest in forecasting the nature of future warfare. In terms of recent published work in relation to future warfare, some of these observations are borne out by reference to *Voyennaya Mysl*. For example, during the first six months of 2019, a relatively small number of articles appeared in relation to the theme of future warfare. In January 2019, Colonel (reserve) M. I. Nosov and Major (reserve) V. V. Karganov published a piece related to the single information space, with clear implications for future warfare: "*Kontseptual'nyye podkhody modelirovaniya*

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[47] Major General (ret.) I. N. Vorobyov and Colonel (ret.) V. A. Kiselyov, 'Russian Military Theory: Past and Present,' *Military Thought*, Vol. 3, 2013.

[48] *Ibid.*

yedinogo informatsionnogo prostranstva podsistem spetsial'nogo naznacheniya" ("Conceptual Approaches to Modeling of Special Purpose Subsystems of Single Information Space").[49]

In February 2019, two articles were published in *Voyennaya Mysl*, linked to the issues of future warfare. The first was written by V. V. Selivanov and Colonel (ret.) Yu. D. Ilyin, who followed a trend in other theorists' writings on the theme of asymmetrical responses to conflict with a high-technology adversary: "*Metodicheskiye osnovy formirovaniya asimmetrichnykh otvetov v voyenno-tekhnicheskom protivoborstve s vysokotekhnologichnym protivnikom*" ("Methodical Frameworks of Asymmetrical Response Formation in Military Technical Struggle Against High-Technology Enemy").[50] Second, in the same issue, Colonel (ret.) A. S. Brychkov, Colonel V. L. Dorokhov and Lieutenant Colonel (ret.) G. A. Nikinorov assessed future warfare through the prism of hybrid warfare: "*O gibridnom kharaktere voyn i*

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[49] M.I. Nosov and V.V. Karganov, '*Kontseptual'nyye podkhody modelirovaniya yedinogo informatsionnogo prostranstva podsistem spetsial'nogo naznacheniya,'* (Conceptual Approaches to Modeling of Special Purpose Subsystems of Single Information Space), *Voyennaya Mysl'*, No. 1, 2019. Nosov is a doctor of technical sciences, associate professor and senior research officer at the Research Center of the Research Department of the Military Signals Academy, and his colleague Karganov works as a senior research officer in the same department.

[50] V.V. Selivanov, Yu. D. Ilyin, '*Metodicheskiye osnovy formirovaniya asimmetrichnykh otvetov v voyenno-tekhnicheskom protivoborstve s vysokotekhnologichnym protivnikom,'* (Methodical Frameworks of Asymmetrical Response Formation in Military Technical Struggle Against High-Technology Enemy), *Voyennaya Mysl'*, No. 2, 2019. Selivanov is a professor and Honored Worker of RF Science as well as head of a Department of the Moscow State Technical University named after N. E. Bauman (Moscow). Colonel Ilyin is Cand. Sc. (Tech.), senior researcher and leading analyst of the SPC "Special equipment" of the Moscow State Technical University named after N. E. Bauman (Moscow).

vooruzhennykh konfliktov budushchego" ("About Hybrid Nature of Future Wars and Armed Conflicts").[51]

In the March issue of *Voyennaya Mysl*, Lieutenant Colonel A. A. Zhigalov, V. A Drogozov and V. V. Matveev examined the development of robotic units for military-medical use: "*Formirovaniye sistemy svyazi i peredachi dannykh dlya upravleniya perspektivnym semeystvom meditsinskikh robototekhnicheskikh kompleksov*" ("Forming a System of Communications and Data Transmission to Operate the Advanced Family of Military Medical Robotic Units").[52] In the same issue, Lieutenant (reserve) Y. A. Chizhevskiy explored how network-centric warfare is being implemented in the United States military: "*Realizatsiya kontseptsii setetsentricheskikh boyevykh deystviy v vooruzhennykh silakh SShA*" ("Implementing the Conception of Network-Centric Combat in the US Army").[53]

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[51] A. S. Brychkov, V. L. Dorokhov and G. A. Nikinorov, '*O gibridnom kharaktere voyn i vooruzhennykh konfliktov budushchego,*' (About the Hybrid Nature of Future Wars and Armed Conflicts), *Voyennaya Mysl'*, No. 2, 2019. Brychkov is a professor and fellow of the Academy of Military Sciences and of the Russian Academy of Social Sciences as well as a professor of the Department of the Russian Federation Armed Forces Military Academy of the Air Defense Forces (Smolensk). Dorokhov is chief of the Department in the same Academy. Their colleague Nikinorov is an associate professor in the same department.

[52] A. A. Zhigalov, V. A Drogozov and V. V. Matveev, '*Formirovaniye sistemy svyazi i peredachi dannykh dlya upravleniya perspektivnym semeystvom meditsinskikh robototekhnicheskikh kompleksov,*' (Forming a System of Communications and Data Transmission to Operate the Advanced Family of Military Medical Robotic Units), *Voyennaya Mysl'*, No. 3, 2019. Zhigalov is the head of department at the Main Administration for Research and Technological Support of Advanced Technologies (Innovation Research) of the Russian Ministry of Defense (Moscow). Drogozov is a leading expert of the Design Bureau at Voentelekom R&D Center (Moscow). And Matveev is a test engineer at the defense ministry's Main Robotics Research and Testing Center (Moscow).

[53] Y. A. Chizhevskiy, '*Realizatsiya kontseptsii setetsentricheskikh boyevykh deystviy v vooruzhennykh silakh SShA,*' (Implementing the Conception of Network-Centric

Coverage of the theme of future warfare linked to high technology resurfaced in the June issue of *Voyennaya Mysl,* which featured a cluster of articles on military robotics. Namely, Lieutenant Colonel N. A. Rudianov and Colonel (reserve) V. S. Khrushchev assessed the implications of developing autonomous robotic systems and how this might change the wars of the future: "*Kontseptualnyye voprosy postroyeniya i primeneniya avtonomnykh robototekhnicheskikh kompleksov voyennogo naznacheniya*" ("Conceptual Issues of Making and Using Military-purpose Autonomous Robotic Units").[54] The same issue contained a piece by Colonel (ret.) N. V. Babin, Lieutenant Colonel O. N. Ivanyushenko and N. N. Magdalinov, looking at engineering robotic units: "*Nekotoryye aspekty boyevogo primeneniya perspektivnogo inzhenernogo robototekhnicheskogo kompleksa shturma i razgrazhdeniya*" ("Certain Aspects of Combat Use of an Advanced Engineering Robotic Unit for Assault and Obstacle Clearing").[55] Finally, Lieutenant Colonel M. A. Gudkov, Colonel (ret.) V. N. Lukyanchik and Colonel (ret.) V. N. Melnik considered robotic units linked to forward aviation: "*Nazemnyy robototekhnicheskiy*

Combat in the US Army), *Voyennaya Mysl'*, No. 3, 2019. Chizhevskiy is a postgraduate student in the Department of Comparative Politics at MGIMO (Moscow).

[54] N. A. Rudianov and V. S. Khrushchev, '*Kontseptual'nyye voprosy postroyeniya i primeneniya avtonomnykh robototekhnicheskikh kompleksov voyennogo naznacheniya*,' (Conceptual Issues of Making and Using Military-purpose Autonomous Robotic Units), *Voyennaya Mysl'*, No. 6, 2019.

[55] N.V. Babin, O.N. Ivanyushenko, N.N. Magdalinov, '*Nekotoryye aspekty boyevogo primeneniya perspektivnogo inzhenernogo robototekhnicheskogo kompleksa shturma i razgrazhdeniya*,' (Certain Aspects of Combat Use of an Advanced Engineering Robotic Unit for Assault and Obstacle Clearing), *Voyennaya Mysl'*, No. 6, 2019. Babin is a senior researcher at the Central Research Institute of Engineering Troops in the Ministry of Defense (Nakhabino, Moscow Region). Ivanyushenko is head of department at the defense ministry's Central Research Institute of Engineering Troops (Nakhabino, Moscow Region); and their colleague Magdalinov is a senior researcher in the same institute.

kompleks peredovogo aviatsionnogo navodchika" ("The Ground-based Robotic Unit of the Forward Aviation Gunlayer").[56]

Similarly, if the *Voyennaya Mysl* net is cast over a longer period, recurring names and certain themes emerge. Since 1997, for example, future warfare has been discussed by V. P. Gulin, V. A Kiselyov, I. N. Vorobyov, S. G. Chekinov, S. A. Bogdanov, M. R. Gizitdinova, S. M. Cherkasov, V. N. Gorbunov, O. V. Alyoshin, A. N. Popov, V. V. Puchnin, A. V. Serzhantov and A. P. Martoflyak. Their subjects of focus included a new concept of war, hybrid operations, the nature of new-generation warfare, mobile underwater robots, armed confrontation in the 21st century and the changing role of naval power.[57]

Casting the net still wider and across additional Russian military publications across the past two decades, the following writers feature heavily: Vladimir Andreyev, Dmitriy Borisov, Vladimir Chebakov, I. Chernishev, Ivan Chichikov, Makhmut Gareev, A. Kondratyev, I. G.

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[56] Lieutenant-Colonel M.A. Gudkov, Colonel (retired) V.N. Lukyanchik, and Colonel (retired) V.N. Melnik, '*Nazemnyy robototekhnicheskiy kompleks peredovogo aviatsionnogo navodchika,'* (The Ground-Based Robotic Unit of the Forward Aviation Gunlayer), *Voyennaya Mysl'*, No. 6, 2019. Gudkov is head of the Research Center at the Military Academy of Communications (St. Petersburg). Lukyanchik is an assistant professor and senior researcher in the same center, as is Melnik.

[57] V. P. Gulin, 'A New Concept of War,' *Military Thought*, Volume 2, 1997; V. A. Kiselyov and I. N. Vorobyov, 'Hybrid Operations: A New Type of Warfare,' *Military Thought*, Volume 24, 2015; S. G. Chekinov and S. A. Bogdanov, 'The Nature and Content of a New-Generation War,' *Military Thought*, Volume 22, 2013; M. R. Gizitdinova and S. M. Cherkasov, 'Mobile Underwater Robots: Their Mission in Navy Missions,' *Military Thought*, Volume 17, 2008; V. N. Gorbunov and S. A Bogdanov, 'Armed Confrontation in the 21st Century,' *Military Thought*, Volume 1, 2009; O. V. Alyoshin and A. N. Popov and V. V. Puchnin, 'The Naval Might of Russia in Today's Geopolitical Situation,' *Military Thought*, Volume 25, 2016; A. V. Serzhantov and A. P. Martoflyak, 'Modern Military Conflicts,' *Military Thought*, Volume 2, 2009.

Korotchenko, Vladimir Kozhemyakin, V. V. Kruglov, S. Leonenko, Yevgeniy Lisanov, D. A. Lovtsov, N. E. Makarov, Gennadiy Miranovich, Sergei Modestov, P. Peresvet, Nikolay Poroskov, A. A. Proxhozhev, Mikhail Rastopshin, V. D. Ryabchuk, Vladimir Shenk, I. D. Sergeev, N. A. Sergeev as well as N. I. Turko.[58]

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[58] V. D. Ryabchuk, '*Problemy Voennoy Hauki I Voennogo Prognozirovaniya v Usloviyakh Intellektual'no-informatsionnogo Protivoborstva*,' (Problems of Military Science and Military Forecasting under Conditions of an Intellectual-Information Confrontation),' *Voyennaya Mysl'*, No. 5, 2008, pp. 68-69; N. E. Makarov, '*Kharakter Vooruzhennoy Bor'by Budushchego, Aktual'nye Problemy Stroitel'stva i Boevogo Primeneniya Vooruzhennykh Sil RF v Sovremennykh Usloviyakh*,' (The Character of Future Armed Conflict, Actual Problems of the Development and Deployment of the Armed Forces of the Russian Federation Today), *Vestnik Akademii Voennykh Nauk*, No. 2, 2010, p. 19; Makhmut Gareev, 'Concepts: The Experience of the Victors in the Great War Cannot Become Obsolete. We Need to Find the Roots of Future Victories in the Past,' *Nezavisimoye Voyennoye Obozreniye*, March 12, 2010; Makhmut A. Gareev, *If War Comes Tomorrow*, Frank Cass, London 1998, pp. 52-53; M. A. Gareev, '*Strategicheskoe Sderzhivanie: Problemy i Resheniya*,' (Strategic Deterrence: Problems and Solutions),' *Krasnaya Zvezda*, No. 183, 8 October 2008; Sergei Modestov, '*Prostranstvo Budushchey Voyny*,' (The Space of Future War),' *Vestnik Akademii Voennykh Nauk*, No. 2, 2003, p. 65; Sergei Modestov, '*Strategicheskoe Sderzhivanie Na Teatre Informatsionnogo Protivoborstva*,' (Strategic Deterrence in the Theater of Information Warfare),' *Vestnik Akademii Voennykh Nauk*, No. 1, 2009, p. 35; Sergei Modestov, '*Kontseptsiya Glubokoy Oborony v Informatsionnom Protivoborstve*,' (A Concept for Deep Defense in Information Warfare),' *Informatsionnaya Bezopasnost' Rossii* (Information Security of Russia), Moscow 1998; I. G. Korotchenko, '*Tendentsii razvitiya sovremennogo operativnogo iskusstva*,' (Tendencies in the Modern Development of Military Art),' *Voyennaya Mysl'*, No. 1, 1999, p. 11; I. D. Sergeev, '*Osnovnyi Faktory, Opredelyayushchie Voenno-Tekhnicheskuyu Politiku Rossii Nakanune XXI Veka*,' (The Main Factors which Determine Russia's Military-Technical Policy on the Eve of the 21 st Century),' *Krasnaya Zvezda*, No. 259, 9 December, 1999; Mikhail Rastopshin, '*V Labirinte Asimmetrichnykh Otvetov*,' (In the Labyrinth of Asymmetric Responses),' *Nezavisimoye Voyennoye Obozreniye*, No. 17, June 01, 2007; Gennadiy Miranovich, '*Voyennaya Reforma: Problemy i suzhdeniya. Geopolitika i bezopasnost Rossii* ,'(Military Reform: Problems and Judgment. Geopolitics and Russian Security),' *Krasnaya Zvezda*, July 31, 1999; V. V. Kruglov, '*O Vooruzhennoy Bor'be Budushchego*,' (On Future Armed Conflict),' *Voyennaya Mysl'*, September-October 1998, No. 5, pp. 54-58; N. A. Sergeyev and D. A. Lovtsov, '*O probleme 'organizatsionnogo oruzhiya*,' (On the Problem of the

'Organization Weapon'),' *Voyennaya Mysl'*, No. 1, 1999, p. 34; I. Chernishev, '*Polychat li poveliteli 'zombi' blast' nad mirom*,' (Can a Ruler Make 'Zombies' Out of the World),' *Orientir*, February 1997, pp. 58-62; Vladimir Andreyev, '*Novye Tendentsii Razvitiya Sredstv Protivoborstva: Netraditsionnoe Oruzhie Mozhet Okazat' Reshayushchee Vliyanie na Iskhod 'Voyny Budushchego*," (New Trends in the Development of Weapons: Non-traditional Weapons May Have a Decisive Influence on the Outcome of the 'War of the Future'),' *Nezavisimoye Voyennoye Obozreniye*, March 4, 1999; Dmitriy Borisov and Vitaliy Koreshkov, '*Voyny Menyayut Oblik: v Sposobakh Vedeniya Boevykh Deystviy Vozrastaet Rol' Nesmertel'nogo Oruzhiya*,' (Wars are Changing their Look: The Growing Role of Non-lethal Weapons in Methods of Combat Operations),' *Nezavisimoye Voyennoye Obozreniye*, February 26, 1999; S. Leonenko, '*O Refleksivnoe upravlenie protivnikom*,' (On Reflexive Control of the Enemy),' *Armeyskiy Sbornik*, No. 8, 1995, p. 28; A. A. Proxhozhev and N. I. Turko, '*Osnovy Informatsionnoy Voyny*,' (The Basics of Information Warfare),' in Analiz Sistem na Poroge XXI Veka: Teoriya i Praktika: T. Chetvertyy (Systems Analysis on the Threshold of the 21 st Century: Theory and Practice: Volume Four), Moscow February 1996; N. I. Turko and S. A. Modestov, '*Refleksivnoe Upravlenie Razvitiem Strategicheskikh Sil Gosudarstva Kak Mekhanizm Sovremennoy Geopolitiki*,' (Reflexive Control in the Development of Strategic Forces of States as a Mechanism of Geopolitics),' in Analiz Sistem na Poroge XXI Veka: Teoriya I Praktika: T. Chetvertyy (Systems Analysis on the Threshold of the 21 st Century: Theory and Practice: Volume Four), Moscow February 1996; Vladimir Chebakov, '*Kto Tut 'Shmel'? Leninskuyu Premiyu Emu…*,' (Who's the Shmel Here? Give Him the Lenin Prize),' *Armeyskiy Sbornik*, No. 3, 2003; Yevgeniy Lisanov, '*Proyti Nad Propast'yu i Ne Svalit'sya*,' (Pass Over the Abyss without Falling In),' *Krasnaya Zvezda*, June 4, 2008, Yevgeniy Lisanov, '*Predvidenie Uchenykh—Voennomu Delu*,' (Foresight of Scientists—Military Affairs),' *Nezavisimaya Gazeta*, No. 193, September 10, 2008; Kondratyev, A, Shchukin, M, '*Razvedyvatel'noe obespechenie boevykh deistvii sukhoputnyhk voisk SShA v gorodskikh usloviiakh*,' (Intelligence Support for the Military Operations of US Ground Troops), *Zarubezhnoe Voyennoye Obozreniye*, No. 9, September, 2008; Kondratyev, A, '*Obshchaia kharakteristika setevykh arkhitectur, primwniaemykh pri realizatsii perspectivnykh setetsentricheskikh kontseptsii vedushykh zarubezhnykh stran*,' (General Characteristics of the Web Architecture, Used in the Process of Applying the Perspective of Network-Centric Concepts of Leading Foreign Countries), *Voyennaya Mysl*, No. 12, December 2008; Vladimir Shenk, '*Stikhiey—po Vragu: Klimaticheskoe Oruzhie Voydet v Arsenal Sovremennykh Armiy*,' (Using Natural Disasters against the Enemy. Climate Weapons will be Part of Modern Armies' Arsenals),' *Voenno-Promyshlennyy Kur'yer*, October 28, 008; Vladimir Kozhemyakin, '*Kariby, Iran, i Kavkaz—Tri Bol'nye Mozoli SShA*,' (Caribbean, Iran, and the Caucasus—Three Painful Calluses for the US),' *Argumenty I Fakty*, No. 38, These authors covered a broad range of future warfare-linked themes:

- Military science and military forecasting;
- The character of future conflict;
- Rooting future warfare in the lessons of the past;
- Strategic deterrence and strategic foresight;
- Network-centric warfare;
- War in space;
- Deep defense in information warfare;
- Asymmetric warfare;
- Psychotronic weapons;
- Climate weapons;
- Reflexive control;
- Nanotechnologies.[59]

The concept of network-centric warfare is closely tied to the RMA, with the advances and practical application unfolding through complex processes in the enhancement of US military combat power, particularly in the 1990s. According to Russian military specialists, this meant new means and methods of conducting warfare, integrating "technical reconnaissance, automation and control of fire damage by means of information and telecommunication networks and data transmission to enhance the effectiveness of combat

September 17, 2008; Ivan Chichikov, '*Nanovoina: Masshtab Ugrozy*,' (Nanowar: The Scale of the Threat),' *Krasnaya Zvezda*, January 28, 2009; Nikolay Poroskov, '*Nanogonka Vooruzheniy*,' (Nano Arms Race),' *Vremya Novostey*, No. 182, 5 October 2007; P. Peresvet, '*Nanovoyna-2030: Skrytaya Ugroza*,' (Nanowar 2030: The Hidden Threat),' *Ekonomicheskiye Strategii* (Economic Strategy), http://www.inesnet.ru/magazine/mag_archive/?mid=85&cid=1826, No. 5-6, 2009; '*Perechen, 'Osnovnykh Napravleniy Fundamental'nykh Issledovaniy v Oblasti Oboronnoy Bezonpasnosti*,' (List of Basic Directions of Research in the Defense Security Area),' *Nezavisimoye Voyennoye Obozreniye*, February 18, 1999.

[59] *Ibid.*

operations through harmonization and coordination of available forces and means based on a common information space."[60]

Russian Analyses of the Origins of Network-Centric Warfare

Russian authorities on network-centric warfare trace the origins of the concept in its evolution within the US military to its first appearance in the computer industry, as a result of a breakthrough in technologies enabling interaction between computers and different operating systems. Later, the concept was adopted by the developers of network-centric approaches toward modern combat operations by the US proponents of the experimental shift from platform-centric to network-centric operations. A Russian military monograph in 2008 noted, "As a model of the fighting, illustrating the process of achieving in the 'network-centric' information war superiority over the enemy abroad is the widely used concept of the 'control loop.' Recently, such a cycle used the basic element of the theory developed by US Air Force Colonel John Boyd and his followers—the so-called OODA (Observe–Orient–Decide–Act) Loop."[61]

As one Russian specialist points out:

> US Navy Vice Admiral Arthur Tsebrovsky and US Department of Defense expert John Garstka noted that the concept of "network-centric warfare" is not only the deployment of digital networks in order to ensure both vertical and horizontal

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[60] N. Sidorin, I. A. Ryabchenko, V. P. Gerasimov, '*Informatsionnyye, spetsial'nyye, vozdushno-desantnyye i aeromobil'nyye operatsii armiy vedushchikh zarubezhnykh gosudarstv: informatsionno-analiticheskiy sbornik*,' Moscow: Voyenizdat, 2011; *Setetsentricheskaya voyna. Daydzhest po materialam otkrytykh izdaniy i SMI*, Moscow: VAGSh Russian Federation Armed Forces, 2010.

[61] A. A. Ivlev, *Osnovy teorii Boyda. Napravleniya razvitiya, primeneniya i realizatsii,* Moscow, 2008.

> integration of all participants in combat operations. It is also a change in the tactics, promising formations with dispersed military orders, optimization methods of intelligence activities, simplification of procedures, harmonization and coordination of fire destruction, as well as a leveling of distinction for management positions means.[62]

In an article published in 2015 in *Vestnik,* V. Kovalov, G. Malinetskii and Y. Matviyenko stress information superiority and the need for unified information and combat networks:

> At its core, "network-centric warfare" is focused on achieving information superiority by organizing the management of forces, providing an increase in their combat power through a unified information network connecting sensors (data sources), decision-makers and forces to supply the necessary information on the situation, accelerating control over such forces and resources. Consequently, it increases the efficiency of operations to defeat the enemy.[63]

A collection of materials on network-centric warfare issued in 2010 by Russia's General Staff takes this still deeper, emphasizing speed of decision making, self-synchronization with initiative from below within the military units deployed in a theater of operations, and the integration of sub-systems:

> According to the concept of development, the "network-centric" warfare method also makes it possible to move from war to

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[62] Savin L.V, '*Setetsentrichnaya i setevaya voyna. Vvedeniye v kontseptsiyu*,' Moscow: *Yevraziyskoye dvizheniye*, 2011.

[63] V. Kovalov, G. Malinetskii and Y. Matviyenko, '*Kontseptsiya 'setetsentricheskoy' voyny dlya armii Rossii: 'mnozhitel' sily' ili mental'naya lovushka?' Vestnik, Akademii Voyennykh Nauk*, No.1, (50), 2015.

> exhaustion to more transient and more sustainable forms of armed struggle, characterized by speed and control of the principle of self-synchronization, or the ability to self-organize military structure from below, without waiting for orders from above.[64]

Another Russian analysis of US approaches toward network-centric operation, published in 2009, adds:

> The conceptual and theoretical-level model of "network-centric" war is presented as a system consisting of three subsystems having a lattice structure: the information subsystem, the touch (intelligence) subsystem, and the subsystem of battle (subsystem of individual tactical units and command and control). The basis of the system is considered to be the first subsystem, which overlaps the second and third subsystem. The elements of the second subsystem are the forces and intelligence agents; and third [is composed of] the means of destruction, the military equipment and personnel of individual tactical units, and the combined government and command. "Network-centric" warfare, according to the authors of the concept, can encompass all levels of government, and the principles of its conduct do not depend on the geographic region, combat missions, or composition and structure of the armed forces. Themselves, the armed forces in this case are an extensive network of well-informed but geographically distributed forces.[65]

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[64] *Setetsentricheskaya voyna: Daydzhest po materialam otkrytykh izdaniy i SMI*, Moscow: VAGSh Russian Federation Armed Forces, 2010.

[65] S.A. Parshin, Yu. Ye. Gorbachov and Yu. A. Kozhanov, *Sovremennyye tendentsii razvitiya teorii i praktiki upravleniya v vooruzhonnykh silakh SShA*, Moscow: LENAND, 2009.

The upsurge in interest in network-centric concepts among Russian military scientists since 2008 reflects a clear influence from the senior military and defense leadership. In 2010, Russia's General Staff Academy published an extensive collection of open-source materials dealing with the concept of network-centric warfare: *Setetsentricheskaya voyna: Daydzhest po materialam otkrytykh izdaniy i SMI* (*Network-Centric Warfare: Digest on Materials of Open Publications and Mass Media*).[66] Moreover, the Russian military scientific community continues to maintain considerable focus on network-centric warfare, especially following and analyzing its evolution within the United States military. In 2018, for example S. I. Makarenko and M. S. Ivanov published a 901-page study: *Setetsentricheskaya voyna—printsipy, tekhnologii, primery i perspektivy* (*Network-Centric Warfare—Principals, Technologies, Examples and Perspectives*).[67]

It is clear, therefore, that within the existing body of professional Russian science, there is persistent interest in network-centric warfare. But the emerging view of the capability in the Russian context is cautious, and many specialists warn against the state investing too heavily in this area, fearing wastage of resources. As such, these experts tend to counsel against seeing its adoption as a panacea. It is also vital to understand that Russian theorists see network-centric warfare capability as an offensive rather than defensive capability, and they envisage it serving as a tool against other high-technology adversaries.[68]

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[66] *Setetsentricheskaya voyna: Daydzhest po materialam otkrytykh izdaniy i SMI*, *Op. Cit.*

[67] S. I. Makarenko, M.S. Ivanov, *Setetsentricheskaya voyna – printsipy, tekhnologii, primery i perspektivy*, *Sankt-Peterburg Naukoyemkiye Tekhnologii*, 2018.

[68] I. M. Kapitanyets, 'What should we be prepared for?' *Voyenno-Istoricheskiy Zhurnal*, June 2001.

In the published writings of Russian military scientists, a deep understanding and body of knowledge exists concerning Western military approaches to network-centric warfare; they tend to analyze the operational experience of such operations and draw conclusions concerning the relative strengths and weaknesses of such approaches. Additionally, Russian specialists have sought to study and draw lessons from examples of Western militaries, such as Sweden's, that tried and later abandoned efforts to introduce network-centric warfare—in order to avoid these pitfalls in Russia. Russian analyses of US/NATO network-centric capability are also closely linked to how Main Intelligence Directorate (*Glavnoye Razvedyvatelnoye Upravleniye*—GRU) specialist officers follow, assess and understand the concept and the key trends involved. An outstanding example is Colonel Aleksandr Kondratyev.[69]

The Influence of Aleksandr Kondratyev: Harnessing Theory for Modernization

Kondratyev, during the formative period of Russian military reform under then–defense minister Anatoliy Serdyukov, contributed extensively to furthering and deepening the domestic understanding of network-centric warfare by writing on its use and evolution within the US military as well as the work carried out on network-centric warfare by China's PLA.[70] These were published in *Nezavisimoe*

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[69] Jacob W. Kipp, 'Promoting the New Look for the Russian Armed Forces: the Contribution of Lieutenant-Colonel Aleksandr Kondratyev,' *Eurasia Daily Monitor*, Volume 7, Issue 113, The Jamestown Foundation, June 11, 2010.

[70] Aleksandr Kondratyev and P. Mikhailov, '*Medal za . . . reformirovanie*,' *Voyenno Promyshlennyy Kuryer*, http://www.archive.vpk-news.ru/article.asp?pr_sign=archive.2007.204.articles.geopolitics_02, October 3, 2007; Aleksandr Kondratyev and M. Shchukin, '*Razvedyvatel'noe obespechenie boevykh deistvii sukhoputnyhk voisk SShA v gorodskikh usloviiakh,'* (Intelligence Support for the Military Operations of US Ground Troops), *Zarubezhnoe Voyennoye Obozreniye*, No. 9, September 2008; Aleksandr Kondratyev, '*Obshchaia kharakteristika setevykh arkhitectur, primwniaemykh pri realizatsii perspectivnykh*

Voennoe Obozrenie, *Voyenno Promyshlennyy Kuryer*, *Voyennaya Mysl* and *Zarubezhnoe Voennoe Obozrenie*—professional journals or leading publications of the General Staff and the GRU. In these articles, Kondratyev examines issues such as command and control, speed of decision-making, moving away from platform-centric approaches to warfare, implications for space and airpower, as well as maritime exploitation. Generally, his work cautioned against seeking exclusively technology-based solutions to the deeper problems confronting the Russian Armed Forces.[71]

In 2011, Kondratyev published a collection of his articles in one volume. The translated titles listed below reveal the depth and breadth of his research into C4ISR/network-centric concepts in foreign militaries:

- The Fight for Information-Based Information;
- Implementation of the Concept of Network War in the ASAF;
- Implementing the Concept of Network War in the US Navy;
- Influence of the Concept of Network War on Efficiency;
- US Forces' Intelligence;
- Unified Understanding of the Situation on the Battlefield is Integral;

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setetsentricheskikh kontseptsii vedushykh zarubezhnykh stran,' (General Characteristics of the Web Architecture, Used in the Process of Applying the Perspective of Network-Centric Concepts of Leading Foreign Countries), *Voyennaya Mysl'*, No. 12, December 2008.

[71] Aleksandr Kondratyev, '*Nekotorye osobennosti realizatsii kontseptsii 'setetsentricheskaia voina' v vooruzhennykh silakh KNR,'* (Some Peculiarities of the Realization of the Concept of 'Network-Centric War' in the Chinese Army), *Zarubezhnoye Voyennoye Obozreniye*, No. 3, 2010, pp. 11–17; Aleksandr Kondratyev, '*Stavka na voiny budushchego*,' *Nezavisimoye Voyennoye Obozreniye*, June 27, 2008; Aleksandr Kondratyev, '*Realizatsiia kontseptsii 'setetsentricheskaia voina' v VVS SShA*,' *Zarubezhnoe Voyennoye Obozreniye*, No. 6, May 2009.

- Attributes of Netcentric War;
- General Characteristic of Network Architectures Used in the Implementation of Netcentric Concepts;
- Leading Foreign Countries' Problematic Issues of Researching New Netcentric;
- Concepts of the Armed Forces of Leading Foreign Countries;
- New Network Opportunities or War for the Arms Market;
- Some Features of the Implementation of the Netcentric Concept;
- Concepts vs China;
- Is an Information Revolution Needed in the Army?;
- New Features for a New Skin;
- Netcentric Front.[72]

In Kondratyev's preface, he outlines a number of areas of complexity in dealing with network-centric warfare and argues that it offers no panacea for Russian military planners. Chief among these relates to the sheer complexity involved in the creation and smooth running of such a system of enhancing warfighting capability:

> At the end of the 19th century, the Russian scientist Alexander Popov invented the radio, which at the beginning the next century was already adopted by the Russian army. A coup in military science did not happen, however; the forms and methods were improved and the use of groupings of troops and new means of armed struggle appeared. A century later, the next stage of implementation of modern information technologies in warfare appeared. The only difference is in scale. In fact, a real revolution is happening now, and it is network-centric. In the era of the formation of the modern multipolar world, the complication of the military-political situation and the

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[72] Aleksandr Kondratyev, *Setetsentricheskiy Gonka za Vremya*, Moscow, 2011.

> appearance of numerous hotbeds of tension for militaries to face, countries around the world are setting new tasks to ensure national security and the fight against terrorism. In these conditions, network-centric warfare turns into a real tool that increases combat capabilities and reduces [the required sizes of] armed forces.
>
> The large-scale introduction of information technology into the military sphere began in the USA. New regulations, equipment and weapons have already been repeatedly tested by the Americans in different wars and armed conflicts. Success is evident; however, even in the United States, there is no consensus on the new concept of network-centric warfare. The military science community is divided into supporters, doubters and opponents of such development. Indeed, network-centrism is not a panacea. With an undeniable increase in the level of combat capabilities, there are a number of serious dangers associated, in the first place, with an increase in the complexity of the system of warfare being formed.[73]

Kondratyev's writings were most frequent in the period 2009–2013. During this time, it also became clear that although there is clear understanding of network-centric warfare capability among Russian military scientists, there was no equally elaborated Russian variant of the concept.[74] In other words, it remained uncertain in the collective

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[73] *Ibid.*

[74] Aleksandr Kondratyev, '*Problemy organizatsii aviatsionnoi podderzhki operatsii sukhoputnykh voisk SShA*,' *Zarubezhnoe Voyennoye Obozreniye*, No. 9, November, 2009; Aleksandr Kondratyev and A. Medin, '*Doroga SShA k novomu obliku sukhoputnykh voisk*,' *Voyenno Promyshlennyy Kuryer*, October 14, 2009; Aleksandr Kondratyev, '*Edinaia razvedka evrosoiuza: byt ili ne byt?*' (The European Union Intelligence Service: To Be or Not to Be?), *Voyenno Promyshlennyy Kuryer*, February 25, 2009.

work of the country's leading specialists in this area as to how precisely the concept is adopted, adapted and applied in the Russian context.[75]

Jacob W. Kipp, an adjunct professor at the University of Kansas, summarized Kondratyev's refined and detailed understanding of network-centric warfare:

> Kondratyev understands the core relationship in John Boyd's OODA Loop (observe, orient, decide, and act), the struggle for the mystery of time in a combat situation. The OODA Loop takes on a new dimension in the information age. The loop could be divided into two parts—one informational (observe and orient) and the second kinetic (decide and act) relating to both maneuver of forces and firepower. If industrial war emphasized the second (kinetic part of the loop) then the information age underscored the importance of the former, understood as C4ISR (command, control, communications, computers, intelligence, surveillance, reconnaissance). Computational power and networks have made possible a quantum leap in informational flow, which has changed the informational/intellectual part of the loop. It turns intelligence into knowledge to aid the decision-makers across the entire battle space. Post-industrial kinetic means would also reshape future war. Kondratyev sees major possibilities in foreign work on lasers and nano-technologies, making them important areas for Russia to develop. Not all the issues associated with the development and employment of these systems have been answered. Yet Kondratyev concludes that many governments had already committed to this technological revolution reshaping military art in the twenty-first century.

[75] Aleksandr Kondratyev, '*Problemnye voporsy issledovaniia novykh setetsentricheskikh kontseptii vooruzhennykh sil vedushikh zarubezhnykh stran*,' *Voyennaya Mysl'*, No. 11, November 2009, pp.1–74; V. V. Kvochkov and Y. A. Martsenyuk, 'On the Character of Wars and Armed Conflicts With the Participation of the Russian Federation,' *Military Thought*, No. 2, 2002.

Russia could not afford to ignore this "qualitative new military potential."[76]

Challenges on the Path to C4ISR Integration

The sheer complexity and set of challenges presented to Russia's defense leadership in pursuing the integration of C4ISR and network-centric concepts in modern combat operations was certainly understood at an early stage by Russian military specialists. For example, Major General (ret.) Vasiliy Burenok, then the director of the defense ministry's 46th Research and Development Institute, argued the reform launched in 2008 was inexorably linked to the adoption of network-centric warfare capability. In an article published in *Nezavisimoye Voyennoye Obozreniye*, in April 2010, Burenok outlined the conceptual and theoretical features of network-centric warfare as a system consisting of three subsystem grids: sensor, information and combat. This system is formed by the information grid, which mutually intersects and overlays the other grids influencing the entire system of armed combat. The sensor system unites reconnaissance, and components of the combat grid are the means of destruction, while these are combined by the technical means of C2 bodies. Burenok explained that the force structure must be adapted to suit network-centric concepts, requiring structural identity or similarity among units as well as information compatibility and transferability (the absence of nodes that might interrupt the information flow).[77]

Burenok then stated that such restructuring must involve the following:

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[76] Jacob W. Kipp, 'Promoting the New Look for the Russian Armed Forces.' *Op.Cit.*

[77] Vasiliy M. Burenok, '*Bazis setecentricheskih voyn—operezhenie, intellect, innovacii,'* (Basis for Network-Centric Wars: Anticipation, Intellect, Innovations) *Nezavisimoye Voyennoye Obozreniye,* http://nvo.ng.ru/concepts/2010-04-02/1_bazis.html, April 2, 2010.

> Stability [*ustoichivost*]: the capability of forces to perform all their assigned missions. Recoverability [*vosstanavlevoaemost*]: the capacity of forces to function or recover their combat capabilities after suffering defeat by the enemy. Proficiency [*operativnost*]: the ability to respond to changes in the operational environment. Flexibility [*gibkost*]: the capacity to generate (formulate) and execute different variants to perform a mission. Innovativeness [*innovatsionnost*]: the capacity to apply new technical means and new methods of performing a mission. Adaptability [*adaptivnost*]: the capacity (non-critical nature [*nekritichnost*]) to change processes for the execution of tasks and of organizational structure in response to change in the concept for the combat employment of troops.[78]

As this author noted in a report published in 2010 by the Foreign Military Studies Office (Fort Leavenworth Kansas):

> The first of these, stability (*ustoichivost*), demands forming the so-called soldier of the network-centric war, prepared "theoretically, technologically and psychologically." Burenok admitted that despite the structural progress of Serdyukov's reform the Russian armed forces in this area remain at the beginning of a very lengthy journey. However, focusing upon the last two aspects, Burenok pointed to the experience of foreign militaries in which innovativeness (*innovatsionnost*) has become a crucial principle in developing the armed forces of leading foreign countries in recent years. The US military, for instance, has outperformed all others simply in terms of the number of its innovations. This innovativeness denotes a military culture within which new types and models of arms can be quickly and efficiently absorbed into the units and formations of the US military. Correspondingly, it underscores the need to revise

[78] *Ibid.*

> combat training manuals and regulations accordingly, carefully select procurement procedures and ensure delivery of new assets to units along with the necessary resources for repair and maintenance. It is precisely this very culture of innovativeness that must be formed within the Russian armed forces, in order to ensure their successful transition into the information age.[79]

At an early stage in the reform and modernization of Russia's Armed Forces, the annual strategic exercises were used to experiment with the introduction of an automated C2 system that would facilitate the development of the embryonic network-centric capability. In March 2010, in an interview with *Rossiyskaya Gazeta*, CGS Makarov discussed a variety of issues arising from the reforms. His interviewer explored the introduction of a new C2 system, experimentally trialed during three major exercises held during 2009—Kavkaz, Lagoda and Zapad—and he confirmed that the General Staff would also field test such systems during the operational-strategic exercise Vostok 2010. Makarov corrected his interviewer, who equated the reform and modernization of C2 with actually possessing network-centric warfare capabilities. Makarov's interjection suggested that the official Russian military understanding of the network-centric concept was not limited to C2:

> The network-centric method makes it possible to collect within the integrated information and communication space all space, aviation, ground, and other assets, intelligence assets, and weapons: seeing in real time, the entire country, and in the future, the world. Also, to employ the requisite forces at a given moment in keeping with the situation. Modern software will make it possible to determine the most expedient options for the accomplishment of combat missions, choose the weapons, and

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[79] Roger N. McDermott, *Russian Perspective on Network-Centric Warfare: The Key Aim of Serdyukov's Reform*, FMSO, December 2010.

> assess the probable impact of attacks, but, *the commanding officer still has the final say* [this author's emphasis], all the same. It is he that makes the final decision on the use of the troops. There is one further advantage of the network-centric method. Constant and concealed supervision of the enemy makes it possible to mount surprise attacks without direct contact with the antagonist. This sows panic and chaos, breaks his will, and ultimately results in his defeat. I shall in confirmation cite the second war in Iraq [2003]. According to our previous canons, two or threefold superiority in men and equipment was needed to break the enemy. For his assured defeat, five or sixfold. So, then, the Iraqis were five to six times superior [in numbers] to the Americans, but were smashed within three weeks.[80]

Makarov went on the say that "ambitious tasks" were set to settle the issues involved in adopting network-centric capability within "two to three years." Despite this over-estimation, however, Makarov had offered a fairly balanced and succinct overview of network-centric warfare, and he refuted any idea that Russian planners restricted themselves to a narrow understanding of the network-centric concept. Moreover, he clearly identified that the human component will remain important, as the complexity of network-centric warfare lies in the fact that it seeks to produce "synergy between man and machine" as well as in the need for a new systematized methodology to aid its introduction.[81]

In January 2013, CGS Army General Gerasimov delivered a keynote address to the annual AVN conference in Moscow. His report covered "The Main Trends in the Forms and Methods of the Armed Forces," focusing on how military science can play a pivotal role in achieving

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[80] Yuriy Gavrilov, 'Interview with General Staff Chief Makarov,' *Rossiyskaya Gazeta*, March 23, 2010.

[81] *Ibid.*

advances in military capability. Noting that the distinction between war and peace has blurred in the modern era, he addressed issues arising from the Arab Spring and outlined Moscow's concerns about "color revolution" or "foreign intervention, chaos, humanitarian disaster and civil war."

Gerasimov then posed the question, "What is modern war?" And how should Russia's military be prepared and armed? The CGS explained that the means and methods of modern conflict have fundamentally changed, denoted by intelligence and dominance of the information space. Information technologies have reduced the "spatial, temporal and information gap between army and government. Objectives are achieved in a remote contactless war; strategic, operational and tactical levels or offensive and defensive actions have become less distinguishable." Gerasimov was demonstrating awareness of the potential role to be played by harnessing network-centric capabilities.[82]

Indeed, some Russian critics of network-centric warfare argue that it is alien to Russian military culture and that it is not the gamechanger in warfare that its US advocates claim is the case. Moreover, a number of systemic barriers exist to adopting network-centric warfare in Russia, both technically and in terms of military manpower.[83] These can be summarized as follows:

- Challenges within the defense industry especially related to advanced micro-components and its technology lag behind leading NATO members;

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[82] Valery Gerasimov, '*Tsennost' nauki v predvidenii,' Voyenno Promyshlennyy Kuryer*, http://vpk-news.ru/articles/14632, February 26, 2013.

[83] A. V. Khomutov, '*Opyt i perspektivy ispol'zovaniya kontseptsii yedinoy informatsionno-kommunikatsionnoy seti v upravlenii voyskami,' Voyennaya Mysl'*, No. 11, 2015.

- The lack of force integration traditionally seen in Soviet/Russian military operations;
- Problems in the design and production of an integrated automated command, control and communications system;
- The rigid nature of Russian military doctrine and tactics that inhibits the adoption of new or innovative approaches to operations;
- The absence of delegated authority down the chain of command to include responsible "officer style" non-commissioned officers (NCO);
- An absence of individual initiative within Russian military culture and traditions at tactical levels;
- Russia's General Staff leadership understands the crucial role of information superiority and the need to both disseminate and utilize information at high speed to be credible in a dynamic operational environment in modern or future warfare. Traditionally, the Russian military has not been short on firepower; its problem has been in identifying and locating the target. To achieve this through enhanced C4ISR, the Armed Forces must connect sensors to the source of fires to exploit truly network-centric capability;
- Moscow's defense ministry, General Staff and the Russian defense industry face long-term challenges of producing and then integrating highly interoperable systems as well as standardizing weapons and equipment, which (although progress is evident) will remain a key factor in the exploitation of high-technology-based approaches to warfare;
- Within the defense industry, standards will need to be raised to address weaknesses in tactical and operational unmanned

combat aerial vehicles (UCAV), and further develop UCAV and UAV strike capabilities.[84]

Despite these barriers to adopting network-centric warfare in the Russian Armed Forces, the idea of network-centric warfare has been preserved as the key driver in the conventional military modernization.[85] For the top brass and defense planners in Russia, this means reliance upon "learning by doing" and, therefore, paying close attention to the experimental use of networked operations in the Syrian theater since 2015, to better understand how this may be furthered in future planning and subsequent shaping of the internal military structure and subsequent modernization priorities.[86]

Indeed, during its military operations in Syria, officially designated as a military aerospace operation (*vozdushno-kosmicheskaya operatsiya*), Russia's Armed Forces evidently experimented with and refined their version of network-centric warfare with the use of advanced air assets as well as precision strikes from long range, exploiting naval platforms to fire Kalibr and Oniks cruise missiles. An important dimension of this feature of Russian operations in Syria is the extent to which it uses inter-service precision strikes involving air and naval platforms operating in the Syrian theater. An insightful assessment of these operations appeared in November 2016 in *Voyennaya Mysl*, the professional journal of the Russian General Staff. Its author, O. V. Tikhanchev, reviews the effort to develop and use reconnaissance strike complexes (*razveditalnie udarnye kompleksy—*

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[84] Author's assessment based on discussions with Russian military SMEs by VTC in Berlin, Brussels, Hamburg, London and Washington DC, October 2020.

[85] Yu. Ye. Donskov, S. V. Golubev and A. V. Mogilev, "*Model' podgotovki spetsialistov radioelektronnoy bor'by k vypolneniyu zadach po informatsionnomu obespecheniyu voyennykh (boyevykh) deystviy*,' *Voyennaya Mysl'*, No. 4, 2015.

[86] Russia's use of C4ISR in its military operations in Syria is discussed in chapter four.

RUK) in the conflict.[87] His article highlights the role of inter-service reconnaissance and fire complexes in Syria; this includes aircraft and missiles launched by naval platforms. This would seem to imply network-centric fires and strikes. The author also highlights the use of UAVs to collect immediate bomb damage assessments as a key part of the complex. Although the network-centric experiments and testing in Syria have been quite limited, it is worth noting that only a few years ago this would have been impossible in Russia's Armed Forces.

Automated Command, Control and Communications Systems

Russia's military leadership, like its Soviet predecessor, has aspired to develop and introduce a modernized network-centric C2 system, long delayed due to the lack of sufficient technical means and state-level investment. Over the past decade, this has changed, as Russia developed its information technology sector and defense industries working with the defense ministry to capitalize on these new technologies. In 2016, Moscow established a national command center, the National Defense Management Center (*Natsionalnogo Tsentra Upravleniya Oboronoy*—NTsUO), aimed at integrating the subordinate command centers at the operational strategic command (military district) and Army Group levels.[88]

In the tactical echelon, the Russian Ground Forces benefit from a variety of new technologies to facilitate the integration of C4ISR and enable network-centric capability. This aligns the procurement and modernization priorities in a broader network-centric warfare

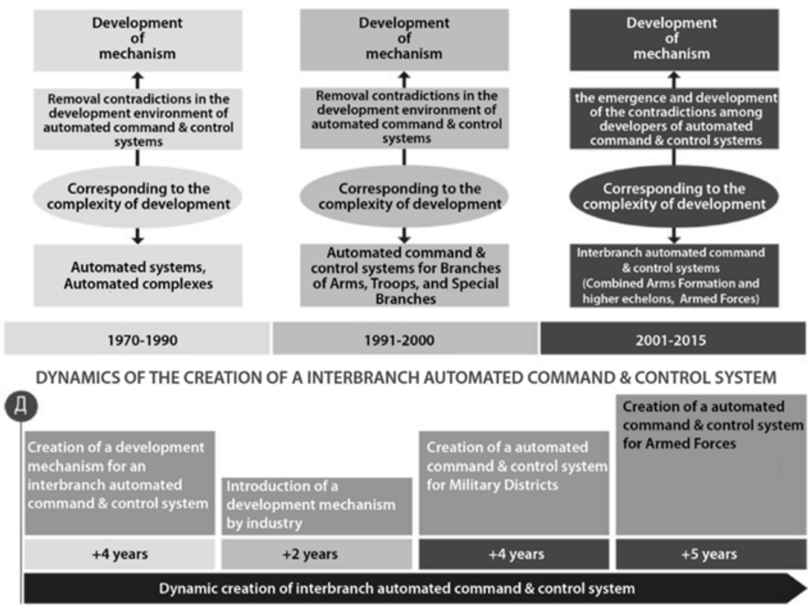
[87] O. V. Tikhanychev, *Op. Cit.*

[88] Ye. O. Ostrovskiy and A. S. Sizov, '*Podkhod k modelirovaniyu kognitivnoy sfery ob'yektov operativnoy razvedki*,' *Voyennaya Mysl'*, No. 2, 2016.

framework.[89] These advances include new tactical radios, a tactical digital mobile subscriber system (military digital cell phone and data system), and tactical laptops and tablets.

The Russian military's theoretical interest in developing and fielding an integrated automated C2 dates back to the early 1970s, and pursuit of this goal has progressed markedly since 2000 (see **Figure 1**).

Figure 1: Creation of the Interbranch Automated Command Control



Source: Voyenno Promyshlennyy Kuryer, September 1, 2015.

In 2000, recently elected President Putin ordered the Russian defense industry to design and develop a Unified System for Command and Control at the Tactical Level (*Yedinaya Sistema Upravleniya v*

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[89] '*Ukazatel' statey, opublikovannykh v zhurnale 'morskoy sbornik' v 2015 G.,' Morskoi' Sbornik*, No. 12, 2015.

Takticheskom Zvene—YeSU TZ). Sozvezdiye Concern was tasked with overseeing the work of a group of domestic defense industry companies in this project. In the aftermath of the August 2008 Russia-Georgia War and the ensuing initiation of military reforms, including the introduction of a brigade-based force structure for the Ground Forces and reforming a flattened C2, progress on the YeSU TZ garnered momentum. The base of Figure 1 suggests that in 2015, a failure of the process occurred in achieving a fully integrated system, and the author offered time-frames and possible approaches toward its resolution.[90] During this process, Russian military theorists and the top brass appeared to focus their discussions on the need to enhance the speed of decision-making and the time required to generate orders for the conduct of an operation.[91] They saw the YeSU TZ as a means to close the gap in this regard with leading advanced militaries.

The Russian defense industry struggled to meet the demands of the defense ministry and the General Staff, despite awareness of the importance to digitize communications and to eventually field an integrated network-enabled command, control and communications system. At the heart of the numerous design flaws and software issues was the failure of the defense ministry to coordinate with senior

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[90] See: Dmitry Kandaurov, 'Computer: It is Time to Replace the Pencil in the Hand a Staff Officer,' *Nezavisimoye Voyennoye Obozreniye*, http://nvo.ng.ru/armament/2010-11-12/10_computer.html, November 12, 2010; Dmitry Kandaurov, 'The Main Resources Available to ASUV: Information and Time,' *Nezavisimoye Voyennoye Obozreniye*, http://nvo.ng.ru/concepts/2010-10-08/6_asuv.html, October 8, 2010. A valuable insight into some of the characteristic flaws in Russian defense planning can be found in: Carolina Vendil, *Russian Military Reform: A Failed Exercise in Defense Decision Making*, Routledge: London, 2009.

[91] Nikolay Pal'chikov, '*Povestke - sud'bonosnyy vybor*,' *Krasnaya Zvezda*, November 6, 2015; V. I. Vladimirov and V. I Stuchinskiy, '*Obosnovaniye boyevogo primeneniya aviatsionnykh nositeley sredstv radioelektronnoy bor'by v operativnoy glubine dlya zavoyevaniya informatsionnogo prevoskhodstva*,' *Voyennaya Mysl'*, No. 5, 2016.

officers and the defense industry. The YeSU TZ was repeatedly tested during tactical or operational-strategic exercises since 2009. On all occasions, new design failures were detected, including the lack of a user-friendly interface, through to concern over the system's survivability during combat operations against a high-technology adversary. This was illustrated in a series of brigade-level tests in 2010, with officers and soldiers complaining that the graphic displays in hand-held or laptop devices were too overloaded with icons and complex software tools.[92]

As the elongated testing phase unfolded, the Ministry of Defense and General Staff came to understand that a wider underlying problem lay in the need to train officers and contract personnel in the use and exploitation of the new system. The training system was forced into rapid adjustment after failures identified based on analysis and "lessons learned" from the annual operational-strategic exercise Kavkaz 2012.

Kavkaz 2012, among other features of the exercises, provided an important testing opportunity for the automated command system (*avtomatizirovannoy sistemy upravleniya*—ASU). Namely, however, it exposed a large number of flaws in the prototype system. The report submitted to the General Staff identified more than 200 such defects; consequently, the leadership of the General Staff recommended to the defense ministry that the YeSU TZ contract be terminated. Then–deputy defense minister Dmitry Rogozin succeeded in preserving, albeit under modified arrangements, the contract with Russia's defense industry and set a timeframe to address the future command system's weaknesses. Among the flaws exposed during the exercise, 160 were considered to be a result of human error, underscoring the

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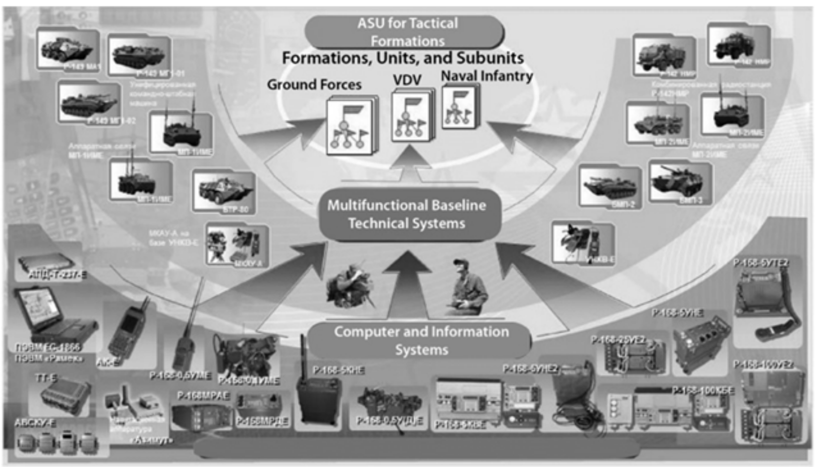
[92] Dmitry Kandaurov, 'ASUV at Alabino: Desired and Actual,' *Nezavisimoye Voyennoye Obozreniye*, http://nvo.ng.ru/armament/2010-11-19/1_asuv.html, November 19, 2010.

need for additional training. The technical issues had to be resolved by Sozvezdiye Concern.[93]

An additional problem is that the Russian military’s services and arms all have different automated systems. For example, the Airborne Forces (*Vozdushno-Desantnye Voyska*—VDV) utilize the automated Andromeda-D system, specifically tailored to meet their operational needs, which offers challenges for overall automated C2 integration.

Figure 2: Russia’s Automated Command System and Linkages



The existence of these divergent systems is illustrated in **Figure 2**. The automated systems differ between the Ground Forces, VDV and Naval Infantry—trying to link all of these to new or modernized platforms and digitized communications systems presents a truly intricate challenge. Russian specialists critical of network-centric warfare stress the failure to create a fully integrated automated system. Yet the pattern in addressing the issues involved suggests that a new generation of systems could be sufficiently integrated in the period

[93] Author’s discussions with Russian SMEs, December 2018.

2027–2030. The Armata, Bumerang and Kurganets platforms for the Ground Forces are classified as Ground Troops vehicles, and they will also have their own Tactical Echelon Integrated Command and Control Systems, which could, in turn, create additional issues in achieving full systems integration. Despite these issues, the testing of the ASU complexes during Kavkaz 2016 was deemed by the defense ministry and the General Staff to be successful, suggesting that some, if not all, of the technical issues may have been remedied. The trend, therefore, in the modernization of the Russian Armed Forces is toward greater information and network-enabled integration, placing more emphasis on speed of command and control, speed of operations, strategic and tactical mobility, and networked-communications during combat operations.

Figure 3: Digital Communication and Automated C2, Providing Entry Into a Single Information Space for the Russian Armed Forces

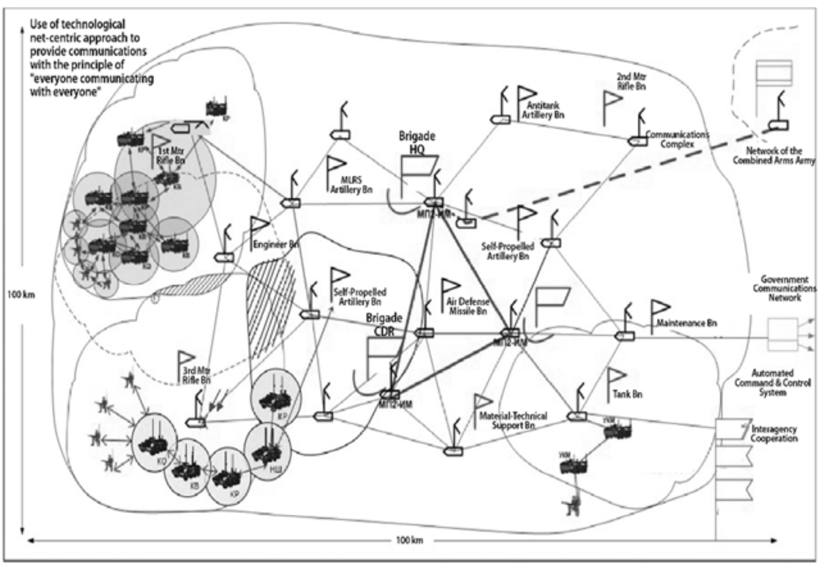


Figure 3[94] illustrates that an integrated communications model is gradually becoming a more realistic prospect for the Russian military, with all fixed command posts already digitized and plans to totally digitize the mobile command post over the next several years. In late 2016, the signals command had referred to the overall system as containing 13 subsystems, and called for further sustained work to improve the functionality of the automated system.[95]

Conclusion

Russia's Armed Forces have moved beyond a theoretical understanding of C4ISR and developing network-centric capability to actually implementing this in practical terms.[96] This does not represent any particular breakthrough in Russian military theory: it simply denotes that the state is now actively investing in supporting the implementation of such ambitious efforts.[97] Nevertheless, despite the undoubted progress in this critical aspect in the drive to adopt high-technology approaches toward modern and future warfare, it will require time, further experimentation, as well as doctrinal and training modifications in order to introduce this more fully and effectively.[98]

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[94] General Skokov (ret.) Livejournal Commentary, http://general-skokov.livejournal.com/10193.html, October 13, 2013.

[95] Galgash Interview, *Op. Cit.*

[96] A. Muratkhanov, V. Litvinenko, '*Varianty ognevogo porazheniya*,' *Armeskiy Sbornik*, May 31, 2016.

[97] Aleksandr Karpovich, '*Kompleksy vozdushnoy razvedki v sostave razvedyvatel'no-ognevoy sistemy*,' *Zashchita i bezopasnost'*, March 31, 2016.

[98] Dobren'kov V.I., Agapov P.V, '*Voyna i bezopasnost' Rossii v XXI veke*,' Moscow: Akademicheskiy proyekt, Al'ma Mater, 2011; Rukshin A. S, '*Nekotoryye itogi reformy Vooruzhennykh Sil. Stat'ya v gazete*,' *Voyenno Promyshlennyy Kur'yer*, 14 November 2012; Zatuliveter YU., Semonov S, '*Oriyentir – dostatochnaya oborona.*

- Progress in the technical training sides of adopting network-centric warfare approaches is most visible in overhauling the command, control, communications and intelligence (C3I) structure, introducing automated C3I, replacing analogue radios and communications systems with modern digital versions, and integrating modern and advanced platforms to network at least part of the force structure, as well as in seeking to experiment with network-centric warfare approaches to fires and precision strikes.
- The process of networking the force structure, which also demands retraining and educating officers and contract personnel in the use of these systems, includes the introduction of new-generation network-enabled personnel gear for individual soldiers (*Ratnik*). Procurement plans over the next several years will see increased emphasis on introducing network-enable platforms, to include the Armata and the Kurganets in the Ground Forces. It is likely that this will be accompanied by further state investment in and progress in relation to EW.
- Although the rate of introducing the automated systems into the Ground Forces brigades may be somewhat slow, it also appears that the defense ministry wishes to avoid networking the entire force structure.
- Despite the advances the Russian military has made and continues to make in this area, there are still a number of barriers to its more successful introduction and exploitation as a "force multiplier," as noted above.
- At present, the Russian Armed Forces possess a limited, embryonic and evolving capability, but as the inventory is modernized and the force moves toward being digitized and informationized over the next several years, with higher

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Pomimo yadernogo zontika Rossiya mozhet obezopasit' sebya merami setetsentricheskogo protivodeystviya,' *Natsional'naya Oborona*, No.11, 2012.

numbers of sufficiently trained contract personnel within the system, it can be expected that Russian network-centric warfare capability will continue to strengthen.

- The priority and principle testing ground for these advances is in the Western Military District, suggesting concern in Moscow over a possible confrontation with NATO forces.
- Russia is likely to harness network-centric capability to suit its own military culture and requirements. Given the publicly available information on the capacity to deliver brigade sets of the YeSU TZ, around 40 percent of Ground Forces units may be network-enabled by 2030. And that percentage will rise to 100 percent in the elite units: Special Forces, GRU Spetsnaz, VDV, Naval Infantry, etc.
- Russia's network-centric capability is being developed with US and NATO vulnerabilities in mind, particularly in potential operational areas on Russia's periphery, and is most likely to emerge as a critical tool to challenge or restrict US/NATO capability to reinforce or deploy in the North Atlantic Alliance's east during a period of crisis.
- The network-centric/C4ISR adoption in Russia's Armed Forces also feeds into and drives the exponentially growing interest and advances in EW capability. Left unchallenged, as these developments unfold in the years ahead, Russia will asymmetrically close numerous technology and capability gaps with the US and NATO, proving a new and potentially dangerous tool set to manipulate and shape events and use during the early phases of kinetic events close to Russia's borders.
- Russia's likely emergence over the next several years with viable network-centric warfare capability will pose increased challenges for NATO, especially on the Alliance's northeastern and eastern flanks, as the Russian Armed Forces make further advances to harness advanced, network-enabled capabilities that are more likely than not

> intended for use in offensive operations on Russia's periphery.

Recent work by Russian military theorists acknowledges that the adoption of network-centric capabilities in Russia's Armed Forces will involve a change in the outlook of the military leadership at all levels, forming the automated infrastructure, operating in a single information space, further developing modern means of surveillance and reconnaissance to fill the modernized telecommunications networks, and populating the Armed Forces with "sufficient numbers of high-precision weapons."[99] Clearly, this will involve long-term and systemic work on the part of Russian defense planners to integrate combat platforms into such an information network, accommodating such change to corresponding measures related to military manpower and training.[100] Thus, following several years of experimentation with network-centric approaches and what this means for force structure, education, training and operational tactics, Russian top brass and theorists are in broad agreement that the concept in the Russian context may be used to inspire, shape and drive the defense industry's work to modernize the country's Armed Forces. Network-centricism is not an end in itself, avoiding what some theorists describe as a "mental trap," but a method to achieve a "factor of power" in the state's future warfare capability.[101]

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[99] B. Iranskiy, '*Khamashekh vpervyye prinyal uchastiye v uchebnykh manevrakh KSIR*,' *Voenno-tekhnicheskoe sotrudnichestvo*, April 2016; Dmitriy Litovkin, '*Armiya perekhodit na elektronnyye pasporta*,' *Izvestia*, July 26, 2016.

[100] Anatoliy Isayenko, '*Nastupayet era tsifrovogo mirotvortsa*,' *Nezavisimoye Voyennoye Obozreniye*, November 13, 2015.

[101] V. Kovalov, G. Malinetskii and Y. Matviyenko, '*Kontseptsiya 'setetsentricheskoy' voyny dlya armii Rossii: 'mnozhitel' sily' ili mental'naya lovushka?' Vestnik Akademii Voyennykh Nauk*, No.1, (50), 2015.

4.

Russia's Entry to Sixth-Generation Warfare: The 'Non-Contact' Experiment in Syria

Whereas Russia's military operations in southeastern Ukraine since 2014 depended on a level of "plausible deniability"—unrealistic as it may have been to achieve in any meaningful manner—when President Vladimir Putin authorized the use of military force in Syria in September 2015, the operations that ensued required no such secrecy.[1] The Syria campaign, thus, became an opportunity for the Russian Armed Forces to test and experiment with both the means and methods of conducting modern combat. An element of this "testing" related to the role played by high-technology systems and weapons. And this included (in the context of Russia's military role in the civil war in Syria) systems and weapons covering a broad range: air defense, electronic warfare, or advanced air- and ground-based platforms.[2] Within this wider range of weapons systems trialed in the

[1] The author wishes to express his gratitude to the following individuals for reviewing and commenting on an earlier draft of this chapter: Dmitry Adamsky, Charles K. Bartles, Lester W. Grau and Guy Plopsky.

[2] See: Rajan Menon, Eugene Rumer, *Conflict in Ukraine: The Unwinding of the Post-Cold War Order*, MIT Press 2015, pp.83–85. '*Yuriy Borisov rasskazal o primenenii*

Syrian conflict was Russia's first use in combat of high-precision cruise missiles.

This chapter examines the implications and role played by the high-precision elements in the prosecution of Russia's military operations during the course of the conflict. It will avoid replicating the existing work of other specialists on Russian foreign, defense and security policy or on the military itself, or repeating analyses of the political rationale underlying the Kremlin's decision in the fall of 2015 to risk entering this conflict, even if in a limited manner. Equally, the following study will not assess Russia's military operations in Syria as a whole, or touch upon the lessons from the conflict that the General Staff may have drawn from these operations.[3]

Instead, the focus of this chapter is on the role played by high-precision weapons in the context of Moscow's increasing adoption of high technology in its further efforts to boost military capabilities. This requires outlining the place such weapons play in Russian military thought; analyzing how these concepts permeate the thinking of the leadership of the General Staff; as well as assessing the use of

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rossiyskoy voyennoy tekhniki v Sirii,' *Gazeta.ru*, December 17, 2018; Aleksey Ramm and Andrey Laykovskiy, '*Dron v boyevykh usloviyakh Zamnachal'nika Gosudarstvennogo tsentra bespilotnoy aviatsii podpolkovnik Andrey Laykovskiy — o primenenii BPLA v Sirii, osobennostyakh podgotovki operatorov i novykh apparatakh dlya Vooruzhennykh sil*,' https://iz.ru/785792/roman-kretcul-aleksei-ramm/dron-v-boevykh-usloviiakh,*Izvestia*, October 12, 2018, https://iz.ru/785792/roman-kretcul-aleksei-ramm/dron-v-boevykh-usloviiakh.

[3] See, for example: Dmitry (Dima) Adamsky, 'Russian Lessons Learned From the Operation in Syria: A Preliminary Assessment,' in Glen E. Howard and Matthew Czekaj (eds.), *Russia's Military Strategy and Doctrine*, Washington DC, 2019, pp.379–410; Michael Kofman and Matthew Rojansky, JD, 'What Kind of Victory for Russia in Syria?' *Military Review*, https://www.armyupress.army.mil/Journals/Military-Review/Online-Exclusive/2018-OLE/Russia-in-Syria/,January 24, 2018, https://www.armyupress.army.mil/Journals/Military-Review/Online-Exclusive/2018-OLE/Russia-in-Syria/.

high-precision strikes during operations in Syria, principally by the Military-Maritime Fleet (*Voyenno-Morskoy Flot*—VMF) and the Aerospace Forces (*Vozdushno-Kosmicheskiye Sily*—VKS); consideration of the extent to which high-technology navigational attack systems were adopted and exploited in the theater of operation in order to significantly enhance the accuracy of using "unguided ordnance." The chapter concludes with an overview of the doctrinal and strategic import of Moscow's use of high-precision strikes as a means of "non-contact warfare."[4]

While this represents an analysis of Russia's entry into "sixth-generation warfare" and "non-contact capability," it should be noted that this was not used in isolation from other operations that were "fourth-generation," or contact-oriented. Moreover, in terms of the sum total of Russian military operations in Syria, the high-precision "non-contact" element is merely a fragmentary feature in the wider application of "hard power." Finally, while offering an invaluable experience to use and refine these weapons in a combat environment, these were nevertheless used against a non-peer adversary.[5] Nonetheless, this was clearly a new capability for Russia's Armed Forces to deploy and utilize in combat operations, also featuring the first use of strategic aviation against enemy forces; and marking as it

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[4] Aleksei Ramm, '*Kuda letit bespilotnaya aviatsiya Versiya dlya pechati Obsudit' na forume Vooruzhennyye sily proyavlyayut vse bol'shiy interes k BPLA*,' *Nezavisimoye Voyennoye Obozreniye*, https://nvo.ng.ru/armament/2021-01-21/1_1125_aviation.html,January 21, 2021, https://nvo.ng.ru/armament/2021-01-21/1_1125_aviation.html; Irina Dronina, '*Ministrov v voyennoye vremya ne menyayut Versiya dlya pechati Obsudit' na forume Kreml' stavit na tekhnologicheskiy proryv i posledovatel'nuyu modernizatsiyu armii i flota*,' *Nezavisimoye Voyennoye Obozreniye*, https://www.ng.ru/armies/2018-05-22/8_7229_shoygu.html,May 22, 2018, https://www.ng.ru/armies/2018-05-22/8_7229_shoygu.html.

[5] Vladimir Vashchenko, Vladimir Dergachev, Artur Gromov, '*Rossiya oprobovala na boyevikakh flot i novyye krylatyye rakety Dmitriy Yevstifeyev*,' Gazeta.ru, October 7, 2015, https://www.gazeta.ru/social/2015/10/07/7808867.shtml.

does the country's entrance into sixth-generation warfare capability, it is highly likely that this non-contact element will continue to feature in Russia's use of its array of military capabilities in future conflicts. It may well be blended into other military capability tools. That said, the experiment with high-precision strikes in Syria also demonstrates a stand-alone capability with systems increasingly difficult to defend against, especially given Moscow's plans to invest in hypersonic cruise missiles capable of overcoming the most advanced air defenses in the world.

Sixth-Generation Warfare in Russian Military Thought

The origins of Russian approaches toward what they term non-contact warfare (*beskontaktnaya voyna*), non-contact *(beskontaktnyy*) elements of military operations, or even the concept of a non-contact operations (*beskontaktnaya operatsiya*) stem from the leading Russian military theorists inspired by the intellectual legacy of Marshal Nikolai Ogarkov's Revolution in Military Affairs (RMA).[6] In Russian military

[6] The late Russian military theorist, Major General Viktor Ryabchuk, writing in 2001, identified many of the themes currently pursued by Russia's political-military leadership in its ongoing pursuit of military modernization to meet the challenges of combat operations in the 21st century: 'The primary future trends in scientific work will be determined by the requirements and course of military reform. From the standpoint of the study of military science, the following are among the tasks confronting military science: developing the concept, forms and methods of information warfare; validating the tactical and technical requirements for fundamentally new types of weapons; providing scientific support for the development of automated troop command-and-control systems that use computer networks; utilizing artificial intelligence systems; further developing the theory of military art; enhancing the effectiveness of military education by broadly computerizing the education process in military institutions of higher learning and in troop training; upgrading the forms and methods of comprehensive logistics support for troop actions; optimizing the forms and methods of military-scientific research; developing the study of military science, military systemology, military conflictology, military futurology and other new branches of military science; and

thought, non-contact warfare is viewed as the pinnacle of "sixth-generation warfare." And to understand these concepts—including their articulation in terms of the "generations of warfare" as well as how the General Staff perceived them on the eve of Russia's entry into the civil war in Syria in 2015—it is necessary to examine some of the developments in Russian military theory during the late 1990s and early 2000s. This context is also crucial to comprehending why the General Staff, and in particular the Russian naval and air forces, sought to experiment with and draw lessons from the use of high-precision weapons for the first time in Russia's history of conflict.[7]

The United States' military operations since 1991 (Operation Desert Storm) sparked a new round of analysis among Russian military theorists assessing developments along high-technology "non-contact" lines on the battlefield. And in 2013, Lieutenant General A. A. Pavlovsky, at that time the chairperson of the Belarus Border Guards and Corresponding Member of the Russian Academy of Military Sciences, drew heavily upon the writings of those theorists to offer a novel description of some key ideas surrounding "sixth-generation warfare":

> Currently, the object of study of the theory of warfare is sixth-generation wars. The main characteristic features of this period, from the point of view of preparation and conduct of war, are:

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improving the methodology of military science.' Viktor Ryabchuk, '*Izucheniye i metodologiya voyennoy nauki*,' *Russkaya Mysl'*, No. 6, November–December 2001.

[7] V. I. Demin, *Voyna i vooruzhennaya bor'ba*, Moscow: Ira-press, 2001; A. F. Klimenko, '*Globalizatsiya i yeye vliyaniye na voyennuyu politiku i voyennuyu strategiyu*,' *Voyennaya Mysl'*, No. 5, 2002; V. Makarov, '*Informatsionnaya voyna: sushchnost', formy, i metody protivoborstva*,' *Armiya*, No. 5, 2001; V. I. Slipchenko, *Beskontaktnyye Voyny*, Moscow: *Izdatel'skiy dom Gran-Press*, 2001.

- The organization of military blocs and alliances in order to involve states in financing military programs and conducting military operations;
- Information confrontation;
- Creation and use of military space infrastructure;
- Conducting experimental aerospace and marine operations;
- Consistent capture, with minimal losses, of advantageous economic and strategic regions of the world;
- Defeat of key objects of military and economic potential, infrastructure and communications of states.[8]

Pavlovsky continues,

> Sixth-generation wars will be radically different from all previous ones. Their main distinguishing feature will be the use of weapons of a new type, *high-precision strike*,[9] and defensive weapons of various bases of the conventional type, weapons based on new physical principles, information weapons, forces and means of electronic warfare. The main goal that will be pursued in this case is the destruction of the military potential of any state, at any distance from the aggressor, with the preservation of its economy and causing minimal damage to its social infrastructures. In the transitional period to the wars of a *new generation*, the main theater of military operations will be *aerospace*.[10]

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[8] A. A. Pavlovsky, '*K voprosu ob evolyutsii razvitiya teorii voyn i voyennogo iskusstva v istorii chelovechestva. Voyny XXI veka*,' *Nauka i Voyennaya Bezopasnost'*, No.1, 2003, pp. 9–12.

[9] Author's emphasis.

[10] Ibid. Author's emphasis.

The meaning was clear: new-generation conflict would be “sixth generation” in its content and design, with the “non-contact element” as its zenith.

Foremost among the Russian military theorists observing these trends in modern and future warfare was Lieutenant General (deceased) Vladimir Slipchenko.[11] In Slipchenko’s writings, he outlines and assesses the hallmarks of “sixth-generation warfare.” Jacob W. Kipp, an adjunct professor at the University of Kansas, who not only wrote about Slipchenko and his peers, but met and interacted with him in the 1990s, observes,

> In the aftermath of Desert Storm in 1991, the late Major-General Vladimir Slipchenko coined the phrase ‘sixth generation warfare’ to refer to the ‘informatization’ of conventional warfare and the development of precision strike systems, which could make the massing of forces in the conventional sense an invitation to disaster and demand the development of the means to mass effects through depth to fight systems versus systems warfare. Slipchenko looked back at Ogarkov’s ‘revolution in military affairs’ with ‘weapons based on new physical principles’ and saw ‘Desert Storm’ as a first indication of the appearance of such capabilities. He did not believe that sixth generation warfare had yet manifested its full implications.
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> However, Slipchenko did believe that sixth generation warfare would replace fifth generation warfare, which he identified as thermonuclear war, and had evolved into a strategic stalemate, making nuclear first use an inevitable road to destruction (from the end of the Soviet Union until his death in 2005, he had

[11] Vladimir Slipchenko, *Voina novogo pokoleniia: Distantsionnye i beskontaktaktnye*, Moscow: OLMA-Press, 2004; Vladimir Slipchenko, *Beskontaktnye voiny*. Moscow: *Izdatel’skii dom*: *Gran-Press*, 2001; Vladimir Slipchenko, *Voina budushchego,* Moscow: *Moskovskii Obshchestvennyi Nauchnyi Fond*, 1999.

> analyzed combat experience abroad to further refine his conception until he began to speak of the emergence of 'no-contact warfare' as the optimal form for sixth generation warfare). In his final volume, Slipchenko redefined sixth generation warfare as involving the capacity to conduct distant, *no-contact* operations and suggested that such conflict would demand major military reforms.[12] Slipchenko made a compelling case for the enhanced role of C4ISR [command, control, communications, computers, intelligence, surveillance, reconnaissance] in conducting such operations.[13]

In the view of these Russian military theorists, the generations of warfare reflect the technological developments applied to war over the past several centuries. In several thousand years of human history, there have been five generations of warfare: the first saw edged weapons; the second, gunpowder-based; third, rifled weapons; fourth, automatic weapons including industrialization of warfare, and the fifth, nuclear. Therefore, when Russian military theorists refer to "sixth-generation warfare," it is in precisely this context.[14]

In Slipchenko's analysis of the North Atlantic Treaty Organization's (NATO) bombing of Serbia in 1999, he notes the progression in modern warfare to move away from reliance upon Ground Forces, to using precision-guided munitions (PGM) and the increased role played by airpower and the informational aspects of war (which includes psychological operations, electronic warfare and cyber

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[12] Author's emphasis.

[13] Jacob W. Kipp, 'Russian Sixth Generation Warfare and Recent Developments,' *Eurasia Daily Monitor*, Volume 9, Issue 17, The Jamestown Foundation, January 25, 2012, https://jamestown.org/program/russian-sixth-generation-warfare-and-recent-developments/.

[14] Makhmut A. Gareev and Vladimir Slipchenko, *Future War*, Foreign Military Studies Office, 2007, pp. 14–15; Chekinov S. G, 'Predicting Trends in Military Art in the Initial Period of the 21st Century,' *Military Thought*, July 2010.

warfare). In terms of the NATO air campaign against Serbia, Slipchenko notes that this evolutionary aspect increased accuracy in air operations against ground targets:

> While it took 4,500 sorties (each aircraft returning many times) and about 9,000 aerial bombs to destroy a railroad bridge over a large river in World War II, a bridge like that was destroyed by about 90 aircraft carrying 200 guided aerial bombs during the Vietnam War. And a single aircraft and one cruise missile destroyed such a bridge in Yugoslavia in 1999. You can see how much progress has been made, to the point where high precision weapons are replacing many different forces and devices.[15]

As Russia's military specialists continued to assess and analyze the development and experience of the United States' military operations in Iraq in 1991, Serbia in 1999 and Iraq in 2003, they increasingly linked such approaches to the application of space-based systems, and termed this as an "aerospace operation" (*vozdushno-kosmicheskaya operatsiya*).[16] Increasingly, as a result, Russian military theorists and, in turn, senior planning staffs, began to consider the air and space domains as one integrated sphere. As these discussions further matured, they ultimately fed into Russian military thinking on the

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[15] Makhmut A. Gareev and Vladimir Slipchenko, *Future War*, Foreign Military Studies Office, 2007, p. 17.

[16] Anatoly I. Khupenen and Oleg Falichev, '*Vozdushno-kosmicheskoye bessiliye*,' *Voyenno-Promyshlennyy Kuryer*, December 1, 2014, https://vpk-news.ru/articles/22954; Alexander Tsymbalov, '*Zadacha - obespechit strategicheskuyu mobilnost*,' *Vozdushno-Kosmicheskaya Oborona*, June 28, 2012, http://www.vko.ru/operativnoe-iskusstvo/zadacha-obespechit-strategicheskuyu-mobilnost; Boris F. Cheltsov, '*Voyennaya doktrina trebuyet utochneniya*,' *Voyenno-Promyshlennyy Kuryer*, https://www.vpk-news.ru/articles/4315,April 25, 2007, https://www.vpk-news.ru/articles/4315; Makhmut A. Gareev, '*Na 'myagkhuyu silu' naydutsya zhestkiye otvety*,' *Vozdushno-Kosmicehskaya Oborona*, February 4, 2014, http://www.vko.ru/strategiya/na-myagkuyu-silu-naydutsya-zhestkie-otvety.

blurring of the space and air domains, which was a natural precursor to the reform in August 2015 that merged the Air Force, Air Defense Forces and Space Forces under a single new command: the Aerospace Forces, or VKS. Indeed, Defense Minister Sergei Shoigu justified the formation of the new arm of service stating that it was "prompted by a shift in the center of gravity of the armed struggle toward the aerospace sphere." Shoigu added, "Now the single command unites aviation, air defense and anti-missile defense troops, space forces and means of the armed forces. This makes it possible, in the first place, to concentrate in a single command the entire responsibility for formulating military and technical policy for the development of troops dealing with tasks in the aerospace sphere [*vozdushno-kosmicheskaya sfera*] and, secondly, to raise the efficiency of their use through closer integration and, thirdly, to ensure the consistent development of the country's aerospace defense."[17] With the political decision imminent for Moscow to intervene in Syria, the General Staff and the VKS were presented with an ideal opportunity to road-test such theoretical approaches toward modern warfare in a high-technology-rooted approach.

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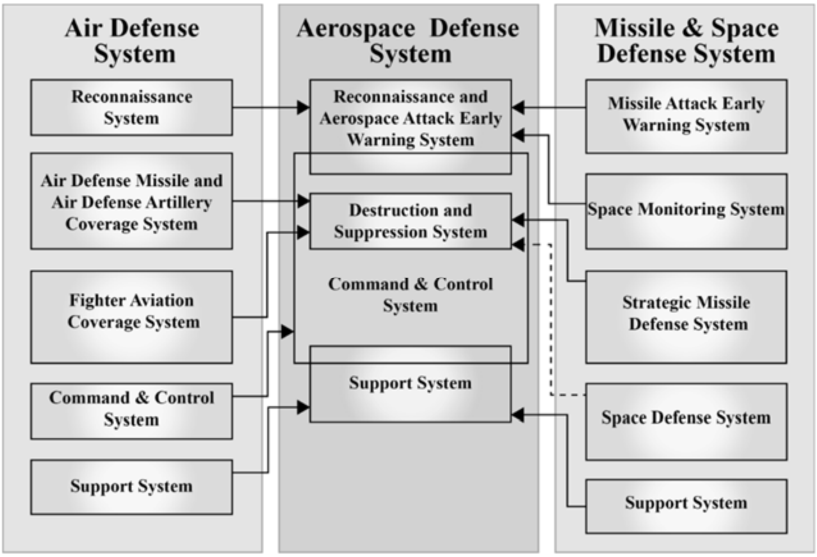
[17] See: Roger McDermott, 'Russia Reforms Aerospace Defense Structures—Again,' *Eurasia Daily Monitor*, Volume 12, Issue 151, The Jamestown Foundation, August 11, 2015, https://jamestown.org/program/russia-reforms-aerospace-defense-structures-again/.

Figure 1: Russian Concept of Command and Control, and Interrelationship of Air, Space and Missile Defense[18]



Thus, on the eve of Moscow's intervention in Syria, Russia's Armed Forces had the structures in place and a conceptual approach to offer to the Kremlin a limited involvement that captured the essence of an "aerospace operation." Over time, this naturally changed as the mission itself and the operational environment became more complex.[19] However, at the outset, the VKS was placed in the lead role, tasked with prosecuting an "aerospace operation," which tied in heavily to close air support operations for Syrian Ground Forces. A

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[18] Recreated and translated by author from: Vladimir Lyaporov, 'Integrated Command and Control Entity Required,' *Vozdushno-Kosmicheskaya Oborona*, December 31, 2015, http://www.vko.ru/oboronka/trebuetsya-edinyy-organ-upravleniya.

[19] The author is indebted to the Israeli analyst of Russian airpower, Guy Plopsky, for highlighting the role played by the concept of 'aerospace operations,' in the recent development of Russian military thought, and for his sharing the following unpublished paper: Guy Plopsky, 'Strategic Air Defence in Contemporary Russian Military Thought.'

component element in this complex process, in this author's view, was the experimentation with sixth-generation approaches to warfare up to and including the first use of Russia's burgeoning "non-contact warfare" capability.[20] However, this new, nascent capability, was not used in isolation, *a la* NATO in Serbia in 1999, but blended into the mixture of other traditional contact operations.

This "non-contact" capability was never used in isolation; nor can it, in fact, be characterized as representative of Russia's military operations within the Syrian conflict. And yet, from a Russian General Staff perspective, it has been a highly important development that permitted refinement of these high-precision systems and provided an additional experience-based source for convincing the political leadership that such weapons systems could offer the hard-power cornerstone of Moscow's "pre-nuclear" or "non-nuclear deterrence."

Gerasimov's Reflections on Operations in Syria

While the place of sixth-generation warfare in Russian military thought may seem like a theoretical discussion or even abstract, it is perfectly clear that since the start of reforms and modernization of Russia's Armed Forces over the past decade, such ideas and sources of fresh approaches to modern conflict are in higher demand. Russia's involvement in military operations witnessed much that was traditional or normal for its Armed Forces. However, it also involved testing and making use of capabilities that were absent in previous operations. While Syria served as a testing ground for numerous Russian hardware and weapons systems, it is also instructive to isolate aspects of these new capabilities. In particular, the Syrian campaign

[20] Reporting in the Russian military media on the annual conference of the Academy of Military Sciences in March 2018, supports the idea that the senior leadership of Russia's Armed Forces considered that elements of their operations in Syria had indeed involved the use of "non-contact" warfare. See: V. Khudoleev, '*Voennaia nauka smotrit v budushchee*,' *Krasnaya Zvezda*, March 26, 2018.

reveals what is new in General Staff thinking and Moscow’s future interests in the adoption of high-technology assets as Russia continues to modernize and develop its force structures to face the security challenges of the twenty first century.[21]

Therefore, the theories and discussions advanced by Russian theorists such as Slipchenko arguably came to permeate the thinking of the contemporary Russian political-military leadership, especially in the sphere of high-precision weapons and the increasingly important role these play, including in non-nuclear deterrence. The debate can be expected to continue to strongly influence how Russia applies military force or coercion in the future.

Army General Valery Gerasimov, the chief of the General Staff and first deputy defense minister, is Russia’s longest-serving senior officer in this post since the dissolution of the Soviet Union.[22] Gerasimov, like his predecessor Nikolai Makarov, continued the tradition of encouraging the development of Russian military science and military art by addressing the annual conference of the Academy of Military Sciences (*Akademii Voyennykh Nauk*—AVN).[23] His speeches are routinely later transcribed and published in article format in the Russian military media. But his February 2013 speech gained particular notoriety in Western commentary following Russia’s seizure of Crimea in the spring of 2014. At that time, a wave of publicity speculated about a so-called “Gerasimov doctrine,”

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[21] O. V. Tikhanychev, ‘*O roli sistematicheskogo ognevogo vozdei’stviia v sovremennykh operatsiiakh*,’ *Voyennaya Mysl’*,” No. 11, November 2016, pp. 16–20.

[22] Oleg Falichev, ‘*Mobilizatsiya voyennoy nauki Novym prezidentom Akademii voyennykh nauk izbran*,’ *Voyenno Promyshlennyy Kuryer,* https://www.vpk-news.ru/articles/60452,January 19, 2021, https://www.vpk-news.ru/articles/60452.

[23] On December 25, 2020, Gerasimov was elected president of the AVN. Viktor Khudoleyev, ‘*Impul's k razvitiyu voyennoy nauki*,’ *Krasnaya Zvezda*, January 22, 2021, http://redstar.ru/impuls-k-razvitiyu-voennoj-nauki/.

attributing to him the creation of a Russian version of "hybrid warfare." This view has since been soundly debunked.[24]

Of course, Gerasimov's annual speeches to the AVN cover a broad and diverse range of themes, but the frequently recurring ones relate to future warfare, strategic foresight and encouraging the further development of Russian military science, especially in the search for innovative ideas.[25] And since Russia's entry into the civil war in Syria, Gerasimov has also tended to address the importance of lessons and implications from that conflict for the future development of the Armed Forces and Moscow's approaches to warfare.

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[24] Charles K. Bartles, 'Getting Gerasimov Right,' *Military Review*, January–February 2016, pp. 30–38; Michael Kofman, 'Russia's armed forces under Gerasimov, the man without a doctrine,' *Riddle*, April 1, 2020, https://www.ridl.io/en/russia-s-armed-forces-under-gerasimov-the-man-without-a-doctrine/. A detailed examination of the historical background to the Gerasimov article in 2013 can be found in: Steven J. Main, 'You Cannot Generate Ideas by Orders: The Continuing Importance of Studying Soviet Military History—G. S. Isserson and Russia's Current Geo-Political Stance,' *The Journal of Slavic Military Studies*, Vol. 29, No. 1, 2016, pp. 48–72.

[25] General Gerasimov noted that during military operations in Syria, President Putin involved himself in the planning on a very regular basis, as well as setting operational aims. Asked about Putin's involvement in overseeing Russia's military operations in Syria, Gerasimov said, 'I usually report to the minister of defense on a daily basis, morning and evening, on the state of affairs and the progress in mission performance, and he reports to the president. Once or twice a week, the minister reports to the president in person, presenting the requisite documents, maps and video materials. Sometimes, the Supreme Commander in Chief [Putin] himself comes to see me, sometimes the defense minister and I go to him to report. The president identifies the targets [and] the objectives; he is up to speed on the entire dynamic of the combat operations—and in each sector, moreover. And of course, he sets the objectives for the future.' See: Viktor Baranets, '*Nachal'nik Genshtaba Vooruzhennykh sil Rossii general armii Valeriy Gerasimov: 'My perelomili khrebet udarnym silam terrorizma*," *Komsomolskaya Pravda*, December 26, 2017, https://www.kp.ru/daily/26775/3808693.

In Gerasimov’s address to the AVN in March 2016, he implied the limited scope of Russia’s operations in Syria:

> At the same time, the organizers of the aggression themselves remain in the shadows. The implementation of their plans was prevented by the entry of the Russian Federation into the conflict on the side of the legitimate government of Syria. It is especially important that the actions of the [Russian Federation’s] Aerospace Forces group are selective, commensurate with the conditions of the situation, [and that] strikes are delivered only at military targets. While the results are being viewed under a magnifying glass by our opponents, there is no basis for accusing Russia of violating humanitarian law.[26]

The following year, while not contradicting the limited nature of the operations, Gerasimov stressed the high-precision strike theme:

> During the operation for stabilizing the situation in Syria, missions that were new for the troops were often resolved on the spot, taking into account the experience that had been acquired and expedience. Here, the Russian army has shown skill in conducting new-type warfare, organizing coalitions, and working with allies.
>
> Russia’s growing combat might and the capabilities of the Armed Forces to resolve strategic missions on a remote theater of military operations was demonstrated to the world community.
>
> Practical experience has been acquired in planning and conducting air operations, delivering massive rocket and air

[26] Valery V. Gerasimov, ‘*Po opytu Sirii*,’ *Voyenno Promyshlennyy Kuryer*, March 7, 2016, https://www.vpk-news.ru/articles/29579.

> strikes, and employing *air-, sea- and land-based high-tech weapons.*[27]

Gerasimov used the opportunity in March 2018 to elaborate more how these high-precision strikes had evolved in Russian military thought, referring to Desert Storm in 1991, as Slipchenko had done, stressing the *non-contact* phase, followed by a shorter phase of ground-based operations. Here, Gerasimov took the experience of using these weapons in operations in Syria to extrapolate a strategic-level lesson and further development of Russia's military capabilities—applying the precision-strike systems to Moscow's non-nuclear deterrence on all its strategic axes:

> The change in the nature of armed struggle is a continuous process. Its results, as a specific aspect of the development of military art, are distinctly reflected in the content of recent warfare. They are all substantively different from one another. And each time, the last war was presented as a new-generation conflict. Thus, from the point of view of military art, the war between the international coalition and Iraq in 1991, characterized by a sharp increase in the [US] Air Force's contribution to the defeat of the Iraqi army, deep envelopments of defensive positions, and delivery of the main strike bypassing defensive lines, is of paramount importance. It included a prolonged *non-contact phase* and a powerful, short-duration phase of ground contact operations. The war between NATO and Yugoslavia was proclaimed as a *new-generation conflict*, in which the goals were achieved without the active involvement of ground forces.

[27] Author's emphasis. Valery V. Gerasimov, '*Sovremennaia voiny i aktual'nye voprosy oborony strany*,' *Vestnik* 2, No. 59, 2017.

> The experience of recent local wars, in particular, the operations on Syrian territory, has given a new impulse for improving the system of the comprehensive destruction of the enemy. To increase its effectiveness, special attention is being focused on the development of *precision weapons*. Groupings of *long-range air-, sea-, and land-based cruise missile carriers have been created on each strategic axis, capable of providing deterrence in strategically important regions*. The improvement of the structure of command-and-control organs, creation of special information support subunits, and introduction of software complexes have made it possible to reduce the preparation time for the combat employment of *long-range precision weapons* by one and a half times.[28]

By March 2019, some of this thinking had reached maturity, stressing once again the narrow scope and relatively light touch required during Russia's application of military force in Syria, and taking this into the formulation of new strategy: a "strategy of limited actions," which could serve as a basis for similar conflicts in the future:

> The Syrian experience has an important role for the development of strategy. Its generalization and introduction made it possible to identify a new practical field: carrying out tasks to defend and advance national interests outside the borders of Russian territory within the framework of the "*strategy of limited actions*."[29] The principal implementation of this strategy is the creation of a self-sufficient grouping of troops (forces) on the basis of one of the branches of the Armed Forces having a high degree of mobility and capable of making the greatest

[28] Author's emphasis. Valery V. Gerasimov, '*Vliianie sovremennogo kharaktera vooruzhennoi bor'by na napravlennost' stroitel'stva i razvitiia Vooruzhennykh Sil Rossiiskoi Federatsii. Prioritetnye zadachi voennoi nauki v obespechenii oborony strany*,' *Vestnik*, 62, No. 2, 2018, pp.16–22.

[29] Author's emphasis.

> contribution to resolving assigned tasks. In Syria, this role was given to Aerospace Forces formations.[30]

While Western analyses and government interpretations of Russian military strategy since 2014 became fixated on "hybrid warfare," Moscow set about enhancing the hard-power element of conventional high-precision strike capability to develop an entirely new set of competences, ranging from operational-tactical to strategic strike and even feeding into "non-nuclear" deterrence. Consistent in Gerasimov's speeches to the AVN on the themes related to Russia's operations in Syria has been the limited nature of the application of military power: "selective, commensurate with the conditions of the situation." And he has repeatedly stressed that a key element was the use of high-precision weapons (*Vysokotochnoye Oruzhiye*—VTO): "air operations, delivering massive rocket and air strikes, and employing *air-, sea-, and land-based high-tech weapons*." Gerasimov had highlighted the non-contact (*beskontaktnyy*) phase of Operation Desert Storm in 1991: "a prolonged *non-contact phase* and a powerful, short-duration phase of ground contact operations." By 1999, Russia's General Staff drew lessons from the NATO bombing of Yugoslavia, which had avoided ground operations. The initial emphasis in Russian operational mission design for the role it played in the civil war in Syria was heavily embedded in as much of a "non-contact," or limited footprint as possible. Only later in the campaign did it become necessary to involve Ground Forces elements, mainly in the role of advisors and aiding the SAA in artillery strikes. As Gerasimov summarized the lessons from Syria, Russia must prioritize VTO: "To increase its effectiveness, special attention is being focused on the development of *precision weapons*. Groupings of *long-range air-, sea-, and land-based cruise missile carriers have been created on each*

[30] Valery V. Gerasimov, '*Razvitie voennoi strategii v sovremennykh usloviiakh. Zadachi voennoi nauki,*' *Vestnik* 67, No. 2, 2019, pp. 6–11.

strategic axis, capable of providing deterrence in strategically important regions."[31]

Following several years of its operations in Syria, in March 2019 Gerasimov articulated the concept of a "strategy of limited actions," reflecting Russia's military actions in Syria and establishing a strategic mechanism for similar operations in the future. In a sense, while this concept emerged over time in the context of Russia's operations in Syria, its underlying principle was neither entirely new nor alien to Russian military thought. Dimity Adamsky, a professor at the School of Government, Diplomacy and Strategy at the IDC Herzliya, identified the utility of the concept of "reasonable sufficiency" in the Kremlin's calibration of the limits of Russia's intervention in Syria: "Seeking a golden range between overshooting and undershooting, it adopted the principle of 'reasonable sufficiency'–*razumnaia dostatochnost*. Applied to the Syria context the principle means limiting the scale of military intervention to the minimum possible that would still allow Russia to project influence and promote regional goals."[32] Critical elements in this strategy of limited actions as applied to the Syrian theater of military operations (*Teatr Voyennykh Deystviy*—TVD) were the use and experimentation with high-precision strike as well as efforts to enhance the overall accuracy of the VKS during operations against ground targets in Syria. While this is the focus of the following analysis, namely Russia's experiment with "non-contact warfare," it in no way denies that Russian operations

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[31] Gerasimov, '*Po opytu Sirii,*' *Voyenno Promyshlennyy Kuryer, Op. Cit*; Gerasimov, '*Sovremennaia voiny i aktual'nye voprosy oborony strany,*' *Op. Cit*; Gerasimov, '*Vliianie sovremennogo kharaktera vooruzhennoi bor'by na napravlennost' stroitel'stva i razvitiia Vooruzhennykh Sil Rossiiskoi Federatsii. Prioritetnye zadachi voennoi nauki v obespechenii oborony strany,*' *Op. Cit*; Gerasimov, '*Razvitie voennoi strategii v sovremennykh usloviiakh. Zadachi voennoi nauki,*' *Op. Cit.*

[32] Dmitry (Dima) Adamsky, 'Moscow's Syria Campaign: Russian Lessons for the Art of Strategy,' *Russie.Nei.Visions*, No. 109, Ifri, July 2018, p. 7.

were predominantly "contact" in the traditional sense and geared toward its overarching goal of supporting the Bashar al-Assad regime through mainly VKS close air support, while also targeting the Islamic State and related groups, including moderate opposition forces to the Damascus government.

Russia's High-Precision Strikes in Syria

The Russian military has a long-held interest in analysis of precision-guided strikes by foreign militaries and in developing such capabilities domestically. This became a growing priority since the reform of Russia's Armed Forces launched in late 2008 and the subsequent military modernization programs. The intervention in the conflict in Syria, however, proved to be a turning point, offering an opportunity to test and refine the use and role played by such weapons in the burgeoning conventional military capabilities impacting on all branches and arms of service. Precision-guided weapons or precision-guided munitions (PGM) originate as Western concepts, emerging within Russian military parlance due to the translation of the Western terms.[33] In Russian military usage, the term referring to systems designed to accurately strike an enemy target at a distance is more precisely denoted as "high-precision weapons," or VTO. The official Russian defence ministry definition of the term is as follows:

> The current VTO system is complex systems and combat support systems and resources, including: the intelligence system, communication channels, control centers, computer facilities, means of delivery and guided munitions. Depending on the management structure and the type of ammunition, the VTO could solve tactical, operational-tactical, operational and

[33] The problem of defining precision-guided weapons is addressed in: Vitaly Tsymbal, 'The Growth of the Strategic Role of Highly Intelligent Weapons and the Problems of Controlling their Growth and Proliferation,' *Nuclear Control*, June–July 1997, pp. 39–43.

> strategic objectives. In the VTO system are: reconnaissance and strike and reconnaissance-fire complexes; air- and sea-launched cruise missiles; some types of short-range missiles; anti-aircraft and anti-missile systems; aircraft guided missiles, cartridges and bombs; individual artillery systems and ASW [anti-submarine warfare] complexes.[34]

The Russian Armed Forces' entry into the civil war in Syria beginning in September 30, 2015, marked a turning point in Moscow's approach toward modern warfare. It served as a testing ground for modernized platforms, new weapons systems, electronic warfare, air defense, force mixture experiments, and new approaches toward the means and methods of combat operations. Significantly, for the first time in Russia's experience of warfare, this involved the use of VTO. It also witnessed efforts to convert unguided missiles and bombs into something akin to precision-guided munitions.[35] Despite expressions of skepticism among Western governments and analysts, Moscow avoided being drawn into a quagmire such as it had experienced in the Soviet-Afghanistan conflict (1979–1989). The negative experiences of Afghanistan and the internal conflicts in Chechnya in 1994–1996 and the second, which began in 1999, were successfully overcome by deploying relatively small forces in as "non-contact" a manner as possible, mainly in support of the failing Syrian Arab Army, demonstrating an (albeit limited) expeditionary force capable of conducting operations in a remote theater. At a later stage, in March 2019, Gerasimov referred to Moscow's strategy in Syria as one

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[34] '*Vysokotochnoye Oruzhiye –VTO*,' *Russian Ministry of Defense*, http://xn--d1abichgllj9dyd8a.xn--90anlfbebar6i.xn--p1ai/encyclopedia/dictionary/details_rvsn.htm?id=12896@morfDictionary, accessed February 15, 2021.

[35] M. Y. Shepovalenko, *Siriyskiy Rubezh,* Moscow: *Tsentr Analiza Strategiy i Tekhnologiy (CAST)*, 2016, pp.112–113.

of "limited actions," with important doctrinal implications for Russia's approach toward future conflicts.[36]

The Moscow-based military journalist Konstantin Bagdanov noted in *Izvestia* in late December 2017 that "The Syrian war has become a real testing ground for new weapons and equipment, as well as a kind of 'exercise' for testing new methods of warfare with their use. In particular, this concerned the active use of drones, as well as equipping the advanced aircraft controllers operating in the combat formations of the Syrian army with new reconnaissance, command and communications systems, which made it possible to actively interact with artillery and aviation." Indeed, Russia's General Staff exploited the Syrian campaign to use it as a real-time training tool. From the earliest stages of Russia's entry into the conflict, with the VKS in the lead role, the defense ministry announced that the costs for conducting operations were primarily sequestered from the funds allocated for combat training.[37] This cost-effective approach fed into the efforts to maximize the accuracy of unguided munitions. However, the decision to attack targets using VTO, a costly option against the stationary targets involved, seems also rooted to testing and adjusting these precision-guided missile systems based on the results of their use in the TVD.

According to Russian military media drawing upon official sources, the main targets of these air attacks were the "positions of terrorists, command posts, factories and workshops, large depots of military equipment, ammunition, fuels and lubricants, special clothing and food, hidden bases that had previously been carefully camouflaged,

[36] Valery V. Gerasimov, '*Vektory razvitiya voyennoy strategii*,' *Krasnaya Zvezda*, March 4, 2019, http://redstar.ru/vektory-razvitiya-voennoj-strategii/.

[37] Konstantin Bogdanov, '*Pokoreniye voyny Kakiye uroki vynesla iz Sirii rossiyskaya armiya*,' *Izvestia*, December 27, 2017, https://iz.ru/688413/konstantin-bogdanov/pokorenie-voiny.

transshipment and strongholds, launchers with communication centers, targets with weapons and ammunition, training camps, bridges and other objects." The workhorse of the air operations from the Khmeimim airbase was the Su-24M2, "used to strike at the accumulation of armored vehicles and enemy manpower [as well as] artillery positions—those targets where low accuracy can be compensated for by the power and number of aviation weapons in a salvo."[38]

The experimental nature of Russia's military involvement in Syria was also summarized by Bogdanov in another commentary:

> Syria has turned into a large-scale training ground, where the Ministry of Defense of the Russian Federation managed to conduct a meticulous check of the new equipment that is supplied to the troops as part of the 2011–2020 State Armament Program. The intensive operation of equipment at a remote theater of operations made it possible to reveal a significant number of defects, the task of correcting which was promptly set before the defense industry. At the same time, a conclusion was made about the priorities in equipping general-purpose forces, which will be taken into account when making up estimates for the next State Armament Program, calculated until 2027.[39]

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[38] See: Igor Semenchenko, '*Ni razu ne promazali Na siriyskom TVD poluchen unikal'nyy opyt*,' *Voyenno Promyshlennyy Kuryer*, December 19, 2017, https://vpk-news.ru/articles/40474; Alexei Ramm, '*Shestnadtsat udarnykh dney Kratkiye itogi deystviy rossiyskoy voyennoy aviatsii*,' *Voyenno Promyshlennyy Kuryer*, October 20, 2015, https://www.vpk-news.ru/articles/27621.

[39] Konstantin Bogdanov, '*Rossiyskaya operatsiya v Sirii: voyennyye i politicheskiye aspekty*,' *Natsional'naya Oborona*, No.11, 2020, https://oborona.ru/includes/periodics/geopolitics/2017/1221/144623069/detail.shtml.

On December 22, 2017, Defense Minister Shoigu stated that operations in Syria had involved over 48,000 Russian military personnel, with the VKS having conducted more than 34,000 sorties and naval aviation flying 420 sorties from the *Admiral Kuznetsov* aircraft carrier. Over a month earlier, on November 7, Shoigu had noted the extent of the utility of the campaign in Syria to the benefit of combat experience for the commanders of Russia's Armed Forces: "All commanders of military districts, combined-arms armies and armies of the Air Force and Air Defense Forces, almost all division commanders and more than half of the commanders of combined-arms brigades and regiments passed through the grouping of troops with their staffs."[40]

Bogdanov, besides noting the experimental nature of Russia's involvement in the conflict and its use as a testing and training ground for its Armed Forces, explains the need for a light footprint in the operations, as well as the enormity of the task in rebuilding and supporting the heavily depleted SAA:

> At the first stage, Russia quite rightly did not want to get involved in the Syrian operation more than the air support of the Syrian Arab Army demanded. The idea of a quick *non-contact* operation dominated minds, while fears of a new Afghanistan still hovered over everything that was happening. At the same time, the combat capability of the Syrian troops and the ability to act independently with the support of aviation from Khmeimim were rated quite high.
>
> However, in practice, it turned out that the SAA is in a much worse condition than expected. The Syrian army as a single force, in fact, did not exist; the organization of hostilities was at a low

[40] Bogdanov, '*Pokoreniye voyny Kakiye uroki vynesla iz Sirii rossiyskaya armiya*,' *Op. Cit.*

> level. The Syrian military showed poor coordination between the branches of the military. In particular, huge problems were observed in the organization of fire support and support for the offensive from the air, and especially in the interaction of tanks with infantry. The flanks of the attacking groupings were not provided, there were failures in the conduct of reconnaissance and the organization of combat security. On the defensive, the reaction to enemy actions was impermissibly late, which allowed IS [Islamic State] militants to successfully conduct high-speed raids, capturing key points in the depths of seemingly already controlled territory.[41]

In September 2016, a high-ranking Russian diplomatic source told *Kommersant* that the decision to intervene in the conflict in Syria one year earlier was made based on a number of factors. These included an analysis of the potential threats to Russia’s security based on assessments by Russian intelligence agencies, and President Vladimir Putin’s unwillingness to repeat what, in his view, was the mistake Moscow had made concerning Libya in 2011. In the context of the international response to the events in Crimea and southeastern Ukraine since 2014, the calculus in the Kremlin and Russia’s General Staff was that any Russian military intervention required a light touch. The Moscow-based defense journalist Ivan Safronov explained,

> Perhaps that is why the Kremlin decided to limit itself to non-contact [*beskontaktnyy*] methods of warfare. It was relatively safe (it was believed that the Islamists did not have air defense systems) and a much cheaper option than maintaining army units in a remote theater of operations. By August 26, 2015, the plan had been approved at the highest level: Russian Defense Minister Sergei Shoigu and his Syrian counterpart, [Fahd] Jassem al-Freij, signed an agreement on the deployment of a

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[41] Ibid.

> Russian aviation group at the Khmeimim airbase for an indefinite period to fight terrorists. But in order to underline the legitimacy of the actions of its armed forces, the Kremlin needed to receive an official request from Bashar al-Assad. This would mean that Russia is the only one of all the countries fighting in Syria to act within the framework of international rules. As a result, Vladimir Putin got the document only on September 29. But this was not due to bureaucratic or other difficulties—diplomats say that al-Assad was ready to make any concessions in order to receive military support. This month was necessary for the Russian Ministry of Defense to prepare for military operations.[42]

Safronov succinctly captures the overview of Russia's first uses of high-precision strikes in any combat operation, through its operations in October and November 2015 to launch land-attack cruise missiles (LACM) against ground targets in Syria:

> On October 7, Russia used Kalibr cruise missiles in Syria. Then, four ships of the Caspian Flotilla performed 26 launches on the positions of the Islamic State militants. This was the first combat use of such missiles. Defense Minister Sergei Shoigu reported on the results of the strike at a meeting with Vladimir Putin, which was shown by all state television channels. On December 8, the Project 636.3 submarine *Rostov-on-Don*, while in the waters of the Mediterranean Sea, struck with 3M14K (Kalibr-PL) missiles from a submerged position at terrorist targets in Syria.
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> In November 2015, the Chief of the General Staff of the RF Armed Forces, Valery Gerasimov, reported on the first-ever combat use of Russian strategic missile carriers. Twelve long-

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[42] Ivan Safronov, '*Khronika pikiruyushchikh bombardirovshchikov*,' *Kommersant*, September 26, 2016, https://www.kommersant.ru/doc/3094571.

> range Tu-22M3 bombers flew from Russian airfields and attacked terrorist targets in the provinces of Raqqa and Deir ez-Zor. Then, the Tu-160 and Tu-95MS missile carriers launched the latest Kh-101 air-launched cruise missiles at militants' targets in the provinces of Aleppo and Idlib.[43]

The use of the Kh-101 air-launched cruise missile also marked a significant step toward the development of a long-range conventional precision-strike capability for the VKS.[44] Based on its use in Syria, it appears to have undergone an upgrade, taking account of the lessons drawn from the local climactic conditions.[45] This was undoubtedly an

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[43] October 7 also marks Vladimir Putin's birthday. Safronov, '*Khronika pikiruyushchikh bombardirovshchikov,*' *Op. Cit*.

[44] The Israeli airpower analyst Guy Plopsky noted the significance of the Kh-101 for enhancing long-range precision strike: 'In this regard, the integration of the Kh-101 on the Tu-95MS dramatically expands the legacy bomber's conventional strike capability, which until recently, was limited to dropping unguided bombs, transforming it into a formidable long-range precision-strike platform capable of accurately engaging hardened targets in heavily defended areas. At present, Russia is also outfitting its Tu-95MS bombers with SVP [navigational attack] systems (developed by ZAO Gefest i T), which will enable Russian bomber crews to retarget their missiles before launch. This will further enhance mission flexibility, allowing modernized Tu-95MS bombers to strike not only fixed but also relocatable targets. The ability of the Kh-101 to cover very large distances also reduces the Tu-95MS's (and Tu-160's) need to rely on in-flight refueling for long distance missions. This, as several analysts have noted, makes the Kh-101 a particularly valuable asset given Russia's relatively small fleet of aerial-refueling tankers and limited overseas basing options. A modernized Tu-95MS can carry up to eight Kh-101 ALCMs on four externally-mounted two-station pylons, while a Tu-160 can carry up to 12 such missiles on two internally-mounted six-station rotary launchers.' Guy Plopsky, 'The Kh-101 and Syria: Maturing the Long-Range Precision-Strike Capabilities of Russia's Aerospace Forces,' *Balloonstodrones.com*, October 18, 2017, https://balloonstodrones.com/2017/10/18/the-kh-101-and-syria-maturing-the-long-range-precision-strike-capabilities-of-russias-aerospace-forces/.

[45] 'Kh-101 Air-Based Cruise Missile Improved after Syria Campaign—Designer,' *Interfax*, January 24, 2018.

important step, arguably in terms of experimenting with these systems, testing them in combat conditions, as well as signaling to other powers that Russia possesses and is capable of using high-precision strikes in modern or future combat operations. As Bogdanov notes, "The military gained experience in the use of strategic cruise missiles (3M14, Kh-555, Kh-101) in a combat situation: ships and submarines of the fleet dealt one hundred strikes, and long-range aircraft—66. The missiles were used at ranges from 500 km to 1,500 km. The Iskander-M missile system was also tested in combat conditions."[46]

In response to the terrorist attack on the Russia Airbus A321, which disappeared from radar while flying over central Egypt soon after taking off from Sharm el-Sheikh on October 31, 2015, and resulted in the fatalities of all 224 people onboard, President Vladimir Putin vowed to act swiftly to take revenge for this atrocity. Putin ordered an attack on Islamic State positions in Syria on November 18, 2015, involving the use of long-range strategic aviation, designated *Asvozmezdiye za Operatsiyu* (Operation Retribution). Some Western sources raised doubts as to whether IS fighters were in these locations at the time of the strikes.[47] However, Defense Minister Sergei Shoigu reported to Vladimir Putin, "Today, from 5:00 to 5:30 Moscow time, 12 long-range Tu-22M3 bombers struck targets of the IS terrorist organization in the provinces of Raqqa and Deir ez-Zor. From 9:00 to 09:40, Tu-160 and Tu-95MS strategic missile carriers launched 34 air-

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[46] Bogdanov, '*Pokoreniye voyny Kakiye uroki vynesla iz Sirii rossiyskaya armiya*,' *Op. Cit*.

[47] 'Syrian Rebels Say Russia Is Targeting Them Rather Than ISIS,' *New York Times*, October 1, 2015; 'Top 5 Ways Putin Has Won Big in Syria and Why Europe Is Embracing Him,' *Informed Comment*, January 26, 2016. See, for example, the harrowing footage here on YouTube, https://www.youtube.com/watch?v=1BvzF_WCmVg.

launched cruise missiles [Kh-101s] at targets in Aleppo and Idlib provinces."[48]

Reportedly, in addition to these platforms, six more Tu-95MSs and five Tu-160s participated in this first strike. Alexei Ramm elaborated the extensive planning and preparations for the attack: "Planning for the use of long-range aircraft for strikes against IS began long before the Russian President announced Operation Retribution. In particular, the necessary documents, as well as various calculations were not only ready but also communicated to the commanders of the aviation units even before the start of the first air strikes of the Russian Aerospace Forces from the Khmeimim airfield. The strategic Tu-95MSs and Tu-160s, equipped with an air-to-air refueling system, were supposed to operate directly from Engels airbase in the Saratov region, where they are based, and for the Tu-22M3s, unable to receive fuel during the flight, they were planned to relocate to the Mozdok airfield, where material and technical means and ammunition were stored in advance for them."[49] While the defense ministry stressed the use high-precision cruise missiles in this operations, it also appears that it included the use of unguided OFAB-250-270 bombs; although this was compensated for by using the Specialized Computing Subsystem (*Spetsializirovannaya Vychislitel'naya Podsistema*) SVP-24-22 navigational attack system (discussed below).[50]

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[48] Alexei Ramm, "Debyut v siriyskom nebe U letchikov dal'ney aviatsii otlichnyye professional'nyye navyki," *Voyenno Promyshlennyy Kuryer*, November 30, 2015, https://www.vpk-news.ru/articles/28277.

[49] *Ibid.*

[50] *Ibid.* Ramm notes, 'The work was somewhat complicated by the high-flying weight of the Backfires [Tu-22s], caused by the large amount of fuel required for the return flight to Mozdok without refueling. Tu-22M3s were forced to carry out bombing from a direct flight without performing maneuvers that would increase the accuracy of strikes. True, according to the Russian Aerospace Forces interlocutor with the VPK [Military-Industrial Commission], the accuracy of the hit met the

In late 2018, the VKS conducted testing of the Raduga Kh-101 using the Pemboy missile-test range in northern Russia, firing 12 of these long-range conventional cruise missiles. As highlighted by Douglas Barrie, a senior fellow for military aerospace at the International Institute for Strategic Studies in London, such continued tests and refinements appear heavily tied to the operational experience gained in Syria:

> The Kh-101 was first used operationally in November 2015 as part of Russia's support for the regime of Bashar al-Assad in Syria's civil war. Not all of the initial missile salvos reached their targets. One missile, at least, crashed in Iranian territory close to the city of Shush, 750 kilometers from the Syrian border. The conventional variant of the missile may have a maximum range of around 4,000 km.
>
> The Russian defence ministry has never discussed how many missiles from the early firings suffered some form of failure. Boris Obnosov, the director of Tactical Missiles Corporation (KTRV), of which Raduga is part, said in 2016 that the basic Kh-101 would be upgraded, in part to improve its accuracy. This effort may have been a response to the missile's initial performance in the Syrian campaign. The 12-shot missile salvo, carried out sometime in the first half of November, could have been to test some of the improvements introduced on the Kh-101 as a result of the Russian Aerospace Forces' experience in Syria.[51]

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declared characteristics, and minor deviations were compensated for by the number of aircraft weapons and their power.'

[51] Douglas Barrie, 'Kh-101 missile test highlights Russian bomber firepower,' *The Military Balance Blog*, February 8, 2019, https://www.iiss.org/blogs/military-balance/2019/02/russian-bomber-firepower.

Thus, the extent of operational experience gained in Syria using and testing these VTO systems cannot be underestimated, and it served as a catalyst to further promote the wider introduction and investment into high-precision strike weapons in the Russian military inventory. Dmitry Gorenburg, a senior analyst at the Center for Naval Analysis, in Arlington, Virginia, interprets Russia’s use of LACMs as primarily a demonstration of such capabilities, recognizing that other more practical strike options were available, while underscoring that Russia’s LACM capability certainly poses difficulties for NATO planners. Gorenburg also notes the general criticism of these operations using LACMs, given they were employed against a non-peer adversary:

> The land-attack cruise missile (LACM) strikes against Syrian targets, launched in October 2015 from relatively small missile ships in the Caspian Sea, were primarily intended to serve as a demonstration of Russia’s capabilities. The attacks were launched from three Buyan M-class corvettes and a Gepard-class frigate and flew over Iranian and Iraqi territory on their way to their targets. They were not necessary for the success of the operation, which could have been carried out perfectly well by Russian aircraft already in Syria. By launching missiles from the Caspian, Russia demonstrated that it could launch strikes from ships well inside Russia’s air defense perimeter. The real goal was to show NATO military planners (and neighboring states) that Russia has a new standoff land-attack missile capability that can be difficult to neutralize.
>
> Russia’s demonstration of new naval strike capabilities continued in December 2015 when Kalibr LACMs were launched against targets from a recently constructed diesel submarine operating in the Mediterranean Sea. This launch of LACMs from hard-to-track submarines further highlighted the potential threat posed by Russian naval vessels against Russia’s potential opponents. These strikes were closely coordinated with

> the air force, which sent out a sizeable percentage of its long-range aviation to conduct strikes against the Islamic State. This force included five Tu-160, six Tu-95MS, and 14 Tu-22M3 long-range bombers, which launched Kh-555 and Kh-101 cruise missiles and also dropped gravity bombs on targets in Raqqa. These cruise missiles, with a range of approximately 2,000 kilometers, had never been used in combat. While a number of analysts dismissed the tactics used by the long-range aviation as outdated, the goal of the operation was to highlight the combat readiness of the aircraft rather than the kinds of tactics the service would actually use in combat against an adversary that can defend against strikes by strategic aviation.[52]

Russia's Military-Maritime Fleet was undoubtedly in the leading role when it came to the use of cruise missiles in the conflict in Syria, and it benefited from what some described as the "kalibrization of the Russian Navy."[53] A much more limited high-precision strike on targets in central Syria was conducted by the VMF in June 2017. Indeed, over time, the numbers of launches of LACMs in any given operation significantly declined. The June 2017 attack involved a detachment of naval assets drawn from the Russian naval force grouping in the eastern Mediterranean Sea. Unlike the first strikes conducted by the VMF on October 7, 2015, this operation involved the use of significantly fewer LACMs, suggesting improvement in the use of the systems. On June 23, 2017, the frigates *Admiral Essen* and *Admiral Grigorovich* were joined in the eastern Mediterranean Sea by

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[52] Dmitry Gorenburg, 'What Russia's Military Operation in Syria Can Tell Us About Advances in its Capabilities,' *PONARS Policy Memo 424*, March 18, 2016, https://www.ponarseurasia.org/what-russia-s-military-operation-in-syria-can-tell-us-about-advances-in-its-capabilities/.

[53] Arnaud Sobrero, 'Russian Submarines: Still a Relevant Threat?' *The Diplomat*, February 11, 2021.

the submarine *Krasnodar* (all part of the Black Sea Fleet) to launch six Kalibr cruise missiles against targets in Hama Province.[54]

According to the Department of Information and Mass Communications of the Russian Ministry of Defense, the need for the strike arose due to the military situation that developed in June 2017 in central Syria. This involved the movement of what the defense ministry described as “Islamic State terrorists” attempting to leave Raqqa in the direction of Palmyra along the so-called “southern corridor.” These forces, without any estimation of the numbers involved, used the cover of night and exploited their local knowledge of the difficult terrain to use various escape routes into Hama Province; apparently, once relocated, they set about equipping command posts in large buildings and constructing weapons and ammunition dumps.[55]

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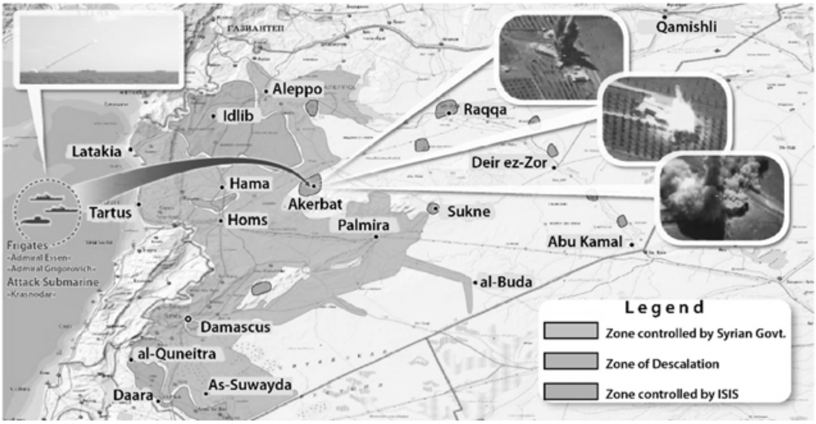
[54] Evgeny Podzorov, ‘*Yuvelirnaya tochnost' Russkiye Kalibry unichtozhayut IGIL v Sirii*,’ *Russkiya Vesna*, July 1, 2017, https://rusvesna.su/news/1498853824,https://rusvesna.su/news/1498853824.

[55] *Ibid*.

Figure 2: Limited Kalibr Strikes on Targets in Hama Province: June 23, 2017.[56]



In this context, the command of the Russian group of forces deployed in Syria organized round-the-clock surveillance of these escape routes and identified the areas to which the militants had relocated. "As a result of a sudden massive missile strike," the Russian defense ministry's Information and Mass Communications Department said, "command posts, as well as large depots of weapons and ammunition of ISIS terrorists in the area of Akerbat, Hama province, were destroyed after a precision strike by the cruise missile Kalibr. The arsenal of the militants detonated. The remnants of ISIS militants and facilities were destroyed by air strikes by Russian Aerospace Forces bombers. Turkish and Israeli commanders were promptly informed about the launches of cruise missiles through the channels of interaction." The official statement added, "the Russian Navy has once again demonstrated the ability to deliver effective strikes against

[56] Evgeny Podzorov, '*Yuvelirnaya tochnost' Russkiye Kalibry unichtozhayut IGIL v Sirii*,' *Russkiya Vesna*, July 1, 2017, https://rusvesna.su/news/1498853824,https://rusvesna.su/news/1498853824.

remote targets with Kalibr precision weapons as soon as possible after receiving a combat order.”[57]

This illustration of the lessening in the numbers of cruise missiles used in each of the strikes on targets on Syria since the first use by the VMF on October 7, 2015, fits into an overall pattern that implies learning from the combat testing of such systems. On October 7, 2015, 26 Kalibr cruise missiles were launched from the Caspian Sea. The attacks on November 11 and December 8, 2015, involved 18 and 4 respectively, with the latter witnessing the first launches from a submarine. In subsequent Kalibr cruise missile strikes by the VMF, the numbers on each occasion remained less that ten until October 5, 2017, (ten) and again declined to single digits in the last two attacks in late October and early November 2017. Whereas the earliest VMF cruise missile strikes involved mainly surface vessels, the last five attacks were exclusively submarine-based.[58] Thus, the

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[57] *Ibid*.

[58] Artem Krechetnikov, ‘*Kaspiyskim ‘Kalibrom’ po Sirii: zachem eto bylo nado?*’ *BBC Moscow*, October 8, 2015, http://www.bbc.co.uk/russian/topics/blog_krechetnikov; ‘*Video raketnykh udarov VKS RF v Sirii,*’ *Izvestia*, November 3, 2017, https://iz.ru/666851/video/video-raketnykh-udarov-vks-rf-v-sirii; ‘*Kaspiyskaya flotiliya vypustila 18 raket ‘Kalibr’ po IG v Sirii. Video,*’ *RIA Novosti*, November 3, 2015, https://ria.ru/20151120/1325098502.html; ‘*Rossiya vpervyye nanesla udar po IG s podvodnoy lodki,*’ *Ntv.ru*, December 8, 2015, https://www.ntv.ru/novosti/1581597/; ‘MRK ‘*Zelenyy Dol’ i ‘Serpukhov’ vypolneny puski krylatykh raket ‘Kalibr’ po tselyam terroristicheskoy gruppirovki ‘Dzhebkhat an-Nusra’ na territorii Sirii,*’ *Russian Ministry of Defense*, August 19, 2016, https://function.mil.ru/news_page/country/more.htm?id=12093238@egNews; ‘*Video: Noveyshiy fregat ‘Admiral Grigorovich’ udaril ‘Kalibrom’ po terroristam v Sirii,*’ *Flot.com*, November 15, 2016, https://flot.com/2016/%D0%A1%D0%B8%D1%80%D0%B8%D1%8F328/; ‘*Video: Dva fregata i podlodka ‘Krasnodar’ vypustili shest' ‘Kalibrov’ po terroristam v Sirii,*’ *Flot.com*, June 23, 2017, https://flot.com/2017/%D0%A1%D0%B8%D1%80%D0%B8%D1%8F174/; ‘*Admiral Essen unichtozhil ‘Kalibrami’ ob’yekty IG v Sirii,*’ *RIA Novosti*, September 5, 2017, https://ria.ru/20170905/1501782578.html; ‘*Rossiyskiye podvodnyye lodki unichtozhili ob’yekty IG v Sirii raketami Kalibr,*’ *RIA Novosti*, September 14, 2017,

experimentation with the navy's use of cruise missiles greatly reduced over time in the number of missiles involved in each strike, as well as the mix of platforms; it commenced with small surface vessels in the Caspian Sea, progressed to a mixture of surface and sub-surface platforms, and culminated in the exclusive use of submarine launches. Moreover, while the decision-making process, which resulted in the use of LACMs against targets in Syria, remains classified, it appears that the VMF was the principal branch of service advocating their use.

The following observations can be drawn from Russia's use of VTO in Syria:

- The use of LACMs was largely successful. The first use involved 26 launches, with some missiles reportedly failing to strike their targets. Later, it evolved to more limited use, showing apparent growing confidence in using fewer LACMs to strike targets;
- The lead advocate for the use of VTO was the VMF;
- The VMF "experiment" with the use of cruise missiles began with surface vessels, progressed to a mix of surface and sub-surface ships, and culminated in the exclusive use of submarine launches. This implied a varied experimentation and refinement of the various naval versions of these systems;
- The VKS's and VMF's use of Kh-101, Kh-555 and 3M14 cruise missiles allowed each service to gain invaluable

https://ria.ru/20170914/1504761180.html; '*Rossiyskaya podlodka atakovala boyevikov, napavshikh na voyennuyu politsiyu v Khame*,' *RIA Novosti*, September 22, 2017, https://ria.ru/20170922/1505317570.html; '*Voyennyy ekspert: Kalibry atakuyut samyye vazhnyye ob'yekty terroristov v Sirii*,' *Radio Sputnik*, October 5, 2017, https://radiosputnik.ria.ru/20171005/1506277308.html; '*Podlodka Velikiy Novgorod nanesla zalpovyy raketnyy udar Kalibrami po terroristam v Sirii*,' *Tvzvezda.ru*, October 31, 2017, https://tvzvezda.ru/news/forces/content/201710311742-3d94.html.

operational experience and overcome "teething issues," resulting in an overall success in the use and deployment of such high-technology strike systems;

- Issues may well exist around the depth and breadth of Russia's VTO arsenal: for example, the Kh-59 appears intended to address the lack of a medium-range ALCM;
- The range and variety of platforms for Russian LACMs poses a long-term challenge for the defense requirements of peer adversaries;
- In the long term, Moscow faces the challenge of balancing the production of supersonic LACMs against traditional LACMs in terms of cost and capability;
- Russian cruise missiles suffer from persistent issues with all-weather capability and the capacity to hit mobile or moving targets.[59]

SVP-24 and Freefall Bombs

Much of the criticism of the VKS's air operations in Syria relates to the fact that most of the ordinance used was unguided rather than the high-precision elements that were frequently highlighted in official Russian defense ministry briefings. High-profile use of LACMs, as detailed above, represents a minute proportion of the overall ordinance dropped during combat operations. The use of general-purpose aviation bombs by the VKS in Syria has been heavily documented.[60] However, defense ministry sources and the Russian military media claimed that the use of highly advanced navigational

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[59] Author's interviews with Western specialists on high-precision strike weapons, Russian SMEs, Brussels, London, Washington DC, January 12–15, 2021.

[60] See for example: 'Russia/Syria: War Crimes in Month of Bombing Aleppo,' *Human Rights Watch*, December 1, 2016, https://www.hrw.org/news/2016/12/01/russia/syria-war-crimes-month-bombing-aleppo.

attack systems compensated for the lack of high-precision ordinance and that these assets were exploited in order to significantly enhance the accuracy of airstrikes.[61] While these claims to greatly enhance accuracy up to and including "high-precision strike" levels are replete within the vast majority of publicly available Russian sources, few analyses have questioned the performance of the SVP-24, or assessed its effectiveness.[62]

In particular, following the early deployment of fixed-wing and rotary aircraft to the Russian Khmeimim airbase southeast of Latakia in September 2015, these platforms were later fitted with the SVP-24 (also known as Gefest), designed by the Russian defense company Gefest & T; this was especially utilized onboard the Su-24M fighter-bombers.[63] Su-25s were also equipped with the navigational and attack complexes OLTS-25 Optical Laser-Television System (*Opticheskaya Lazerno-Televizionnaya Sistema*). The OLTS-25 enabled higher accuracy in the use of Kh-25 and Kh-29 guided

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[61] See: M. Y. Shepovalenko, *Siriyskiy Rubezh,* Moscow: Tsentr Analiza Strategiy i Tekhnologiy (CAST), 2016.

[62] Very few Western commentaries question the precision accuracy claims around the use of the SVP-24 and its variants in combat operations in Syria. See: Hadi Gholami Nohouji, 'Cost Effective Aerial Campaign: Russian Airstrikes in Syria and the SVP-24,' *Southfront*, September 1, 2017, https://southfront.org/cost-effective-aerial-campaign-russian-airstrikes-syria-svp-24/; Michael Peck, 'Did Russia Really Build a Smarter Smart Bomb?' *The National Interest*, March 14, 2016, http://nationalinterest.org/feature/did-russia-really-build-smarter-smart-bomb-15484.

[63] In addition to the basic SVP-24 complex intended for installation on the Su-24M, the following variants of the complexes have been developed: SVP-24-22 (for the modification of Tu-22M3strategic bombers); SVP-24-33 (for modification of carrier-based Su-33 fighters); SVP-24-27 (for modification of MiG-27 fighter-bombers and for export); SVP-24-25 for modernization of the Su-25 attack aircraft). G. A. Belyayev, '*Boyevyye vozmozhnosti samoletov, osnashchennykh SVP-24 'gefest,"* Unpublished paper, Ufa University, July 2020.

missiles against ground targets. Variants of the SVP-24 have also been developed for use on other VKS platforms, including strategic bombers. Russian sources claim the system ensures high accuracy using, for example, the FAB-500 (four to seven meters from an altitude of 5–6 km).[64]

Illustrating the publicity and attention to this system, in an article in *Voyenno Promyshlennyy Kuryer* in October 2015, the Moscow-based defense journalist Alexei Ramm notes, “Representatives of the military department confirmed that the Su-24s involved in the attacks on the Islamic State have undergone modernization, during which they installed SVP-24 complexes, which allow conventional free-fall bombs to hit ground targets with high accuracy.”[65] Ramm accepts that early VKS sorties in the Syrian TVD were initially inaccurate. However, the author explains the improvement in the targeting as heavily tied to exploiting the SVP-24:

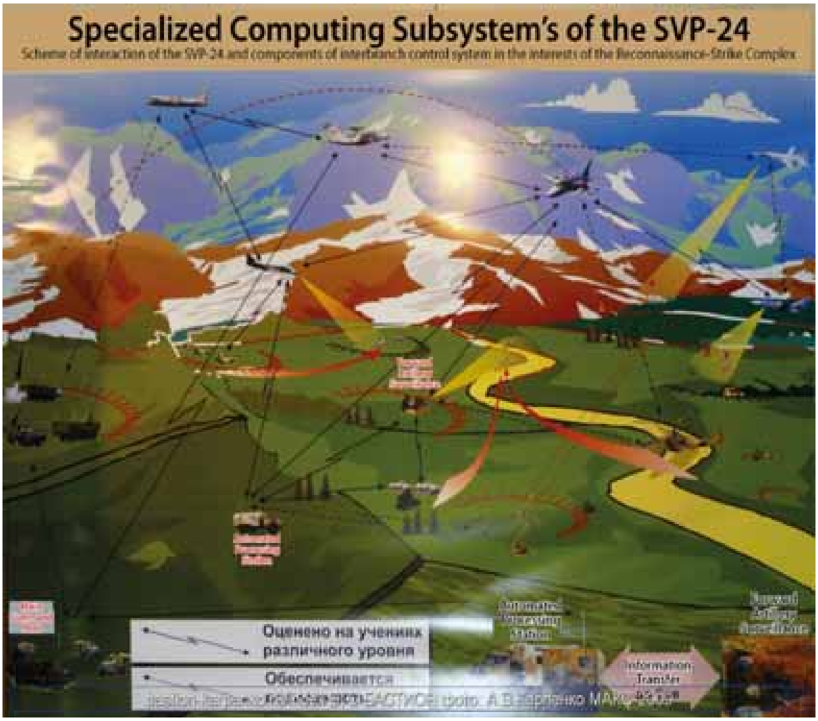
> In subsequent sorties, the accuracy of strikes increased significantly, which indicates that the crews of front-line bombers most likely began to effectively use the SVP-24 systems installed on their aircraft. Su-25 attack aircraft were also actively involved in night strikes. This suggests that the recently adopted modification of the Su-25SM3 with a new optoelectronic thermal imaging system is being used. However, like the Su-24, attack aircraft struck with conventional FAB free-fall bombs.[66]

[64] ‘*Novaya sistema ‘Gefest’ pozvolyayet ispol'zovat' nekorrektiruyemyye boyepripasy kak vysokotochnyye,*’ *TASS*, August 25, 2017, https://tass.ru/armiya-i-opk/4507779; ‘*Pritsel'no-navigatsionnyy kompleks SVP-24 ‘Gefest’ budet modernizirovan,*’ *Topwar.ru*, May 8, 2019, https://topwar.ru/157691-pricelno-navigacionnyj-kompleks-svp-24-gefest-budet-modernizirovan.html.

[65] Aleksei Ramm, ‘*Siriyskiy start rossiyskikh letchikov*,’ *Voyenno Promyshlennyy Kuryer*, October 5, 2015, https://www.vpk-news.ru/articles/27415.

[66] Ibid.

Figure 3: SVP-24



Source: http://bastion-karpenko.ru/svp-24-gefest/, Accessed February 15, 2021.

Numerous commentaries in Russian military media promoted the idea that the SVP-24, originally designed and introduced to the Russian Air Force in 2008 but later heavily exploited during the modernization of VKS platforms used in operations in Syria, marked a breakthrough in enhancing the accuracy of unguided munitions. The recurring theme was that the experience of operations in Syria had tried and tested the system and achieved greater accuracy in striking ground targets.[67]

[67] 'Russia's advanced technology helps use unguided munitions as precision bombs,' *TASS*, August 25, 2017, https://tass.com/defense/962079.

Lieutenant General (ret.) Dmitriy Lomako, the deputy general director of Gefest & T, explained that the system was in development over many years, drawing upon lessons from the use of Russian airpower in the experience of the conflicts in Chechnya in the 1990s:

> We work on intellect for combat aviation, including helicopters. We started in 1996, at a difficult time for Russia and its economy, with a technical specification from the Defense Ministry for modernization of the onboard and ground-based equipment of the Su-24M aircraft, prompted by the well-known events in Chechnya. Even during that stage, we built in a high degree of upgradeability, which subsequently allowed us to modify the SVP-24 for fitting to other aviation systems: the Tu-22M3, Su-33, Su-25, and partially the Il-22 for multiplexing streams from radio stations on various frequencies, relaying, and broadening the scope of net-centric command and control of troops. We are now upgrading the SVP-24 on the Ka-52 helicopter.[68]

Reportedly, such upgrades can be carried on a wider range of VKS platforms over a two-to-three-week period.

An aircraft fitted with this system can perform combat sorties at low or higher altitudes and deliver more accurate strikes. As illustrated in **Figure 3** above, the system integrates ground-based, aerial and space-based systems for enhanced targeting.[69] Military analyst Oleg Falichev outlines its critical characteristics that make possible such advances in targeting using free-fall ordinance:

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[68] Oleg Falichev, '*Intellekt dlya samoletov*,' *Voyenno Promyshlennyy Kuryer, August 14, 2018,* https://vpk-news.ru/articles/44363.

[69] Oleg Falichev, '*Bomby dlya khalifata*,' *Voyenno Promyshlennyy Kuryer,* June 25, 2018, https://vpk-news.ru/articles/43350.

> The key feature of the system is not that it guides the munition to the target but that it zeroes the carrier in to the release point and calculates the exact moment for dropping unguided aviation bombs. And this is how it differs fundamentally from the American JDAM: US armorers bolt a tailored single-use GPS guidance kit onto the bomb, whereas the SVP-24 can be endlessly reused with unguided munitions. The SVP-24 specialized computer subsystem consists of several components located both on the aircraft and on the ground. This enables not only navigation and bombing for a previously reconnoitered target but also, when required, retargeting in real time to cater for changes in the operational environment.[70]

Noting the increasingly widespread use of the SVP-24 and its variants, including in VKS platforms in Crimea, Anton Lavrov and Roman Kretsul in an article in *Izvestia* in July 2020, reflected this tendency to present the SVP-24 as a breakthrough in high-accuracy targeting. "The Russian military praised the effectiveness of the SVP-24. According to the Ministry of Defense, in real conditions it made it possible to achieve accuracy comparable to guided munitions. The accuracy of the Su-24M with it has more than tripled. When dropped from a height of up to 6 km, the deviation of bombs from the target is a few tens of meters," the authors asserted, adding, "The new system continuously monitors the coordinates of the target and the aircraft itself, calculating the parameters of the fall of bombs after dropping. It automatically corrects for wind, temperature and aircraft maneuvers. The command to use ammunition is issued at the exact time. There were recorded cases of sniper destruction of even point

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[70] Falichev, '*Intellekt dlya samoletov*,' Op.Cit. It is unclear if the Russian system relies on satellite navigation (GPS or GLONASS), but the laser guidance may be unaffected by satellite navigation jamming.

objects by single unguided bombs: detached houses, tanks and militant vehicles."[71]

A similar theme was pursued by an online Russian defense ministry publication in April 2018, again stressing the high-precision accuracy of the SVP-24 used by VKS platforms:

> Through the GLONASS system (note—not GPS!), the coordinates of the target (they are given by ground reconnaissance) and the coordinates of the aircraft are linked to each other. The plane goes to the desired point and drops bombs, in fact, under computer control. In this case, adjusting the trajectory of the bomb is not necessary. The SVP-24 provides alignment of the target with the location of the bomber—adjusted for the trajectory of the bomb, taking into account its ballistics and weather conditions. The calculations are made by the SVP-24 onboard computer complex, which combines aiming, navigation and control devices. The bomb is dropped at an altitude of 5–6 km, where a modern portable anti-aircraft missile system (MANPADS) cannot reach.[72]

Igor Semenchenko, exemplifies these particular themes in an article in *Voyenno Promyshlennyy Kuryer* in December 2017. He praises the overall performance of the VKS in Syria, emphasizing the increased rates in daily sorties as well as their use of intelligence, surveillance and reconnaissance (ISR), confirming the need to avoid altitudes lower than 5,000 meters and claiming that the onboard sighting and

[71] Anton Lavrov Roman Kretsul, '*Molot 'Gefesta:' morskiye bombardirovshchiki udaryat s osoboy tochnos,*' *Izvestia*, July 20, 2020, https://iz.ru/1037376/anton-lavrov-roman-kretcul/molot-gefesta-morskie-bombardirovshchiki-udariat-s-osoboi-tochnostiu.

[72] Nikolai Poroskov, '*Umnyy pritsel dlya rossiyskikh aviabomb,*' *Zvezdaweekly.ru*, April 17, 2018, https://zvezdaweekly.ru/news/20184161558-AcFeK.html.

navigation equipment enabled the VKS to hit ground targets with "high accuracy."[73]

> Let us emphasize: initially, there were about 20 sorties per day, but gradually their number increased. In the course of the operation, tactics also changed. Our pilots went to work alone, attacking several targets in a sortie. The methodology of their combat work was based on data from space [as well as] aerial reconnaissance, and only after clarifying all the information received from the headquarters of the Syrian army. As a rule, they attacked from a height of more than five thousand meters to avoid being hit by portable anti-aircraft missile systems of the Stinger type. The onboard sighting and navigation equipment of the aircraft made it possible to ensure that terrorists hit any ground targets with *high accuracy*.[74]

Semenchenko adds:

> The Russian air group created in Syria, consisting only of modern and modernized models of kit equipped with *advanced weapons and sighting and navigation systems*, made it possible to deliver *high-precision strikes* against bandit formations throughout Syria without entering the enemy's MANPADS zone. The widespread use of reconnaissance and strike systems based on reconnaissance, control and communications complexes made it possible to implement the principle of "one target–one missile (bomb)." The superiority of the Russian group in reconnaissance means, electronic warfare, integrated

[73] Igor Semenchenko, '*Ni razu ne promazali Na siriyskom TVD poluchen unikal'nyy opyt*,' *Voyenno Promyshlennyy Kuryer*, December 19, 2017, https://vpk-news.ru/articles/40474.

[74] *Ibid.* Author's emphasis.

> control and engagement systems ensured the *non-contact* defeat of the enemy with minimal risk to our troops and forces.[75]

Nonetheless, despite this introduction of advanced high-technology (albeit in existence since 2008, though having undergone further improvements), there are certainly questions concerning its actual performance-enhancing characteristics. An anonymous US-based blogger accurately and succinctly describes the SVP-24 and how this system differs from the US Joint Direct Attack Munition (JDAM) approach, which enhances each bomb to effectively transform it into a precision-guided munition:

> The SVP-24 special computing subsystem was a different approach. Instead of installing kits on every bomb the Russians opted to install multiple modules, sensors, cameras and displays which would aid the pilot by calculating a targeting solution. The SVP-24 can be installed on any helicopter or plane and can be programmed to fire rockets, unguided bombs, or other packages. On helicopters flying low this makes rocket attacks brutally accurate. On airplanes however due to the unpredictability of wind at different layers of atmosphere planes are forced to fly lower to get more accurate attack windows which will drop the packages closer to target. The higher the plane the more impacted overall accuracy will be. This is generally calculated with the size of the bomb. As some bombs have [an] explosive radius and kill radius (pressure shock wave) that span in the meters (a 2000lb bomb can cover nearly 365 meters/1200 feet in a killing zone) accuracy becomes less important (and precision strikes become more of a play on words).[76]

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[75] *Ibid.* Author’s emphasis.

[76] The blogger also details, ‘Each aircraft, being fixed or rotary-wing, will have a series of external sensors installed such as a guidance camera, GLONASS module, terrain-following radar, weather and pressure sensors, as well as sensors reading the direction and speed of the aircraft, etc. The pilot would input the target destination

Most Russian sources make little or no reference to the challenges facing the use of the SVP-24 in combat operations. The blogger correctly identifies some of the limitations of the system, including these atmospheric conditions within which the VKS platforms flew, such as wind factors, and the need to use the system at lower altitudes. The point is that at higher altitudes, despite contrary claims about the system's performance characteristics, the accuracy reduces. This point was also rightly highlighted by Michael Kofman, the director for Russia and Eurasia at the Center for Naval Analysis, in Arlington, Virginia:

> Russian fixed-wing aircraft lacked targeting pods to employ what few precision-guided munitions were available, and there were almost no precision munitions available initially because they had not bought them. Hence, only a tiny percentage of the weapons used in Syria could be considered precision-guided. Under the modernization program, the Aerospace Forces invested in a more accurate targeting system package called Gefest-SVP, which was supposed to provide much higher accuracy for existing unguided weapons. Forced to conduct strikes at altitudes above 4,000 meters to avoid ground fire and man portable air defenses, the Russian air force found that Gefest offered limited improvements in accuracy.[77]

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and the system would use all the available sensors to calculate multiple attack vectors and windows, which the pilot would have to fly through for the package to be automatically released to hit target.' See: 'The Great Game: JDAM Vs SVP-24,' *The Tacticians Database*, October 16, 2016, http://tactdb.blogspot.com/2016/02/the-great-game-jdam-vs-svp-24.html.

[77] Michael Kofman, 'Syria and the Russian Armed Forces: An Evaluation of Moscow's Military Strategy and Operational Performance,' in Robert E. Hamilton, Chris Miller, Aaron Stein (Eds), *Russia's War in Syria: Assessing Russian Military Capabilities and Lessons Learned*, Foreign Policy Research Institute, 2020, pp. 52–53.

In addition to the flight altitude issues involved, as most of the VKS sorties had to be conducted at altitudes above 4,000 meters to avoid the risks of ground fire of MANPADS, other, no less important factors were at play. Those included the lack of sufficient quantities of high-precision systems, especially early in the operations, as well as an absence of targeting pods. Hence, in the overall VKS operations, only a tiny percentage of precision-guided weapons were used.[78]

In an interview in *Voyenno Promyshlennyy Kuryer* published in November 2015, Oleg Falichev raised issues concerning VKS operations in Syria with Major General (ret.) Igor Semenchenko, the first deputy chief of the Operations Directorate of the Air Force General Staff (1997–2003) and the leading advisor to the Federation Council Committee on Defense and Security (2003–2013). Semenchenko, like others, drew attention to the role played by the SVP-24 to enhance the role of free-fall bombs during combat operations. He explained that unlike the US concept of using the JDAM to convert conventional bombs into precision weapons, the SVP-24 functions in a markedly different way:

> The SVP-24 provides alignment of the target with the location of the carrier, corrected for the trajectory of the bomb, calculated by the onboard computer complex, taking into account the hydrometeorological conditions and its ballistics. Conventional ammunition gains performance *comparable* to high-precision weapons. Meanwhile, in a combat situation, additional factors are superimposed, which significantly *reduce* the accuracy of bombing. These are errors in establishing the coordinates of the target, which can reach several meters. An additional several meters of deviation is introduced by determining the location of the carrier according to GLONASS data in the combat zone. Coordinates may be slightly distorted during sharp maneuvering

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[78] *Ibid.*

> in the target area. The lack of complete information about the hydrometeorological situation and the state of the air environment also affects it.[79]

Taking into account these factors, it is possible to assess the accuracy of the combat use of free-fall bombs using the SVP-24. The probability of hitting a small protected underground structure is 30–40 percent, and the probability of hitting weakly protected ground targets of a medium size can reach 60 percent. With 12–16 medium- and large-caliber bombs on board, the SVP-24–equipped Su-24M is capable of destroying up to two stationary targets of the Islamic State's military infrastructure in one sortie. Apparently, for this reason, no more than one sortie is conducted per target.[80]

Semenchenko's analysis is important in further refining the role played by the SVP-24 in enhancing the accuracy of VKS operations in Syria. While the system certainly aids in the delivery of free-fall bombs, it does not equate with "high-precision strike." Semenchenko rightly notes that by employing the SVP-24, free-fall bombs can be used in a way *comparable* to but not equal to high-precision weapons.[81] He further adds some of the variable factors that may reduce accuracy in any bombing conducted using the system, ranging from coordinate errors, distortions due to maneuvering during a sortie, to the lack of complete data on the hydrometeorological

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[79] Author's emphasis. Igor Semenchenko and Oleg Falichev, '*Ot 'vozmezdiya' ne uyti*,' *Voyenno Promyshlennyy Kuryer*, November 30, 2015, https://www.vpk-news.ru/articles/28274.

[80] *Ibid.*

[81] Author's emphasis.

situation or the state of the air environment.[82] Falichev concurs that a number of variable factors can reduce the accuracy of the SVP-24; however, the system remains a significant target tool for the VKS. As he notes, “Factors arise in a combat environment that significantly degrade bombing accuracy: technical margin of error of the munition itself, imprecision of target coordinates, GLONASS errors, incomplete weather information. Allowing for these, free-fall bombs used in combat can be judged to be accurate to within 50–100 meters, but the SVP-24 reduces that to 15–20 meters.”[83]

Table 1: VKS Air-Launched Precision-Guided Weapons

KAB-250L	Smart bomb with gyrostabilized laser-homing head
KAB-500L	Smart bomb with gyrostabilized laser-homing head
KAB-1500LG-F	Smart bomb with gyrostabilized laser-homing head
KAB-1500L-Pr	Smart bomb with gyrostabilized laser-homing head
KAB-250S	Smart bomb with inertial satellite-homing system using GLONASS/NAVSTAR
KAB-500S	Smart bomb with inertial satellite-homing system using GLONASS/NAVSTAR

[82] Igor Semenchenko, Oleg Falichev, ‘*Ot ‘vozmezdiya’ ne uyti*,’ *Voyenno Promyshlennyy Kuryer*, November 30, 2015, https://www.vpk-news.ru/articles/28274.

[83] Falichev, ‘*Intellekt dlya samoletov*,’ *Op. Cit.*

RBK-500 SPBE-D	Expendable cluster bomb dispenser loaded with 15 self-aiming antitank submunitions
Kh-55	Strategic cruise missile with autonomous autocorrelation inertial-guidance system integrated with terrain contour-matching system, with television-guidance system in final phase
Kh-55SM	Strategic cruise missile with autonomous autocorrelation inertial-guidance system integrated with terrain contour-matching system, with television-guidance system in final phase
Kh-555	Strategic cruise missile with autonomous autocorrelation inertial-guidance system integrated with terrain contour-matching system, with television-guidance system in final phase
Kh-59M	Air-launched tactical guided missile with television-correlation homing head
Kh-59M2	Air-launched tactical guided missile with command broadcast [*translyatsionno-komandnyy*] guidance system
Kh-25ML	Air-launched tactical guided missile with semiactive laser-homing head
Kh-29L	Air-launched tactical guided missile with semiactive laser-homing head

Kh-29T	Air-launched tactical guided missile with passive television-homing head
Kh-31AD	Anti-ship missile with active radar-homing head
Kh-35U	Anti-ship missile with active radar-homing head
Kh-59MK	Anti-ship missile with active radar-homing head
Kh-41 Moskit	Anti-ship missile with combination onboard control system, which includes inertial navigation system, radio altimeter, and active-passive radar-homing head
Kh-25MP	Anti-radar missile
Kh-31PD	Anti-radar missile
Kh-58USh	Anti-radar missile
9M127-1	Air-launched antitank missile with laser-homing heads
Vikhr-1	Air-launched antitank missile with laser-homing heads
9M120 Ataka	Air-launched antitank missile with semiautomatic radio command guidance system
R-60	Short-range air-to-air guided missile with passive infrared-homing head
R-73	Short-range air-to-air guided missile with passive infrared-homing head

RVV-MD	Short-range air-to-air guided missile with passive infrared-homing head
R-27T	Medium-range air-to-air guided missile with passive infrared homing head
R-27ET	Medium-range air-to-air guided missile with passive infrared-homing head
R-27R	Medium-range air-to-air guided missile with inertial-semiactive radar-homing head
R-27P	Medium-range air-to-air guided missile with passive radar-homing head
R-77	Medium-range air-to-air guided missile with monopulse Doppler active radar-homing head
RVV-Aye	Medium-range air-to-air guided missile with monopulse Doppler active radar-homing head
RVV-SD	Medium-range air-to-air guided missile with monopulse Doppler active radar-homing head
R-33	Long-range air-to-air guided missile with inertial-semiactive radar-homing head
R-33S	Long-range air-to-air guided missile with inertial-active radar-homing head

Source: VKS Order of Battle: http://www.milkavkaz.net/2015/12/vozdushno-kosmicheskie-sily.html.

The above table is drawn from a Russian online blogger source, and it is intended to present a snapshot of the high-precision weapons in the

VKS inventory. It is worth noting the extent to which, by late 2015, some of these bomb types were being presented in the class of "smart," or "guided."[84] Already by late 2015, with the Russian defense ministry heavily pushing the high-precision usage and increased accuracy in bombing sorties by the VKS, this impression appeared to percolate in both Russian and Western sources.

In the Russian defense ministry's frenzy to "advertise" its "precision strikes" in operations in Syria, numerous commentaries in the military media stressed this aspect of the weaponry used in the campaign. Below, profiling some of the weapons used that benefited from the enhanced SVP-24-based targeting system is that fantasy claim to include a thermobaric weapon (ODAB-500):

- **KAB-500S**: high-explosive guided (corrected) air bomb "dropped-forgot." Designed to destroy stationary ground and surface targets such as warehouses, military-industrial facilities, ships in the parking lot. It can be used around the clock in any weather. Unlike foreign analogs, the main model is not built on GPS/GLONASS satellite navigation but on the recognition of the terrain map.[85]

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[84] The identity of the blogger or group of Russian bloggers responsible for this site is unclear. However, among Western Russian military SMEs, it is considered to be fairly accurate. It is, as noted, only provided here to offer a Russian-based source that portrays the extent of progress in the VKS of procuring high-precision or higher-precision strike weapons. Author's interviews with Russian military SMEs, Berlin, London, Oslo, Washington DC, Stockholm, January 21–22, 2021.

[85] Oleg Falichev, '*Bomby dlya khalifata*,' *Voyenno Promyshlennyy Kuryer*, June 25, 2018, https://vpk-news.ru/articles/43350: 'The KAB homing head does not use the object itself, but landmarks to know its exact coordinates and aim at a target that does not stand out from the landscape. This makes it more reliable when using modern electronic warfare equipment, when GPS/GLONASS signals can be suppressed. Weight—560 kilograms [of which] 195 kilograms of explosives.'

- **The KAB-250S/LG**: the most compact guided aerial bomb in its class. Equipped with a system for receiving satellite coordinates, and its own thermal imaging homing head. The LG modification allows one to aim it using laser target designation. Weight—250/127 kilograms of explosives.[86]
- **RBK-500 SPBE**: one-time cluster bomb. Equipped with 15 autonomous homing anti-tank warheads, which are equipped with dual-mode infrared target coordinators. Designed to destroy armored vehicles in conditions of natural and artificial interference. After ejection of submunitions from RBK-500, they release parachutes and begin to rotate around their axis in search of targets.[87]
- **ODAB-500**: space-detonating aerial bomb. A kind of high-explosive bomb. But its effectiveness is much higher. In the bow, there is an electromechanical device for spraying explosives. The bomb contains 193 kilograms of high-energy volatile liquid. After the discharge, after a set time, the spraying of the warhead begins, which creates a cloud of a mixture of explosives with air and is undermined by a detonator.[88]

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[86] *Ibid.*

[87] *Ibid.* Falichev adds these details: 'The IR coordinator has a 30-degree viewing angle and scans the area at 6–9 rpm. After detecting the target and determining the point of detonation of the warhead using an on-board computer (approximately at an altitude of 150 m), defeat is carried out. A copper blank with a diameter of 173 millimeters and weighing one kilogram accelerates to two thousand meters per second and is capable of penetrating up to 70 millimeters of armor, the blow is applied to relatively weakly armored areas (roofs of towers and engine-transmission compartments). Weight—500/15 kilograms of elements of 14.5 kilograms.'

[88] *Ibid.* Falichev adds, 'A volumetric explosion creates a powerful wave of excess pressure, and then a backward wave that pulls air into the resulting vacuum (therefore, such bombs are often called vacuum bombs). The effective range of the blast wave against enemy personnel in open areas is more than 50 meters. Weight—500/193 kilograms of explosives.'

- **Kh-29L**: an air-to-surface missile. It has an increased damaging factor of high-explosive and fragmentation action. It is equipped with a laser seeker. The target is illuminated by a laser, along which guidance is made, while the rocket perceives only the required wavelength of light, which ensures a high stability of target locking.[89]
- **Kh-25ML**: air-to-surface missile. It aims at the target using a semi-active laser seeker. Target illumination can be carried out by an airborne or ground target designation station. The design of the illumination station and the missile seeker excludes the influence of laser radiation from other sources. The task of the pilots is only to detect and mark the target on the TV display.[90]

Equally, it is worth clarifying that over the course of VKS operations in Syria, primarily tasked with close air support for the Syrian Arab Army and later with Russian Ground Forces assistance in the wider context of counterinsurgency, it is undoubtedly the case that the level of lethality in these VKS strikes greatly improved. In an important assessment of the role of Russian airpower in Syria by Ralph Shield in the *Journal of Slavic Military Studies*, in 2018, the author refers to greater use by the VKS of "precision and near-precision strike," partly

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[89] *Ibid.* The author notes, 'The image captured by the GOS is broadcast on a television screen in the cockpit. The retention of the illumination beam is provided by an automatic tracking system. The missile itself chooses the most advantageous trajectory for approaching the target, striving to hit it at the highest possible angle in order to penetrate the least protected structures and armor of vehicles. Weight—660/116 kilograms of explosives. The flight range is 8–10 kilometers.'

[90] Falichev adds, 'Accurate retention of the beam on the target is provided by an automatic tracking system. At the end of the trajectory, the rocket makes a 'slide.' Designed to engage small-sized mobile and stationary targets. Weight—300/90 kilograms of explosives. The flight range is 8–10 kilometers.'

explaining the "greater per sortie kill rates over Russia's past conflicts." Shield clarifies:

> Battle damage verification against fielded forces is notoriously difficult, particularly against an irregular enemy, and even more so in the midst of an active conflict. That said, enough anecdotal evidence exists for Syria to surmise that the RuAF [Russian Air Force] has achieved at least qualified success in the employment of precision and near-precision technology. Granting that officially released materials present a charitably filtered view, verified RuAF weapon seeker and targeting system videos showing munitions successfully tracking to kills on fixed targets and stationary vehicles demonstrate solid operational confidence and improved per sortie kill rates over Russia's past conflicts. This impression is corroborated by participant interviews and the judgments of third-party conflict observers that correlate the onset of Russian bombardment with a definite improvement in airstrike lethality. In Aleppo, for example, Russian airstrikes were characterized by those subject to their effects as consistently accurate when deployed against identifiable targets. The fact that its fighter-bombers have been able to obtain this result while operating almost exclusively from a medium altitude sanctuary signals that the RuAF has attained a threshold proficiency in the air-delivery of guided and unguided ordnance.[91]

While numerous factors feed into the VKS performance during their operations in Syria, as Shield asserts, the VKS achieved a "threshold proficiency in the air delivery of guided and unguided ordinance." Of course, other factors at play include the experience, confidence and

[91] Ralph Shield, 'Russian Airpower's Success in Syria: Assessing Evolution in Kinetic Counterinsurgency,' *The Journal of Slavic Military Studies*, Vol. 31, No. 2, pp. 218–219.

professionalism boosted on the part of VKS pilots over the timescale of conducting these operations. However, there is equally no doubt that the exploitation of the SVP-24 and its variants played an important role in the VKS's success. As noted above, this appears time and again within the Russian sources. For example, in August 2018, like other senior Russian defense officials, Yuriy Borisov, the deputy prime minister for the defense and space industry, lavished high praise on the system: "The SVP-24 is a good tool. It takes into account the aircraft's flight data for speed, altitude, g-force, attitude, the number and type of munitions and their ballistic characteristics, and climatic conditions up to and including the wind direction and speed, and then calculates the moment to release the munition. Some of the bombing was even with munitions from the time of the Second World War, the cheapest and by default unguided but right on target."[92]

While it is true that the vast bulk of Russian ordinance dropped on targets in Syria during the course of the VKS operations since September 2015 were unguided or free-fall bombs, the picture this portrays is quite misleading. The use of the SVP-24 undoubtedly played a major part in offering the VKS a capability hitherto unseen in Russian combat operations: it resulted in a major improvement in targeting. Moreover, the SVP-24 was never intended or designed to compete with or be compared to the US JDAM, representing as it does a different approach rooted in a cost-effective mechanism to enhance the accuracy of what would otherwise be unguided ordinance. The SVP-24, as Semenchenko rightly stated, was intended to offer to make unguided free-fall bombs comparable to, but not equal to PGMs. By August 2018, of the more than 18,000 VKS sorties flown, over half had involved using the SVP-24. This exploitation of advanced Russian

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[92] Falichev, '*Intellekt dlya samoletov*,' *Op. Cit.*

technology offered a means to improve overall performance in VKS operations.[93]

Russia's High-Precision Strikes as a Non-Contact Capability

Russia's use of high-precision strikes during its operations in Syria moved beyond simply a theoretical understanding or an aspirational approach to such modern warfare. The ideas and thinking underlying this experiment trace their origins to Marshal Ogarkov's RMA, and his intellectual descendants such as General Slipchenko, arguing that such "sixth-generation" warfare, with its greatest advances pertaining to "non-contact" operations, was tried and tested in Russia's military operations in Syria.[94] Unlike US/NATO models of using "non-contact" as an element in military operations, the Russian approach in Syria was to blend this into existing "contact operations," never losing sight of the overall role of its involvement in Syria as offering support for the SAA, targeting "terrorist groups," and even going after the moderate Syrian opposition. This relied mainly on the design and formulation of an "aerospace operation," which, over time, became more complex and demanded additional features of Russia's "hard

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[93] Falichev, '*Intellekt dlya samoletov*,' *Op. Cit;* Semenchenko, '*Ni razu ne promazali Na siriyskom TVD poluchen unikal'nyy opyt*,' *Op. Cit*; Semenchenko, Falichev, '*Ot 'vozmezdiya' ne uyti*,' *Op. Cit.*

[94] Vladimir Slipchenko, *Voina novogo pokoleniia: Distantsionnye i beskontaktaktnye*, Moscow: OLMA-Press, 2004; Vladimir Slipchenko, *Beskontaktnye voiny*. Moscow: *Izdatel'skii dom*: Gran-Press, 2001; Vladimir Slipchenko, *Voina budushchego,* Moscow: *Moskovskii Obshchestvennyi Nauchnyi Fond*, 1999. See: Jacob W. Kipp (ed), M. A. Gareev, *If War Comes Tomorrow: The Contours of Future Armed Conflicts*, London: Frank Cass, 1998; Jacob W. Kipp, 'The Labor of Sisyphus: Forecasting the Revolution in Military Affairs during Russia's Time of Troubles,' in Thierry Gongora and Harold von Riekhoff (Eds.), Toward a Revolution in Military Affairs? Westport, Connecticut: Greenwood Press, 2000, pp. 87–104; Jacob W. Kipp, 'Thinking about Future War: Views and Comments from Moscow,' *The Journal of Slavic Military Studies*, Spring 2007.

power," including limited use of Ground Forces in support of the SAA.[95] This is not to deny the presence and exploitation of other "soft power" elements, though these lie beyond the scope of this analysis. However, in this context, and with much of the operational environment in Syria offering opportunities for Russia's Armed Forces to experiment with a variety of hardware and weapons systems, this also included the road-testing of the VTO.

Of course, questions exist concerning the interpretations of non-contact strikes. Is this about the use of long-range unmanned means of attack and non-kinetic means of attack specifically against adversary infrastructure, industrial-economic objects, political objects and distant military infrastructure or assets; if so, is this a new capability? If, however, "non-contact strikes" is interpreted as the use of these means of attack against adversary military targets at large (in theater), then it may be a new sub-capability of a greater strike capability. Some of the things that comprise the offensive component, on the other hand, are new. Old capabilities would include aircraft with unguided munitions, rocket and tube artillery. New capabilities include those displayed in Syria, such as unmanned aerial systems, new types of EW systems, precision-guided weapons, etc. Some of these can be considered a non-contact strike capability.[96]

From the perspective of Russia's General Staff, the use of VTO in Syria was a clear success. Of course, the earliest strikes revealed shortcomings, and it seems that the use of "non-contact" capabilities were adjusted over time. The VKS was in the lead role for the

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[95] See: Roger McDermott, 'Russia Reforms Aerospace Defense Structures—Again,' *Eurasia Daily Monitor*, Volume 12, Issue 151, The Jamestown Foundation, August 11, 2015, https://jamestown.org/program/russia-reforms-aerospace-defense-structures-again/.

[96] Author's interviews with specialists on Russian airpower, London, Tel Aviv, Washington DC, January 26–28, 2021.

aerospace operation; however, the first use of cruise missiles came from the VMF, with the 26 Kalibr cruise missiles fired against ground targets in Syria on October 7, 2015. This level of attack, with some reported missiles falling short of target, was never repeated.[97] The entire process of using cruise missiles against targets in Syria witnessed clear development and evolution, implying growing confidence that smaller numbers of missiles could be used to strike the designated ground targets. As noted, in the experience of the VMF, the platforms started with exclusively surface vessels, progressing to a mixture of surface and sub-surface ships, culminating in the last five attacks only involving submarine launches. The General Staff appears to have used the experiment with cruise missiles in Syria to convince the political leadership to invest long-term in populating the Armed Forces with increased numbers and varieties of VTO as part of Moscow's future "non-nuclear deterrence," vis-à-vis peer adversaries.

Thus, when General Gerasimov, in his speech to the AVN in March 2018, outlined future high-technology threats to Russia stemming mainly from the United States, he asserted that the answer lies in Moscow's development of VTO capability, to include developing and procuring supersonic cruise missiles capable of overcoming enemy air defenses:

> Our answer is not long in coming. Contemporary models of armaments, including fundamentally new types of weapons, are being adopted and deployed. The mass production of new models of weapons has begun in the interests of equipping the Armed Forces with them. "Avangard," "Sarmat," and the latest "Peresvet" and "Kinzhal" weapons have demonstrated their high level of effectiveness and successfully passed the test of the

[97] M. Y. Shepovalenko, *Siriyskiy Rubezh,* Moscow: *Tsentr Analiza Strategiy i Tekhnologiy* (CAST), 2016, pp.112–113.

> “Poseidon” and “Burevestnik” complexes. Work is planned for the creation of the “Tsirkon” sea-based hypersonic missile.
>
> There is no doubt that we are leaders in this field in comparison with the world’s technologically developed countries. Thus, recently, a decision was made on conducting scientific and design work on the development of ground complexes of mid- and lower-range hypersonic missiles. The creation of new models of weapons will not drag Russia into a new arms race. The number of new complexes sufficient for deterrence will be created within the framework of the planned military budget.[98]

Although, as observers have noted, the majority of Russia’s military operations in Syria were not in the category of “non-contact,” the element being blended into the overall experimentation should not be ignored or underestimated; clearly, the General Staff had solid reasons for advocating the use of cruise missile testing in such a combat situation. However, in the Western and Russian sources covering these operations in Syria, there is almost universal underestimation of the extent to which the targeting of sorties flown by the VKS were markedly enhanced in their accuracy to deliver on target using genuinely innovative Russian high-technology navigational and attack systems based on the SVP-24 and its variants. While open to criticism—the SVP-24 may not replicate “high-precision” strikes—a number of former senior Russian air force officers have nonetheless noted that it offers a capability “comparable to high-precision strike”; improvement in any operational environment is surely advantageous.

Returning to the theme of Moscow’s first use of cruise missiles in military operations during its involvement in the conflict in Syria, this also has strategic implications. While tested at the operational-tactical

[98] Valery V. Gerasimov, ‘*Razvitie voennoi strategii v sovremennykh usloviiakh. Zadachi voennoi nauki,*’ *Vestnik* 67, No. 2, 2019, pp. 6–11.

level in the Syrian TVD, the primarily aerospace operation ultimately led to testing such systems from multiple platforms—air-, sea- and land-based. Moscow has a long-held interest in turning to conventional high-precision strike as an added layer of strategic deterrence. In 1992, this was expressed, albeit as an aspiration in a statement issued by the Presidium of the Russian Federation Supreme Soviet, *On Priorities in Russian Federation Military Policy*, dated April 1, 1992. The statement read as follows, "Forces with *high-precision weapons* and the delivery systems for them should become the main factor of deterring large-scale conflicts and local wars from breaking out against Russia and the other CIS [Commonwealth of Independent States] member states."[99] Building on the origins of the RMA, former deputy defense minister Andrei Kokoshin coined the phrase "non-nuclear deterrence" (*neyadernogo sderzhivaniya*) or "pre-nuclear deterrence" (*pred'iadernoe sderzhivaniya*); in 2010, this entered the lexicon of Russia's Military Doctrine.[100] The General Staff and defense ministry have pointed to the use of VTO in the Syria campaign to convince the political leadership that the conventional element of "non-nuclear" deterrence lies in such high-precision weaponry.

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[99] Author's emphasis. See: Security, Disarmament, Conflicts, RAU, Moscow, 1992.

[100] See: Andrei Kokoshin, *O sisteme neyadernogo sderzhivaniya v oboronnoi politike Rossii,* Moscow: Moscow University Press, 2012; V. I. Poletayev and V. V. Alferov, '*O neyadernom sderzhivanii, ego roli i meste v sisteme strategicheskogo sderzhivaniya,*' *Voyennaya Mysl'*, No. 7, July 2015, pp. 3–10; A. N. Bel'skiy, D. A. Pavlov, O. B. Klimenko, '*Aktual'nye voprosy obezpecheniya voyennoy bezopasnosti Rossiiskoy Federatsii,*' *Voyennaya Mysl'*, No. 1, January 2015, pp. 3–10; *Voyennaya Doktrina Rossiiskoy Federatsii*' [Military Doctrine of the Russian Federation], 2014, https://rg.ru/2014/12/30/doktrina-dok.html, Section 12, point G; and Section 21, point M; V. A. Sobolevskiy, A. A. Protasov, V. V. Sukhorutchenko, '*Planirovanie primeneniya strategicheskikh vooruzhenii,*' *Voyennaya Mysl'*, No. 7, July 2014, pp. 9–27; A. V. Nedelin, V. I. Levshin, M.E. Sosnovsky, '*O primenenii iadernogo oruzhiya dlya deeskalastii voennikh dyestvii,*' *Voyennaya Mysl'*, No. 3, May–June 1999, pp. 34–37.

While the further adoption of high-precision strike systems undoubtedly boosts Russia’s strategic deterrence, questions persist regarding production costs and capacity. To date, these weapons have mainly been tested only in the Syrian TVD; whereas, the capability may be more restricted against a peer adversary. In 2014, Defense Minister Shoigu claimed that the VTO stock would increase “30 times by 2020.”[101] However, assuming such targets are achievable in the first place, as Barry Watts explained in 2013, “even in the case of very inexpensive PGMs [VTOs], resource constraints and institutional preferences can confront even a major power with the prospect of running out during high-intensity operations.”[102] Watts was commenting on the US; yet, despite Shoigu’s promises, Moscow also faces such constraints.

The figures for manufacturing a Kalibr cruise missile in Russia are classified as secret; though widely differing estimates can be found in the Russian military media, ranging anywhere from $750,000 to $6,500,000 per missile. By contrast, the production cost of a US Tomahawk cruise missile is around $1,500,000.[103]

The Kalibr missile’s producer is Novator, based in St. Petersburg. The Moscow-based military observer Igor Ischenko pointed out that in the first six months of 2016, Novator had produced 47 Kalibrs. But based

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[101] Piotr Butowski, ‘All missiles great and small: Russia seeks out every niche,’ *International Defence Review,* August, 26, 2014.

[102] Barry, D. Watts, *The Evolution of Precision Strike,* Center for Strategic and Budgetary Assessments, 2013, http://csbaonline.org/uploads/documents/Evolution-of-Precision-Strike-final-v15.pdf.

[103] Maksim Solopov and Aleksandr Artemev, ‘*Rassledovania RBK: skolko tratit Rossia na voinu v Sirii,*’ *RBC,* October 28, 2015, http://www.rbc.ru/investigation/politics/28/10/2015/562f9e119a79471d5d7c64e7; ‘Rockets galore – Modern warfare is expensive. But it is to become less so,’ *The Economist,* September 29, 2012.

on the defense ministry's plans to introduce this cruise missile in greater numbers into the VMF, Ischenko posited this would demand around 1,500 missiles ready for service at any one time. Moreover, this number is on the extremely conservative end of the amounts that would be required for training and testing.[104]

Conclusion

In this context, a more cost-effective and, naturally, less high-profile element relates to the exploitation of unguided ordinance with the SVP-24 variants to achieve an increased level of lethality—as came out of Russia's experiments in Syria with high-precision weapons. Indeed, this may well prove to be more useful to Moscow in its future involvement in regional conflicts, as it is certainly more cost-effective. During its operations in the Syrian TVD, Moscow demonstrated that it has harnessed a "non-contact warfare" capability. But it used this in a limited manner, folded into support for existing operations. It nonetheless clearly judged this to be a success, offering valuable combat-based experience to test and refine these systems.

At the strategic level, such "non-contact" capabilities feed into strengthening Russia's non-nuclear deterrence. And evidently, these systems will continue to receive considerable state investment in the years ahead to include the introduction of hypersonic conventional strike systems such as the Tsirkon, posing considerable challenges for peer adversaries in the event of conflict. While, this new capability was tried and tested in the Syrian TVD, it is quite a different question as to its utility in the context of any future conflict with a peer adversary. Moreover, Moscow would need to have the capacity to produce and use enough of these weapons to overcome enemy air and missile defense systems, while maintaining enough in reserve for the

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[104] Sergei Ischenko, '*Slishkom krupnyi 'Kalibr,"* *Svobodnaia Pressa*, September 8, 2016, http://army-news.ru/2016/09/slishkom-krupnyj-kalibr/.

contingency of conflict escalation. Moreover, it remains an open question as to how these systems correlate with each other. How is the further development and introduction of precision-guided weapons influencing Russian strategic military thought? And, how does the political-military leadership calculate and determine the optimum balance in the future between precision, unguided and nuclear weapons arsenals?

Through the limited experiments with the use of VTO during its operations in Syria, Moscow has demonstrated the entry of its Armed Forces into the realm of “sixth generation warfare” and its pinnacle of “non-contact” capability. For now, however, the nature of application has still proven to be quite limited.

5.

The Role of Hypersonic Weapons in Russian Military Strategy

One of the hallmarks of Russia's Armed Forces transformation and modernization since 2008 has been the extent to which it has implemented plans to develop and enhance conventional precision-strike capability.[1] It showily demonstrated its entry to the precision-strike regime during Russian military operations in Syria, ordered by the Kremlin in support of the Bashar al-Assad regime in late September 2015.[2] More recently, following high profile-statements by the political-military leadership, wider attention has fixated upon Moscow's plans to introduce hypersonic weapons (*Giperzvukovogo Oruzhiya*—GZO; or *Giperzvukovyye letatel'nyye apparaty*—

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[1] The author wishes to express his gratitude to the following individuals for reviewing and commenting on an earlier draft of this chapter: Douglas Barrie, Charles K. Bartles, Lester W. Grau, Gudrun Persson, Guy Plopsky and Bettina Renz.

[2] See: Dmitry (Dima) Adamsky, 'Russian Lessons Learned From the Operation in Syria: A Preliminary Assessment,' in Glen E. Howard and Matthew Czekaj (eds.), *Russia's Military Strategy and Doctrine*, Washington DC, 2019, pp.379–410; Michael Kofman and Matthew Rojansky, 'What Kind of Victory for Russia in Syria?' *Military Review*, https://www.armyupress.army.mil/Journals/Military-Review/Online-Exclusive/2018-OLE/Russia-in-Syria/, https://www.armyupress.army.mil/Journals/Military-Review/Online-Exclusive/2018-OLE/Russia-in-Syria/, January 24, 2018.

GZLA) into the military's inventory.[3] These systems, while new in the sense that such capabilities have heretofore been absent in the Armed Forces, actually appear to be an extension of Russian pursuits in precision strike, though covering both nuclear and conventional capabilities.

In general terms, hypersonic missiles will provide Russia's Armed Forces with strike options against an array of potential targets, easily overcoming enemy air defenses. Specifically, the conventional variants of these systems offer a more readily usable strike option in any conflict with a peer adversary since these stop short of escalation to nuclear conflict. Of course, Russia is not alone in seeking to develop and procure such highly advanced missile systems, with active work in this field ongoing in the United States and China.[4] The reemergence of Russia as one of the leading military powers in the world is clear from its successful military modernization across a number of broader areas, yet entering the elite club of countries with such hypersonic capabilities raises numerous policy-related questions about Moscow's future defense posture. Russia's hypersonic missile capability will steadily develop over the course of the next decade and beyond; but it is worth examining from a Russian military perspective the potential value of such weapons and where they fit into strategy and doctrine.

In scholarly precise terms, hypersonic capacity can include all spacecraft, including recoverable spaceplanes, or the warheads, known as hypersonic glide vehicles (HGV) of intercontinental ballistic missiles (ICBM) in the final segment of their flight path. However, their military applications can be divided into two main categories. The first is the hypersonic element of a ballistic missile,

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[3] Hypersonic speeds are those that exceed Mach 5 (five times the speed of sound).

[4] 'Hypersonic Weapons: Background and Issues for Congress,' Washington DC: Congressional Research Service, https://sgp.fas.org/crs/weapons/R45811.pdf, October 19, 2021.

which has a complex trajectory and creates new opportunities to overcome missile defenses and to create high-precision non-nuclear systems. The second is hypersonic air- and sea-launched cruise missiles.[5]

The following chapter examines Russia's hypersonic weapons program from the perspective of how this is viewed by the senior military leadership as adding value to existing military capabilities. It will address how hypersonic weapons systems fit into Russian military strategy, exploring these issues through the writings of senior Russian military officers and military theorists. This approach necessitates outlining the type of systems under development, considering the utility of the conventional application of hypersonic weapons along with how Russian officers perceive these and discuss such capabilities.

Hypersonic Systems as Nuclear or Conventional Weapons

Russian President Vladimir Putin used his annual address to the Federal Assembly (upper chamber of parliament) on March 1, 2018, to highlight advances in the country's hypersonic missile systems.[6] The hypersonic systems to which Putin referred were soon characterized as *superoruzhie* (super weapons). Indeed, Putin's statements on such systems, and the implied advances of the domestic defense industry to manufacture such missile systems covering nuclear and conventional strike capabilities, not only displayed growing confidence in the Russia's burgeoning military capability but the belief that Moscow is ahead of foreign competitors in this field. The role of such systems in the strategic thinking and planning of Moscow's political-military leadership will continue to expand in the

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[5] '*Po tu storonu sverkhzvuka voyennyye konstruiruyut giperzvukovoye oruzhiye*,' Lenta.ru, https://lenta.ru/articles/2016/11/12/hypersonic/, November 12, 2016.

[6] Vladimir Putin, '*Poslaniye Prezidenta Federal'nomu Sobraniyu,*' Kremlin.ru, http://kremlin.ru/events/president/news/56957, March 1, 2018.

future as these systems enter service, with their range and accuracy to strike targets enhanced by the long-term aim to extend the range and scope of battlefield sensors. It marks Russia's further advance into high-precision strike capability, which will greatly enhance its overall deterrence—both nuclear and non-nuclear—as well as offer additional options to target enemy forces at depth.[7]

Unsurprisingly, Putin repeated his references to these systems in his address to the Federal Assembly on February 20, 2019, in the context of Washington's decision, announced on February 2, to suspend the United States' participation in the 1987 Intermediate-Range Nuclear Forces (INF) Treaty. Thus, Putin again warned potential adversaries about Russia's development of new weapons capable of overcoming any air- or ballistic-missile-defense systems. Yet he seemed to exude renewed confidence in the capacity of the domestic defense industry to develop and deliver these modern systems to the Armed Forces.[8] The political-military leadership was essentially cashing in on Putin's political message, simultaneously denying that existing systems violated the terms of the INF Treaty, while stressing that, in the future, new Russian hypersonic weapons would be impossible to defend against.

The INF Treaty bans ground launched intermediate-range (defined as 500–5,500 kilometers) ballistic and cruise missiles as well as their associated launch vehicles . In the aftermath of Putin's statements, the North Atlantic Treaty Organization (NATO) issued an unusually tough response, noting that it considered Russian threats to targeted

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[7] *Ibid*.

[8] '*Otvet na ugrozu: nazvany tseli Tsirkona v SShA Ivan Apuleyev*,' Gazeta.ru, https://www.gazeta.ru/army/2019/02/24/12204421.shtml, February 24, 2019; '*V Rossii planiruyut razrabotat' nazemnyy Kalibr-M s dal'nost'yu 4,5 tys. Km*,' *Izvestia*, https://iz.ru/849163/2019-02-23/v-rossii-planiruiut-razrabotat-nazemnyi-kalibr-m-s-dalnostiu-45-tys-km, February 23, 2019.

allies unacceptable. NATO deputy spokesperson Piers Cazalet added that the Alliance wanted to avoid a new arms race and urged Moscow to return to abide by the terms of the INF Treaty before it would become void on August 1, 2019. In particular, Moscow would need to scrap its controversial 9M729 cruise missiles, which, according to Western assessments, were in breach of the INF—an assertion that Moscow denied.[9]

While much of the focus on the Russian violations of the INF centered on the 9M729 cruise missiles, these were really only part of the issue; many of the Russian systems in development or close to procurement flagrantly violated the treaty's terms. One illustration of this is the planned variant of the Kalibr family of cruise missiles, designated as Kalibr-M, which, reportedly, would be capable of striking targets at up to 4,500 km. Reportedly, Moscow plans to develop the Kalibr-M both in ground-launched and sea-launched cruise missile (GLCM, SLCM) variants.[10]

Of course, Moscow's interest in the military application of hypersonic technology was already advancing in the late Soviet era. In the second half of the 1980s, NPO Mashinostroyenia (in Reutov, Moscow region) developed the Albatros missile system. In part, this program pursued the creation of a cruise missile warhead capable of performing an evasive maneuver to overcome enemy air defenses.[11] Also in the 1980s,

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[9] '*V NATO prokommentirovali poslaniye Putina Federal'nomu Sobraniyu*,' *Voyennoye Obozreniye*, Topwar.ru, https://topwar.ru/154373-v-nato-prokommentirovali-poslanie-putina-federalnomu-sobraniju.html, February 20, 2019.

[10] '*Rossiya perestroit Kalibr v otvet na vykhod SShA iz raketnogo dogovora*,' Lenta.ru, https://lenta.ru/news/2019/02/23/kalibr/, February 23, 2019.

[11] Older cruise missiles are hard to detect (vs ballistic) but move slowly (such as the Tomahawk) and can be shot down by aircraft. The newer generation of high-speed

Soviet research and development (R&D) on military hypersonic technology included work on the Kholod and Kholod-2, as well as the Igla systems. In parallel, they developed the Metorit strategic supersonic missile and the Kh-90 missile, known as the Hypersonic Experimental Aircraft (*Giperzvukovoy Eksperimental'nyy Letatelnyy Apparat*—GELA).[12]

In Putin's list of hypersonic weapons presented to the Federal Assembly in March 2018, only one these—the Kinzhal—was sub-strategic (range less than 5,500 km).[13] In an analysis of Russian hypersonic missile systems, Richard Connolly, the director of the Eastern Advisory Group and an associate fellow at the Royal United Services Institute (RUSI), outlined the characteristics of these hypersonic systems. These are worth detailing to distinguish between the nuclear and the dual use systems:[14]

- *Sarmat*—The inclusion of the RS-28 Sarmat intercontinental ballistic missile (NATO reporting name SS-X-29 or SS-X-30) in Putin's speech in 2018 was no surprise to analysts. The super-heavy, liquid-fueled ICBM has been under development by the Makeyev Rocket Design Bureau since

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cruise missile are hard to detect and difficult for air-defense systems to counter in the best of circumstances.

[12] '*Po tu storonu sverkhzvuka voyennyye konstruiruyut giperzvukovoye oruzhiye*,' Lenta.ru, https://lenta.ru/articles/2016/11/12/hypersonic/, November 12, 2016.

[13] The Kinzhal is not a hypersonic glide vehicle or cruise missile, but a maneuverable ALBM (Air-Launched Ballistic Missile). Due to its hypersonic speed it is included in the analysis of Russia's hypersonic weapons systems. ALCMs and ALBMs were not subject to the 1987 INF Treaty.

[14] Richard Connolly, 'Putin's 'Super-Weapons," in Samuel Bendett (et.al.), Advanced military technology in Russia Capabilities and implications, London: Chatham House, September 2021, pp.23–33.

2009. The Sarmat is expected to replace the Soviet-era RS-36M Voevoda (SS-18 Satan) in the Uzhurskaya and Dombarovskaya divisions of the Strategic Missile Forces of the Russian Federation (*Raketnye Voyska Strategicheskogo Naznacheniya*—RVSN). Successful launch tests were carried out in 2020 and, by February 2021, preparations were under way for flight tests at the Severo-Yenisei test site. According to the commander of the Strategic Missile Forces, Colonel-General Sergey Karakaev, the new missile should enter service in 2022 with the 62nd Missile Division based at Uzhur (Krasnoyarsk region), where the construction of new facilities to house the missile is under way.

- *Avangard*—The Avangard missile system combines the old and the new: the old in the form of a Soviet-era RS18A (SS-19 Stiletto) ICBM, and the new being a Yu-71 hypersonic glide vehicle (HGV). The Avangard system emerged after the Soviet-era Albatross research project to develop an HGV was resurrected, following the US withdrawal from the Anti-Ballistic Missile (ABM) Treaty in 2002. After a number of unsuccessful trials during the 2010s, several efficacious tests took place over the course of 2015–2016. The most recent test occurred in December 2018, after President Putin's "super weapons" announcement in March of that year. The first two Avangard systems were placed on active duty at the end of 2019. Russian officials have also expressed the hope that enough Avangard systems will be produced to fully equip two missile regiments (approximately 18–20 missiles in total) by the end of the State armaments Program (*Gosudarstvennaya Programma Vooruzheniya*—GPV) to 2027.

- *Poseidon*—The existence of the Poseidon nuclear-armed, unmanned underwater vehicle (UUV) was first revealed publicly in November 2015, when broad details became available in the form of program schematics photographs at a Ministry of Defense meeting. Initially known as the Oceanic Multipurpose System Status-6—or simply as Status-6—it was characterized as a large, autonomous (i.e. crewless) and fast (i.e. with a reported speed of around 70 knots) nuclear-tipped torpedo. After the system was renamed the Poseidon in 2018 by a public poll, Putin and other defense officials steadily revealed more information about both the system and its intended role. According to the Russian president, the Poseidon is a multi-purpose UUV that "can carry either conventional or nuclear warheads, which enables them to engage various targets, including aircraft [carrier] groups, coastal fortifications and infrastructure." It is also powered by a miniature nuclear reactor, giving it an unlimited range (in practical terms). The Poseidon is also reported to be capable of diving to depths of up to one kilometer, rendering it safe from existing manned submarines.

- *Burevestnik*—Of the four strategic systems unveiled by Putin in 2018, the least is known about the 9M730 Burevestnik [Petrel] (SSC-X-9 'Skyfall') ground-launched, nuclear-powered cruise missile. When Putin publicly revealed the program in 2018, he stated that the novelty and operational utility of the Burevestnik is in its unlimited (in practical terms) range, which would enable the missile to evade any adversary's air defense systems. The missile might also be much more difficult to detect,[15] principally because its unlimited range would permit it to fly at low altitudes throughout its journey. By contrast, the range of other, conventionally powered, cruise missiles—such as the US Tomahawk and Russian Kalibr families, powered by

[15] It may be emitting a lot of radiation.

> turbojets or turbofans—is curtailed the longer they fly at low altitudes.[16]

As Connolly notes, most of these systems have been in development for quite some time, with little known about the Burevestnik. On the Kinzhal sub-strategic hypersonic missile system, Connolly summarizes:

> - *Kinzhal*—The 9-S-7760 Kinzhal (Dagger) air-launched ballistic missile (ALBM) was the only sub-strategic system unveiled by Putin in 2018. It is a modified variant of the 9M723 Iskander ground-launched ballistic missile but is launched by the MiG-31K missile carrier—a modified version of the MiG-31 Foxhound interceptor.[17] The MiG-31K is used to launch the missile at high (i.e. supersonic) speed, thereby boosting the speed of the Kinzhal. The Kinzhal, therefore, like the Iskander, follows an aero-ballistic flight profile. According to Putin, the Kinzhal eventually reaches a speed of Mach 10 and is capable of maneuvering throughout all phases of its flight trajectory. It is reported to possess a range of around 2,000 km from the point of release from the MiG-31K. It has also been reported that the Kinzhal will be launched from the supersonic Tu-22M3M Backfire bomber that is under development and, further in the future, the Su-57 Felon fifth-generation fighter aircraft.[18]

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[16] *Ibid*.

[17] The MiG-31s converted into the MiG-31K are the MiG-31D3 variant.

[18] Connolly, 'Putin's 'Super-Weapons," *Op.Cit*. Although tests of the Kinzhal linked the missile with the Su-57 as the platform that will carry the weapon, it remains questionable given the size. The Russian press has also mentioned a different, smaller hypersonic weapon in development that will be carried by the Su-57 among other platforms. Smaller hypersonic missiles include the Lichinka-MD and OKR Gremlin hypersonic projects.

Consequently, most of the systems referred to by Putin in his March 2018 address to the Federal Assembly relate to modernizing the country's nuclear deterrent and by exploiting hypersonic capability to ensure its longer-term strike capability.[19] Among the sub-strategic systems in the hypersonic category, two stand out in particular and have attracted greater attention based on public statements by the political-military leadership and tests, these are the Kinzhal and the Tsirkon.[20] Beyond modernizing the nuclear deterrent by adding hypersonic systems, conventionally armed hypersonic systems such as the Kinzhal and Tsirkon offer further standoff strike capability, and they appear to signal a longer-term shift in Russian military strategy toward fostering an element of preemption in conventional warfighting.[21]

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[19] Putin, '*Poslaniye Prezidenta Federal'nomu Sobraniyu,' Op.Cit.*

[20] In October 2021 the Russian daily *Izvestia* reported work on the new hypersonic missile for the Su-57, the Lichinka-MD. This hypersonic system would eventually replace the Kh-31 supersonic anti-ship missile. The Lichinka-MD entered its second stage of development in 2019. The lead developer is Tactical Missile Armament Corporation. "Product 70" is used as an engine in the rocket, in development by the Soyuz machine-building design bureau, which specializes in engines for super-high-speed missiles. In 2019, Deputy Defense Minister Alexei Krivoruchko announced the development of a promising anti-ship missile for the Su-57. Work on the active homing head was being carried out by the Ural Design Bureau Detal. Anton Lavrov, Aleksei Ramm, '*Giperzvuki Su: rossiyskiye voyennyye poluchat kompaktnuyu raketu*,' *Izvestia*, https://iz.ru/1231901/anton-lavrov-aleksei-ramm/giperzvuki-su-rossiiskie-voennye-poluchat-kompaktnuiu-raketu, October 7, 2021.

[21] In addition to the Tsirkon and Kinzhal, some of the smaller air-launched hypersonic missiles (and possibly larger ones too) currently under development are likely to be conventionally armed (or dual-use) weapons. For example, the Lichinka-MD.

Kinzhal and Tsirkon as Standoff Strike Systems

The 9-S-7660 Kinzhal nuclear-capable air-launched ballistic missile can also be armed with a conventional, high-explosive fragmentation warhead. The Kinzhal was first tested using a MiG-31D3, in the Southern Military District (MD) in March 2018. In addition to its hypersonic capability, the Kinzhal flies at the stratosphere boundary to minimize air resistance and is specially designed to evade enemy air defenses. Moreover, the weapon offers improved high-precision targeting and has the ability to perform evasive maneuvers at every stage of its flight. It can be launched from Tu-22M3 bombers or MiG-31K interceptors. The ALBM's overall weight and characteristics compelled the defense ministry to specially modernize the existing MiG-31D3 to the MiG-31K. The newer MiG-31K interceptor has more advanced onboard equipment, an increased fuel supply, and superior communications equipment to facilitate the receipt of target designation data. These changes forced the Aerospace Forces (*Vozdushno Kosmicheskikh Sil*—VKS) to redevelop the methodology for the combat use of the MiG-31K and to retrain its pilots. The MiG-31K accelerates to Mach 2.3 to provide the Kinzhal with the necessary launch speed, allowing the hypersonic ALBM to accelerate up to Mach 10. With its alleged 2,000 km range, the Kinzhal avoids requiring the MiG-31K to enter the coverage area of enemy air defenses.[22]

In May 2020, the VKS began preparing to create a MiG-31K regiment in the Siberian city of Kansk, (Central Military District) that would be fully equipped with Kinzhal. The training of flight crews was scheduled to commence in late 2021, with the switch to the new

[22] Roman Kretsul, Bogdan Stepovoy, '*Kinzhal'naya vataga: v Sibiri poyavitsya polk s giperzvukovymi raketam*i,' *Izvestia*, https://iz.ru/986304/roman-kretcul-bogdan-stepovoi/kinzhalnaia-vataga-v-sibiri-poiavitsia-polk-s-giperzvukovymi-raketami, May 10, 2020; Timur Alimov, '*Raketu Kinzhal vpervyye ispytali v Arktike*,' *Rossyiskaya Gazeta*, https://rg.ru/2019/11/30/raketu-kinzhal-vpervye-ispytali-v-arktike.html, November 31, 2019.

weapons systems complete by 2024. The preparations at the VKS base in Kansk was designed as a model for equipping other VKS regiments. However, the location itself confirms the strategic importance of the new hypersonic missile system and its importance to the VKS. Introducing the Kinzhal to the VKS regiment in Kansk offers the capability to cover potential aerial threats in all strategic directions across the Russian Federation. The commander of the Central MD, Lieutenant General Alexander Lapin, stated that the rearmament of the fighter regiment with hypersonic missile systems is scheduled for completion in 2024.[23]

Moscow-based Russian military expert Vladislav Shurygin highlighted the selection of Kansk and its strategic importance: "The place of this deployment was chosen as rationally as possible. From Siberia, MiGs with a long flight range can be thrown to the north, south, west or east of the country. The situation in all these areas cannot be called calm. In particular, after the withdrawal of the American army from Afghanistan, the situation in Central Asia, where militants will come, may worsen. In the Far East, we have unresolved territorial disputes with Japan. There are disagreements in the Arctic with a number of NATO countries over the use of the Northern Sea Route. Hypersonic missiles will certainly cool any hotheads."[24]

Plans call for the Kinzhal-equipped regiment in Kansk to eventually be protected by the S-350 Vityaz surface-to-air missile (SAM) system,

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[23] Kseniya Murasheva, '*V Rossii poobeshchali sozdat' polk s giperzvukovym oruzhiyem V Sibiri*,' Ferra.ru, https://www.ferra.ru/news/techlife/v-rossii-poobeshali-sozdat-polk-s-giperzvukovym-oruzhiem-10-05-2020.htm, May 10, 2020; Kretsul, Stepovoy, '*Kinzhal'naya vataga: v Sibiri poyavitsya polk s giperzvukovymi raketam*i,' *Op.Cit*.

[24] Kretsul, Stepovoy, '*Kinzhal'naya vataga: v Sibiri poyavitsya polk s giperzvukovymi raketam*i,' *Op.Cit*.

which will be put into service in another city in Krasnoyarsk Territory, Achinsk, by the end of 2025. Shurygin explained, "The MiG-31K with Kh-47M2 [sic][25] missiles must be reliably covered by air-defense systems. The S-350 will meet enemy aircraft and cruise missiles on the far approaches to the airfield. The Pantsir-S1, armed not only with anti-aircraft missiles but also with an artillery mount, will cover the MiG-31 and finish off the enemy that has broken through." The Kinzhal hypersonic missile system will be an invaluable asset for the VKS, providing high-precision strike or nuclear options. The refitted MiG-31K has been modernized to suit the new air-launched ballistic missile. Over a three-year period, the regimental flight crews will be trained, doubtless drawing on the experience of testing the ALBM in the Southern MD and in November 2019 over the Arctic, before this advanced system is fully functional in Central MD.[26]

Moscow is modernizing and increasing its high-precision strike systems, partly reflecting the drive to implement the pre-nuclear deterrence element contained in its 2014 Military Doctrine, as well as due to these arms control treaties proving moribund.[27] The context provides an explanation as to why the Russian leadership places such emphasis upon hypersonic systems: Moscow can, in part, present those new weapons as capable of overcoming "any" foreign missile-defense systems. The Tsirkon 3M22 is one of the systems at the forefront of this process, in addition to the maritime-based variants of the Kalibr cruise missiles. The political-military leadership claims the

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[25] Kh-47M2 is an erroneous designation for the Kinzhal. Kinzhal is the name of the entire weapons system (designated 9-A-7660), while 9-S-7660 is the designation of its hypersonic missile.

[26] Kretsul, Stepovoy, '*Kinzhal'naya vataga: v Sibiri poyavitsya polk s giperzvukovymi raketam*i,' *Op.Cit*.

[27] *Voyennaya doktrina Rossiyskoy Federatsii*, https://rg.ru/2014/12/30/doktrina-dok.html, December 30, 2014.

Tsirkon can reach speeds of up to Mach 9, and has a strike range of 1,000 km.[28]

On March 2, 2019, *TASS* reported that the Russian navy, the Military-Maritime Fleet (*Voyenno-Morskoy Flot*—VMF), planned further test firing of the new 3M22 Tsirkon: designated in the Russian media as a scramjet-powered, maneuvering, anti-ship, hypersonic cruise missile. A sea-based test firing from a surface vessel was scheduled for late 2019, with a submarine launch intended early in 2020. Earlier tests of the Tsirkon were conducted mainly from coastal areas. The test launch in late 2019 involved the Project 22350 frigate *Admiral Gorshkov*, from the Northern Fleet.[29] The Tsirkon will be procured by the VMF as a hypersonic cruise-missile system designed for naval surface vessels and submarines, able to attack both ships and ground targets. Submarine test launches involved the newest multi-purpose nuclear submarine, the Project 885M Kazan. These submarine launches rehearsed strikes on sea- and ground-based targets.[30]

Moscow's political-military leadership places growing emphasis on long-range standoff precision strike systems as a key element in its ongoing modernization program. This has involved modernizing the weapons inventory in the VMF with Kalibr cruise missiles.[31] Such

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[28] '*VMF i Tsirkon: soveshchaniye proshlo v rezhime sekretnosti*,' *Vesti*, https://www.vesti.ru/article/1273994, December 2, 2019.

[29] '*Raketu Tsirkon ispytayut s fregata Admiral Gorshkov v kontse 2019 goda*,' *Izvestia*, https://iz.ru/855180/2019-03-12/raketu-tcirkon-ispytaiut-s-fregata-admiral-gorshkov-v-kontce-2019-goda, March 12, 2019.

[30] '*Istochnik: rossiyskaya atomnaya podlodka Kazan v 2020 godu vpervyye vystrelit Tsirkonom*,' *TASS*, https://tass.ru/armiya-i-opk/6232214, March 19, 2019.

[31] '*Krylatyye rakety Kalibr budut ustanavlivat' na podlodki proyekta 971*,' TsAMTO, http://www.armstrade.org/includes/periodics/news/2016/0321/105534041/detail.shtml, March 21, 2016; Aleksandr Sharkovskiy, '*Pal'miroy pozhertvovali radi polnogo osvobozhdeniya Aleppo*,' *Nezavisimoye Voyennoye Obozreniye*,

advances in standoff strike capabilities complement efforts to strengthen "pre-nuclear" deterrence and offering additional conventional capabilities.[32] One emerging pattern is to equip Russia's naval forces with the latest Tsirkon hypersonic cruise missile system. In June 2020, the defense ministry announced that these strike systems would be placed onboard the newest frigates entering service in the Pacific Fleet. Nevertheless, like the effort in recent years to boost the strike capability of the VMF by mounting the Kalibr cruise missile system on surface ships, the plans for the Tsirkon include both frigates and submarines, which will extend across several of the VMF fleets.[33]

The Pacific Fleet was consequently earmarked to receive three new Project 22350 frigates by 2025; each of these will be armed with the Tsirkon missile system. The defense ministry plans the first of these, the *Admiral Amelko*, to arrive in the Pacific Fleet in 2023, with the additional two frigates entering service in 2025. This forms part of a wider plan to introduce Tsirkon-capable frigates in other fleets. A total of eight such frigates are planned, with three ships each for the Pacific and Northern Fleets and two for the Black Sea Fleet. The final four of these frigates will be fitted with 24 vertical launchers instead of the standard 16. The eight "Admiral" series of frigates are tasked with naval grouping protection, communications and counter-terrorism as well as peace-support missions and functions. Their armament allows them to offer air defense for other ships, support amphibious landing,

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http://nvo.ng.ru/wars/2016-12-16/1_930_palmira.html, December 16, 2016; Nikolay Poroskov, '*Oruzhiye pryamogo popadaniya*,' *Nezavisimoye Voyennoye Obozreniye*, http://nvo.ng.ru/armament/2016-11-25/8_927_weapon.html, November 25, 2016; Oleg Vladykin, '*Dlya chego nuzhny podlodki u beregov Sirii*,' *Nezavisimoye Voyennoye Obozreniye*, http://www.ng.ru/armies/2016-10-31/1_6849_siria.html, October 31, 2016.

[32] '*Rossiyskiy giperzvukovoy Tsirkon udarit iz-podo l'da*,' https://lenta.ru/news/2020/06/03/zirkon, Lenta.ru, June 3, 2020.

[33] *Ibid*.

and to strike various land and sea targets. They will be built using stealth technology, incorporating the most advanced composite materials, with an overall effort to reduce their radar visibility.[34]

Although the estimated range of the Tsirkon may be up to 1,000 km, reported test launches from naval platforms to strike ground targets appear more limited to around 500 km. In January 2020, *Admiral Gorshkov* launched the Tsirkon from the Barents Sea to strike a ground target at a training facility in the Northern Urals.[35] The Tsirkon will prove to be a significant boost to the VMF, since this missile's hypersonic speed would likely overwhelm most air-defense systems.

The defense ministry's plans to introduce the Tsirkon system also extends to Project 885 and 885M nuclear submarines, with reports that these will be capable of firing from under the ice. While some sources link this test to the Tsirkon, it is likely that it represents a prototype test, with the official testing for such submarine launches still more than two years away. In December 2019, the Severodvinsk (Project 885) allegedly carried out test launches of the Tsirkon from under the ice in the Arctic region. According to Deputy Defense Minister Alexei Krivoruchko, the Tsirkon is intended for Project 885, 885M and 949AM submarines, Project 22350 and 23560 surface ships, as well as the Project 1144.2 guided-missile cruiser *Admiral Nakhimov*. Krivoruchko additionally confirmed plans to develop a ground-based version of the system. Boris

[34] Aleksei Ramm, Bogdan Stepovoy, "*Sdat' Kazan: noveyshuyu podvodnuyu lodku gotovyat k gosispytaniyam*,' *Izvestia*, https://iz.ru/1021748/aleksei-ramm-bogdan-stepovoi/sdat-kazan-noveishuiu-podvodnuiu-lodku-gotoviat-k-gosispytaniiam, June 10, 2020.

[35] Aleksei Ramm, Roman Kretsul, Bogdan Stepovoy, '*Prikaz Admiralam: fregaty s Tsirkonami usilyat Tikhookeanskiy flot*,' *Izvestia*, https://iz.ru/1019812/aleksei-ramm-roman-kretcul-bogdan-stepovoi/prikaz-admiralam-fregaty-s-tcirkonami-usiliat-tikhookeanskii-flot, June 4, 2020.

Obnosov, the general director of the Tactical Missile Weapons Corporation, explained that the Tsirkon advances in standoff strike systems are part of "several dozen" hypersonic projects currently in development.[36]

Preparation for the introduction of such hypersonic weapons systems into service in the VMF extends to linking automated naval command and control (C2) to these strike capabilities.[37] In early August 2021, Russia's Northern Fleet staged a large naval exercise in the northeastern Atlantic, in which it again tested the Tsirkon 3M22 hypersonic cruise missile system. The Tsirkon 3M22 will be procured for surface ships and submarines in 2022. However, the exercise not only tested the Tsirkon, it carried out an innovative trial of a new naval automated control system (*avtomatizirovannoy sistemy upravleniya*—ASU); the reported results of this combination of automated (C2) and hypersonic strike systems mark an exponential increase in Russia's maritime and non-contact standoff strike capabilities.[38]

The Northern Fleet exercise focused on testing the new naval ASU, integrating maritime and aviation assets to facilitate, in real time, a rehearsed attack on enemy shipping. The missile launches involved

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[36] '*Rogozin prokommentiroval slova Trampa o razrabotke 'super-puper-rakety*,'' RIA Novosti, https://ria.ru/20200516/1571530426.html, May 16, 2020; Vlad Kozlovskiy, 'V*MS Rossii mogut poluchit' giperzvukovyye rakety Tsirkon v 2020 godu*,' Profile.ru, https://profile.ru/news/protection/army/vms-rossii-mogut-poluchit-giperzvukovye-rakety-cirkon-v-2020-godu-306956/, May 10, 2020.

[37] The Northern Fleet conducted more than twelve test launches of the Tsirkon missile system in 2021 from surface and sub-surface platforms. '*Boleye 70 ispytaniy novogo vooruzheniya, v tom chisle giperzvukovogo raketnogo oruzhiya Tsirkon i Kinzhal, obespechil Severnyy flot v 2021 godu*,' https://function.mil.ru/news_page/country/more.htm?id=12401326@egNews, Russian defense ministry, December 31, 2021.

[38] '*Khvatit odnoy rakety. Rossiyskiy flot vooruzhat ubiytsey avianostsev*,' *RIA Novosti*, https://ria.ru/20210827/tsirkon-1747385601.html, August 27, 2021.

the nuclear submarine *Orel*, the cruiser *Marshal Ustinov* and the frigate *Admiral of the Fleet Kasatonov*. Two crews of Tu-142 reconnaissance and anti-submarine aircraft transferred data about the hypothetical enemy to the command, and they also launched a strike at a distance of hundreds of kilometers from the target.[39] The ASU unified the C2 with the processes of intelligence, surveillance and reconnaissance (ISR) to offer real-time operational capability in target acquisition and executing the attack. In addition to receiving ISR from aircraft, the ASU obtains data collected by ground-based radars, satellites and unmanned aerial vehicles (UAV). The naval ASU offers the capability to enhance the speed of decision-making in the use of the Tsirkon 3M-22, and it also functions equally well with other precision-strike systems, such as the Kalibr, Vulkan or Yakhont.[40]

Flying at distances of hundreds of kilometers from both the command and potential targets, the Tu-142 aircraft transmitted information about enemy locations. Meanwhile, according to defense ministry sources, the ASU itself identified the most important targets and "decided" how to destroy them. Russian military experts see this ASU development as greatly enhancing the firepower, speed of target acquisition, and destruction of maritime targets—clearly boosting the capabilities of the VMF.[41]

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[39] '*V khode masshtabnykh ucheniy Severnogo flota proveli ispytaniya avtomatizirovannoy sistemy upravleniya aviatsiyey i korablyami*,' *Moskovsky Komsomolets*, https://murmansk.mk.ru/social/2021/08/26/v-khode-masshtabnykh-ucheniy-severnogo-flota-proveli-ispytaniya-avtomatizirovannoy-sistemy-upravleniya-aviaciey-i-korablyami.html, August 26, 2021.

[40] *Ibid.*

[41] Anton Lavrov, Anna Cherepanova, '*Tselevoy ukazatel: Tsirkony poluchili sverkhdal'neye navedeniye*,' *Izvestia*, https://iz.ru/1210911/anton-lavrov-anna-cherepanova/tcelevoi-ukazatel-tcirkony-poluchili-sverkhdalnee-navedenie, August 23, 2021.

Russian defense ministry officials contend that the innovation in the use of the naval ASU lies in detection as well as the system's involvement in target selection. Indeed, reporting on the conduct of the exercise strongly implied a role for artificial intelligence (AI), as the various assets were brought together throughout the automated C2, while the system itself "selected" the targets. The ASU was designed principally for use with the Tsirkon 3M22: together they make a highly potent combination. Since tests began on the Tsirkon 3M22, the VMF leadership has looked to these among other hypersonic systems to radically boost maritime capability. However, integrated with the new naval ASU, these systems will play a much greater role in Russian military operational capability and in deterrence.[42]

Russia's Defense Minister Sergei Shoigu, referring to the testing of Tsirkon missiles, claimed that these had demonstrated the highest accuracy with launches at sea targets, leaving "no chance for the enemy." Deputy Defense Minister Alexei Krivoruchko also confirmed that the state tests were planned to be completed in 2021 and would begin serial deliveries in 2022. "Russia was the first in the world to receive hypersonic weapons, and a new ASU is needed to fully reveal all of its strengths," according to military expert Vladislav Shurygin, who added, "At the same time, it will also receive information from radars and satellites. After detecting a target, hypersonic speed makes it possible to hit it in a matter of minutes, even at a distance of hundreds of kilometers. During the flight time, the ships simply will not have time to go far."[43]

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[42] *Ibid.*

[43] *Ibid.*

Strategy of Active Defense

Since President Putin's speech to the Federal Assembly in March 2018, announcing Moscow's ambitions and intentions to introduce a range of hypersonic weapons systems into the country's military inventory, speculation has been rife within Western analytical circles as to the purpose underlying such efforts to strengthen Russia's nuclear and conventional strike capabilities. It is important to understand how the political-military leadership perceives such weapons systems and their potential role across the range of Russian military capabilities, including boosting nuclear pre-nuclear deterrence. Additional key analytical questions include what prompted such an agenda and where these systems fit into Russian military thought.[44] A crucial element, therefore, in this quest to untangle the role played by hypersonic strike systems, especially those with conventional application potential, necessitates distinguishing between the rhetoric and speculation as well as identifying how the military leadership thinks about such weapons systems. How do these new weapons systems fit existing Russian military thought? Are these systems simply an extension of conventional standoff strike capability? Or do they also play a role in a potentially innovative development within Moscow's approaches toward warfare generally. Finally, do these weapons play a role within doctrinal foundations that may influence or play a part in General Staff thinking in future conflicts?

In an effort to contextualize the potentially innovative role assigned to such weapons systems in the future—and considering how Moscow might exploit such additional capabilities—it is important to place this in the setting of Russian military strategy. In turn, this is heavily

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[44] I.N Vorobyev and V.A. Kiselev, '*Otechestvennaya voennaya teoriya: istoriya i sovremennost,' Voyennaya Mysl'*, No. 3, 2010, pp.43–49; Vorobyev I.N, Kiselev V.A, '*Evolyutsiya printsipov voennogo iskusstva*,' *Voyennaya Mysl'*, No. 8, 2008, pp.2–8.

connected with how technology may transform approaches to warfare and, therefore, impact upon the development of military strategy.[45] Moreover, in examining key concepts and defining how the General Staff leadership thinks about hypersonic strike capability, the question arises as to whether the procurement of these systems constitutes a new set of options at the disposal of the political leadership in a confrontation with a peer adversary. The starting point is military strategy and related derivative concepts.[46] "Military strategy" ("*voyennaya strategiya*") is defined in the Russian military encyclopedic dictionary as follows:

> An integral part of the art of war, its highest field, which includes the theory and practice of the military activity of the state. The provisions of military strategy are based on the results of assessing the state and directions of development of the military-political situation, scientifically grounded goals, principles, directions and tasks, objective needs and real possibilities for the functioning and development of the military organization of the state. Military strategy is closely related to the policy of the state, and is directly dependent on it. Politics set military strategy tasks, and the strategy ensures their implementation. Military strategy is formulated in relation to the military-strategic sphere of the setting of the state's military doctrine.
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> The main questions of the theoretical and practical aspects of military strategy are: the likely nature of wars and the military's

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[45] V.N. Gorbunov and S.A. Bogdanov, '*O kharaktere vooruzhennoi bor'by v XXI veke*,' *Voyennaya Mysl'*, No. 3, 2009, pp.2–14. Burenok V.M, *Tekhnologicheskie i tekhnicheskie osnovy razvitiya vooruzheniya i voennoi tekhniki*, Moscow: Granitsa, 2010; Burenok V.M, Ivlev A.A, Korchak V.Yu, *Razvitie voennykh tekhnologii XXI veka: problemy, planirovanie, realizatsiya*, Tver: Kupol 2009.

[46] S.N. Mikhalev, *Voyennaya strategiya: podgotovka i vedeniye voyn Novogo i Noveyshego vremeni*, *Kuchkovo pole*, 2003, pp. 949.

> ways of preventing them; the means, goals and objectives of the Armed Forces in war and in the military; actions of a strategic scale; the necessary funds for their maintenance; the content, methods and conditions for preparing and waging war in general and various forms of strategic actions; strategic planning of the use of the Armed Forces in war and strategic operations; the use of aircraft types in them; fundamentals of moral, psychological, technical and logistical support for the actions of the Armed Forces; leadership of the Armed Forces in the peaceful and military; time; development of strategic requirements for the construction of the Armed Forces, preparation of the economy, population and territory of the state for war; strategic views of the leading states and coalitions, their capabilities to prepare, unleash and conduct war and military operations of a strategic scale.[47]

Hypersonic weapons systems have strategic value for Russian military planners. In the references to these systems and the context in which they are being developed, it is clear that the General Staff leadership assigns strategic importance to these capabilities. However, following from Russian military strategy are key conceptualizations that appear to be similar but need clarification in order to try to address the question as to how the General Staff thinks about hypersonic weapons and especially those systems with a conventional application. Conceptually, these systems are closely tied to the strategy of active defense (*strategiya aktivnoy oborony*), which was referred to in his speech (and later article) by the chief of the General Staff, Army General Valery Gerasimov, addressing the annual conference of the Academy of Military Sciences (*Akademii Voyennykh Nauk*—AVN) in

[47] Russian military encyclopedic dictionary, https://encyclopedia.mil.ru/encyclopedia/dictionary/details.htm?id=14383@morfDictionary, accessed, September 5, 2021.

Moscow on March 2, 2019.[48] This concept, as will be seen, can easily be confused with the long-established and varied concept of "active defense" (*aktivnaya oborona*); but the two concepts are different.

In re-conceptualizing "active defense"' as a "strategy of active defense," Gerasimov may have been presenting his ideas in a format immediately identifiable and having resonance with his largely military audience during the AVN conference.[49] However, the way in which he added additional explanation around his use of the term, as well as closely relating this to the plans to develop and procure hypersonic weapons, left little room for doubt that he was outlining something new. As noted, the two concepts could be misread or misinterpreted as essentially the same—though they are not.[50] To be clear, the concept of "active defense," originating in the military thought of leading Russian imperial officers in the early 20th century, witnessed conceptual evolution in the course of Moscow's experience of military conflict throughout the century and more recently resurfaced with important meaning for operational-tactical and tactical planning.

Again, the Russian military encyclopedic dictionary offer the following definition:

> Active defense, in the historical literature, is a term denoting the defensive actions of one of the belligerents in order not only to hold territory, but mainly to exhaust and bleed large enemy forces. Active defense was used by Soviet troops during the Great

[48] Valery V. Gerasimov, '*Genshtab planiruyet udary*,' *Voyenno Promyshlennyy Kuryer,* https://vpk-news.ru/articles/48913, March 11, 2019.

[49] Author interviews with retired Russian officers via VTC, Moscow, October 6–7, 2021.

[50] *Ibid*.

> Patriotic War and consisted of firmly holding prepared lines (positions) in combination with counterstrikes and counterattacks, extensive use of anti-tank and other reserves. In the post-war period, the term is used only in historical literature; in modern conditions, the concept of defense activity is used to characterize defensive actions.[51]

The term "active defense" was written about in 1915, later going through modifications during the 1920 and 1930s, before emerging as a recognizable military concept during the Great Patriotic War (GPW, 1941–1945). It was denoted by military operations designed to exhaust large-scale enemy force groupings using active maneuver forces in the main counterattack. In some sources, its value lay in combining firepower of the first echelon formations and maneuver with reserves.[52] Soviet Marshal Mikhail Tukhachevsky criticized active defense, due to its offensive nature and alleged failure to meet the criteria implied in any transition to defensive actions (gaining time and pinning down the enemy). Tukhachevsky believed that active defense under such circumstances would prove to be unsuitable and instead called for organizing a conventional offensive. After 1945, the concept of "active defense" faded and was mainly used only in military-historical literature. However, the term reappeared in Russian military usage later in the Soviet era and survived the transition to the post-Soviet Armed Forces lexicon, albeit in altered application.[53]

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[51] Russian military encyclopedic dictionary, https://encyclopedia.mil.ru/encyclopedia/dictionary/details.htm?id=2748@morfDictionary, accessed, September 15, 2021.

[52] '*Aktivnaya oborona,' Sovetskaya voyennaya entsiklopediya, Voyennoye izdatel'stvo Ministerstva oborony Soyuza SSR*, Moscow, 1976. Vol.1, p.133; '*Aktivnaya oborona,' Bol'shaya sovetskaya entsiklopediya, A. M. Prokhorov (Ed), Bol'shaya sovetskaya entsiklopediya*, 1970. Vol.1, p.354.

[53] '*Aktivnaya oborona,' Voyennyy entsiklopedicheskiy slovar' A. P. Gorkin (Ed), Bol'shaya rossiyskaya entsiklopediya*, Moscow, 2001, Vol.1, p.45; '*Aktivnaya*

Indeed, "active defense" is a good example of how Russian-Soviet military concepts change over time, largely in response to the changing character of warfare. As such, "active defense" underwent revision from its earlier understanding and use during World War I, through the theoretical discussion among the leading Soviet officer military theorists in the 1920s and 1930s, with further change compelled by operational experience in the GPW, before reemerging more recently in contemporary Russian military theory. Thus, Lester W. Grau and Lieutenant Colonel Charles K. Bartles, in their 2016 book, *The Russian Way of War; Force Structure, Tactics, and Modernization of the Russian Ground Forces*, examined Russian combat manuals and military training materials to formulate how the concept of "active defense" is used in the modern Russian Armed Forces.

According to the authors, the characteristics of an "active defense" include that it:

- Places the enemy under constant fires;
- Creates unfavorable conditions for the enemy to conduct battle;
- Conducts extensive maneuver of forces and systems in the conduct of fires and assaults;
- Conducts defensive counterattacks.[54]

Achieving an active defense involves:

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oborona,' Voyennyy entsiklopedicheskiy slovar' raketnykh voysk strategicheskogo naznacheniya, I. D. Sergeyeva (Ed), *Bol'shaya Rossiyskaya entsiklopediya*, Moscow, 1999; M. N. Tukhachevskiy, *Oboborone*, Moscow: Voyenizdat, 1964, Vol.1, pp. 264.

[54] Lester W. Grau and Charles K. Bartles, *The Russian Way of War; Force Structure, Tactics, and Modernization of the Russian Ground Forces*, FMSO: Kansas, Fort Leavenworth, 2016, p.61.

- Careful organization of the means of nuclear and conventional fires to destroy the enemy and the skillful implementation of this during combat;
- Timely maneuver of forces and systems, fires and obstacles against a threatened axis;
- Jamming of enemy C2 systems, weapons and aircraft.[55]

This, in turn, leads to the use of two possible types of defense—positional defense and maneuver defense—with positional defense serving as the primary type. In author interviews with retired Russian military officers with experience of courses in the Combined Arms Academy in Moscow, they confirmed that the above outline of the "active defense" concept is how Russian officers use or understand the term today.[56]

Returning to Gerasimov's speech delivered at the annual AVN conference on March 2, 2019, it was additionally published in the official defense ministry publication, *Krasnaya Zvezda* (*Red Star*), *Voyenno Promyshlennyy Kuryer* (*Military Industrial Courier*) and republished in the official journal of the AVN, together with the 2019 conference papers.[57] All these speeches/papers were based on or

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[55] *Ibid*, p.62.

[56] Author interviews with retired Russian officers via VTC, Moscow, October 6–7, 2021.

[57] M.A. Gareev, '*Itogi deyatelnosti Akademii voyennykh nauk za 2018 god i zadachi akademii na 2019 god*,' (Results of the academy of military sciences activities in 2018 and the tasks of the academy for 2019), A.M. Tsyganov, '*Voyenno-politicheskiye aspekty stroitel'stva i razvitiya Vooruzhennykh Sil Rossiyskoy Federatsii na sovremennom etape,*' (Military and political aspects of construction and the development of the armed forces of the Russian Federation at the modern stage), A.A. Kokoshin, '*Perspektivy razvitiyavoyennoy tekhnosfery I Budushcheye voyn i neboyevogoprimeneniya voyennoy sily,'* (Development prospects of military technosphere and the future of wars and noncombat employment of military force), V.I. Ostankov, '*Kharakter sovremennykh voyennykh konfliktov i yego vliyaniye na voyennuyu strategiyu,*' (The nature of modern military conflicts and its effect on

linked to the theme of military strategy. Among the notable and eminent Russian military theorists, or defense academicians, were Andrei Kokoshin and Lieutenant-General Vladimir Ostankov. Kokoshin presented the paper "*Perspektivy razvitiyavoyennoy tekhnosfery Budushcheye voyn i neboyevogoprimeneniya voyennoy sily*," ("Development prospects of military technosphere and the future of wars and noncombat employment of military force"), and Ostankov, "*Kharakter sovremennykh voyennykh konfliktov i yego vliyaniye na voyennuyu strategiyu*," ("The nature of modern military conflicts and its effect on military strategy"). Ostankov is a leading military scientist at the Academy of the General Staff and is a former head of the General Staff think tank, the Center for Military-Strategic Research (*Tsentr Voyenno-Strategicheskikh Issledovaniy*—TsVSI).

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military strategy), A.A. Korabel'nikov, '*Vzaimosvyaz' voyennoy strategii, operativnogo iskusstva i taktiki v sovremennykh usloviyakh*,' (Interrelation between military strategy, operational art and tactics in modern conditions), S.R. Tsyrendorzhiyev, '*Osnovy kontseptsii obosnovaniya perspektivnogo oblika silovykh komponentov voyennoy organizatsii Rossiyskoy Federatsii*,' (Concept basis of justification of the perspective face of power military organization components of the Russian Federation), Ye.A. Derbin, '*O sovershenstvovanii strategicheskogo rukovodstva oboronoy Rossii*,' (About Improvement of the strategic leadership of Russian defense), T.S. Goreslavskiy, '*Torgovlya vooruzheniyami kak instrument politicheskogo vliyaniya na mezhdunarodnoy arene*,' (Weapons sales as a tool of political impact on the international scene), V.P. Kozin, '*Osobennosti negativnogo otnosheniya SShA k dogovoram v oblasti kontrolya nad vooruzheniyamii perspektivnaya reaktsiya Rossii s tochki zreniya ukrepleniya yeye natsional'noy bezopasnosti i strategicheskoy stabil'nosti*,' (Peculiarities of the US negative attitude to agreements in the field of arms control and perspective reaction of Russia from the point of view of its national security and strengthening strategic stability), V.P. Baronov, '*Bioterrorizm kak odno iz novykh napravleniy v budushchikh voynakh,*' (Bioterrorism is one of new directions/areas in future wars), S.V. Aksenov, '*Obespecheniye ustoychivosti gruppirovki strategicheskikh yadernykh sil v usloviyakh informatsionnogo protivoborstva,*' (Ensuring of the strategic nuclear forces grouping sustainability in the conditions of information warfare), V.G. Kazakov, '*Razvitiye operativnogo iskusstva i taktiki Voyenno-vozdushnykh sil v sovremennykh usloviyakh,*' (The development of operational art and tactics of the Air Force in modern conditions), *Vestnik*, No 2 (67), 2019, pp.6-72.

In this context, Gerasimov presented his paper to the AVN, *Razvitiye voyennoy strategii v sovremennykh usloviyakh. Zadachi voyennoy nauki* (Military Strategy Development in Modern Conditions: The tasks of Military Science).[58] Gerasimov addressed the theme of Russian military strategy in the context of the national threat perception, which raised issues of how the defense and security establishment see the potential threat to Russia's national security posed by the United States. Gerasimov stated, for example,

> The United States and its allies have determined the aggressive vector of their foreign policy. They work out military actions of an offensive nature, such as "global strike," [and] "multi-sphere battle," they use technologies of "color revolutions" and "soft power." Their goal is to liquidate the statehood of unwanted countries, undermine sovereignty, [and] change the legally elected bodies of state power. This was the case in Iraq, Libya and Ukraine. Currently, similar actions are being observed in Venezuela. The Pentagon has begun to develop a fundamentally new strategy of warfare, which has already been dubbed the "Trojan horse." Its essence lies in the active use of the "protest potential of the fifth column" in the interests of destabilizing the situation while simultaneously delivering VTO [high-precision weapons] strikes against the most important targets.[59]

Gerasimov then explained that in response to the posture adopted by the United States and its allies toward Russia, the country's military scientists and the General Staff had developed "conceptual approaches to neutralize the aggressive actions of potential adversaries." He declared the nature of this conceptual "response," as:

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[58] V.V. Gerasimov, '*Razvitiye voyennoy strategii v sovremennykh usloviyakh. Zadachi voyennoy nauki*,' *Vestnik*, No 2 (67), 2019, pp.6-11.

[59] *Ibid*.

> The basis of "our response" is the "strategy of active defense" [*strategiya aktivnoy oborony*], which, taking into account the defensive nature of Russian Military Doctrine, provides for a set of measures to preemptively neutralize threats [*uprezhdayushchey neytralizatsii ugroz*] to the security of the state.
>
> It is the justification of the measures being developed that should constitute the scientific activity of military scientists. This is one of the priority areas for ensuring the security of the state. We must stay ahead of the enemy in the development of military strategy—go "one step ahead."[60]

Significantly, Gerasimov later linked the "strategy of active defense" to hypersonic weapons systems:

> As a result, an urgent task in the development of military strategy is to substantiate and *improve measures of nuclear and non-nuclear deterrence*.[61] Any potential aggressor must understand that any form of pressure on Russia and its allies is futile.
>
> Our answer will not be long in coming. For this, modern weapons are being adopted and deployed, including fundamentally *new types of weapons*. Serial production of new types of weapons and equipping for the Armed Forces has begun. Avangard, Sarmat, the newest weapons Peresvet and Kinzhal have shown their high efficiency, the complexes Poseidon and Burevestnik are being successfully tested. Planned work is underway to create a sea-based hypersonic missile Tsirkon.

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[60] *Ibid*.

[61] Author's emphasis. *Ibid*.

> There is no doubt that in this area we are confidently leading in comparison with the technologically developed countries of the world. Thus, a decision was made to conduct scientific and design work to develop ground-based systems for medium- and shorter-range hypersonic missiles.[62]

Gerasimov made clear the linkage between the "strategy of active defense," which he rooted firmly in the 2014 Russian Military Doctrine, stressing that one of its elements is to "preemptively neutralize threats," with hypersonic weapons evidently envisaged as central to this. Since only the Kinzhal and Tsirkon have potential conventional application, it appears that these were what he had in mind in terms of preemption. However, Gerasimov also referred to future ground-based hypersonic weapons systems in both medium- and short-range versions.[63]

Some Western analysts soon picked up on the innovative nature of Gerasimov's use of the term "strategy of active defense." In late March, US defense analysts Dave Johnson published a commentary on Gerasimov's address to the AVN in the NATO Defense College Russian Studies Series. Johnson noted:

> According to General Gerasimov, current circumstances require Russia to continue to develop the forms and means of use of the Armed Forces for strategic deterrence and for the defence of the state. General Gerasimov said that Russia's response to current and foreseen threats is a "strategy of active defence" entirely in line with the defensive character of Russia's military doctrine. The strategy comprises "integrated means for the pre-emptive

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[62] *Ibid.*

[63] *Ibid.*

> neutralization of threats to the security of the state" and is guided by principles for:
>
> - Prevention of war: strategic foresight to enable timely response to emerging threats;
> - Preparation for war: includes maintaining constant high combat readiness and readiness for mobilization of the armed forces and creation of strategic reserves and stockpiles;
> - The conduct of war: on the basis of coordinated employment of military and non-military means acting on the basis of surprise, decisiveness, and continuity of strategic action.
>
> General Gerasimov went on to say, "acting quickly, we should preempt the enemy with our preventive measures, promptly identify his vulnerabilities and create threats of unacceptable damage to him. This ensures the capture and retention of the strategic initiative."[64]

Johnson identified the significance of Gerasimov's address to the AVN conference in 2019, examining the implications of the "strategy of active defense," underscoring the preemptive aspects, but interconnecting strategic foresight, preparing for and conducting war to the theme of gaining and maintaining the strategic initiative. The Norwegian defense analysts Maren Garberg Bredesen and Karsten Friis also noted the innovative element of Gerasimov's "strategy of active defense," and linked this to a response to the threat perception *vis-à-vis* the US and its allies:

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[64] Dave Johnson, 'General Gerasimov on the Vectors of the Development of Military Strategy,' Review of Speech by General Gerasimov at the Russian Academy of Military Science, Moscow, March 2, 2019, NATO Defense College, Russian Studies Series 4/19, https://www.ndc.nato.int/research/research.php?icode=585, March 30, 2019.

> Importantly, the active defense strategy— while presented as being a "defensive" response to Western political and military encroachment—foresees active, even anticipatory, use of military force based on prediction. The importance of such prediction and scenario-based thinking appears to be reinforced by concerns regarding the breakdown of international arms control regimes and the ensuing unpredictability in military-political affairs—all of which Gerasimov blames on Washington's unilateral actions. Thus, for Gerasimov, seizing and upholding the strategic initiative has become increasingly important. Maintaining this initiative involves a set of measures aimed at strategically deterring and preemptively neutralizing threats to Russian national security. Towards this end, Gerasimov urges the upgrading of nuclear and non-nuclear weapons. He also draws attention to the utility of precision-strike capabilities in targeting the enemy's critical nodes, such as decision-making centers and missile launchers.[65]

Garberg Bredesen and Friis drew attention to Gerasimov's assertion that maintaining the strategic initiative relies on a set of measures to strategically deter and preemptively neutralize threats to Russia's national security. In terms of hypersonic systems inflicting unacceptable damage on the adversary, this envisages targeting critical nodes, such C2 centers and enemy missile platforms.[66]

If there was any doubt concerning the distinction between the concept and term of "active defense" or "strategy of active defense," this was clarified by no less an authority than Colonel General Vladimir

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[65] Maren Garberg Bredesen, Karsten Friis, 'Missiles, Vessels and Active Defence: What Potential Threat Do the Russian Armed Forces Represent?' The RUSI Journal, https://www.tandfonline.com/doi/full/10.1080/03071847.2020.1829991, Vol.165, Issue 5–6, 2020.

[66] *Ibid.*

Zarudnitskiy, the head of the Academy of the General Staff. In the January 2021 issue of *Voyennaya Mysl'*, Zarudnitskiy published "Kharakter i soderzhaniye voyennykh konfliktov v sovremennykh usloviyakh i obozrimoy perspektive," ("The Nature and Content of Military Conflicts in Present-day Conditions and in the Foreseeable Future").[67] Zarudnitskiy almost summarized Gerasimov's earlier address to the AVN conference:

> Counteracting "multi-sphere" [*mnogosfernosti*][68] measures will require coordinated actions of the state in all spheres of confrontation within the framework of an active defense strategy [*strategii aktivnoy oborony*], which, taking into account the defensive nature of the Military Doctrine of the Russian Federation, should provide for complex measures to preemptively neutralize threats to state security.
>
> In connection with the increase in the spatial scope and multi-sphere of military operations, the issues of organizing and maintaining interaction and coordination of actions of multi-service and multi-departmental groupings of troops (forces) are emerging to the fore.[69]

Zarudnitskiy not only linked the "strategy of active defense" to preemption, but also tied this to Moscow's response to the US concept of multi-domain operations. What is unambiguous in these public statements by senior Russian military officers is that hypersonic

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[67] V.B. Zarudnitskiy, '*Kharakter i soderzhaniye voyennykh konfliktov v sovremennykh usloviyakh i obozrimoy perspektive*,' *Voyennaya Mysl'*, No.1, 2021, pp.34, 44.

[68] This is the Russian term for the US concept of multi-domain operations.

[69] Zarudnitskiy, '*Kharakter i soderzhaniye voyennykh konfliktov v sovremennykh usloviyakh i obozrimoy perspektive*,' *Op.Cit.*

weapons systems are considered tools of preemption, as well as playing a deterrence role.[70] Preemption as a theme was taken up in an article devoted to the subject in the December 2021 issue of *Voyennaya Mysl'*. Major General (reserve) Vyacheslav Kruglov, a professor and leading researcher at the defense ministry's Research Center for the Military Potential of Foreign Countries, and Colonel Aleksei Shubin, a department head and professor of the defense ministry's Central Research Institute 18, addressed this in "O vozrastayushchem znachenii uprezhdeniya protivnika v deystviyakh" ("On the Increasing Importance of Preempting Adversary Actions").[71] Kruglov and Shubin discussed the role played by standoff high-precision strike systems, including subsonic cruise missiles and hypersonic weapons. The authors noted the use of high-precision strike systems by Russia's Armed Forces during operations in Syria:

> The emergence of new means of warfare, in particular, high-precision, long-range, sea and airborne weapons [the Kalibr cruise missile, the Kinzhal and Tsirkon hypersonic missile systems], gives rise to such new forms of military operations as strategic strike and missile air-naval strike—the first time such strikes were struck in Syria on the formations of the Islamic State.[72]

The article clearly links preemption with the development and procurement of hypersonic systems, mentioning the Kinzhal and the Tsirkon.[73] This in turn, the authors argue, will demand innovative

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[70] *Ibid.*

[71] V.V. Kruglov and A.S. Shubin, '*O vozrastayushchem znachenii uprezhdeniya protivnika v deystviyakh*,' *Voyennaya Mysl'*, No.12, pp.27–34.

[72] *Ibid.*

[73] *Ibid.*

approaches toward conducting future military operations, reflecting consideration of how such weapons might be best applied. Here, the authors even attempt to fit the role of hypersonic weapons such as the Kinzhal and the Tsirkon into the Soviet theory of deep battle, or the deep operation, most likely in an effort to make the connection with their readership of an identifiable continuum in military thought:

> Other types of new weapons announced by the president of Russia in his address to the Federal Assembly of the Russian Federation in 2018, also require further development of new forms and methods of their application and, in general, the conduct of military operations. The introduction of these new forms in conjunction with the main modern method of military operations, which presupposes simultaneous [this is how time manifests itself] defeat of the enemy to the full depth of its operational formation [in the long term—to the entire depth of its strategic deployment], in fact, is a consequence of the further development of the theory and practice of *deep operation*.[74]

Also in the December 2021 issue of *Voyennaya Mysl'*, Colonel Mikhail Stepshin and Andrei Anikov, leading researchers in the TsVSI, focused on the role of weapons development on the shape of future warfare: "Razvitiye vooruzheniya, voyennoy i spetsial'noy tekhniki i ikh vliyaniye na kharakter budushchikh voyn" ("Progress in Weapons, Special and Military Hardware and Their Effect on the Nature of Future Warfare").[75] The TsVSI co-authors analyzed priorities in Russia's weapons, military and special equipment (*Vooruzheniya, Voyennoy i spetsial'noy tekhniki*—VVST). On this basis, Stepshin and Anikov considered the directions and trends in

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[74] Author's emphasis. *Ibid.*

[75] M.P. Stepshin, A.N. Anikonov, '*Razvitiye vooruzheniya, voyennoy i spetsial'noy tekhniki i ikh vliyaniye na kharakter budushchikh voyn*,' *Voyennaya Mysl'*, No.12, 2021, 35–43.

Russia's R&D of VVST and its influences on future warfare, outlining these as follows:

- Development of hypersonic weapons (*Giperzvukovogo Oruzhiya*—GZO);
- Development of weapons based on new physical principles (*Oruzhiya na Novykh Fizicheskikh Printsipakh*—ONFP);
- Improvement of high-precision long-range weapons (V*ysokotochnogo Oruzhiya Bol'shoy Dal'nosti*—VTO DB);
- Development of robotic military complexes (*Robototekhnicheskikh Kompleksov*—RTK);
- Development of unmanned aerial vehicles (*Bespilotnykh Letatel'nykh Apparatov*—BPLA) with the expansion of the range of functions performed by them;
- Development of elements of artificial intelligence (AI; *Iskusstvennogo Intellekta*—II) in the creation of advanced models of weapons and military equipment.[76]

Rooted in their analysis of the probable trends in Russia's development of VVST, the authors argue that such systems in combination have the potential to change the nature of warfare itself. Thus, future war, in their view, may have the following features:

- Non-contact impact on the enemy;
- Information defeat of control elements of critical enemy targets;
- Application of GZO, VTO and ONFP against enemy critical facilities;
- Use of UAVs to break through the air-defense/missile defense system;
- Massive use of unmanned aircraft for various purposes (reconnaissance, strike, electronic warfare);

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[76] *Ibid.*

- Coverage of military operations from one to several theaters of operations;
- Duration of hostilities from several hours to several days, depending on the level of achievement of the goal of the war;
- Massive use by all types of the Armed Forces of robotic systems for combat and support purposes;
- Application of elements of artificial intelligence in the general decision-making support system for command and control of troops and weapons;
- Complex application of both military and non-military measures of armed struggle in achieving the goals of war.[77]

Stepshin and Anikov not only place hypersonic weapons systems in pole position in their assessment of VVST priorities, but see these in terms of striking critical enemy infrastructure. Indeed, as noted earlier, one of the advantages offered by such systems given their speed and likely successful evasion of enemy air defenses is the high probability of striking their targets. Of course, the role of hypersonic weapons is not analyzed by these authors in isolation from other developments in Russia's military modernization. However, it is clear that senior Russian military officers with credible influence upon General Staff thinking pay serious attention to the utility of developing such strike capabilities.

In the AVN annual conference on March 2, 2019, during which Gerasimov outlined the "strategy of active defense," Lieutenant General Vladimir Ostankov also presented a paper on the nature of modern military conflicts and its effect on military strategy. This was published together with the other conference papers in *Vestnik*, and it should be noted that Ostankov concluded his article by noting that Russian deterrence policy linked hypersonic weapons to intimidation and inflicting unacceptable damage to an adversary in response to

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[77] *Ibid.*

large-scale aggression—as Gerasimov had also stated. The presence of this element in both papers delivered to the AVN conference by Gerasimov and Ostankov certainly cannot be attributed to mere coincidence.[78] In a May 28, 2019, article in *Voyenno Promyshlennyy Kuryer*, Ostankov considers the issue of Russian perspectives on future warfare, linking this to Moscow's defense posture in several areas and repeated the linkages between hypersonic weapons systems and intimidation of adversaries.[79] At the article's outset, Ostankov ties high technology and modern weapons systems to their impact on shaping the views and concepts of the Armed Forces, explaining that the most important aspect of military strategy is to predict the nature of future wars—military forecasting[80] as a specialist field—and outline the potential of the future enemy in order to form adequate counter measures. Ostankov then described the main features of modern warfare as follows:

- The massive use of high-precision and hypersonic weapons and Electronic Warfare (EW) tools;
- A multifaceted impact on the enemy throughout the depth of its territory and simultaneously in the global information and aerospace confrontation;
- Strengthened centralization and automation of troops and weapons control;

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[78] Ostankov, '*Kharakter sovremennykh voyennykh konfliktov i yego vliyaniye na voyennuyu strategiyu,*' *Op.Cit*.

[79] Vladimir Ostankov, '*Ustrasheniye giperzvukom*,' *Voyenno Promyshlennyy Kuryer*, https://vpk-news.ru/articles/50462, May 28, 2019.

[80] Kokoshin A.A, Bartenev V.I, '*Problemy vzaimozavisimosti bezopasnosti i razvitiya v strategicheskom planirovanii v Rossiiskoi Federatsii: ot tselepolaganiya k prognozirovaniyu*,' *Problemy prognozirovaniya*, No. 6, 2015, pp.6–17; Ksenofontov M.Yu, '*Teoreticheskie i prikladnye aspekty dolgosrochnogo rognozirovaniya*,' *Problemy prognozirovaniya*, No. 2, 2002, pp.1–30.

- Participation in the battles of irregular armed formations and private military companies (PMC);
- The complex use of force and non-military measures implemented with the wide use of the protest potential of the population;
- The use of externally funded political forces and social movements.[81]

Significantly, Ostankov claims that the Russian political leadership has augmented its deterrence posture by adopting a deliberate policy of intimidating potential adversaries. Still, Ostankov believes the dominant role in future warfare still lies in the application of kinetic force. He refers to the changing face of warfare and its implications for the future:

> New technologies have significantly reduced the spatial, temporal and informational gap between troops and command and control. Frontal collisions of large groups of troops (forces) at the strategic and operational levels are gradually becoming a thing of the past. A remote non-contact impact on the enemy becomes the main way to achieve the goals of the battle and operation. The destruction of its objects is carried out [across] the entire depth of the territory. The differences between the strategic, operational and tactical levels, [as well as] offensive and defensive actions are erased.[82]

Ostankov draws his ideas together with specific linkage to the future role of hypersonic weapons in Russian military strategy:

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[81] Ostankov, '*Ustrasheniye giperzvukom*,' *Op.Cit.*

[82] *Ibid.*

> Anticipating a similar change in the nature of the struggle, military strategy develops requirements for the development of inter-specific reconnaissance-strike and reconnaissance-fire complexes, determining their place in the combat system and shared participation in the destruction of the enemy. No wonder that a unit has been created within the General Staff of the Armed Forces of the Russian Federation to deal with this problem. Analysis of the United States' military capabilities has resulted in a transition of Russia from the policy of deterring a potential adversary with nuclear weapons to a *policy of intimidation by causing unacceptable damage with hypersonic weapons* in response to any large-scale aggression.[83]

Ostankov, similar to other senior Russian military officers, considers the role of hypersonic weapons especially with a conventional application as playing a critical part in the "strategy of active defense," as outlined by Gerasimov. In Ostankov's view, this also has a key role in Russia's deterrence policy: marked by a shift to a *policy of intimidation by causing unacceptable damage with hypersonic weapons.*[84] Thus, as hypersonic weapons systems enter service in growing numbers in Russia's Armed Forces in the 2020s and 2030s, including Kinzhal and Tsirkon as well as the ground-based medium- and short-range variants, these will play an increasingly prominent role in national deterrence policy—offering enhanced standoff strike capability, and providing a usable conventional high-precision strike against key enemy targets.[85]

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[83] Author's emphasis. *Ibid.*

[84] Author's emphasis. *Ibid.*

[85] *Ibid*. Oleg Odnokolenko, '*Armii Sirii nuzhna tol'ko pobeda*,' *Nezavisimoye Voyennoye Obozreniye*, http://nvo.ng.ru/wars/2015-11-20/1_siria.html, November 20, 2015; '*Turetskiy seyner vynudil rossiyskiy storozhevik otkryt' ogon' v Egeyskom more*,' Kp.ru, December 13, 2015, http://www.kp.ru/daily/26470.7/3340041/; Vladimir Slipchenko, *Voiny novogo pokolenia – Distantsionnye i bezkontaktnye*,

Conclusion

Moscow's interest in the development and procurement of hypersonic missile systems reflects similar attention to this field by the United States and China.[86] Arguably, Russia's defense industry is ahead of the curve in this area. Yet this interest is an evolution of advances in hypersonic technology applied to the military in the later Soviet era. In the context of Russia's military modernization and the revival of its conventional Armed Forces since the reforms launched in late 2008, hypersonic missile systems fit a broad swathe of Moscow's security concerns and mark a continuum with Soviet military thought.[87]

International attention sparked by the program to produce Russian hypersonic missile systems implies that this area is entirely new and denotes a paradigm shift in the defense posture of the political-military leadership. Indeed, this misunderstanding has been exacerbated by the extent to which the term "super weapons" has taken hold within the analytical discourse. Moscow's planned hypersonic weapons are by no means a game changer in the international security environment, nor do they provide evidence that the Kremlin leadership is pursuing an aggressive or expansionist foreign and defense policy.[88]

Olma-Press, Moscow, 2006, p. 94; S. G. Chekinov and S. A. Bogdanov, '*Evoliutsia sushchnosti i soderzhania poniatia voina v XXI stoletii*,' *Voyennaya Mysl',* No. 1, 2017, pp.36–37;

Aleksei Nikolskiy, '*Siriiskaia pobeda GLONASS*,' *Vedomosti,* March 1, 2017.

[86] 'Hypersonic Weapons: Background and Issues for Congress,' *Op.Cit*.

[87] '*Po tu storonu sverkhzvuka voyennyye konstruiruyut giperzvukovoye oruzhiye*,' *Op.Cit*.

[88] Underlying assumptions among Western analyses, including governmental, based on arguing that Moscow's military modernization marks a significant shift in

By reactivating the domestic capacity to conduct R&D on such systems and to invest in their procurement, Russia's political leadership finds potential answers to military-technical issues such as overcoming potential adversary air defenses, ensuring the delivery of such strikes against high-value targets. At the same time, hypersonics are politically appealing in the sense that they can be cast as a response to US missile defense close to Russia's borders. While Russia's hypersonic weapons cover both nuclear and conventional capabilities—at the nuclear level, going one step further in ensuring first-strike and retaliatory-strike potential—the systems with conventional applications, such as the Kinzhal or Tsirkon, are notably sub-strategic systems, which undoubtedly offers better operational-tactical warfighting capability. This will be added to, according to Chief of the General Staff Valery Gerasimov, by ground-based medium- and short-range hypersonic missiles.[89] These systems, while initially benefiting the Aerospace Forces and the Military-Maritime Fleet, will also add standoff strike capability for the Ground Forces in the ground-based versions, likely entering service within the Missile and Artillery Troops (*Raketnyye Voyska i Artilleriya*—RV&A) .

How these systems with conventional operational-tactical capability fit into Russia's military strategy or define the extent to which such capabilities are new in Russian military thought is quite complex. It is possible to argue that these systems are intended to add to existing standoff strike capability, with the added value of the high probability of evading enemy air defenses. In this sense, Russian hypersonic missiles will further boost non-contact warfare capability. Moreover, hypersonic systems evidently complement and add real value to the

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national defense policy, is thoroughly redressed in Bettina Renz, *Russia's Military Revival*, Cambridge: Polity Press, 2018.

[89] Gerasimov, '*Razvitiye voyennoy strategii v sovremennykh usloviyakh. Zadachi voyennoy nauki*,' *Op.Cit*.

2014 Military Doctrine by asserting the role of "non-nuclear deterrence."[90]

An additional role in Russia's military strategy directly afforded by the procurement of hypersonic missiles, especially those with a conventional application such as the Kinzhal or Tsirkon, relates to Gerasimov's elaboration of the "strategy of active defense." As Gerasimov noted in his address to the AVN in March 2019, the strategy of active defense contains an anticipatory element to "preemptively neutralize threats (*uprezhdayushchey neytralizatsii ugroz*)," stemming from and rooted in the 2014 Military Doctrine.[91] This preemptive component of the "strategy of active defense" seems clear from the context in which Gerasimov talked about hypersonic systems during his address to the AVN—an address themed around military strategy and the role of military science. It is quite striking that during the same AVN conference, General Staff Academy leading military scientist General Vladimir Ostankov reinforced the idea that Russian deterrence policy links hypersonic weapons to intimidation and inflicting "unacceptable damage" (*nepriyemlemyy ushcherb*) on an adversary in response to large-scale aggression.[92] This theme of linking hypersonic systems—specifically the Kinzhal and Tsirkon—to deterrence resurfaced in the December issue of *Voyennaya Mysl'*, with Major General (reserve) Vyacheslav Kruglov and Colonel Aleksei Shubin clearly tying such weapons to preemption. Equally, leading

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[90] '*Voyennaya doktrina Rossiyskoy Federatsii*,' https://rg.ru/2014/12/30/doktrina-dok.html, December 30, 2014.

[91] Gerasimov, '*Razvitiye voyennoy strategii v sovremennykh usloviyakh. Zadachi voyennoy nauki*,' *Op.Cit*.

[92] The term *nepriyemlemyy ushcherb* (unacceptable damage) in Soviet and Russian military thought was normally associated with nuclear deterrence. In recent years, reflecting Russia's increasingly credible conventional military capability, the term has evolved to include a conventional application. Ostankov used the term in his article in *Vestnik* in this conventionally applicable sense.

researchers at the General Staff think tank, the TsVSI, place hypersonic systems development in primary place in their assessment of the influence modern weapons have on emerging views of future warfare.[93]

As Moscow makes further advances in hypersonics to boost Russian military capability in the 2020s and 2030s and beyond, this will need to be complemented by successful efforts to increase and diversify its array of battlefield sensors.[94] This would resolve the issue of target acquisition for hypersonic weapons and integrate these into the reconnaissance-strike system.[95] On the one hand, adding hypersonic missiles to the military inventory certainly strengthens overall capability. But on the other hand, it will also bring fresh challenges. These potential difficulties include completing systems integration, minimizing the vulnerability to enemy precision strikes, and lowering the relative manufacturing costs of these weapons compared to existing precision-strike weapons. Target acquisition of relocatable/moving targets at long range will also continue to be an issue, particularly for naval targets. Moreover, the primary long-range target acquisition platform—the Tu-142 heavy propeller aircraft—is unsuitable for contested environments. Large non-stealth UAVs are

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[93] Ostankov, '*Kharakter sovremennykh voyennykh konfliktov i yego vliyaniye na voyennuyu strategiyu,' Op.Cit;* Kruglov and Shubin, '*O vozrastayushchem znachenii uprezhdeniya protivnika v deystviyakh*,' *Op.Cit*; Stepshin and Anikonov, '*Razvitiye vooruzheniya, voyennoy i spetsial'noy tekhniki i ikh vliyaniye na kharakter budushchikh voyn*,' *Op.Cit*.

[94] S.I. Makarenko and M.S. Ivanov, *Setetsentricheskaya voyna – printsipy, tekhnologii, primery i perspektivy, Monografiya – SPb: Naukoyemkiye tekhnologii*, St. Petersburg, 2018, pp. 149–150.

[95] Anan'yev, A.V, Filatov, S.V, '*Obosnovaniye neobkhodimosti sozdaniya mezhvidovogo razvedyvatel'no udarnogo kompleksa bespilotnykh letatel'nykh apparatov malogo klassa dlya aviatsionnogo formirovaniya*,' *Vozdushno-Kosmicheskiye Sily: Teoriya i Praktika*, No.13, 2020.

not particularly suitable for such environments either, and the Russian military has yet to field them in meaningful numbers.[96] Taken together, Moscow's hypersonic weapons program remains a work in progress and is still in its relatively early stages.

[96] Another option is submarines, but they have limitations too. As for satellites, Russia has yet to deploy suitable satellites for this purpose in useful numbers. Locating mobile land targets at long-ranges (for example hypersonic missile launchers) is another challenging issue.

6.

Electronic Warfare in Contemporary Russian Military Thought

Russia's conventional Armed Forces have transitioned from Soviet-legacy forces into a modernized, compact and combat capable military within a relatively short period following the reforms launched in the fall of 2008.[1] This complex and challenging process has been characterized by a movement away from Soviet force structures and reliance upon the massive use of mobilized personnel to form more flexible, mobile forces capable of conducting military operations in an informationized operational environment.[2] One of the many features of this military modernization involving greater exploitation of advanced and modern technologies is in evidence in the area of electronic warfare (EW). Though electronic warfare capability played a role in Soviet military thought, with more recent digitization and the

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[1] The author wishes to express his gratitude to the following individuals for reviewing and commenting on an earlier draft of this chapter: Charles K. Bartles, Peter Liivet, Guy Plopsky and Greg Whisler.

[2] Niels Bo Poulsen & Jørgen Staun (Eds.), *Russia's Military Might – A Portrait of its Armed Forces*, Copenhagen, 2021.

overall drive to meet the challenges of warfare in the information era, it has re-emerged as a significant tool in the array of Russian conventional military capabilities.[3] In an informationized operational environment, electronic warfare should be regarded as the warfighting discipline within the Electromagnetic Environment (EME). The EME interweaves through all operational domains and, as a consequence, underpins the informationized environment.[4] Russia's operational weaknesses in the course of the Russo-Ukrainian War in 2022 caused many to question advances in Russian military capability. However, the lack of use of advanced EW assets in the initial period of war and the lack of consistent and integrated EW exploitation during the prosecution of the war was especially mystifying.

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[3] I. Sutyagin and J. Bronk, *Russia's New Ground Forces – Capabilities, Limitations and Implications for International Security*, London: Royal United Services Institute, 2017.

[4] Referring to the distinction between the electromagnetic spectrum (EMS) and the EME, Commander Ignacio Nieto observes, "The lessons learned from the conflicts in Ukraine and Syria provide a unique insight into the complexity of conducting military operations in a congested and contested Electro-Magnetic Spectrum (EMS). Even though the term 'spectrum' is well understood by the majority, it is the Electro-Magnetic Environment (EME) which best captures the message NATO [the North Atlantic Treaty Organization] tries to convey when it comes to operating, exploiting, transmitting and receiving, or sending electromagnetic energy in time and space. In this vein, NATO nations have agreed to define EME as all of the electromagnetic phenomena occurring in a given place. Phenomena more than radio frequencies are better aligned with the essence of EME." Ignacio Nieto, 'The Electromagnetic Environment and the Global Commons: Are we Ready to Take the Fight to the Spectrum?' Joint Air Power Competence Center, https://www.japcc.org/the-electromagnetic-environment-and-the-global-commons/#:~:text=In%20the%20transformation%20document%2C%20NATO,planning%20of%20every%20single%20operation., January 2020.

Nonetheless, this chapter explores how the Russian General Staff and senior military commanders perceive the meaning and role of electronic warfare in the modern and future battlespace. It, therefore, addresses the place of EW in contemporary Russian military thought, its significance across a range of capabilities and how this might further evolve. Consequently, the chapter raises a number of interlinked questions: How do Russian defense planners and executives within its defense industry think about electronic warfare, and what are the meanings or concepts used to frame the discussions occurring within the body of professional military literature? Are there distinctions between the role of EW in Soviet military thought and how it is viewed in contemporary theory and force planning? How has the role of this capability developed in Russia's experience of war, and are patterns or trends identifiable that may offer insight into the likely future trajectory of EW? How are Russia's modern electronic warfare forces structured and trained? It is also valuable to consider examples of their systems, both in service and prototypes to establish priority areas for force development: How have these advances been tested and experimented with during combat operations in Ukraine and Syria? What is the likely long-term role for EW capability in the Russian Armed Forces' structure and defense planning in the longer term?[5]

It should be stressed at the outset that EW in contemporary Russian military thought and defense planning plays a combat support role, though senior officers are lobbying for this to be elevated to an

[5] Author lectures on Russian EW, *Fuhrungsakademie*, Hamburg, June 2, 2021, September 10, 2021; Author interviews with NATO EW officers, May 18, 2021, June 22-24, 2021.

independent combat arm.[6] As such, EW capability within the structure of Russia's conventional Armed Forces is located in a variety of supporting roles. For example, it is critically tied to air defense both at strategic and operational-tactical levels. Electronic warfare also plays a key part in the Russian military's use of fires, especially in artillery. Moreover, conceptually, Russian EW is linked to a much broader swathe of capabilities, such as information warfare or information confrontation, or even cyber warfare. It plays such an omnipresent role in Russian military operations that disentangling it from the structures or systems it supports can prove to be challenging. Russian EW capability equally feeds into the development in recent years of the application of existing theory on network-centric operations to the implementation of these informationized capabilities.[7]

The following analysis of Russian electronic warfare capability will examine the definition, history and its role; outline the structure and training of Russia's contemporary EW Forces; illustrate examples of modern and future systems; present the testing and refinement of this capability in operational environments in Ukraine and Syria; and finally describe the discussion among senior Russian officers on the possible future upgrading of the service to a combat arm in its own right.

In any analysis of a specific element in overall military capability, there is always the risk of giving an impression that it plays a game-changing role. To avoid this, throughout the following study it must be borne in mind that EW in contemporary Russian military thought is

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[6] Yu. Ye. Donskov, A. S. Korobeynikov, O. G. Nikitin, '*K voprosu o prednaznachenii, meste i roli voysk radioelektronnoy bor'by v armeyskikh operatsiyakh,*' *Voyennaya Mysl'*, No.12, 2015, pp.20–24.

[7] This is explored in greater detail in chapter three: 'Tracing Russia's Path to Network-Centric Military Capability,' and in chapter four: 'Russia's Entry to Sixth-Generation Warfare: the 'Non-Contact' Experiment in Syria.'

assigned the role of combat support; it provides important supporting features to the combat arms either individually depending on the type of operation, or in network-centric operations functioning in a non-platform-centric mode.[8] Even if it evolves in the future into a full-fledged combat arm, EW within the Russian military system would continue to provide combat support especially to the branches of service: the Ground Forces, Aerospace Forces (*Vozdushno Kosmicheskikh Sil*—VKS) and Military-Maritime Fleet (*Voyenno-Morskoy Flot*—VMF). Its emergence within the swathe of conventional Russian military capabilities essentially squares the circle and confirms the assertion by Soviet Admiral Sergei Gorshkov in 1973: "The next war will be won by the side that best exploits the electromagnetic spectrum."[9]

EW lies at the heart of a core group of highly advanced Russian military capabilities that were not consistently or fully exploited in the war in Ukraine in 2022. This was hampered by Moscow's political decision to classify the intervention in Ukraine as a "special military operation," meaning the Russian military was fighting at peacetime strength rather than employing the manpower or approaches required by large-scale warfare. The reasons for the General Staff not factoring into operational planning the wider and integrated usage of high-tech military capabilities are unknown. However, given the level of destruction and targeting of civilian and economic infrastructure, the overall operational design may have involved eschewing the use of

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[8] Yu. Ye, Gorbachev, S. N. Pogodin, '*Vzglyady komandovaniya vooruzhennykh sil SShA na sushchnost' i soderzhaniye elektromagnitnoy voyny*,' *Voyennaya Mysl'*, No.3, 2021, pp.129–139; V.A. Balybin, '*Nauchno-issledovatel'skiy ispytatel'nyy institut (radioelektronnoy bor'by) — 60 let na strazhe efira*,' *Voyennaya Mysl'*, No.12, 2020, pp.78–85.

[9] Cited in 'JP-385 Joint Electromagnetic Spectrum Operations,' May 22, 2020, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_85.pdf?ver=2020-04-09-140128-347.

such advanced capabilities. If the destruction of a nation and its statehood was the aim, high-technologies—including EW—may not have been deemed a priority.

Definition, History and the Role of Electronic Warfare

Russia's Armed Forces have long had an interest in exploiting electronic warfare for combat operations. Originating in the tsarist era, during the Russo-Japanese War (1904–1905), this growing element of modern warfare later gained increasing interest and influence in Soviet military thought and practice.[10] More recently, following the deep and systemic reform of the Armed Forces launched in the aftermath of the August 2008 Russian-Georgian War, complemented by consistent state investment in military modernization, this level of interest among Russia's defense and military planning staffs has developed exponentially. Indeed, electronic warfare has become one of the factors defining Russia's modern military power.[11] In order to understand these processes, along with the exploitation of advanced technologies applied to its further development, it is helpful to explore the definition of the term in the Russian military lexicon as well as how it is perceived by Russian specialists and serving officers. Equally instructive is to examine electronic warfare's historical formation and expanding role in contemporary Russian military thought along with its contribution to overall military capability.[12]

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[10] Tsvetnov V. V, Demin V. P, Kupriyanov A. I, *Radioelektronnaya bor'ba. Radiomaskirovka i pomekhozashchita*, Moscow: MAI, 1999, Volume 1, pp.240; Tsvetnov V. V., Demin V. P., Kupriyanov A. I, *Radioelektronnaya bor'ba. Radiorazvedka i radioprotivodeystviye*, Moscow: MAI, 1998, Volume 2, pp. 248.

[11] Colonel M. Doskalov, '*Perspektivy razvitiya sistemy radioelektronnoy bor'by rossiyskoy federatsii na period do 2020 goda*,' http://federalbook.ru/files/OPK/Soderjanie/OPK-9/III/Doskalov.pdf, May 21, 2013.

[12] V. Silyuntsev, V. Demin, D. Prokhorov, '*Boyevoye primeneniye REB*,' *Armeyskiy Sbornik*, July 2016, pp. 43-53; Kruglov, '*Perspektivy razvitiya amerikanskikh sredtsv*

The term itself, electronic warfare (*radioelektronnaya bor'ba* —REB), is much more complicated to define as an aspect of military operations and capability than would appear at first glance. Given advances in modern technologies and approaches to the conduct of military operations, the term acquires an inherent elasticity that reflects changes in the threat landscape, shifts in Russian thinking on the role of electronic warfare, and ongoing efforts to modernize these assets. In Russian, the term *radioelektronnaya bor'ba* more literally translates as "radio-electronic combat [or 'struggle']," clearly reflecting the origin of the phrase in the early 20th century, during Russia's military operations against Japan and the need to monitor and disrupt radio signals.[13] While *radioelektronnaya bor'ba* (REB) is the correct Russian term, in the interests of simplicity and clarity, the English abbreviation for electronic warfare (EW) will be used throughout this chapter.

The need for some awareness of the specifics of the term and how it is used in published works and discussions among Russia's EW officers and specialists is more than simply semantic. Within the corpus of specialist literature, Russian EW officers frequently go into detail on the content of the meaning and conceptual understanding of EW; this finds its roots in the changing character of modern warfare, as noted, and the Armed Forces' transitioning into informationized and increasingly network-enabled approaches toward warfare.[14] The

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REB I taktika ikh primeneniya v sovremennykh vooruzhonnnykh konfliktakh,' *Zarubezhnoye Voyennoye Obozreniye*, No. 2, 2014, pp. 57-63; Dobykin V. D., Kupriyanov A. I., Ponomarov V. G., Shustov L. N, *Radioelektronnaya bor'ba. Silovoye porazheniye radioelektronnykh sistem*, Moscow: Vuzovskaya kniga, 2007; Paliy A. I, *Ocherki istorii radioelektronnoy bor'by*, Moscow: Vuzovskaya kniga, 2006.

[13] A. Paliy, '*Radioelektronnaya bor'ba v khode voyny*'" *Voyenna Istoricheskiy Zhurnal*, No. 5, 1976, pp. 10–16.

[14] V. Baulin, A. Kondratyev, '*Realizatsiia kontseptsii 'setetsentricheskaia voina v VMS SShA*,' *Zarubezhnoe Voennoe Obozrenie*, No. 6, June 2009; Burenok, V, '*Bazis setecentricheskih voyn – operezhenie, intellect, innovacii*,' *Nezavisimoye Voyennoye*

attention to such detail by Russia's leading EW specialists means that they use this as a mechanism within which to convey their ideas and theories about how EW may be better exploited in the future; it also has important ramifications for how the military, defense ministry leadership and the domestic defense industry involved in manufacturing EW systems all communicate with each other and share some level of common understand about the complexity of the issues and tasks at hand.[15] What follows, therefore, is specific to Russia's Armed Forces, and most likely will not quite fit or precisely match expectations or professional understanding among non-Russian EW specialists.

At the outset, in the official definition in *Voyennyy Entsiklopedicheskiy Slovar'* (*Military Encyclopedic Dictionary*), the term *radioelektronnaya bor'ba* (REB/EW) is presented as a type of armed struggle using electronic means against enemy command, control, communications, computers intelligence, surveillance and reconnaissance (C4ISR) systems to "change the quality of information," or using electronic means against various assets to change the conditions of the operational environment. EW consists of "suppression" and "protection," and it aims to "reduce the effectiveness" of enemy forces, including command and control (C2) and its use of weapons. It targets enemy communications and reconnaissance by changing the "quality and speed" of information

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Obozreniye, 2 April, 2010; Burenok, V, Kravchenko, A, Smirnov, S, '*Kurs – na stetsentrcheskuiu sistemu vooruzheniia*,' *Vozdushno Kosmicheskaia Oborona*, May 2009.

[15] V. K. Novikov and S. V. Golubchikov, '*Formy radioeletronnoy bor'by v sovremennykh usloviyakh*,' *Vestnik*, No.2, 2019, pp. 139–143.

processes. In defense, EW protects such assets and those of friendly forces.[16]

Prior to exploring the existing official definitions in more detail, it is worth considering other attempts to define the term by non-military specialists. In 2015, for example, the reputable Moscow-based independent think tank the Center for Strategies and Technologies (CAST) published a book on Russian EW, which as its basis outlined the meaning of the term. In that study, EW was presented as a series of activities taken to gather intelligence, suppress enemy radio and optical electronic assets and systems, and/or protect friendly radio and optical electronic assets/systems. It also offers the view that EW is essentially a conflict interaction of information systems or conflict in the information space. Throughout the book *Radioelektronnaya bor'ba. Ot eksperimentov proshlogo do reshayushchego fronta budushchego*, (*Electronic Warfare: From the Experiments of the Past to the Future Decisive Front*), published by CAST in 2015, a much narrower definition was used: namely that EW is essentially warfare in the radio wave spectrum.[17]

The immediate issue presented in this definition is its restriction to the radio wave spectrum only. Yet, as noted in the professional publications by serving Russian EW officers, there is dissatisfaction with even the more detailed definition in *Voyennyy*

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[16] *Voyennyy Entsiklopedicheskiy Slovar'*, http://encyclopedia.mil.ru/encyclopedia/dictionary/details_rvsn.htm?id=14416@morfDictionary, Accessed on August 4, 2021.

[17] N.A. Kolesova and G. Nasenkova, (Eds), *Radioelektronnaya bor'ba. Ot eksperimentov proshlogo do reshayushchego fronta budushchego* (*Electronic Warfare: From the Experiments of the Past to the Future Decisive Front*), CAST: Moscow, 2015, pp.14–15.

Entsiklopedicheskiy Slovar'. Indeed, this official definition of EW is relatively detailed, an extract from which reads:

> A kind of armed struggle, during which radio emissions (radio interference) are applied to the radio-electronic means of control systems, communications and reconnaissance of the enemy in order to change the quality of military information circulating in them, to protect their [own] systems from similar influences, as well as to change the conditions (properties of the environment) of the propagation of radio waves… EW components are electronic suppression and electronic protection. The objects of influence in the course of electronic warfare are electromagnetic fields (waves), radio-electronic means and systems. Active and passive means are used to create radio interference. Active means are those that use the principle of generation to generate radiation (for example, transmitters, jamming stations). Passive means use the principle of reflection (re-radiation) (for example, dipole and corner reflectors, etc.). Electronic warfare is one of the main types of operational (combat) support of the Strategic Missile Forces.
>
> At present, electronic warfare is a complex of coordinated measures and actions of troops carried out in order to: reduce the effectiveness of C2 of enemy troops and weapons, ensure the specified effectiveness of C2 of troops and the use of their own means of destruction. Achievement of these goals is carried out within the framework of the defeat of the systems of C2 of troops and weapons, communications and reconnaissance of the enemy by changing the quality of information circulating in them, the speed of information processes, parameters and characteristics of electronic means; protection of their control systems, communications and reconnaissance from defeat, as well as protected information about weapons, military equipment, military facilities and actions of troops from technical means of reconnaissance of foreign states (the enemy) by ensuring

> specified requirements for information and information processes in automated control systems, communications and intelligence, as well as the properties of electronic media.[18]

The complexity involved and the need for coordination with the domestic defense industry has prompted discussion among Russia's serving EW officers. In 2017, EW specialist officers Colonel V. F. Guzenko and Colonel A. L. Morarescu considered the term EW in the context of the need for clarity among defense planners and the defense industry, publishing *Radioelektronnaya bor'ba. Sovremennoye soderzhaniye* (*Electronic Warfare: Terms and Definitions*). The authors noted ongoing work on defining as well as rethinking the "essence and content" of EW in modern conditions and its role and place in the Armed Forces. Guzenko and Morarescu noted,

> Since 2014, the revision of statutory documents on electronic warfare in the Armed Forces of the Russian Federation has continued and shown the practice of charter-creative work is a creative and constant process. Indeed, the development and clarification of terminology, basic use of EW forces and means has been going on for a long time, discussions and disputes on this problem (sometimes hot and sharp) are still going on. And there are reasons for this: the enemy, the objects of influence and accordingly, the tasks of electronic warfare are changing, a new area of confrontation—the information and telecommunications space, new equipment with completely different, unconventional principles of work and application.[19]

[18] *Voyennyy Entsiklopedicheskiy Slovar'*, *Op.Cit.*

[19] Guzenko V.F, Morarescu A.L, '*Radioelektronnaya bor'ba. Sovremennoye soderzhaniye*,' *Radioelektronnaya bor'ba v Vooruzhennykh Silakh Rossiyskoy Federatsii – 2017,* http://reb.informost.ru/2017/sod.php.

Their article was prompted by discussions related to proposed changes to draft amendments to the GOST RV 0158-022: *Elektronnaya voyna. Terminy i opredeleniya* (*Electronic Warfare: Terms and Definitions*). The national GOSTs (*Gosstandartov RF: GOST R*) function in Russia as state standards to regulate quality and production of products. The GOST in question, passed in July 2009, of course relates directly to the manufacturing of EW systems. As the authors noted: "The content of the GOST is a *common language for the military and industry*, the basis for the terminology of the developed statutory documents on electronic warfare."[20] Draft change No. 2 in GOST RV 0158-002, reads:

> Electronic warfare is a set of coordinated measures and actions on electronic damage radio-electronic/information-technical objects of the enemy, radio-electronic protection of their radio-electronic/information-technical objects, counteraction to technical means of reconnaissance of the enemy, as well as radio-electronic information support.[21]

Guzenko and Morarescu describe this as "cumbersome." The authors also provide other short definitions used for statutory documents: "Electronic warfare (EW): a set of agreed actions and actions of troops (forces) for electronic destruction of enemy radio-electronic objects, electronic protection of their radio-electronic objects, as well as countering technical means of enemy reconnaissance." And in another example: "Electronic warfare includes: electronic destruction, electronic protection, counteraction to technical means of enemy reconnaissance and electronic information support of measures and actions in electronic warfare." These differences are caused by "information and technical objects with which the forces and means

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[20] Author's emphasis. *Ibid*.

[21] *Ibid*.

of electronic warfare operate are of a radio-electronic nature, therefore, information-technical objects are also understood as radio-electronic objects," and, "the component of electronic warfare electronic 'information support' is removed from the general definition, in order, firstly, to emphasize its internal role in relation to the organization and the conduct of electronic warfare, and, secondly, to prevent misunderstandings by commanders about the essence of electronic information support, equating the latter to intelligence."[22]

Guzenko and Morarescu conclude by suggesting a modern interpretation of EW should distinguish between offensive (electronic attack) and defensive actions (essentially playing a supporting role). The latter is further broken down into constituent components: electronic protection and countermeasures to technical enemy means (radio-electronic information support, providing a component of EW). In this regard, EW has two parts: the first includes the actions of forces and means of EW to disorganize enemy command and control; and the second includes actions by EW forces for the implementation of a set of measures for electronic protection and countermeasures against the technical means of reconnaissance by foreign states.[23]

Finally, a more workable definition of the term EW can be found in an article by leading Russian EW serving officers in April 2021 in the General Staff journal *Voyennaya Mysl'*:

> Electronic warfare is a type of combat (operational) support, a set of coordinated measures and actions of troops (forces) for electronic destruction of enemy radio-electronic objects, radio-electronic protection of their radio-electronic objects, as well as countering the enemy's technical reconnaissance means.

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[22] *Ibid.*

[23] *Ibid.*

> Electronic warfare includes: electronic defeat, electronic protection, counteraction to technical means of reconnaissance of the enemy, [and] electronic information support.[24] Electronic warfare is organized and conducted in order to disorganize the C2 of enemy troops (forces) and weapons, reducing the effectiveness of his reconnaissance and the use of weapons and ensuring sustainable control of his troops (forces) and weapons.[25]

Russia's EW Forces trace their roots to 1904 and the defense of Port Arthur against Japan; April 15 is celebrated every year as EW Forces Day. Of course, intercepting telegraph signals stemmed from the earlier development of using telegraph signals in warfare in the latter nineteenth century. Later, the Soviet EW forces were critically used as support elements in many of the major battles of the Great Patriotic War (1941–1945) and featured in the use of radio-detonated mines in Kiev, Odessa, Orsha and Kharkiv.[26] In 1956, the Union of Soviet Socialist Republics (USSR) formed its first communications, radar, and radio-navigation jamming battalions throughout all branches of the Armed Forces.[27] It was not until the 1970s, though, that EW

[24] The authors in essence describe electromagnetic maneuver.

[25] Yu.I, Lastochkin, Yu.Ye, Donskov, A.L, Moraresku, '*Analiz sovremennykh kontseptsiy po vedeniyu operatsiy v elektromagnitnom spektre s pozitsiy radioelektronnoy bor'by*,' *Voyennaya Mysl'*, No.4, 2021, p.32.

[26] Today, Kyiv, Odesa and Kharkiv in Ukraine, and Orsha in Belarus. S. Kozhevnikov, '*Radioelektronnaya bor'ba v gody Velikoy Otechestvennoy voyny*,' *Belorusskaya Voyennaya Gazeta*, April 16, 2014.

[27] V. D. Dobykin, A. I. Kupriyanov, V. G. Ponomarov, L. N. Shustov, *Radioelektronnaya bor'ba. Silovoye porazheniye radioelektronnykh sistem*, Moscow: Vuzovskaya kniga, 2007;

matured into a top-grade type of operational (combat) support for full-scale operations and low-level combat actions, evolving in its role from occasional supporting actions, such as jamming of selected enemy radars, to that of an operational mainstay of combat support provided by a group of EW units to suppress enemy electronic assets and systems in operations or engagements. Indeed, by the 1970s, Soviet EW had matured into a higher-level combat support capability, building on its earlier role in occasional supporting actions to forming an organic EW force to suppress enemy electronic assets and systems in operations or engagements.[28]

Russia's military interest in the area of EW was stimulated by analyses in the 1990s of the use of EW by the United States and its coalition partners in the First Gulf War in 1991. Numerous studies by Russian General Staff officers in the 1990s covered the EW usage by the US military in 1991. In the earliest action in Operation Desert Storm on January 1, 1991, US Air Forces EF-111A and US Navy/Marine Corps EA-6B aircraft, supported by EC-130s, used noise and deception jamming signals to block Iraq's communications frequencies.[29] The late Jacob W. Kipp observed this pattern in an article in 1997. And in the latter 1990s, leading Russian military theorists were paying

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A. I. Paliy, *Ocherki istorii radioelektronnoy bor'by*, Moscow: Vuzovskaya kniga, 2006.

[28] Yu. Ye. Donskov, A. S. Korobeynikov, O. G. Nikitin, '*K voprosu o prednaznachenii, meste i roli voysk radioelektronnoy bor'by v armeyskikh operatsiyakh*,' *Voyennaya Mysl'*, No. 12, 2015, pp. 20–24; V. V. Tsvetnov, V. P. Demin, A. I. Kupriyanov, *Radioelektronnaya bor'ba. Radiomaskirovka i pomekhozashchita*, Moscow: MAI, 1999; V. V. Tsvetnov, V. P. Demin, A. I. Kupriyanov, *Radioelektronnaya bor'ba. Radiorazvedka i radioprotivodeystviye*, Moscow: MAI, 1998.

[29] Carlo Kopp, 'Operation Desert Storm. The Electronic Battle Parts 1–3,' *Australian Aviation*, June/July/August, 1993.

attention to the role of EW as a force multiplier long before that field came to be viewed this way in official defense circles in Moscow.[30] As Russian military theorists and defense scholars grappled with the development of network-centric warfare and C4ISR integration in foreign militaries, the role played by EW formed an integral part of their thinking.[31]

Network-centric warfare came to be seen as a vital force multiplier and a means to instigate deeper and meaningful military transformation; an essential element in this approach involves EW. Its origins, of course, lie in late-Soviet military theory and the proponents of the Revolution in Military Affairs (RMA), championed by Marshal Nikolai Ogarkov, the chief of the Soviet General Staff between 1977 and 1984.[32] What changed since the 2008 Armed Forces reform is that the Russian political-military leadership has implemented these theoretical approaches toward future warfare, becoming more receptive to alternative perspectives on how information is changing the character of war and transforming the battlespace.[33]

The recent historical impetus to reform the EW Forces is tied to the experience of smaller conflicts in the operational experience of

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[30] Jacob W. Kipp, 'Confronting the RMA in Russia,' Military Review, May/June 1997, pp. 49–55.

[31] E. Kruglov, '*Perspektivy razvitiya amerikanskikh sredtsv REB I taktika ikh primeneniya v sovremennykh vooruzhonnnykh konfliktakh*,' *Zarubezhnoye Voyennoye Obozreniye*, No. 2, 2014, pp. 57–63.

[32] V. Burenok, '*Bazis setecentricheskih voyn – operezhenie, intellect, innovacii*,' *Nezavisimoye Voyennoye Obozreniye,* April 2, 2010; V. Burenok, A. Kravchenko, S. Smirnov, '*Kurs – na stetsentrcheskuiu sistemu vooruzheniia*,' *Vozdushno Kosmicheskaia Oborona*, May 2009.

[33] A. I. Kupriyanov, L. N. Shustov, *Radioelektronnaya borba. Osnovy teorii*, Moscow: Vuzovskaya kniga, 2011.

Russia's Armed Forces since the dissolution of the USSR in 1991. In the first campaign in Chechnya (1994–1996), large EW Forces were deployed under the control of an operational intelligence group from the joint force command. However, the Russian EW Forces' core issue came from within the military units themselves. By the end of 1994, in the Ground Forces there was not even one fully staffed EW unit; to conduct operations, units were formed using inadequately trained personnel. During the initial assault at the end of 1994, EW Forces operated behind the battle formations of advancing troops, within a battalion tactical group or regiment. In addition to conducting signals intelligence (SIGINT), the EW Forces suppressed enemy tactical communications while on the advance, during active battles, and during the storming of Grozny. As a result of the use of small EW maneuver groups at the platoon level, which functioned within battle formations or at checkpoints, this approach became the normal tactical application of Russian EW Forces in Chechnya.[34]

However, based on the operational experience of using EW in the first Chechnya campaign, the following defects were identified:

- A lack of fully manned EW units;
- A low level of tactical readiness of EW assets;
- The absence of automated control points and a lack of direction-finding systems;
- A low level of reliability of jamming stations;
- Complications with equipment while conducting EW on the march;

[34] N. A. Kolesova and G. Nasenkova, (Eds), *Radioelektronnaya bor'ba. Ot eksperimentov proshlogo do reshayushchego fronta budushchego* (*Electronic Warfare: From the Experiments of the Past to the Future Decisive Front*), CAST: Moscow, 2015, pp. 222–227.

- An absence of radio-electronic assets to suppress space-based and cellular communications.[35]

Prior to launching the second campaign in August 1999, an unsuccessful effort was made to reequip the EW Forces with modern equipment. Foreign models were bought and domestic development and adaptation was deemed part of the solution. Financial constraints at the beginning of the second conflict resulted in the forces having much the same equipment as during the first campaign. While technological advances were lacking, there were changes to the use of the EW Forces, making their deployment more effective. Ground Forces' EW units, interior troops and other agencies more closely coordinated their actions. In 1999, within the 58th Combined Army, was formed the 831st EW Command Center, which had an RP-330KP experimental automated EW command post, simplifying the C2 of subordinate EW units. A unified EW force and equipment group was formed of 20 maneuver groups from 17 EW units, 84 radio intercept posts, 15 direction-finding posts, and 76 jamming posts.[36]

EW Forces located Chechen broadcasting locations and suppressed them, to include attempting to jam the powerful television transmitter in Grozny. A jamming helicopter was used against the transmitter with limited results. More success was found against transmitters in border areas. As opposed to 1996, EW units were able to identify and suppress city communication centers during the 1999–2000 storming of Grozny. The disruption of communication led to the loss of centralized command and control among the Chechen forces. The use of direction-finding assets for targeting was more complicated. Frequently, artillery strikes were conducted in accordance with established coordinates, without the input of additional intelligence

[35] *Ibid.*

[36] *Ibid.*

assets and without proper fire control or correction.[37] Although Russia's EW Forces gained invaluable experience in the Chechen wars, they were mainly applied against civilian and commercial communications systems that were being used by inexperienced operators. Chechnya did not permit EW Forces to operate against anti-air defense systems, precision munitions, automated C2 systems, airborne warning and control system (AWACS) aircraft, or unmanned aerial vehicles (UAV), which are all typical tasks of modern EW forces.

Moreover, the Russian Armed Forces' lack-luster performance in the August 2008 Russian-Georgian War served to confirm that Moscow still possessed an under-funded and inadequately trained Soviet legacy force ill-suited to conducting modern operations. Many of the tasks performed by Russia's EW Forces in the conflicts in Chechnya were in evidence in the conflict in Georgia. During the ground operation in South Ossetia, two maneuver groups were employed from the 1077th independent EW battalion of the 19th motorized rifle division. The EW groups, whose total personnel numbered 49 troops, were embedded into the battalion tactical groups of the 135th and 693rd motorized rifle regiments; these were the first to advance into the territory of South Ossetia after the conflict began. The small number of air-based EW assets were late in coming in comparison with the ground-based groups. Only after losing five aircraft did the operation to suppress Georgia's air defenses begin, using EW helicopters and planes intended to provide collective self-defense against aircraft. These air-based EW assets countered civilian and military radars in Gori, Marneuli, Tbilisi and Senaki. On August 10, the Russian air force began conducting anti-radiation missile strikes to destroy the

[37] *Ibid.*

radars around Gori and Tbilisi that prevented the use of Georgia's Buk and Osa anti-air missile systems.[38]

Airborne EW assets were also deployed above the main Caucasus Mountain range in the border area with South Ossetia and over the Black Sea south of Abkhazia. An-12PPs flew ahead during airstrikes to protect Russian formations as well as patrolled the skies for 12–16 hours daily. Jamming helicopters hovered overhead practically on a permanent basis. During the course of the conflict, at least two of the new pre-production models of the Su-34 tactical bomber were deployed. The Su-34 proved effective at suppressing anti-air systems and conducting electronic surveillance. Moreover, the primary task of this jet was protection of the aviation combat formations with its onboard Khibiny EW system. It is not known whether the more powerful suspension pod unit for group defense was used or if it was the wing-tip system. Nonetheless, compared to the weak ground-based EW Forces and the dated equipment installed on previous-generation aircraft, the Su-34 proved a serious asset against Georgia's anti-air defense systems.[39] It is against this background that the Russian EW Forces' operational roles in more recent conflicts, in Ukraine and Syria, have demonstrated a remarkable transformation in capability, equipment and professionalism, attained in a comparatively short period due to the reform effort.

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[38] N. A. Kolesova and G. Nasenkova, (Eds), *Radioelektronnaya bor'ba. Ot eksperimentov proshlogo do reshayushchego fronta budushchego*, (Electronic Warfare. From the experiments of the past to the future decisive front), CAST: Moscow, 2015, pp. 227–229.

[39] *Ibid*. "An-12PP electronic warfare aircraft. Western reporting name Cub-C. It is an even more extensive rebuild with equipment housed in large nose/tail/canoe radomes conferring a significant active jamming capability": http://www.military-today.com/aircraft/an_12.htm, Accessed October 19, 2021.

To provide an overview and insight into how this increased level of General Staff attention to building and enhancing EW capability has flowered in recent years, especially within Russian military thought, it is beneficial to briefly consider some of the themes covered in professional publications by serving Russian EW officers. In addition to Russian military EW specialists publishing in the leading professional journals such as *Voyennaya Mysl'* (*Military Thought*), *Vestnik AVN* (*Bulletin of the Academy of Military Sciences*) or *Armeyskiy Sbornik* (*Army Digest*) among others, a collection of highly specialized articles appeared since 2013 in an annual online format: *Radioelektronnaya bor'ba v Vooruzhennykh Silakh Rossiyskoy Federatsii* (*Electronic Warfare in the Armed Forces of the Russian Federation*). However, the most recent issue of the annual *Radioelektronnaya bor'ba v Vooruzhennykh Silakh Rossiyskoy Federatsii* was published in 2019, and it is unclear as to why the collection has ceased publication.[40]

Nonetheless, its annual collections of articles offer invaluable insights into the emerging and future areas of development for Russia's EW forces and capabilities. In order to offer a flavor of these, the following overview is provided of some of the main issues and themes explored by Russian EW specialists in the 2019 publication. These included the EW research and testing institute serving as the scientific foundation of EW; the role and place of EW in the air-defense forces; the 3rd Central Research Institute of the Ministry of Defense of the Russian Federation; problematic issues of EW at the strategic level; robotization of the armed forces of leading foreign countries; reducing the visibility of weapons, military and special equipment in various physical fields; military-scientific support of R&D as an element in the life cycle management of electronic warfare equipment; the system for testing complexes of electronic jamming of radio

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[40] *Radioelektronnaya bor'ba v Vooruzhennykh Silakh Rossiyskoy Federatsii – 2019,* http://reb.informost.ru/2019/index.php.

communications and radio navigation; information support for the management of the use of the radio frequency spectrum and ensuring electromagnetic compatibility in the Armed Forces; the main aspects of the organization of automated control of EW systems; modern trends in the development of EW systems with space data relay systems.[41]

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[41] As can be seen from the themes covered in this Russian publication, the details are highly sensitive especially in the field of EW. It is unclear as to why the publication was suspended. In recent years, Moscow has made more of its military journals available online. Often the access to recent, or even sometimes to older articles in the journal archive depends on opening a subscription. In some cases, the full articles are not available in an online edition. In any case, the professional EW online publication appears to have been suspended with its last issue in 2018; this could be subscription linked. In the 2018, issue the following were among the various themes covered: subsystems for EW control at the tactical level; countering UAVs; robotic EW systems; EW to repel an enemy aerospace attack; automation of radio frequency bodies; developing the capabilities of ground mobile equipment for EW based on high-altitude aeromechanical antennas; trends in the doctrinal concepts of US Armed Forces Operations in the EMS; EW research for the RVSN; developing the experimental and testing base of the EW research institute; the 34th Institute of Naval Communications to ensure electronic suppression of enemy radio communications; protection of VKS groupings; constructing devices for detecting pulsed ultra-wideband signals for reconnaissance and EW systems; EW to protect the Missile and Artillery Troops (*Raketnyye Voyska i Artilleriya*—RV&A) from high-precision strikes; EW in the VKS; EW in the VDV; the EW service in the Central Joint Strategic Command/Military District; Murmansk-BN on protecting the Arctic; information technologies of the future for training junior EW specialists; improving long-range aviation EW service. *Radioelektronnaya bor'ba v Vooruzhennykh Silakh Rossiyskoy Federatsii – 2018,* http://reb.informost.ru/2018/sod.php. The 2017 issue covered: EW in a complex EMS environment; development of C2 for the EW forces; prospects for automated control in EW formations of using ultra-wideband signals for communications, reconnaissance and EW in the tactical control link; conversion of the radio frequency spectrum; problems of increasing the survivability of the Air Defense Forces of the Ground Forces; development and application of means for imitating

While these sources offer unique insight into the nature of analysis and discussion among the Russian Armed Forces' EW specialists, the search for wider context and exploration of how EW is perceived by the leading service personnel is cast much wider within the body of Russian military literature. Undoubtedly, there has been an upsurge in the quantity and quality of published analysis on Russian EW since the reform of the Armed Forces that began in 2008. The EW leadership and Russian military theorists specializing in EW have in particular chosen the journal of *Voyennaya Mysl'* to express their views regarding the development, role and future of EW in Russia's growing conventional military capabilities. *Voyennaya Mysl'* was undoubtedly consciously selected as the platform for their writings to influence this publication's General Staff readership. Nonetheless, while that journal serves as a key platform for Russian EW specialists to advance and disseminate their views, other outlets in the Russian military media are also in use. And it is among this corpus of Russian military publications that the perspectives and aspirations of the Russian EW leadership and main military theorists are found, most notably on two critical issues: the role of EW in modern military operations and the future continued elevation of EW within Russia's informationized Armed Forces.

In comparison with the other officers in leadership posts in the branches and arms of service or in support roles such as the Missile and Artillery Troops (*Raketnyye Voyska i Artilleriya*—RV&A) or Ground Forces Air Defense Forces (*Voyska Protivovozdushnoy Oborony Sukhoputnye Voiska*—PVO SV), the chief of the EW Forces,

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radio signals from radio electronic devices in air-defense weapons; UAVs to expand the capabilities of ground mobile EW equipment; ensuring the maintainability of electronic jamming and air reconnaissance aircraft complexes; features and prospects for the development of naval EW in network-centric warfare. *Radioelektronnaya bor'ba v Vooruzhennykh Silakh Rossiyskoy Federatsii – 2017,* http://reb.informost.ru/2017/sod.php.

Lieutenant General Yury Lastochkin, has proved quite prolific in his published output, covering a broad range of themes in relation to Russian EW and its role both in supporting combat operations and in contemporary military thought.[42] In an interview in April 2020 with the defense ministry's *Krasnaya Zvezda* (*Red Star*), Lastochkin linked Russian EW directly to informationizing the Armed Forces and the information and telecommunications space emerging as a new conflict area:

> Modern military operations are characterized by the widespread use of a whole range of combat information and control systems operating in a single information and telecommunication space, the counteraction of which determines the leading role of electronic warfare in modern armed conflicts… [the] emergence of a new area of confrontation—the information and telecommunications space—significantly expands the range of tasks of EW Forces and means and puts the methods of their use among the most important measures for the comprehensive support of the actions of groupings of troops (forces) in modern conditions. At the same time, the role of electronic warfare at the present stage is determined by its potential capabilities in electronic suppression of information transmission channels, the introduction of "intelligent" interference into automated control systems of enemy troops and weapons; electronic protection of information of its technical means of transmission and processing of data from destruction, distortion, intelligence and information leakage through technical channels; comprehensive technical control of the effectiveness of measures

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[42] This is denoted as PVO SV (Ground Forces Air Defense Forces) to avoid confusion with VPVO.

> to counter enemy technical means and electronic protection of their troops (forces).[43]

Lastochkin, of course, was not isolated in expressing such a symbiotic relationship between information warfare (*informatsionnaya voyna*) or information confrontation (*informatsionnoye protivoborstvo*) and the role of EW in Russian military thought. Western specialists on the Russian military have also identified such linkages.[44] For example, Carolina Vendil Pallin, a researcher in the Russia program at the Swedish Defense Research Agency (FOI) in Stockholm, states that Russia "sees information warfare as an integrated entity, where propaganda, electronic warfare and IT operations are all used simultaneously."[45]

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[43] Viktor Khudoleyev, '*Strazhniki efira na pravil'nom puti*,' *Krasnaya Zvezda*, April 15, 2020.

[44] In 2006, Major General (ret.) Ivan Vorobyev and Colonel Valeriy Kiselev placed EW in a wider schematic of electronic and information warfare (*radioelektronnaya i informatsionnaya*), arguing this type of war would encompass all domains and be waged in every direction, but with degrading enemy C2 as its critical objective. They characterized EW only as a component of the electronic-information battle. It includes electronic counter-measures (*radioelektronnoye podavleniye*), electronic-information support and electronic counter-counter-measures (*radioelektronnaya zashchita*). The authors described EW as a "very capacious concept," adding, "From a technical aspect, it is the effect of emissions of electromagnetic and other kinds of directed energy on enemy electronic assets and on his personnel, C2 entities, combat equipment, military installations, weapons and computer networks. From a tactical aspect, electronic warfare consists of the organization of electronic counter-counter-measures and electronic support to combat operations." Ivan Vorobyev and Valeriy Kiselev, '*Nevidimyy, no obespechivayushchiy prevoskhodstvo v upravlenii: elektronno-informatsionnaya bitva kak odna iz form takticheskikh deystviy*,' *Armeyskiy Sbornik*, No. 3, 2006, pp. 26–28.

[45] Carolina Vendil Pallin, 'Russian information security and warfare,' In Roger E. Kanet, *Routledge Handbook of Russian Security,* London and New York: Routledge,

Such a critical linkage is also expressed as the foundation of an article by a group of Russian EW officer researchers at the Reconnaissance and Electronic Warfare Department in the Military Academy of Army Air Defense in Smolensk. Colonel G. V. Konstantinov, Lieutenant Colonel A. V. Chizhankov and Lieutenant Colonel I. A. Shishechkin explained,

> The experience of armed conflicts in recent years shows that one of the characteristic features of modern armed confrontation is its actual beginning long before active hostilities. At the same time, the achievement of *information superiority*[46] over the enemy and dominance in the information space are becoming the most important conditions for the successful resolution of conflict as a whole. According to the views of military experts in the militaries of the United States and NATO [North Atlantic Treaty Organization] countries, gaining information superiority

2019, pp. 203–213; See: Carolina Vendil Pallin, 'Internet control through ownership: the case of Russia,' Post-Soviet Affairs, Vol. 33, No. 1, 2017, pp. 16–33.

[46] Author's emphasis. The term information superiority (*informatsionnoye prevoskhodstvo*) had already appeared within Soviet military thought in the 1970s, caused by increasing awareness of the potential of automated information systems. The increasing role of EW in the Soviet Armed Forces also resulted in the 1980s in the term radio electronic superiority (*radioelektronnoe prevoskhodstvo*) being used. I. D. Pombrik, '*Obespecheniye nepreryvnosti upravleniya voyskami v sovremennykh operatsiyakh*,' *Voyennaya Mysl'*, No.3, 1976, pp. 50–57; A. A. Zhovanik, '*O roli svyazi v avtomatizirovannykh sistemakh upravleniya voyskami*,' *Voyennaya Mysl'*, No.11, 1976, pp. 28–39; V. M. Stishkovskiy, '*Zadachi i vozmozhnosti voyennoy svyazi*,' *Voyennaya Mysl'*, No.3, 1977, pp. 40–50; I. N. Vorob'yev, '*Novoye oruzhiye— novaya taktika*,' *Voyennaya Mysl'*, No.6, 1984, pp. 47–59; G, I. Salmanov, '*Sovetskaya voyennaya doktrina i nekotoryye vzglyady na kharakter voyny v zashchitu sotsializma,*' *Voyennaya Mysl'*, No.12, 1988, pp. 3–13.

> is possible largely due to the implementation of the concept of conducting information operations.[47]

The authors understand that dominance in the information space is created by electromagnetic dominance since the majority of information systems require the EMS to operate in all geophysical domains. Konstantinov, Chizhankov and Shishechkin went on to emphasize that the main domain in modern warfare is in the information space, the struggle defined as information confrontation (*informatsionnoye protivoborstvo*), which is an integral part of any stage in modern armed conflict. They highlight the technical basis of modern C2 and weapons systems, noting that they rely on electronics and computerized means, which allow these to be targeted. EW can provide such targeting of the enemy's information and control systems (*informatsionnykh i upravlyayushchikh sistem*—IUS) by carrying out information and electronic attack. Thus, EW makes it possible to solve a significant part of the tasks of *gaining and maintaining information superiority* both by influencing the enemy's IUS and protecting their own similar systems and assets.[48] Moreover, Konstantinov, Chizhankov and Shishechkin note that in a number of leading documents of the Russian Armed Forces, EW is interpreted as "an active component of information confrontation" (*aktivnaya sostavlyayushchaya informatsionnogo protivoborstva*).[49]

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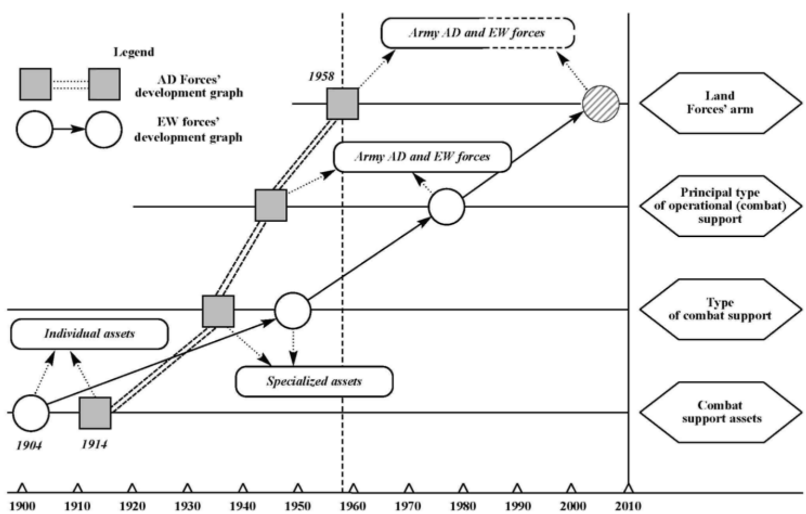
[47] G. V. Konstantinov, A. V. Chizhankov, I. A. Shishechkin, '*Razvitiye teorii primeneniya formirovaniy radioelektronnoy bor'by v interesakh protivovozdushnoy oborony voysk i ob'yektov*,' *Voyennaya Mysl'*, No.10, 2019, pp. 49–55.

[48] Author's emphasis.

[49] Konstantinov, Chizhankov, Shishechkin, '*Razvitiye teorii primeneniya formirovaniy radioelektronnoy bor'by v interesakh protivovozdushnoy oborony voysk i ob'yektov*,' *Op.Cit*.

An additional symbiotic relationship exists between EW and air defense. This relates to all areas of air defense, to include strategic, operational and tactical levels. EW assets are a vital feature, therefore, in the Air Defense Forces (*Voyska Protivovozdushnoy Oborony*—PVO) and the Ground Forces Air Defense Forces (*Voyska Protivovozdushnoy Oborony*—VPVO). Colonel Yu. Ye. Donskov, Colonel A. S. Korobeynikov and Lieutenant Colonel O. G. Nikitin trace 100 years of development in air defense and EW as elements in Ground Forces combat power (**Figure 1**), clearly linking both aspects of modern warfare as complementary.[50]

Figure 1: Comparative Development of Air Defense and EW Forces in a Joint Ground Force



As the authors observe, unlike artillery, air defense and EW are comparatively new additions to the array of military capabilities.

[50] Yu. Ye. Donskov, A. S. Korobeynikov, O. G. Nikitin, '*K voprosu o prednaznachenii, meste i roli voysk radioelektronnoy bor'by v armeyskikh operatsiyakh*,' *Voyennaya Mysl'*, No.12, 2015, pp.20–24.

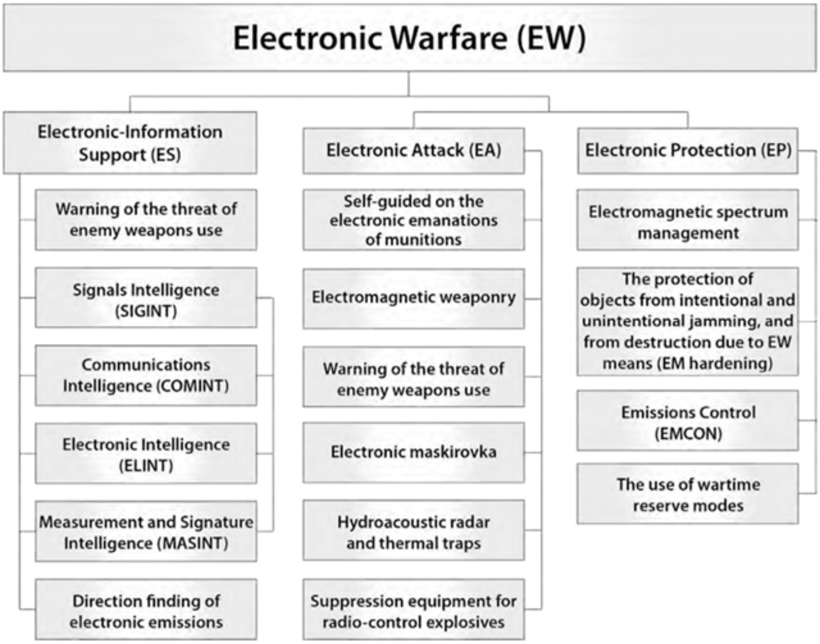
Donskov, Korobeynikov and Nikitin also argue that unlike the air-defense forces, EW has not clearly emerged as a supporting structure for combat operations in the same way:

> The definition of the purpose fulfilled by Air Defense (defending against strikes by an aerial enemy and protecting friendly Ground Forces and ground assets from air strikes) makes special mention of the Air Defense Forces' aerial targets—the enemy's aerial attack weapons that can launch single, multiple, and concentrated strikes against troops and assets in the friendly Ground Forces' area of operations. Understandably, development of this modern component of the forces' combat power, in particular, has largely given the current status to the Ground Forces' Air Defense arm and set its future course.[51]

Although the authors focused primarily upon the role of EW in the Ground Forces, the VKS has arguably thought more comprehensively about the role of EW in strategic air defenses. The authors clearly see linkages between air defense and EW, but they appear to perceive the latter as the poor cousin in this relationship, implying that air defense and EW require rebalancing. Such linkages, serving to effectively weave EW into the fabric of Russian military capabilities, provide a basis and context within which to further examine the role and conceptual utilization of these niche assets.

[51] *Ibid.*

Figure 2: Russian Concept of Electronic Warfare[52]



Conceptually, Russia's EW Forces divide into three elements: electronic-information support, electronic attack (EA) and electronic protection (EP). As US Lieutenant Colonel Charles K. Bartles and Lester W. Grau note, there is also a close linkage between EW and artillery and signals intelligence (SIGINT). In electronic-information support (**Figure 2**), there is, in addition to a SIGINT element, communications intelligence (COMINT), electronic intelligence (ELINT), and measurement and signature intelligence (MASINT).[53] Electronic strike (electronic fire) can be further classified

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[52] Dr. Lester W. Grau, Charles K. Bartles, *The Russian Way of War; Force Structure, Tactics, and Modernization of the Russian Ground Forces*, FMSO: Kansas, Fort Leavenworth, 2016, p.290.

[53] *Ibid.*

> by the amount of force used—single, group, massive; the number and types of suppressed objects—concentrated, selective, concentrated-selective; the time of the strike—the first, second, subsequent; according to the sequence of attack or suppression by radio-electronic means—simultaneous, sequential; according to the tasks being solved—tactical, operational, strategic; by the type of means of destruction used or suppression—information (jamming), power, information-power, information-psychological.[54]

Radioelektronnaya bor'ba in contemporary Russian military discussion, thus, acknowledges a transition to the modern information environment in which its military will operate in the electromagnetic space (EMS). This extends well beyond a narrower definition of operating only in radio wavelengths. The primary targets for the EW Forces are radio and cellular communications, radars, enemy electronic systems as well as adversary EW capabilities. Consequently, EW suppresses or protects, depending on attack or defense, targeting the following:

- C4ISR;
- Location and target distribution systems;
- Fire control;
- Computers;
- Utility/network systems.[55]

[54] V. K. Novikov and S. V. Golubchikov, '*Formy radioeletronnoy bor'by v sovremennykh usloviyakh*,' *Vestnik*, No.2, 2019, pp. 139–143.

[55] N. A. Kolesova and G. Nasenkova, (Eds.), *Radioelektronnaya bor'ba. Ot eksperimentov proshlogo do reshayushchego fronta budushchego* (*Electronic Warfare: From the Experiments of the Past to the Future Decisive Front*), CAST: Moscow, 2015, p. 30.

Moreover, before anything can be suppressed, it first has to be intercepted; this depends on the success of SIGINT using ELINT or COMINT, with intelligence data received through Electronic Support (ES). Once identified, it can be suppressed, neutralized or destroyed through targeted Electronic Attack (EA). To defend these systems, Electronic Protection (EP) is employed. Consequently, EW is integrated with other technical intelligence assets functioning within the EMS. A close relationship exists between SIGINT and EW; and within Russian military EW units, they also perform an additional SIGINT function. Close links between SIGINT, air defense, artillery and EW was striking in Russia's operations in southeastern Ukraine in 2014-2015.[56] Russian EW units protect artillery systems from enemy targeting and closely coordinate with SIGINT to trigger action by either air-defense or artillery units; tactical Russian EW systems are used in artillery targeting.

As Russian EW officers assert, depending on the nature of the specific operations and armed conflict, the main aims of EW are:

- To degrade an adversary's C2 of forces and weapons;
- Reduce the effectiveness of an adversary's intelligence gathering and use of weapons; and
- To maintain resilience in command and control of own forces and weapons.[57]

To summarize, the main role of EW in contemporary Russian military thought includes the following:

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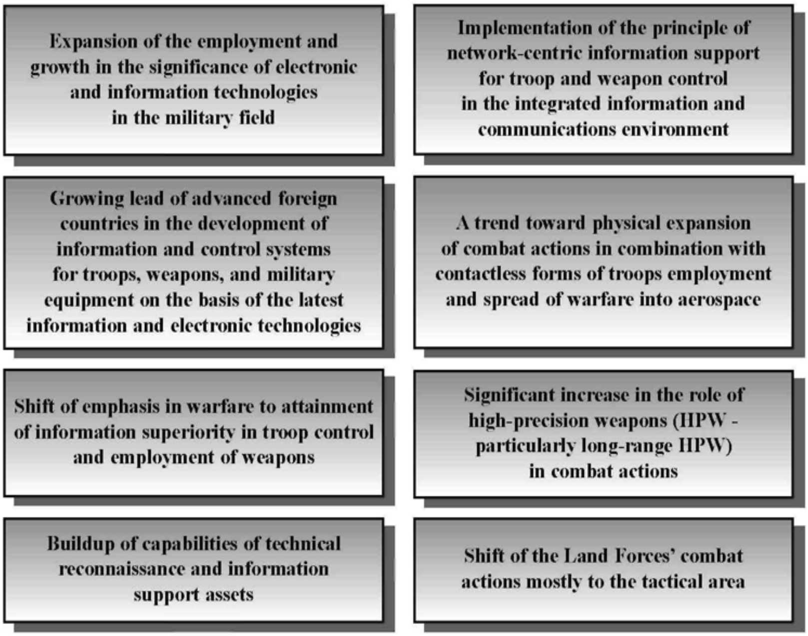
[56] V. Silyuntsev, V. Demin, D. Prokhorov, '*Boyevoye primeneniye REB*,' *Armeyskiy Sbornik*, July 2016, pp. 43–53.

[57] Ye. Nikulin, M. Koval, Yu. Koban, '*Soglasovannoye primeneniye. Osobennosti radioelektronnoy bor'by v sovremennykh vooruzhennykh konflikt*,' *Armeyskiy Sbornik*, No. 9, 2021, pp. 64–70.

- Detection and electronic destruction of radio-electronic objects of the enemy's C2 and reconnaissance systems, including radio, optoelectronic and acoustic suppression, functional damage by electromagnetic radiation, damage with homing weapons for radiation, and imitation of the radio-electronic situation;
- Electronic protection of its electronic facilities, including the coordinated distribution, assignment and use of operating frequencies, ensuring the electromagnetic compatibility of their electronic systems;
- Counteraction of technical means of reconnaissance by the enemy; and
- Control over the implementation of the activities of electronic protection and the technical means of reconnaissance.[58]

[58] Yu. I. Lastochkin, Yu.Ye. Donskov, A.L. Moraresku, '*Analiz sovremennykh kontseptsiy po vedeniyu operatsiy v elektromagnitnom spektre s pozitsiy radioelektronnoy bor'by*,' *Voyennaya Mysl'*, No.4, 2021, p. 32.

Figure 3: Role of Electronic Warfare[59]



A number of factors also conflate to promote the further growth of the importance and relevance of EW in Russia's conventional military capabilities (**Figure 3**). As Lastochkin notes,

> The potential role of electronic warfare is growing significantly in combat actions today and will keep increasing in the future. The explanation is that the new stage of the revolution in science and engineering initiated by the massive employment of electronic assets and computers by the militaries in developed countries encourages them to establish shared integrated computerized electronic information systems. Their basic purpose is now to provide full-scale information support for

[59] Yu. I. Lastochkin, '*Rol' i mesto radioelektronnoy bor'by v sovremennykh i budushchikh boyevykh deystviyakh*,' *Voyennaya Mysl'*, No.12, 2015, pp. 16–21.

> combat actions by the adversary ground troops' task forces and regular formations in general. As a result, therefore, the network-centric system built on the basis of various computerized information assets to support combat actions has been turned into the core component of the adversary's operation (engagement) so that its successful operation has a direct effect on the success of combat actions in our day and age. Fighting these electronic computerized assets and systems is a key element of present-day and future combat actions, on which their course and outcome depend and will depend.[60]

Russia's Contemporary EW Forces: Structure and Training

The chief of the Electronic Warfare Forces of the Armed Forces of the Russian Federation (*Voyska Radioelektronnoy Bor'by Vooruzhonnykh sil Rossiyskoy Federatsii*) is Lieutenant General Yury Lastochkin. A career EW officer, Lastochkin served as platoon and battalion commander during tours of duty in Chechnya (2000–2006). Following his graduation from the Academy of the General Staff in June 2009, Lastochkin was appointed deputy chief of the EW Forces; on August 7, 2014, he was elevated to chief of the EW Forces. Two deputies serve under General Lastochkin: one major general and a colonel.[61] According to the Russian defense ministry,

> The Directorate of the Chief of the Electronic Warfare Troops of the Armed Forces of the Russian Federation is intended to supervise the construction and training of electronic warfare troops, planning and organization of electronic warfare in the

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[60] *Ibid.*

[61] '*Lastochkin Yuriy Illarionovich Nachal'nik voysk radioelektronnoy bor'by Vooruzhennykh Sil Rossiyskoy Federatsii, general-leytenant*,' https://structure.mil.ru/management/details.htm?id=10750759@morfHeroes, Accessed, July 26, 2021.

> Armed Forces, as well as to perform the functions of the central connecting body of electronic warfare equipment for inter-service use and the main radio frequency body of the Russian Ministry of Defense.[62]

The directorate of the chief of the EW Forces consists of four departments and two support services, each of which are headed by a colonel (**Figure 4**).[63] The 1st Department is responsible for the organization and planning of electronic warfare, maintaining the combat readiness of formations and EW units, as well as the organization and implementation of measures for the development and improvement of the EW Forces. The 2nd Department is tasked with organizing training for specialists and military units (subunits) in addition to organizing the daily activities of the EW Forces. The 3rd Department oversees the relevant EW Forces' ability to counteract the technical means of intelligence by foreign states; also, it organizes the radio-electronic protection of radio-electronic means of state and military communications; and it develops the Unified System of Integrated Technical Control of the Russian Armed Forces. Finally, the 4th Department facilitates the pursuit of a unified military-technical policy on the development of EW technology; and it plans and organizes the technical support for the EW Forces.[64]

The two supporting services are the Radio Frequency Service and the Military-Scientific Committee. The Radio Frequency Service is

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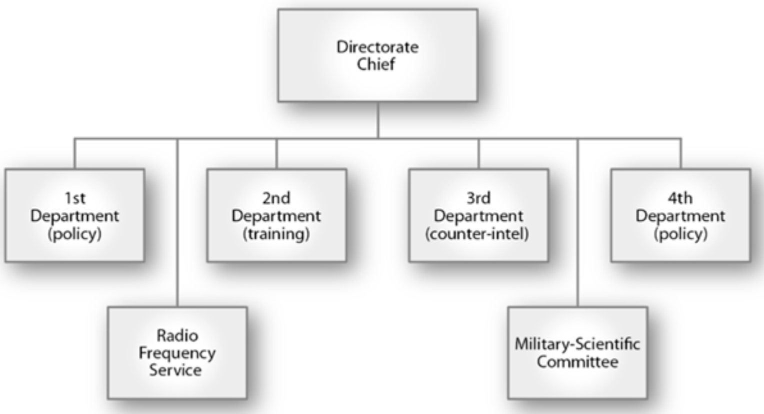
[62] '*Upravleniye nachal'nika voysk radioelektronnoy bor'by Vooruzhennykh Sil Rossiyskoy Federatsii*,' https://structure.mil.ru/structure/ministry_of_defence/details.htm?id=9713@egOrganization, Accessed, July 28, 2021.

[63] *Rukovodyashchiy sostav voysk REB VS RF, 2018,* http://reb.informost.ru/2018/pdf/0-6.pdf.

[64] *Ibid.*

responsible for the determination of the procedures for the use of the radio frequency spectrum for defense purposes and coordinates the activities of federal executive bodies in this area; it also oversees legal protection issues. While the Military-Scientific Committee is tasked with the organization and control of all scientific work for the EW Forces as well as the scientific substantiation of the construction, development and use of the EW Forces, their weapons, military and special equipment, along with military-scientific support at all stages of their life cycle.[65] In this latter area, it most likely coordinates with relevant organizations conducting material-technical support (*materialno-tekhnicheskogo obespechenie*—MTO).

Figure 4: Electronic Warfare Directorate



The reorganization of the military district system in December 2010 reduced the existing six districts to four (Western, Southern, Central and Eastern). These gained the function in wartime of Joint Strategic Commands (*Obyedinennyye Strategicheskoye Komandovanie*—OSK), while retaining the previous Military District (MD) (*Voyennyy Okrug*—VO) functions in peacetime. On January 1, 2021, the

[65] *Ibid.*

Northern Fleet was upgraded to the status of an OSK/MD, formalizing a process that began in 2014; consequently, there are presently five OSKs/MDs.[66]

Each of the OSKs/MDs contains a specialist EW service headed by a major general or admiral. The Western OSK/MD's EW service, at the OSK headquarters, began to function following the reorganization of the military district system in December 2010. Since June 2014, it has been headed by Major General Sergei Gashkov.[67] The Southern OSK/MD's EW service was initially headed by a colonel. Since April 2011, it has been led by Major General Viktor Fedorenko. The EW service of the Central OSK/MD followed a similar pattern, with its colonel head of service replaced, in October 2013, by Major General Sergei Portnykh. The Eastern OSK/MD's EW service was also first headed by a colonel from the EW Forces. However, unlike the other OSKs, this has continued, with its most recent head of service appointed in August 2015: Colonel Sergei Klindukhov. The Northern Fleet OSK/MD, officially formed on January 1, 2021, is headed by Captain 1st rank Valeriy Lukoyanov; he has, in effect, held the post since December 1, 2010, with the EW service of the Northern Fleet located in the fleet HQ.[68]

The Russian service branches (*vid*) and the arms of service (*rod*) also each contain an EW service, headed either by a colonel or a captain 1st Rank. The Ground Forces' (*Sukhoputnye Voiska*) EW Service has functioned as an element in the army since 1969, when it was formally

[66] Yury Gavrilov, '*Flot ukhodit v avtonomku Severnyy flot Rossii priravnyali k voyennomu okrugu*,' *Rossiyskaya Gazeta*, https://rg.ru/2020/12/22/severnyj-flot-rossii-priravniali-k-voennomu-okrugu.html, December 22, 2020.

[67] The officers named as holding these posts is based on data from 2018 that has not been updated by the EW Forces structures.

[68] *Rukovodyashchiy sostav voysk REB VS RF, 2018, Op.Cit.*

created. It is headed by Colonel Igor Kalitkin. The EW service of the Aerospace Forces (*Vozdushno Kosmicheskikh Sil*—VKS) was formed with the creation of the VKS on August 1, 2015; the EW service is headed by Colonel Andrei Tikhonov.

EW in the Military-Maritime Fleet (*Voyenno-Morskoy Flot*—VMF) dates to December 10, 1956, with a radio countermeasures and camouflage department formed as part of the operational management of the Main Staff of the Navy. In the 1960s, the C2 bodies of the VMF's electronic warfare were transformed into the EW services of the General Staff of the Navy, the headquarters of the fleets and flotillas. In the 1980s, the Naval Electronic Warfare Directorate was reorganized into the EW service of the General Staff of the Navy, which, since 1985, has been consistently led by rear admirals. In 2012, the electronic warfare service of the Main Headquarters of the Navy was relocated from Moscow to the Main Admiralty (St. Petersburg). From 2012, the EW service in the headquarters of the VMF is headed by Captain 1st Rank Aleksandr Yachmenev.[69]

Similarly, the Strategic Rocket Forces (*Raketnye Voyska Strategicheskogo Naznacheniya*—RVSN) established an EW service in 1968. In November 1978, the EW Directorate of the RVSN was created, consisting of three departments. By 1987, the EW Directorate of the RVSN again reorganized the EW service into three groups. Starting from June 23, 1993, the EW service was reduced to two groups. Between 1987 and 2001, the RVSN EW service was headed by major general officers or a colonel; after that, the RVSN was reorganized as an arm of service. As of 2014, the RVSN EW service has been headed by Colonel Vladislav Antonov.

Finally, the Airborne Forces' (*Vozdushno-Desantnye Voyska*–VDV) EW service was formed first in August 1968, functioning as an

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[69] *Ibid.*

electronic countermeasures service. In the late 1970s, it was transformed into an EW service and, since 1976, it has been led by colonels. From 2013, the VDV EW service, located in the VDV HQ, has been headed by Colonel Dmitry Arapov.[70]

In the Military-Maritime Fleet (VMF), the EW elements are combined into separate EW centers. In the Aerospace Forces (VKS), four known EW battalions are located in the Air Force and Air Defense Armies (Western OSK/MD: Pesochnyi; Central OSK/MD: Engels; Eastern OSK/MD: Artem; Southern OSK/MD: Novomikhailovskii).[71] EW in the VMF is organized on the basis of specialist EW centers: in the Northern Fleet OSK/MD is the 186th EW center, military unit 60134 (Severomorsk); in the Western OSK/MD is the 841st EW center, military unit 09643 (Yantarny, Kaliningrad); and in the Eastern OSK/MD, there are the 471st EW center, military unit 20918 (Petropavlovsk-Kamchatsky), and the 474th EW center, military unit 10604 (Shtykovo). The Ground Forces, however, by far the leading service in terms of EW assets and their chief advocate for further development, are organically populated with EW units and assets. This includes five EW brigades functioning across the OSK/MD system, providing support to the maneuver brigades (motorized rifle and tank), with EW battalions located within each of the eleven combined-arms armies and one tank army, and present within the maneuver brigade structure at the company level (**Figure 5**).[72]

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[70] *Ibid.*

[71] A.V. Karpenko, '*Voyska radioelektronnoy bor'by VS RF istochnik*,' http://bastion-karpenko.ru/army-electronic-rf/, accessed, August 6, 2021; Author interviews with NATO EW officers by VTC, May 12, 2021.

[72] *15-ya otdel'naya brigada radioelektronnoy bor'by (v/ch 71615),* http://voinskayachast.net/suhoputnie-voyska/specialnie/vch71615; *16-ya otdel'naya brigada radioelektronnoy bor'by (v/ch 64055),* http://voinskayachast.net/suhoputnie-voyska/specialnie/vch64055; *17-ya otdel'naya brigada radioelektronnoy bor'by (v/ch*

Figure 5: Dislocation of Ground Forces EW Brigades and VMF EW Centers

As the reform of the Armed Forces began its structural implementation in 2009, the EW Forces underwent a similar transformation. This utilized the existing disparate EW units throughout the Armed Forces, reorganizing the overall EW Forces structure at operational and operational-tactical levels, alongside strategic level capability. In April 2009, the 15th EW Brigade was formed in Novomoskovsk, Tula Oblast, and was later transferred to Tambov (Western OSK/MD); the process of forming additional EW brigades was finally completed by December 2015, with the 19th EW Brigade in Rassvet (Southern OSK/MD). Russia's Armed Forces now have five EW brigades, located across its OSKs/MDs. Two are located in the Western OSK/MD; one is subordinate to the General Staff and

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11666), http://voinskayachast.net/suhoputnie-voyska/specialnie/vch11666; 1*8-ya otdel'naya brigada radioelektronnoy bor'by*, https://66.ru/rabota/office/182022/; *19-ya otdel'naya brigada radioelektronnoy bor'by*, http://bmpd.livejournal.com/1852552.html. On December 1, 2015, the 1270th electronic warfare center of the Southern MD, located in a suburb of Rostov-on-Don (military unit No. 62829), was reorganized into the 19th EW Brigade.

serves as a reserve structure (**Figure 5**). Each of these brigades consists of four EW battalions and one company.[73] These brigades are tasked with providing combat support to the maneuver brigades; these can also be detached as smaller units depending on the specific mission requirements. The EW brigades vary in terms of size and manpower. While there is no publicly available data on their order of battle (ORBAT),[74] it is likely that they are significantly smaller than the maneuver brigades, possibly similar in size to Multiple Launch Rocket System (MLRS) brigades (approximately 500 personnel).

Additionally, the EW Forces formed battalions in the OSKs/MDs: in the Western OSK/MD, there are the 49th EW battalion, military unit 54916 (Ostrov), the 142nd EW battalion, military unit 03047 (Kaliningrad), EW battalion, military unit 32713 (Pesochny); and there are two additional battalions in unknown locations, the 540th EW battalion and the 703rd EW battalion.

In October 2018, the defense ministry announced an additional effort to further enhance EW capabilities within the Ground Forces by forming new EW battalions functioning at the level of a combined-arms army (CAA); this would place one EW battalion in each of the eleven CAAs and one tank army. This change to the overall structure of EW in the Ground Forces was trialed by forming a new EW

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[73] Aleksey Ramm, Dmitriy Litovkin, Yevgeniy Andreyev, '*V voyska radioelektronnoy bor'by pridet iskusstvennyy intellekt*,' *Izvestia*, http://izvestia.ru/news/675891, April 4, 2017. The 15th EW Brigade in Tambov, in Western OSK/MD, is subordinated to the General Staff. A. Yasinskiy, '*Napravlenie deiatelnosti 15-oi otdelnoi brigady radioelektronnoi borby (verkhnovnogo glavnogo komandovaniia) v oblasti radioelektronnoi borby*,' *Radioelektronnaia bor'ba v Vooruzhennych Silach Rossiiskoi Federatsii*, 2015.

[74] No exact Russian version of ORBAT exists in official manuals or within the military lexicon. The closest equivalence is *gruppirovka sil i sredstv* (grouping of forces and means).

battalion at the 58th Army base in Vladikavkaz, and following the successful experiment the defense ministry decided to proceed with the plan to form these battalions across the CAAs. These subunits are equipped with Divnomorye mobile complexes. Some of Russia's most powerful EW systems, such as the Krasukha series, Leer-3, or Moskva-1, are also located in the Ground Forces' EW battalions; these systems offer ranges of several hundred kilometers. Moscow-based military expert Aleksei Leonkov noted,

> Previously, such battalions were only at military districts' disposal; now, their quantity will increase considerably, and they will appear at a lower [operational] tactical level. So-called inter-branch EW battalions are being created, which it will be possible to rapidly redeploy to the most dangerous zones and to mobilize for various units' and formations' purposes. This will expand manifold the possibilities of electronic concealment. Thanks to modern technology, the troops will be reliably sheltered from an adversary's reconnaissance equipment by interference.[75]

The formation of the 15th EW Brigade in April 2009 signaled at the very earliest stages of the wider reform process that the role of EW would burgeon and take on a new and more organized set of capabilities. While the EW structural transformation accompanied the rapid move to transition the Ground Forces to a brigade-based structure, the approach to forming the EW brigades was more gradual and ponderous; this reflected a careful assessment of the combat support requirements for the newly formed maneuver brigades, primarily rooted in the General Staff assessing the course and results of experimentation in the annual operational-strategic exercises.

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[75] Aleksandr Kruglov, Nikolai Surkov, '*Pekhotu prikroyut elektronnym zontikom*,' *Izvestia*, https://iz.ru/744402/aleksandr-kruglov-nikolai-surkov/pekhotu-prikroiut-elektronnym-zontikom, October 10, 2018.

Forming the fifth EW brigade in late 2015 provided a better organized support base for EW from strategic to tactical levels.[76]

Russia's Ground Forces possess a three-tiered system for EW. At the level of OSKs/MDs, there are five EW brigades in each (with the exception of the Northern Fleet OSK/MD), including one that subordinates to the General Staff; at the level of combined-arms army (CAA), each of the eleven CAAs and one tank army have an EW battalion; and at the maneuver brigade and divisional level, each has an EW company focused on tactical tasks.[77] Additionally, a trend has emerged to expand EW companies in the maneuver divisions into EW battalions, implemented in most of the divisions in the Western and Southern Military Districts.

As a direct result of the reform process, the EW Forces are present throughout the Armed Forces, in the Ground Forces, Aerospace Forces, Military-Maritime Fleet, Strategic Rocket Forces and

[76] '*15-ya otdel'naya brigada radioelektronnoy bor'by (v/ch 71615)*,' http://voinskayachast.net/suhoputnie-voyska/specialnie/vch71615, '*19-ya otdel'naya brigada radioelektronnoy borby*,' http://bmpd.livejournal.com/1852552.html, Accessed, June 17, 2021; Aleksei Ramm, '*Elektronnaya voyna – mify I pravda (chast 1)*,' *Voyenno Promyshlennyy Kuryer*, http://vpk-news.ru/articles/27272, September 30, 2015.

[77] '*Spetsialisty REB obshchevoyskovoy armii ZVO podavili sistemu svyazi uslovnogo protivnika v khode ispytaniy kompleksa Palantin v Voronezhskoy oblasti*,' Ministry of Defense of the Russian Federation, https://function.mil.ru/news_page/country/more.htm?id=12373034@egNews&_print=true, July 20, 2021; Anton Lavrov, Aleksei Ramm, '*Gasi volnu: yug Rossii zakroyut nepronitsayemyye glushilki*,' *Izvestia*, https://iz.ru/1091042/anton-lavrov-aleksei-ramm/gasi-volnu-iug-rossii-zakroiut-nepronitcaemye-glushilki, November 24, 2020.

Airborne Forces.[78] But the Ground Forces, as noted above, are the leading advocate of EW in the Russian military, pushing for greater investment levels, continued modernization and even a higher service status. Thus, General Lastochkin outlines the EW Forces as follows:

> EW forces and means are part of the strategic system of radio jamming, the Unified System of Systematic Technical Control (*Yedinoy sistemy kompleksnogo tekhnicheskogo kontrolya*—KTK), and the array of EW units of military districts, large formations [armies] and formations [divisions, brigades] of the branches and services of the Russian Federation Armed Forces.[79] At present, the main forces and means are concentrated in the Ground Forces, Aerospace Forces and Navy [VMF], and the component inter-service groupings of military districts. In the VDV, we have established EW subunits in assault divisions. In the RVSN, there are KTK subunits for every missile army, division, and testing ground. Since 2014, the forces and means of radio jamming in the districts have carried out duty missions.[80]

Lastochkin highlighted that the reorganization of the Ground Forces into a brigade-based structure has created maneuver brigades (tank and motorized rifle) that all contain EW specialists functioning at the company level. To illustrate this, **Figures 6** and **7** demonstrate the organic location of the EW Forces within the maneuver brigades of Russia's Ground Forces. In the motorized rifle brigades (**Figure 6**), the EW company is shown within the brigade structure. In the top section of the figure are the set of battalions in the motorized rifle brigade,

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[78] Balybin, V.A, Baturin, Yu.O, Gulidov, A.A, '*O sovershenstvovaniyi sistemy vooruzheniya radioelektronnoy bor'by*,' *Voyennaya Mysl'*, No.4, 2013, pp.38-45.

[79] KTK seems to be a Russian variant of electronic support.

[80] Yury Lastochkin, Oleg Falichev, '*Kupol nad Minoborony*,' *Voyenno Promyshlennyy Kuryer*, http://www.vpk-news.ru/articles/36422, April 26, 2017.

with its combat support elements in lower left and the combat service support (such as logistics) in the lower right.

Figure 6: Motorized Rifle Brigade (MRB) Structure

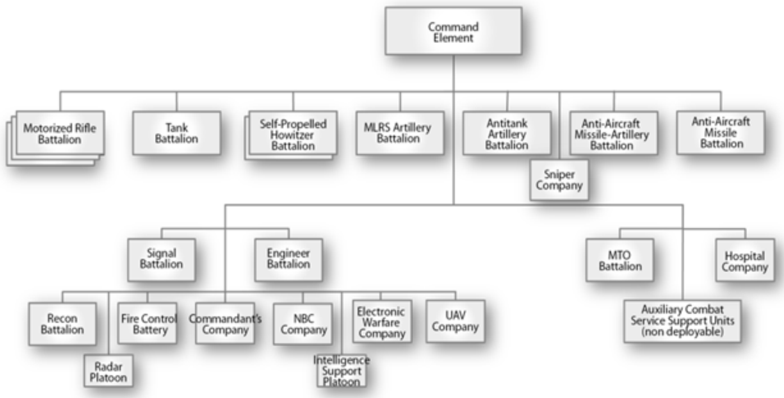
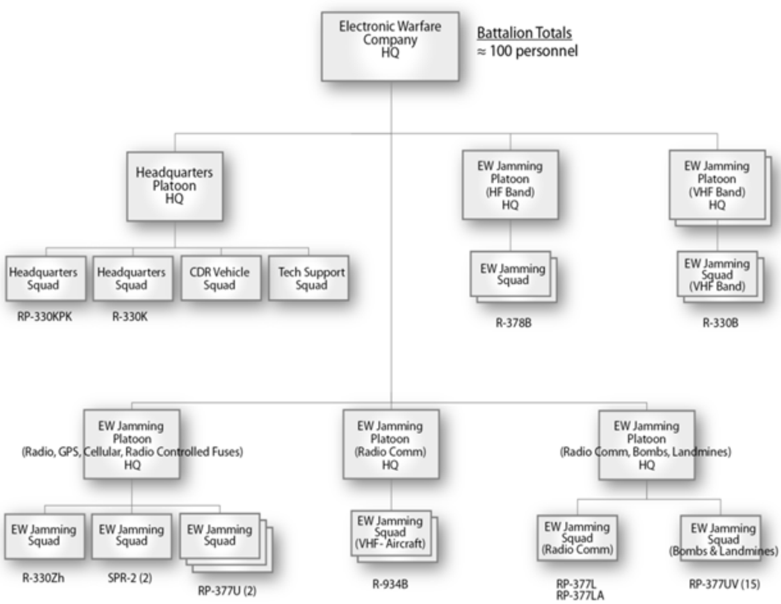


Figure 7: EW Company Structure in the MRB



Among the combat support units is the EW company (structure detailed in **Figure 7**). The EW systems located in the Ground Forces' maneuver brigades reportedly provide coverage of up to 50 kilometers. This is a crucial feature of Russia's Ground Forces, since, in contrast to Western counterparts, the EW component is represented organically within its brigade structure; which means that the army cannot move or conduct combat operations without EW support. Of course, at this level, the EW assets are tactical. At the tactical level, the EW companies within the maneuver brigades possess the following assets[81] (as shown in **Figure 7**):

- RP-330KPK VHF Automated Jamming Station;
- RP-330K Automated Control Station; R-378B HF Automated Jamming Station;
- R330B HF Frequency Jammer linked to the Borisoglebsk-2 HF Automated Jamming Station;
- R-330Zh Zhitel Automated Jammer against INMARSAT, IRIDIUM Satellite Communication Systems, GSM and GPS;
- SPR-2 VHF/UHF Radio Jammer; RP-377U Portable Jammer against improvised explosive devices (IED);
- RP-934B VHF Automated Jamming Station against communications and tactical air guidance systems;
- RP-377L IED Jammer;
- RP-377LP Portable Automated Jammer; and
- RP-377UV Portable Automated Jammer.

A vital role in the development and technological modernization of the EW Forces is played by the Russian domestic defense industry. In 2009, the existing disparate group of domestic defense industry companies working on manufacturing EW systems underwent

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[81] Lester W. Grau and Charles K. Bartles, *The Russian Way of War; Force Structure, Tactics, and Modernization of the Russian Ground Forces*, FMSO: Kansas, Fort Leavenworth, 2016, p. 290.

vertical integration into Kontsern Radioelektronic Tekhnologii (KRET), a member of Rostec.[82] KRET intensively lobbies and promotes EW interests in cooperation with the Russian military. In addition to KRET, Sozvezdiye and the UAV designer Special Technology Center (*Spetsialnyy Tekhnologicheskiy Tsentr*— STTs) also work closely with the EW Forces. In 2010, the defense industry formed the Scientific-Technical Center for EW in Voronezh, (*Nauchno-Tekhnicheskiy Tsentr Radioelektronnoy Bor'by*—NTTs REB). The NTTs REB is responsible for R&D on future EW systems.[83] In October 2015, Defense Minister Sergei Shoigu established the EW Forces Military-Scientific Committee and shortly after formed two scientific-production companies to promote the modernization of the EW inventory. The quantity and quality of EW systems being procured by the Armed Forces has grown as a consequence. Moreover, this was further supported by transforming the EW educational and training system, with its first simulators procured in 2018 to boost EW training capacity. All EW units have been reequipped with Magniy-REB training complexes, and the defense ministry has introduced an integrated teaching and learning system (*Integrirovannyy Trenazherno-Obuchayushchiy Kompleks*—ITOK) designed to further enhance the training of EW specialists.[84]

Following its formation in 2009, KRET worked on the Krasukha-4, a powerful broadband noise jamming station. It entered service in 2012. The system's primary function is to jam the radars of strike aviation.

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[82] Rostec, established in 2007, is the State Corporation for Assistance to Development, Production and Export of Advanced Technology Industrial Product. It specializes in investing in strategically important companies mainly in the defense and high-technology sectors of the Russian economy.

[83] See: http://www.ntc-reb.ru/.

[84] Yury Lastochkin, '*Ni dnya bez pomekh*,' *Voyenno Promyshlennyy Kuryer*, http://www.vpk-news.ru/articles/30428, April 27, 2016.

The initial user of the Krasukha-4 was the VKS, employing the system to provide cover for critically important targets. Since its first introduction, the Krasukha-4 systems entered service with other combat arms. In 2013, KRET developed jamming stations to counter radio-actuated proximity fuses of SPR-1 and SPR-2 artillery munitions. The modernized Rtut-BM is an advanced version of such systems. KRET supplied ten Rtut-BM systems for the EW Forces in 2013; the contract concluded was for 700 million rubles ($12 million). The Kaluga Scientific Research Institute of Radio Technology (*Kaluzhskiy Nauchno-Issledovatelskiy Radiotekhnicheskiy Institut*—KNIRTI), the leading Russian enterprise in the development of primarily air-based EW systems, facilities and assets, is also part of KRET. KNIRTI was tasked with developing the fourth-generation Khibiny ECM suite for the Su-34 fighter-bomber, intended to protect the aircraft against engagement by air-defense assets. It differs from older-generation systems in its multilevel multiprocessor control system employing digital methods of signal processing.[85]

In addition to KNIRTI, Samara's Ekran Scientific Research Institute Federal State Unitary Enterprise (*FGUP Nauchno-Issledovatelskiy Institut Ekran*) is a major developer of aircraft EW systems. The enterprise specializes in multifunctional integrated onboard systems of protection against engagement by air-defense missiles fitted with radar and infrared guidance. A new NII Ekran product, the Vitebsk family of EW systems, based on the L-370-3S active jamming station, began entering service with the Air Force in 2013. The Vitebsk is intended to replace the Gardeniya and Sorbtsiya ECM systems developed in the 1970s and 1980s. Individual elements of the Vitebsk have been installed on the Ka-52 helicopter and Mi-8MT transport helicopters. Other products from the Samara NII include an onboard

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[85] Sergei Denisentsev, '*Okno vozmozhnostey dlya REB*,' *Voyenno Promyshlennyy Kuryer*, https://vpk-news.ru/articles/20874, June 30, 2014.

active jamming station, an optronic suppression laser station, an active towed radar decoy, and expendable jamming transmitters.[86]

The Taganrog Scientific Research Institute of Communications (*Taganrogskiy Nauchno-Issledovatelskiy Institut Svyazi*—TNIIS), the leading Russian enterprise for the development of EW systems for the VMF, is part of KRET. All the major surface ships of the Russian fleet are equipped with instrumentation it has developed. The KRET enterprises' output has been delivered to all the branches and combat arms of the Armed Forces. In April 2012, by a decision of the Russian Federation Government's Military Industrial Commission, Yury Mayevskiy, the deputy general director of KRET, was appointed general designer for electronic warfare systems and facilities.[87]

A no less important element in ensuring the quality of the EW Forces relates to training. The training of specialists for the EW Forces is entrusted to the Military Educational and Scientific Center of the Air Force Academy "named after Professor N. Ye. Zhukovsky and Yu. A. Gagarin," and the Inter-branch Center for the Training and Combat Use of Electronic Warfare Troops (training and testing).[88] The training of EW specialists for the VKS is performed at the VVS Academy by the 5th Faculty of EW and Information Security. Also, the planning and implementation of scientific activities in the EW Forces is carried out by the Research and Testing Institute for Electronic Warfare of the Military Educational and Scientific Center of the Air

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[86] *Ibid.*

[87] *Ibid.*

[88] V. A. Anokhin, V. V. Mikhailov, D. V. Kholuyenko, '*O napravleniyakh sosredotocheniya usiliy v razvitiyi radioelektronnogo vooruzheniya*,' *Voyennaya Mysl'*, No.3, 2016, pp. 81–87.

Force.[89] Since 2019, the Air Force Academy in Voronezh has been developing a program of professional training for EW specialists aimed at formulating methods of disorganizing enemy robotic EW systems.[90]

Junior specialists for units and subunits of the EW Forces are organized at the Inter-Branch Center for the Training and Combat Use of Electronic Warfare Troops (Tambov) (*1084-go Mezhvidovogo tsentra podgotovki i boyevogo primeneniya*—MTsPBP). The EW center in Tambov uses integrated simulator complexes in the training of personnel. According to General Lastochkin, the MTsPBP was specially designed and built for the training of EW specialists. Officers are trained at the Faculty of Electronic Warfare and Information Security at the Military Educational and Scientific Center of the Air Force Academy in Voronezh.[91] Highly qualified officers serving as EW specialists can access courses of the Military Educational and Scientific Center of the Ground Forces Combined Arms Academy, the Military Academy of Communications named after Marshal of the Soviet Union S. M. Budyonny, the Strategic Missile Forces Military Academy named after Peter the Great, and the A. F. Mozhaisky,

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[89] '*Upravleniye nachal'nika voysk radioelektronnoy bor'by Vooruzhennykh Sil Rossiyskoy Federatsii*,' *Op.Cit*.

[90] M. V. Zhirnov, '*Organizatsiya podgotovki spetsialistov radioelektronnoy bor'by k dezorganizatsii sistem upravleniya nazemnymi robototekhnicheskimi sredstvami inostrannykh armii*,' *Vozdushno-Kosmicheskiye Sily. Teoriya i Praktika*, No.14, 2020, pp. 26–40; S. V. Golubev, M. V. Zhirnov, A. I. Chernenko, '*Obosnovanie dopolnitel'nogo soderzhaniya voenno-professional'noy podgotovki specialistov radio`elektronnoy bor'by v voennom vuze dlya vypolneniya zadach dezorganizacii sistem upravleniya nazemnymi robototehnicheskimi sredstvami inostrannyh armii*,' *Vozdushno-Kosmicheskiye Sily. Teoriya i Praktika*, No.12, 2019, pp. 75–83.

[91] V. A. Balybin, '*Nauchno-issledovatel'skiy ispytatel'nyy institut (radioelektronnoy bor'by) — 60 let na strazhe efira*',' *Voyennaya Mysl'*, No.12, 2020, pp. 78–85.

Military Academy of Aerospace Defense named after Marshal of the Soviet Union G. K. Zhukov.[92]

When it comes to training and EW exercises, Lastochkin observes,

> Particular attention in the course of exercises and training is paid to increasing the level of training of personnel, improving the skills and abilities of conducting electronic warfare in a complex electronic environment. In addition, new forms, methods and techniques of combat are being tested, specialist and research tasks are being solved. As a result of these measures, the strengths and weaknesses of the combat training of EW units and subunits are revealed, on the basis of the analysis of which, during assembly events with the leadership of the EW Forces, specific tasks are set for subsequent periods of training.[93]

Equally, EW Forces training involves tactical and operational-strategic military exercises. Combat training is an integral part of training in the course of the daily activities of the EW Forces. Annually, EW formations and units participate in command post exercises and special exercises of the EW Forces. The EW Forces regularly organize and conduct joint training of their units with non–defense ministry units from the Ministry of Internal Affairs (*Ministerstvo Vnutrennikh Del*—MVD), the Federal Security Service (*Federal'naya Sluzhba Bezopasnosti*—FSB), Federal Protective Service (*Federalnaya Sluzhba Okhrany*—FSO), Federal Service for Technical and Export Control (*Federal'naya Sluzhba po Tekhnicheskomu i Eksportnomu Kontrolyu*—FSTEK), and the Ministry of Telecom and Mass Communications of Russia on Conducting Radio and Radio

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[92] Viktor Khudoleyev, '*Strazhniki efira na pravil'nom puti*,' *Krasnaya Zvezda*, April 15, 2020.

[93] *Ibid.*

Engineering Control (*Minkomsvyazi Rossii po vedeniyu radio i radiotekhnicheskogo kontrolya*).[94]

According to the plans formed annually by the chief of the EW Forces, special tactical exercises and specialist exercises are conducted within EW units and subunits; these are carried out at brigade, battalion and company levels. Thus, in the annual training cycle of the EW Forces, as well as their own tactical- and operational-level exercises and while participating in the annual operational-strategic military exercises (Zapad, Vostok, Tsentr, Kavkaz), these units also train with non–defense ministry security forces. Since 2012, the tempo of EW exercises has increased two-fold; and in August 2016, it staged the Elektron-2016 EW exercise—the first of its kind since 1979.[95] The Elektron EW exercise has become an annual training event. Moreover, bilateral defense agreements allow Russia's EW Forces to conduct joint training activities with allies. For example, in December 2009, Moscow and Minsk signed a bilateral defense agreement to cooperate on EW and planned to form a unified EW system for the regional group of forces. Belarus appears to be Russia's closest partner on EW; the level of EW coordination and cooperation between Minsk and Moscow peaks every four years in the joint Belarusian-Russian

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[94] V. Lobov, P. Chernyshov, O. Gaponov, '*Sovremennyy opyt organizatsii i prakticheskogo resheniya zadach radio-, radiotekhnicheskogo kontrolya i monitoringa radiochastotnogo spektra vo vzaimodeystvii s federal'nymi organami ispolnitel'noy vlasti Rossiyskoy Federatsii*,' *Radioelektronnaya bor'ba v Vooruzhennykh Silakh Rossiyskoy Federatsii – 2017*, http://reb.informost.ru/2017/pdf/1-9.pdf, pp. 45–47.

[95] '*Spetsialnyye Ucheniya Elektron-2016 Provodyatsya Na Yuge Rossii*,' DefendingRussia.ru, https://defendingrussia.ru/a/cpecialnyje_uchenija_elektron2016_prohodjat_na_juge_rossii-6207/, August 19, 2016.

Zapad combined strategic exercise (*sovmestnoe strategicheskoe uchenie*).[96]

Indeed, the annual operational-strategic military exercises, the highlight of the combat training year in Russia's Armed Forces, are consequently always staged with the participation of the EW Forces. They are inherently involved in many aspects of these exercises, including coordination with air defense to counter notional massed missile-aviation strikes (*massirovannyye raketno-aviatsionnyye udary*—MRAU) by the hypothetical adversary. In terms of the MRAU, Russian military theorists, including EW specialists, are paying increasing attention to the role of EW in countering enemy use of MRAU. This may involve overwhelming numbers of UAVs (including swarms), cruise missiles and other precision-guided munitions (PGM), alongside decoys, etc., which cannot be neutralized by kinetic means alone (not enough surface- or air-to-air missiles). Consequently, EW means are regarded as an intrinsic element in countering enemy MRAU. They are important since, in some cases, EW offers the ability to neutralize or degrade some means of air attack non-kinetically. The mix of kinetic and non-kinetic means to counter the MRAU involves other defensive measures (using camouflage, decoys, etc.) and offensive measures (attacking adversary PGM carriers, bases, including aircraft on the ground, ships, etc.), and is seen by Russian military theorists as the only way to effectively repel a large-scale US/NATO attack.[97]

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[96] 'Moscow, Minsk to Jointly Prepare Electronic Warfare Structure,' *Interfax*, June 8, 2011.

[97] Nikolai Boky, Viktor Silyuchenko, Igor Kamensky, '*Vazhneyshaya zadacha ZRV VKS*,' *Vozdushno-Kosmicheskiy Rubezh* 9, No. 3, August 2019, p. 83; Oleg Kotov and Andrey Chizhankov, '*Effektivnaya razvedka vozdushnogo protivnika*,' *Arsenal Otechestva*, November 6, 2018; V. I. Litvinenko, '*Osnovnyye Tendentsii Ognevogo Porazheniya v Yedinom Informatsionnom Prostranstve v Sovremennykh Operatsiyakh (Boyevykh Deystviyakh)*,' *Vestnik*, No. 1, 2014, pp. 99–103.

The air-defense units tasked with mounting such a response work closely with the EW Forces. In Zapad 2021, these units were involved in rehearsing defense against enemy use of UAV swarms.[98] And during Zapad 2017, for example, the participating Russian EW Forces divided into red and blue teams at one stage of the exercise in order to train for operations in a contested EMS operational environment.[99]

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[98] In August 2021, in preparation for Zapad 2021, a joint EW grouping was formed (Belarus and Russia). EW units and subunits were tasked with breaching the communication channels of the opposing side, interfering with radio exchange, and protecting their own forces from electronic intelligence. The Russian defense ministry also stated that the EW emphasis during the exercise was to counter enemy cruise missiles and UAVs along with fire and electronic impact on a simulated enemy. Roman Kretsul and Anna Cherepanova, ' "*Izmerit" podavleniye: v sentyabre proydut masshtabnyye ucheniya voysk REB*,' *Izvestia*, https://iz.ru/1205342/roman-kretcul-anna-cherepanova/izmerit-podavlenie-v-sentiabre-proidut-masshtabnye-ucheniia-voisk-reb, August 11, 2021.

[99] '*Spetsialisty REB ZVO distantsionno vyveli iz stroya stayu udarnykh dronov uslovnogo protivnika na SSU Zapad-2021 na poligone Mulino v Nizhegorodskoy oblasti*,'
https://function.mil.ru/news_page/country/more.htm?id=12383502@egNews, September 11, 2021; '*Podrazdeleniya REB i svyazi soyedineniy YUVO i VDV razvernuli sistemy ASUV i obespechili zashchitu ot BLA protivnika pod Volgogradom v khode SKSHU Kavkaz-2020*,'
https://function.mil.ru/news_page/country/more.htm?id=12315189@egNews, September 21, 2020; Natalya Valkhanskaya, '*Podrazdeleniya REB vychislili terroristov na ucheniyakh Tsentr-2019*,' Tvzezda,
https://tvzvezda.ru/news/2019920555-R90W5.html, September 20, 2019; Anton Valagin, '*Na ucheniyakh Vostok primenyat sekretnoye elektronnoye oruzhiye*,' *Rossiyskaya Gazeta*, September 12, 2018; Oleg Vladykin, '*Zapad-2017 natselen na zashchitu Vostoka*,' *Nezavisimoye Voyennoye Obozreniye*, September 15, 2017; '*Sily PVO Zapadnogo voyennogo okruga razvernulis' v novykh rayonakh na ucheniyakh Zapad-2017,*' TASS, September 16, 2017; '*SKShU Kavkaz-2016*,'
https://sc.mil.ru/files/morf/military/archive/FR_2016-09-12.pdf, September 13,

Since the reformed structure of the EW Forces emerged alongside the annual operational-strategic exercises, every one of these exercises has featured the involvement of the EW Forces across a broad range of participation activities—from air defense through to providing combat support for ground defense and counter-offensives for the Ground Forces, embedded in rehearsed strikes, as well as maneuvers by all service branches and arms of service.[100]

Modern and Future Russian EW Systems

The EW Forces have benefited exponentially and consistently from Moscow's wider efforts to reform and modernize its conventional Armed Forces. Initiating the creation of the Ground Forces' EW brigades in 2009 and completing this process by 2015 presaged the reintroduction of annual EW military exercises for these forces in 2016. Likewise, the modernization of Russia's EW assets has proved to be relentless. While much of this relied upon Soviet-era design plans, the results of this inventory modernization are nevertheless considerable. To appreciate the scale and depth of these processes, it is necessary to provide an overview of EW systems entering service in recent years and what they are designed to achieve in support of combat operations, outlining aspects of the research and development (R&D), and turning to the EW Forces' leadership to examine their perspectives on the future priority areas of EW systems development. As already noted, many features of the Russian conceptualization and approaches toward EW are unique to their system and military culture. Of paramount importance is the extent to which the EW

2016; '*V khode ucheniy Tsentr-2015 voyska REB otrabotayut naneseniye radioelektronnogo udara*,' *Vesti*, September 15, 2015.

[100] A. S. Korobeynikov, D. V. Kholuyenko, S. I. Pasichnik, '*Effektivnost' gruppirovki voysk radioelektromioy bor'by v khode kompleksnogo porazheniya informatsionno-iipravlyayushchey sistemy protivnika*,' *Voyennaya Mysl'*, No.8, 2015, pp. 30–34.

capabilities are fully integrated into the structural architecture of the Russian Armed Forces. As Bartles and Grau explain,

> Russian electronic warfare involves the normal missions of controlling and denying the enemy use of the electromagnetic space through electronic attack (counter-measures), electronic protection (counter-counter-measures), and electronic warfare support (search, interception, locations and identification measures). However, the Russians include physical destruction as an integrated part of electronic warfare. To do this, they will assign high-performance aircraft, helicopter gunships, artillery and mortars and ground assault to the assets included in the electronic warfare maneuver group. The electronic warfare maneuver group may be formed in support of an attack, withdrawal or march under threatened conditions. The Russian maneuver brigade's EW company is a central actor in this effort but the effort is controlled by the brigade.[101]

EW in support of combat operations is organized and conducted by the commander of the combined group of forces (the commander of the OSK) alongside the instructions from the General Staff. The sequences and content of the work by the EW Forces will follow guidelines and directives from the operational C2. The structure of the EW group of forces is determined by purposes they are assigned in support of combat missions, the nature of the electronic operational environment in the theater of military operations, as well as the capabilities and condition of EW assets available.[102] EW groups of forces and assets for assigned tasks in an operation are formed to

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[101] Dr. Lester W. Grau and Charles K. Bartles, *The Russian Way of War; Force Structure, Tactics, and Modernization of the Russian Ground Forces*, p. 298.

[102] Nikulin, Koval, Koban, '*Soglasovannoye primeneniye. Osobennosti radioelektronnoy bor'by v sovremennykh vooruzhennykh konflikt*,' *Op.Cit.*

support combined-arms groups of forces as they are being created along functional, zonal and geographical lines. If one or two strike groups are formed, then the same number of EW groups of forces and assets may be created. EW units from the OSKs (combined formations, formations) and under central subordination are added to support missions in an armed conflict zone. From these units, mobile EW groups (tactical groups) are formed for autonomous operations in specific locations. EW against the C2 systems of an adversary's forces and weapons involves delivering the selected ways of electronically affecting elements of those systems, conducted in close coordination with the use of firepower against command posts and electronic nodes and of intelligence gathering and concealment assets.[103]

Examples of Ground Forces EW systems functioning at the company level in maneuver brigades are as follows:

- The R-378AM High Frequency (HF) communications jammer, designed for detection and finding the direction of enemy HF radio frequencies. The jammer provides analysis of and selects the emitters' signal parameters.[104]
- The upgraded R-330B/R-330T Very High Frequency (VHF) jamming system, designed for detection, direction finding, and jamming of VHF communication and tactical C2 links at fixed frequencies with conventional waveforms, in

[103] *Ibid.*

[104] Operating frequency range 1.5–30 Megahertz (MHz); Panoramic scan rate 480 MHz/s; Jamming output power 1.0 kilowatt (kW); Narrowband 3.0; 10.0; 20.0; 50.0; Response rate (from detection to jamming) 15 milliseconds (ms); Multi-target jamming capability up to 5; Deployment time less than 40 minutes; Scan rate up to 7,000 MHz/s; Detection-to-suppression time less than 5 ms; Frequency hopping signal detection up to 300 hop/s Crew of 4; Truck chassis Ural-43293.

programmable and automatic frequency tuning modes, as well as for transmitting short encoded messages.[105]

- The R-934B Automated VHF–UHF Aircraft Radio Communication Jamming Station, designed for detection, direction finding, position finding (using two jamming stations) and jamming of VHF–UHF aircraft radio communication means, tactical aircraft guidance systems in the 100–150 Megahertz (MHz) and 220–400 MHz frequency bands as well as terrestrial radio communications and mobile radios in the 100–400 MHz range that use fixed frequencies, frequency hopping and transmission of short telecode messages. The R-934B can operate under a command post or operate independently.[106]
- The P-330ZH Zhitel automated jamming station, which provides for the automated detection, direction finding and signal analysis of radio emission sources in the designated operating frequency range. The system is capable of disrupting the enemy's ability to locate mobile ground stations (user terminals) of the "INMARSAT," "IRIDIUM," and GSM-900/1800 satellite communication systems, the

[105] The jamming system provides analysis and selection of emitters' signal parameters. The R-330B/R-330T VHF jamming system consists of an equipment vehicle on a wheeled (R-330T) or tracked (R-330B) chassis, a diesel electric power station mounted on a two-axle trailer (R-330T), or an MT-Lbu armored tracked chassis (R-330B).

[106] Frequency range 100–400 MHz; Transmitter power 500 W; jammed RF links (at fixed frequencies) 4; jammed RF links (with frequency hop) 1; RMS direction-finding error not more than 3 degrees; Time of deployment 30 minutes; Crew 3; Types of jamming signals: 1) high-frequency signal modulated in frequency by noise with deviation of 800 and 6000 Hz, 2) high-frequency signal modulated in frequency shift of 5, 10, 20 and 40 kHz and unit intervals of 150 and 800 μs, 3) high-frequency signal manipulated in phase (0–180°) with discretization of unit elements of 800 μs.

"NAVSTAR" (GPS) satellite navigation system, and the base stations cellular communication system.[107]

- The SPR-2 (Rtut-B) jamming station, designed to protect friendly troops and equipment against artillery fire equipped with radio proximity fuses by causing premature detonation.[108]
- The RP-377L (Lorandit) Compact Multifunctional Radio Monitoring, Direction-Finding and Jamming Complex, which provides for the search of position location and jamming of VHF/UHF radio electronic communications.[109]
- The Borisoglebsk-2, one of Russia's newest tactical EW systems, which started replacing the R-330 Mandat in 2012. The Borisoglebsk-2 is the primary and latest EW system operating at the company level in the maneuver brigades and divisions. Although few published details exist about the characteristics of the Borisoglebsk-2, it reportedly can suppress twice the frequency bandwidth of its predecessor in the HF and UHF bands, and it operates 100 times faster. Reportedly, it has the capability to disrupt mobile satellite

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[107] Frequency range 100–2,000 MHz; Transmitter power 10 kW; Suppression range 20–30 km; RMS direction-finding error not more than 2 degrees; Time of deployment less than 40 minutes; Crew 4.

[108] Protected area 5 km; Frequency range 95–420 MHz; Energy potential not less than 300 W; Deployment times less than 4 minutes; Crew 2.

[109] Frequency range (search and detection) 20–2,000 MHz; Frequency range (direction and finding) 25–2,000 MHz; RMS direction-finding error not more than 3 degrees; Instant monitoring bandwidth 180–1200 kHz; Types of searching signals FM, AM, SSB, FSK, PSK; Transmitter output greater than 100 W; Deployment time 15 minutes.

> communications and radar navigation systems. The system is mounted on an MT-LBu chassis (extended length).[110]

In addition to such examples of EW systems functioning within the EW Forces, the systematic modernization that followed the 2008 reforms has resulted in a swathe of complexes entering service. These include the RB-341V Leer-3 electronic jamming system equipped with the Orlan-10 UAV; the Sled-KU integrated technical monitoring and communications intelligence collection station; and the LGSh-503 information leakage prevention equipment (*sredstvo predotvrashcheniya utechki informatsii*). The EW Forces also received the modernized Krasukha-4 complex. The Krasukha series was first designed for the RVSN, but the Krasukha-4 operates within the EW brigades and the VKS. Lieutenant Colonel Yevgeny Shaydt, the chief of the Western OSK/MD EW Service's Electronic Engagement and Electromagnetic Compatibility Support Section, states,

> The Krasukha-4 mobile complex is distinguished by an exquisite design solution, multifunctionality, and use of the newest software. An entirely new complex capable of performing an enormous number of electronic detection and warfare missions against enemy UAVs has been created based on SPN-2 and SPN-4 jammers. Krasukha-4 successfully counters onboard radars of the most advanced attack, reconnaissance, and unmanned aviation at ranges up to 300 km.[111]

The Leer-3, which also operates in the EW battalions, aerodynamically is a scatterable (*zabrasyvayemyy*) jammer capable of

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[110] Grau, Bartles, *The Russian Way of War; Force Structure, Tactics, and Modernization of the Russian Ground Forces*, pp. 292–297.

[111] Vladimir Chernov, '*Krasukha - imya: novyye mobil'nyye kompleksy vkhodyat v sostav voysk radioelektronnoy bor'by*,' *Na Strazhe Rodiny*, April 15, 2016.

simultaneously blocking three cellular communications operators within a radius of up to six kilometers. The Dzyudoist, Lorandit and Plavsk complexes, along with the Svet-VSG fixed radio monitoring equipment, are all used for integrated technical monitoring. The Svet-KU mobile EW complex became operational in 2012; it operates in the 30–18,000 MHz frequency band. The Pelena-1 high-power ground jamming complex jams early-warning aircraft radars at a distance up to 250 km. Also, the Borisoglebsk-2 EW complex, mounted on the MT-LBu (multipurpose lightly armored tracked carrier), has been in service since 2014. It uses energy- and structurally secure broadband signals, providing jam-resistant high-speed data transmission. Gurzuf, Ograda and Start radar jammers, PK-2 and PK-16 launchable jammer complexes with radar and thermal jamming projectiles, and ML-22 and ML-27 deception decoys became operational with the VMF. The strategic-level Murmansk-BN complex, at least one of which was known to have been based in Sevastopol (Crimea) prior to the Kremlin's massive invasion of Ukraine on February 24, 2022, has an effective range of 3,000 km and can jam more than 20 frequencies simultaneously.[112]

The first Murmansk-BN complexes entered service at the 841st EW Center of the Baltic Fleet in late 2019. Murmansk-BN is one of the most powerful EW systems in the world. This is an automated radio-interference complex for communication lines in the short-wave (HF) range. Most of the information about it is classified. It is known that the range of jamming radio communications of the complex is about 3,000 km; and with an ideal signal transmission, some reports suggest it can be increased to 8,000 km. The standard deployment time of equipment is 72 hours, after which it can, at a distance of several thousand kilometers, not only deprive an enemy ship of communication and navigation but also disable the electronics of its onboard weapons. Work on strategic EW systems began in the USSR

[112] *Ibid.*

in the 1960s, but it was only possible to develop the necessary basis and manufacture a prototype in 2015. Then it was first tested in the Northern Fleet and introduced there a year later. In March 2017, Murmansk-BN was also deployed in Crimea.[113] These systems deployed in the Baltic and Black Sea regions provide considerable Russian EW coverage on NATO's eastern flank.

In January 2016, *Krasnaya Zvezda* reported the procurement of the Murmansk-BN in the 471st EW Center in Kamchatka, boosting the EW capabilities of the Eastern OSK/MD and the VMF Pacific Fleet. The Kamchatka 471st EW Center received two Murmansk-BN modern automated systems for radio-electronic suppression of enemy shortwave communications. In march mode, each of them comprises a mobile fleet of seven heavy multi-axle automotive vehicles on a KAMAZ platform with appropriate hardware. When combat-deployed, the latest system occupies an area of 640,000 square meters. "The Murmansk-BN is a 21st century arsenal," Captain 3rd Class Roman Nechayev, the chief of staff of the 471st EW Center, stated, adding,

> The basis of operation of the latest system comprises modern mathematical principles. In its specifications it surpasses its predecessor by almost several orders of magnitude. For example, the stations of the old fleet were rated at five kW. The Murmansk-BN in certain modes of operation can reach 400 kW. Other features of the new equipment are also impressive, in

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[113] Aleksei Kozachenko, '*Glushitel'nyy uspekh. V Kitaye vysoko otsenili sistemu REB Murmansk-BN*,' *Argumenti i Fakti*, https://aif.ru/society/army/glushitelnyy_uspeh_v_kitae_vysoko_ocenili_sistemu_reb_murmansk-bn, October 4, 2021.

> particular, its range of effective application. The distance of 3,000 km for the Murmansk-BN is not its limit.[114]

This means that in the hands of the Kamchatka EW specialists, the system is capable, from its deployment site, of performing tasks both on its territory and far from its approach routes—and if necessary, outside the 12-mile territorial waters zone, from Chukotka to islands in the Sea of Japan.

R&D on EW systems is led by Egorievets V. The firm has reportedly carried out state tests of a complex of climatic EW equipment. Another critical element in conducting EW R&D is the Research Institute of the Air Force Academy. Its scientific and industrial activities cover all aspects of EW, from the development of conceptual and regulatory documents to developmental work at all stages in the life cycle of the technology. In addition, at the federal level, NIII (REB) carries out information and analytical support for the work of the military industrial complex and the Interdepartmental Commission for planning and coordinating the development of the EW system. The institute is principally made up of nine military-scientific schools, comprising 19 doctors and more than 130 candidates of science. Studies are conducted in close cooperation with the defense ministry, the services of the various EW Forces in the Armed Forces, the OSKs/MDs, and defense enterprises. A full cycle of research is provided for "idea," "prototype" and "testing." An example of fruitful cooperation is the organization of close cooperation between the Research Institute of the Air Force (Voronezh) and the Academic Institutes of Theoretical and Applied Electrodynamics (Moscow), Informatics and Automation (St. Petersburg) in the form of "virtual" joint laboratories, the provisions of which are approved by the

[114] Yury Rossolov, '*Korotkovolnovyy ekran*,' *Krasnaya Zvezda*, January 18, 2016.

president of the Russian Academy of Sciences and the chief of the General Staff.[115]

In a statement about the priorities in the State Armaments Program (*Gosudarstvennaya Programma Vooruzheniya*—GPV) 2018–2027, President Vladimir Putin refereed to EW assets as well as developing and further strengthening high-technology precision strike systems. Putin highlighted the focus of the GPV to 2027 "on equipping the troops with high-precision air-, land- and sea-based weapons, UAVs, as well as equipping servicemen with the latest reconnaissance, communications and electronic warfare." EW capability will continue to receive strong state support as the military modernization continues.[116]

In an interview in April 2018, Colonel Yury Gubskov, the chief of the EW Forces' 1084th Inter-Branch Training and Combat Employment Center (MTsPBP), noted that Russia's EW capability can impact on the C4ISR of all foreign militaries.[117] On the future procurement priorities for the EW Forces, Gubskov asserted that Russia's EW systems are qualitatively changing:

> They are becoming more mobile, highly-intelligent, and automated. A gradual transition is occurring from narrowly specialized to multifunction complexes, which permit the

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[115] Yury Lastochkin, Oleg Falichev, '*Kupol nad Minoborony*,' *Voyenno Promyshlennyy Kuryer*, http://www.vpk-news.ru/articles/36422, April 26, 2017.

[116] Vladimir Mukhin, '*Rossiyu ozhidayet demilitarizatsiya*,' *Nezavisimoye Voyennoye Obozreniye*, https://www.ng.ru/politics/2018-05-11/1_7222_demiltaryrisation.html, May 11, 2018.

[117] Aleksei Ramm, '*Novyye sistemy smogut effektivno reshat' zadachi bez uchastiya cheloveka*,' *Izvestia*, https://iz.ru/733218/aleksei-ramm/novye-sistemy-smogut-effektivno-reshat-zadachi-bez-uchastiia-cheloveka, April 27, 2018.

> disruption of the functioning of various types of electronic systems—radars, radio communications, navigation, and others. The development of information technologies and their use in electronic warfare hardware permits us to talk about the possibility of the development of robotic complexes with elements of artificial intelligence in the near term. The new systems will be able to effectively accomplish missions in a complex electronic situation without human participation.[118]

The EW emphasis in the GPV to 2027, therefore, appears to be most likely centered upon automation, mobility, and exploiting AI and robotic complexes. The first brigade-level EW C2 system, the RB-109A Bylina automated EW system, has an AI capability aiding its automated C2. This utilizes advanced technologies. Russian media reports frequently use the term *avtomatizirovanniy* (automated) to describe such systems. However, the advanced technology features of the RB-109A Bylina specifically uses the term *iskusstvennyy intellekt* (artificial intelligence). Reportedly, the Moskva-1 EW system also benefits from AI technology. The defense ministry plans a large-scale procurement of the Bylina EW complexes to be completed by 2025. Bylina can analyze the situation and find and classify targets in real time without the operators' participation. After this, it determines which systems will better suppress or destroy enemy communications equipment or other targets. Russian experts note that the employment of these complexes will significantly increase the effectiveness of the EW systems on the battlefield. *Arsenal Otechestva* editor-in-chief Viktor Murakhovskiy stated, "The battlefield's contemporary information space is saturated with electronic systems—both ours and the enemy's. We are talking about unmanned aerial vehicles, communications systems, and radars. In that situation, it is important

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[118] *Ibid.*

to suppress enemy electronics and, in so doing, not interfere with our own."[119]

The Russian Moskva-1 EW system, which has been supplied to the Ground Forces since 2015, has two modules: the 1L265E electronic intelligence module and the 1L266E automated control post for jamming stations. Moskva-1 is designed for the detection of the enemy's military equipment and cruise missiles by monitoring the airspace. Moskva-1 identifies targets, sets the course, measures parameters and trails air radiation sources operating in the radio frequency range. Moskva-1 transmits data on detected enemy targets to either air defense and aviation units for destruction, or to other electronic warfare systems for suppression. Often, the Moskva-1 system works in conjunction with the Krasukha S-4 EW system. Moskva-1 can simultaneously set tasks for nine electronic warfare and air defense systems. At the same time, Moskva-1 remains invisible to the enemy's radio surveillance, since it operates in passive radar mode and transmits all information through secure communication channels. A high-level of AI is a key characteristic of the Moskva-1: for example, during a massive enemy air attack, the system automatically determines the most important targets.[120]

Reportedly the defense ministry upgraded the Krasukha-4, to field the Krasukha-20 EW jamming system, which is designed to interfere with Airborne Warning and Control Systems (AWACS). The Krasukha-20 can either interfere with an AWACS actively (emission of radiation)

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[119] Aleksei Ramm, Anton Lavrov, Bogdan Stepovoy, '*Vidit tsel': Bylina smozhet atakovat' protivnika bez uchastiya operatora*,' *Izvestia*, https://iz.ru/1000101/aleksei-ramm-bogdan-stepovoi/vidit-tcel-bylina-smozhet-atakovat-protivnika-bez-uchastiia-operatora, April 16, 2020.

[120] '*Radiuse polutysyachi kilometrov vse pod kontrolem Moskvy*,' *Voyenno Promyshlennyy Kuryer*, https://vpk-news.ru/news/56157, March 30, 2020.

or passively relate the AWACS coordinates to an air-defense system. This modernization of the Krasukha series will expand its range from 250 km to 400 km, among other improved characteristics. The Krasukha-20 also plays a role in protecting Iskander-M missile systems, with their likely deployment being in the EW battalions in the CAAs. In July 2020, the modernized Krasukha-20 began its first deliveries to the Armed Forces. One of its main missions is to neutralize AWACS airborne radars. Without their assistance, the US-built F-22 Raptor and F-35 Lightning II stealth aircraft cannot attack; in battle, their own radars would compromise their stealth capabilities. The active jamming generated by the Krasukha-20 system will block the radiation of the powerful AWACS radar, without allowing it to see the targets and guide strike aircraft to them.[121]

To illustrate the likely future shape of Russian EW procurement, in 2023 the EW Forces are set to receive a new system designated as Divnomorye-U. It is designed to jam enemy radars and satellites and seems likely to be the longer-term replacement for the Moskva-1, Krasukha-2 and Krasukha-4. This new system is intended to suppress onboard electronic systems of aircraft, helicopters and UAVs and can also interfere with satellites and operate at distances of several hundred kilometers.[122]

Combat use of the complex is carried out in automated mode. Reportedly, its equipment detects and instantly analyzes the target

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[121] During exercises, the Krasukha-20 handled detection of the domestic A-50U long-range radar detection and command and control aircraft, which has characteristics similar to those of the US E-3 Sentry. Anton Valagin, '*Oslepit' AWACS: chto mozhet novaya versiya sistemy REB Krasukha*,' *Rossiyskaya Gazeta*, July 13, 2020.

[122] Pavel Markush, '*Rossiyskiye voyennyye nauchilis' osleplyat' vrazheskiye samolety-radary i sputniki*,' *URA*, https://ura.news/news/1052333432, May 4, 2018.

signal, as well as the type, power and direction of radiation. A high-tech automated system independently develops a suppression plan and selects the most effective option, clearly implying the use of AI.[123] As a result, high-power jamming radiation generated by the Divnomorye-U neutralizes the enemy's radar effect, regardless of its type. The Divnomorye-U is capable of equally successfully jamming both ground-based radars and aircraft radars, such as those onboard the E-8 JSTAR, E-3 AWACS, E-2 Hawkeye, helicopters and UAVs. Even satellite radar stations are jammed in the Divnomorye-U coverage area.[124]

The Divnomorye-U can simultaneously serve as a high-technology command post, radio-technical intelligence station, and a powerful means of suppressing enemy targets. These functions were already provided by the Moskva-1, Krasukha-2 and Krasukha-4, meaning that the advance marked by the planned introduction of the Divnomorye-U lies in integrating these functions as well as in exploiting AI and automation.[125] The new complex is mounted on one vehicle with an all-terrain chassis, making it highly mobile and increasing the difficulty for enemy forces to detect and locate this asset. It can be activated within minutes of arriving in a designated area; and after carrying out its EW, tasks it can rapidly redeploy. It marks a step forward in Russian EW capability by reducing the number of personnel required for its operational use, suppressing a wide range

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[123] Vitaly Orlov, '*Voyna nevidimaya i effektivnaya*,' *Voyenno Promyshlennyy Kuryer*, https://vpk-news.ru/articles/63516, August 24, 2021.

[124] *Ibid*.

[125] Orlov, '*Voyna nevidimaya i effektivnaya*,' *Op.Cit*; *'Noveyshiye rossiyskiye kompleksy REB oslepyat vrazheskiye samolety-radary i dazhe sputniki*,' *Izvestia*, https://iz.ru/739217/2018-05-04/noveishie-rossiiskie-kompleksy-reb-oslepiat-vrazheskie-samolety-radary-i-dazhe-sputniki, May 4, 2018.

of targets, and being able to act autonomously and with high-mobility.[126]

Technological developments in Russian EW systems rooted in achieving greater integration as well as exploiting AI and automated C2 to greatly enhance the speed of action are consistent with other advances in EW capability referred to in late 2017 by the then–deputy defense minister, Yury Borisov. These related to three examples: the Palantin, Rtut-BM and the Tirada-2S systems. The performance characteristics of these EW complexes confirm the extent to which the defense ministry prioritizes their continued technological evolution in order to strengthen military capabilities to conduct operations in the EMS.[127]

The Palatin operational-tactical EW complex was developed by one of the divisions of Rostec—JSC Concern Sozvezdie. The latter is tasked with the development of the military's automated C2 systems. Palantin is the primary and latest EW system operating at the battalion level in the CAAs. Palantin outperforms similar complexes of previous generations. It is equipped with high-tech equipment and blinds the enemy's technical means both in the ultra-shortwave and shortwave ranges, depriving units of effective C2 by organizing "insoluble problems" in communications. The Palantin ensures the active conduct of effective radio reconnaissance and suppresses all known radio communication systems of a potential enemy. This includes complexes formed on the basis of modern software-defined radio (SDR) platforms. It can link several different EW systems into a single network. During tests conducted in the Central OSK/MD in

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[126] '*Nad Divnomor'yem Avaksy ne letayut! V voyska REB postupili noveyshiye kompleksy*,' *Topwar.ru*, https://topwar.ru/140969-voyska-reb-poluchat-mobilnye-kompleksy-divnomore.html, May 4, 2018.

[127] Orlov, '*Voyna nevidimaya i effektivnaya*,' *Op.Cit.*

2019, the Palantin was tested by EW specialists functioning as part of a battalion tactical group in which it was able to suppress radio communications of a simulated adversary force in a zone of up to 1,000 km.[128]

Similarly, Rtut-BM is an EW system mounted on a light, multi-purpose tracked chassis. Several defense enterprises are tasked with serial production of this complex: the Muromteplovoz plant, which produces the base chassis, NPO Kvant in Nizhny Novgorod, manufacturing the equipment, and Kazan Optical and Mechanical Plant, functioning as an assembly site for the Rtut-BM. The Rtut-BM counters guided weapons and protects military units from artillery fire and ammunition with radio fuses.

The Tirada-2S is an electronic communications suppression complex capable of effectively neutralizing satellite communications. It uses a narrow beam to target the frequencies of certain satellite communication channels. The Tirada-2S generates sighting obstacles that maximally overlap the possibility of transmitting a signal to the addressee: as the satellite attempts to overcome the electromagnetic curtain set by the ground-based system, this drains its energy resource.[129] These systems offer formidable conventional military capability both in terms of protecting Russian military units, providing critical jamming of adversary communications and radars, as well as disrupting enemy C2 and some weapons systems. Such advances exploit AI to greatly enhance the speed of using these systems in combat.[130]

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[128] *Ibid.*

[129] *Ibid.*

[130] A. N. Sidorin and A. N. Bezrodniy, '*Perspektivy primeneniya tekhnologiy iskusstvennogo intellekta v radioelektronnoy bor'be*,' *Voyennaya Mysl'*, No. 12, 2021, pp. 108–118.

While the Ground Forces are undoubtedly prioritized and benefit from EW modernization, the other service branches, the VMF and the VKS, are by no means excluded from these technological advances. On October 28, 2018, the defense ministry confirmed that the latest version of the Samarkand EW system had been deployed to Kaliningrad and other "strategic areas." At least 16 of these new systems were deployed in 13 units, as part of a wider program costing 61 million rubles ($920,000) with its completion scheduled for November 2019. Moscow-based Russian military specialists believe that the Samarkand EW system is designed to jam an adversary's communication systems; it would target enemy C4ISR assets and operate against GPS (including by spoofing), confusing enemy coordinates. The Samarkand is a suppression system, meaning that when enemy forces attempt to conduct operations within its zone, they experience problems with communications and all electronic equipment, ranging from sights to guidance systems.[131]

In 2017, the Northern Fleet reportedly received both Svet-KU and Samarkand EW systems. Concerning the Svet-KU system, this complex was designed to assess the electromagnetic environment, searching and detecting radio emissions, and locating the sources of such emissions when working with stationary and mobile complexes of technical radio intelligence.[132] Reliable information on the specifications of the Samarkand is difficult to establish. Some specialists believe the system is aimed at suppressing enemy tactical communications, while others see it as having a much wider use.

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[131] '*Eksperty rasskazali o printsipakh raboty kompleksov REB Samarkand*,' *Izvestia*, https://iz.ru/805723/2018-10-28/eksperty-rasskazali-o-printcipakh-raboty-kompleksov-reb-samarkand, October 28, 2018.

[132] Andrei Rezchikov and Aleksei Nechayev, '*Samarkand prevratit armii NATO v voysko dikarey*,' *Vzglyad*, https://vz.ru/society/2018/10/28/674524.html, October 28, 2018.

Maxim Shepovalenko, an expert at the Moscow-based Center for the Analysis of Strategies and Technologies (CAST), regards the Samarkand as capable of attacking enemy EW capacity: “All the EW facilities work in one way or another for all the electronic means of the adversary, be it means of communication, navigation, radiolocation, or whatever. Everything that radiates will be suppressed.” If this is correct, then the Samarkand EW system has operational- and strategic-level significance. Shepovalenko believes the system is designed to suppress enemy communications at the level of a unified command.[133]

Likewise, the VKS has benefited from continued investment in EW systems for advanced platforms. A vital test case in this context relates to the Khibiny EW complex, designed for the latest Sukhoi fighters and fighter-bombers. This technology provides enhanced protection for these VKS platforms against enemy radars and missiles. The nature of recent advances lies in adopting a conceptual use of the advanced system to afford protection for an air grouping, rather than only for individual platforms.[134]

The latest Khibiny EW complex will reportedly effectively “blind” enemy radars and satellites to the presence of a VKS air grouping. Normally, these Khibiny complexes are mounted on the wingtips of advanced Sukhoi platforms: Su-35S fighters, Su-34 bombers and Su-30SM fighters. This was widely seen in VKS operations in Syria. On one wing-tip, the Khibiny system acts as a receiver to determine enemy radio and communications frequencies, while the second generates the jamming element. The system is automated and

[133] *Ibid.*

[134] ‘*Voyska RF poluchilo modernizirovannyye kompleksy Khibiny*,’ *Pravda-tv.ru*, https://www.pravda-tv.ru/2018/06/09/364542/vojska-rf-poluchilo-modernizirovannye-kompleksy-hibiny, June 9, 2018.

analyzes enemy signals before determining the best means of jamming, again implying not only automation but the use of AI. The latest Khibiny variant, the Khibiny-U, is mounted under the fuselage of the Su-34 to provide broad coverage for an air grouping and to boost EW capability against high-technology adversaries. In the upgraded Khibiny-U, the entire capability is magnified to provide cover for an air grouping against enemy radars and space-based assets. Some Russian EW specialists believe the newest Khibiny-U EW complex offers a near-stealth capability for Russian VKS operations.[135]

The upgraded Khibiny-U is based on operational experience gained by the VKS in Syria, deploying experimental versions of the new EW platform and drawing lessons from it. Of course, the existing Khibiny complexes largely relied on Soviet designs, but the latest variant in the Khibiny family is quite recent in terms of technology. The wing-tip variety was designed for use on the Su-34 (L-175V Khibiny-10V) and the Su-35S (L-265 Khibiny-10M). Previous versions of the Khibiny EW complex were mounted on the wing-tips of the Su-35 and Su-34, but due to their weight they reduced these planes' ammunition payloads. The idea of developing a single integrated system to offer protection for an air grouping seems to mimic the United States Air Force (USAF), which uses the EA-18 Growler to cover fighter groups. By mounting the new Khibiny-U under the Su-30SM, it effectively transforms the platform into an EW aircraft operating in support of a fighter group.[136] With Khibiny complexes entering service in 2014, they began to feature in operational-strategic exercises involving VKS platforms. The Khibiny EW complex for the Su-34 has been used in the Western OSK/MD to test Suppression of Enemy Air Defenses

[135] Aleksandr Kruglov, Aleksei Ramm, Bogdan Stepovoy, '*Aviatsiya poluchila usovershenstvovannuyu zashchitu*,' *Izvestia*, https://iz.ru/741830/aleksandr-kruglov-aleksei-ramm-bogdan-stepovoi/aviatciia-poluchila-usovershenstvovannuiu-zashchitu, June 9, 2018.

[136] *Ibid.*

(SEAD) against high-technology adversaries. These typically involve up to ten aircraft, with the hypothetical enemy unable to determine whether there is a single fighter or an air grouping conducting SEAD.[137]

Such advances in Russia's EW capabilities based on the success of military modernization prompt questions about the overall conceptual scheme in place for this process. Are they developing new or modern EW systems simply in order to have more and better systems than an adversary, or are there other underlying themes at play? The chief of the EW Forces, Lieutenant General Lastochkin, notes, for example, a distinction between "traditional" approaches toward modernizing EW systems and "innovative" ones. In his view, the traditional approach presupposes the expansion of the nomenclature of the best systems, a reduction in the type of EW assets, their integration, increased protection from precision weapons, as well as mobility and modernization potential. In the innovative plan, he identifies five key areas:

- Deployment of controlled radio suppression units to operate in enemy territory on the basis of unified small-size reconnaissance and jamming modules delivered with the help of UAVs;

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[137] The R&D was carried out by the Kaluga Research Radio Engineering Institute. It first worked on such systems from 1977 to 1990. In 1995, it completed the first test cycle, and in 1997 the second test cycle allowed some procurement options. In 2013, Kaluga Research signed a contract to develop an EW system for the Su-30SM. However, it was not until 2014 that the Khibiny EW complex first entered service on the Su-34. Dmitriy Grigoryev, '*Bombardirovshchiki ZVO unichtozhili PVO s pomoshch'yu REB Khibiny*,' *Rossiyskaya Gazeta*, https://rg.ru/2017/10/27/reg-cfo/bombardirovshchiki-zvo-unichtozhili-pvo-s-pomoshchiu-reb-hibiny.html, October 27, 2017.

- Creating the means of destruction by powerful electromagnetic radiation based on the use of specialized ammunition and mobile complexes;
- Development of software impact technology on highly organized C2 systems by violating the accessibility, integrity and confidentiality of information;
- Introduction of the means of imitation of false radio-electronic signals [electronic deception] and disinformation for enemy C2 systems;
- Increasing the level of information security of EW command posts, improving the algorithms for supporting decision-making through a single loop of C2 for forces and assets.[138]

Lastochkin's list of priorities for the innovative strengthening of the EW Forces' inventory lies in the use of advanced technologies to further enhance the attack and protective roles assigned to EW. Within a space of just three years, Lastochkin's list of future priority areas for the EW Forces' modernization had significantly grown and, unsurprisingly, included AI and big data. Lastochkin noted that the EW Forces were already benefiting from the following: "the creation of robotic means of electronic suppression; increasing the throughput of means and complexes of electronic destruction; disorganization of communication systems and data transmission for various purposes; the fight against robotic weapons systems, military equipment and high-precision weapons, including the enemy's UAVs; disruption of navigation and signals support; active counteraction to the means of electronic reconnaissance."[139] Lastochkin then referred to the EW in the GPV to 2027 and said the main efforts to modernize EW in terms of innovation are as follows:

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[138] Lastochkin, Falichev, '*Kupol nad Minoborony*,' *Op.Cit.*

[139] Viktor Khudoleyev, '*Strazhniki efira na pravil'nom puti*,' *Op.Cit.*

- An increased level of information security for EW C2 through the use of big data technology in the automation systems of the EW Forces in strategic and operational levels;
- The use of geographic information systems in all modern EW models, which will reduce the time for conducting operational-tactical calculations by three to five times;
- Practical implementation of artificial intelligence technologies based on neural networks, which makes it possible to double the completeness and reliability of operating in the EMS;
- Introduction of communication technologies with integration into a single unified digital communication system of the Armed Forces for the organization of continuous data exchange in all control levels;
- Greater reliability of the storage of operational information within the EW automation systems and a provision of a time-synchronized unified information space based on cloud technologies;
- Application of virtual and augmented reality technologies in EW simulators to improve the quality and reduce the time for training EW specialists;
- Development means of imitation of the radio-electronic situation and the introduction of disinformation into the control system of enemy troops and weapons. Some of these areas are already being implemented in the course of the current state defense order.[140]

Lastochkin, and the EW Forces leadership, place great emphasis on exploiting AI, big data and automation in order to improve the speed and effectiveness of future Russian EW systems. And based on experimentation with EW in the course of military exercises as well as strategic-level exercises and operational insights gained in Ukraine

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[140] *Ibid.*

and Syria, it is abundantly clear that EW has become an integral feature of contemporary Russian military thought. This raises questions about the nature of experimentation and testing in combat and combat support roles in Ukraine and Syria. Were there patterns involved in the type of EW systems deployed in these theaters of operations? Why was so much EW equipment sighted in southeastern Ukraine? How valuable were the lessons drawn by the General Staff from the testing and roles assigned to EW systems in Ukraine and Syria? Why do Russian EW specialists and military theorists appear to stress the experience of EW systems in operations in Syria?

Testing and Refining EW in Operational Environments: Ukraine and Syria

Testing and refining EW systems—whether in tactical specialist exercises or in large-scale operational-strategic military exercises, or in the course of EW Forces working closely with defense industry companies to coordinate and implement the military modernization agenda—paled in comparison with the opportunities to learn from operations in Ukraine and Syria. Each of these distinct theaters of operations afforded invaluable real-time laboratories to experiment with a wide range of systems, including those still at the R&D stage.[141] In Ukraine, prior to the large-scale re-invasion in 2022, these tests and experiments fell broadly into four categories: seizing Crimea;

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[141] 'Latest from the OSCE Special Monitoring Mission to Ukraine (SMM), based on information received as of 19:30, May 14, 2017,' http://www.osce.org/special-monitoring-mission-to-ukraine/317386, May 15, 2017. Orlan-10 UAVs have also been shot down by the Ukrainian Armed Forces during the conflict in Donbas.

Paul Robinson, 'Explaining the Ukrainian Army's Defeat in Donbass in 2014,' (Eds), J.L. Black and Michael Johns, *Return of the Cold War. Ukraine, the West*, and Russia, Routledge: London, 2016; Roger McDermott, *Brothers Disunited: Russia's Use of Military Power in Ukraine*, Foreign Military Studies Offices, http://fmso.leavenworth.army.mil/Collaboration/international/McDermott/Brotherhood_McDermott_2015.pdf, April 2015.

combined-arms interventions in support of the Russian-led separatists in southeastern Ukraine in the battles of Ilovaysk and Debaltseve; deployed Russian EW equipment and temporary deployments of EW systems in Donbas; and the presence of such systems within the separatist formations.

During the operation to annex Crimea (February–March 2014), as the various Special Forces and Airborne Forces units initially spread across the territory, the deployed EW Forces used ECM to sever military communications between the peninsula and mainland Ukraine; meaning that in the earliest stages of the operation, EW was used to isolate the Ukrainian military bases in Crimea from contact with C2 in Kyiv. Indeed, the EW Forces consider themselves, for this reason, the unsung heroes of the operation. Due to the success in severing Ukrainian military communications and effectively shutting down its C2, this eliminated the possibility of Kyiv organizing armed resistance to the invasion. As more Russian Ground Forces units were deployed to Crimea, by March 11, 2014, for example, Leer-2, Lorandit and Infauna EW systems were in evidence; the Infauna is an EW asset in the inventory of the VDV.[142]

On two occasions, Russian units and equipment were directly deployed across the border to support separatists; in August 2014 in Ilovaysk and in January–February 2015 at Debaltseve—during the talks resulting in the Minsk Two ceasefire agreement. In each case, Russian and separatist forces rapidly secured victory; in both cases, EW was used in preparing, conducting and completing the local operation.[143] In Ilovaysk (25 km east of Donetsk), Ukrainian forces

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[142] N. A. Kolesova and G. Nasenkova, (Eds), *Radioelektronnaya bor'ba. Ot eksperimentov proshlogo do reshayushchego fronta budushchego* [*Electronic Warfare: From the Experiments of the Past to the Future Decisive Front*], CAST: Moscow, 2015, p. 229.

[143] Author interviews with former members of the OSCE SMM, April 15, 2021.

were encircled by Russian Armed Forces units from Pskov and Kursk; this involved the deployment of battalion tactical groups, reconnaissance and sabotage groups, including EW units, transferred from Russian territory.[144] EW assets were deployed in preparation for the ensuing operation; these suppressed enemy communications. The EW assets included Leer-2 complexes, Rtut-BM stations to jam GPS signals and UAV data-links such as the Shipovnik-Aero, or Krasukha-2 and Krasukha-4 for suppression of communications, and the automated jamming complex Borisoglebsk-2. EW Forces carried out the following: suppressing radio communications at tactical and operational levels, fixing and locating enemy forces by identifying EMS usage, disrupting C2, blocking mobile networks, and spreading false information as part of PSYOPS (psychological operations).[145]

EW assets were deployed and used in concentric distances from the area of operations, with the closest-to-combat operations at distances of 1–3 km, with RB-531B Infauna disrupting Ukrainian military communications, supported by Rtut-BM, Leer-2 and Lorandit complexes. At a range of 15–30 km outside the line of contact, Russian EW systems included Leer-3, R-330ZH Zhitel, R-934UM and the automated Borisoglebsk-2. Further out from the line of contact, at 60–240 km, air-suppression systems were in use, such as Shipovnik-Aero, Krasukha-2, and the DRLOU A-50 airborne early-warning aircraft.[146] Russian EW was used to aid target acquisition for artillery fires. EW assets detected Ukrainian communications in order to provide targeting data to conduct accurate artillery strikes. Communications

[144] *Ibid.*

[145] Vyacheslav Gusarov, '*Osobennosti organizatsii i vedeniya radioelektronnoy bor'by v boyakh za Ilovaysk. Analitika IS*,' http://sprotyv.info/ru/news/kiev/osobennosti-organizacii-i-vedeniya-radioelektronnoy-borby-v-boyah-za-ilovaysk-analitika, December 5, 2016.

[146] *Ibid.*

were also intercepted and PSYOPS were mounted against Ukrainian military personnel by sending negative text messages (SMS) to their phones.[147] PSYOPS and EW integration was used intermittently but targeted significant numbers of Ukrainian military personnel.[148]

In January–February 2015, the area around Debaltseve witnessed a surge in fighting, with Russian-led operations focused on securing the strategically important transport hub in Luhansk region. Russian and separatist forces saw the need to "tidy up" the area by taking Debaltseve, despite ongoing talks leading to Minsk Two. Russian EW systems prepared the battlefield and were involved during combat operations. A comprehensive technical EW monitoring group was tasked with monitoring the EMS. EW assets were deployed by the Russian Armed Forces for direction finding/geolocation, or disrupting enemy communications among other features. This also featured automated jammers. The overall scheme of the EW operations implemented an automated cycle of radio-survey/detection, jamming and intelligence analysis working closely with SIGINT and providing information in real time.[149] The high level of accuracy in artillery fires stemmed from successful employment of EW to fix and locate enemy targets by identifying cellular emissions

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[147] Author interviews with Ukrainian EW specialists, May 24, 2021. It is unlikely this could have been carried out on a wide scale; rather, it probably used deployed EW assets to targets pockets of resistance. Equally, targeting enemy cell phones in this way may imply Russian access to sensitive Ukrainian military personnel details.

[148] See: 'Electronic Warfare by Drone and SMS: How Russia-backed separatists use 'pinpoint propaganda' in the Donbas,' Atlantic Council's Digital Forensic Research Laboratory, https://medium.com/dfrlab/electronic-warfare-by-drone-and-sms-7fec6aa7d696, May 18, 2017.

[149] This equates to intelligence preparation of the battlespace (IPB). Developing a full picture of adversary systems in order that targeting becomes more effective, at a time and space of their choosing.

in communications between Ukrainian service members.[150] Russia's military actions in Donbas afforded experimental opportunities for various EW systems, ranging from disorganizing enemy C2, warping information in support of PSYOPS, jamming, blocking and disrupting the adversary's communications and radars, and disorganizing the enemy's ability to maintain C2 during operations.[151]

In an insightful analysis of Russian EW deployments in Ukraine, Sergey Sukhankin, a Senior Fellow at The Jamestown Foundation, drew the following conclusions about the purpose and role played in testing these systems since 2014:[152]

1. *Radio-electronic intelligence gathering and interception*. This element is best seen in the testing of the RB-636 "Svet-KU" system, which is specifically concerned with "control […] and monitoring of radio signals […] transmitted by radio channels." According to Russian sources, this complex can—under certain circumstances (GSM, CDMA2000 and UMTS networks)—independently block systems of communication.
2. *Radio-electronic suppression*, which is primarily tested through the employment of the following two systems:

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[150] Vyacheslav Gusarov '*Taktika rossiyskikh grupp REB v boyakh za Debal'tsevo. Analitika IS*,' http://sprotyv.info/ru/news/kiev/taktika-rossiyskih-grupp-reb-v-boyah-za-debalcevo-analitika, January 5, 2017; See: http://sprotyv.info/ru/news/kiev/radioelektronnaya-borba-rossiyskih-terroristicheskih-sil-v-nachalnoy-faze-voennogo, September 20, 2016.

[151] Author interviews with Ukrainian EW specialists, May 24, 2021.

[152] Sergey Sukhankin, 'Blind, Confuse and Demoralize: Russian Electronic Warfare Operations in Donbas,' The Jamestown Foundation: Washington DC, https://jamestown.org/program/blind-confuse-and-demoralize-russian-electronic-warfare-operations-in-donbas/, August 27, 2021.

- The “Tirada-2” jamming complex, which was first spotted in Donbas in 2019. This complex has also been tested—within the scope of military exercises—on the territory of the Central Military District (CMD), in Sverdlovsk Oblast. Russian sources have claimed that Tirada-2 is primarily concerned with tasks related to location and blocking and suppression of communications satellites. In commenting on the results of those exercises in the CMD, Russian sources have argued that this complex is capable of not only blocking but also completely incapacitating enemy satellites.
- The R-934B “Sinitsa” jamming station, whose main tasks are concerned with disrupting target-setting for the adversary’s aviation and blocking data transmission from reconnaissance aircraft. Russian experts have compared the Sinitsa against the Krasukha mobile, ground-based EW system (also spotted by the OSCE mission Ukraine in 2018), which is capable of disrupting low Earth orbit satellites and cause permanent damage to targeted radio-electronic devices. And according to these specialists, the Krasukha is more like a “rapier” (due to its centered angle of coverage and suppression) while the Sinitsa is more like a “club” (due to a much wider and broader coverage). Interestingly, the most recent (since early 2021) reports from the front line note that “the UAF is experiencing difficulties with radio connections as well as reconnaissance,” which is attributed by Ukrainian sources to “actions of the Russian EW forces.”

3. *Informational-psychological operations*—not a new phenomenon—have acquired some new traits.[153]

The Russian-led separatists, the Donetsk People's Republic (DPR) and the Luhansk People's Republic (LPR) are organized into the 1st (DPR) and 2nd Army Corps (LPR); each of these structures contains an EW company.[154] While much of the Russian EW assets identified on the territory of southeastern Ukraine may well feature in the inventories of these army corps at the company level, other systems reportedly seen and used in Donbas belong at the Russian EW brigade level.[155]

In 2019, Ukrainian Major General Borys Kremenetsky detailed the Russian use of EW in southeastern Ukraine and also delineated a number of the systems used along with their roles.[156] Kremenetsky stressed key functions of Russian EW units, including:

> degrading radio communications (the sudden disappearance of radio communication due to unknown reasons), blocking cellular (GSM) radio signals without their further restoration, defining the points of access and targeting the areas of mass

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153 *Ibid.*

154 An anonymous blogger at Milkavkaz.com presented a detailed breakdown of the structure of the Russian Led Forces in Donbas from 2014 to 2017; however, it is unclear whether the blogger was a genuinely independent source of this information. Since last accessed by this author on December 27, 2019, the site has been removed. *Vooruzhennyye sily DNR i LNR*, http://milkavkaz.com/index.php/8-main/25-voorujonnie-sili-dnr-i-lnr, June 6, 2017 (accessed December 6, 2019).

155 '*V Vooruzhennykh Silakh Rossiyskoy Federatsii Otmechayetsy Den' Spetsialista Po Radioelektronnoy Bor'be*,' http://eurasian-defence.ru/?q=node/38809, April 15, 2017.

156 Borys Kremenetsky, 'EW Lessons Learned: Russian Hybrid Warfare in Ukraine,' Royal United Services Institute, March 20, 2019.

> access to GSM communication, using radio-electronic warfare capabilities to spot the location of counterbattery radars, using new physical principles to destroy electronic equipment (the Murmansk-BN played a special role), sending cellular text messages to the private phones of Ukrainian soldiers and ascertaining (through data obtained from smartphones) their location.[157]

Kremenetsky claimed that the Murmansk-BN had been used effectively in Donbas to destroy Ukrainian electronic equipment.[158] However, as noted, the Murmansk-BN was designed for the Russian VMF, first introduced into the fleets in 2016, functioning as part of the navy's EW Centers. The system is already deployed in Crimea, raising the question as to why the Russian EW Forces would need to send this system into Donbas since the same effects could be achieved from the Crimean peninsula, given its reported range. Nonetheless, this sighting and use of such Russian EW systems in southeastern Ukraine not only confirms assets above the company level and, therefore, evidently in the inventory of the Russian Armed Forces; it also suggests that such assets are regularly rotated in and out of Donbas as part of conflict escalation control rehearsals.

Many Russian EW systems were deployed and trialed in both Ukraine and Syria. However, unlike in Ukraine, the use of EW systems in Syria afforded broader opportunities to test these in the context of high-technology opponents, albeit indirectly; also adding aircraft and air-based EW systems into the mix. Russia's military operations in Syria, commencing in late September 2015, were designated by the defense ministry as an "aerospace operation" and, therefore, largely restricted

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[157] Sukhankin, 'Blind, Confuse and Demoralize: Russian Electronic Warfare Operations in Donbas,' *Op.Cit*.

[158] Kremenetsky, 'EW Lessons Learned: Russian Hybrid Warfare in Ukraine,'

to air strikes and close air support for the Syrian Arab Army (SAA). That said, it also involved limited on-the-ground support both for Russian Special Forces and military advisors involved in the training of SAA units. All this necessitated EW support.[159]

Initially, EW operations appeared limited to force protection in terms of air assets and base protection. By October 2015, Russia deployed the Krasukha-4 ground-based EW system to its airbase near Latakia. The Krasukha-4 is a multifunctional jammer, mainly designed to jam airborne radars.[160] Deploying the system to the Khmeimim airbase was part of a process to support other air-defense assets to protect the base from air attack. In terms of assessments, it is likely the Russian military wanted to field test the system to check its reliability, since there were reports raising doubts about the Krasukha-4.[161] Moscow requested that the details of its deconfliction agreement with Washington in the fall of 2015 not be released. Yet reportedly, its agreement with Israel included reference to "electromagnetic arenas," suggesting that Israeli concern about VKS activity in Syria included EW.[162]

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[159] EW receives surprisingly little coverage in the following: M. Yu. Shepovalenko (Ed), *Siriyskiy Rubezh*, CAST: Moscow, 2016, pp. 105–120.

[160] '*Razvedyvatel'nyye samolety, sistemy radioelektronnoy bor'by i vysokotekhnologichnaya voyna Rossii v Sirii*,' *Russian Insider*, http://russia-insider.com/ru/oborona-i-bezopasnost/razvedyvatelnye-samolety-sistemy-radioelektronnoy-borby-i, October 31, 2015.

[161] '*Radioelektronnaya bor'ba, Voyna v Sirii*,' *Defence.ru*, https://defence.ru/article/krasukha-4-v-sirii-god-elektronnogo-schita-nad-khmeimim/, October 11, 2016; '*V Siriyu pribyli noveyshiye rossiyskiye kompleksy radioelektronnoy bor'by 'Krasukha-4,''* *Military-informant.ru*, http://military-informant.com/airforca/v-siriyu-pribyili-noveyshie-rossiyskie-kompleksyi-radioelektronnoy-borbyi-krasuha-4.html, October 5, 2015.

[162] Barbara Opall-Rome, 'Russia, Israel to Broaden Defense Coordination in Syria,' *Defense News*, www.defensenews.com/story/defense/air-space/2015/11/30/russia-israel-broaden-defense-coordination-syria/76576390/, December 1, 2015; Neil

Following the Turkish Air Force shooting down a Russian Su-24M in late November 2015, air-defense and EW components were markedly stepped up. In the months following the incident with the Turkish Air Force, Moscow sought to strengthen air defense and supporting EW at key locations in Syria to enhance its force protection.[163]

In addition to the Krasukha-4, the most readily identifiable Russian EW assets in Syria were the Khibiny and Leer-3, though some other assets may have been moved in and out in support of operations or to experiment with the air-defense mix. Khibiny ECM pods were frequently in evidence on the wingtips of Su-30SM, Su-34 and Su-35S platforms deployed in Latakia, providing individual platform protection and acting as jammers.[164] The General Staff would have paid close attention to how these pods functioned in a combat environment, in addition to referencing the meteorological conditions. Russian EW systems, for example, used passive tracking to build a database of coalition aircraft signatures. Reportedly, the US AC-130 and the EC-130H Compass Cell EW aircraft experienced jamming of their communications and GPS.

The deployment of the Su-34 is of special interest since it was earmarked to receive the larger Tarantul ECM pod; this is likely in

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MacFarquhar, 'US Agrees With Russia on Rules in Syrian Sky,' *New York Times,* www.nytimes.com/2015/10/21/world/middleeast/us-and-russia-agree-to-regulate-all-flights-over-syria.html?_r=0, October 20, 2015.

163 'Turetskiy Korall protiv rossiyskogo Triumfa: sistemy REB u granits Sirii,' http://topwar.ru/87224-tureckiy-korall-protiv-rossiyskogo-triumfa-sistemy-reb-u-granic-sirii.html, December 3, 2015.

164 Yevgeny Saltykov, '*Bitva za efir: rossiyskiye sistemy REB pokazali v Sirii svoyu effektivnost*',' *Vesti*, http://www.vesti.ru/doc.html?id=2732816, March 18, 2016.

support of the Khibiny system.[165] Indeed, the absence of the larger ECM pods for air group cover may explain why most airstrikes were conducted by the older Su-24s and Su-25s operating without escorts. Ground operations alongside the SAA against enemy forces certainly heavily relied upon the Leer-3 system. It is highly likely that this asset aided SAA assaults on opposition forces since it is used to jam cellular networks and would have degraded the ability of these adversary forces to communicate with each other.[166] It is also user friendly in such operational environments since it involves the Orlan-10 UAV, removing the jammer/operator from harm's way. Some Russian sources suggest that when the Leer-3 was first deployed to Syria, it could only function against GSM, while its ability to operate against 3G and 4G networks was unconfirmed.[167]

An illustration of the force protection element in EW deployments to Syria was provided in January 2018. EW and air defense assets deployed to protect its Khmeimim airbase near Latakia successfully countered an enemy UAV swarm attack on January 5, 2018. Of the 13 UAVs used in that attack, 6 were brought down solely by EW systems. Russian EW systems have similarly been used to disrupt a number of later enemy UAV swarm attacks. Indeed, the risk that such attacks could involve much larger numbers of drones led Russian companies involved in EW manufacturing to conclude that air defenses require

[165] Tarantul is an EW complex for Su-34s to conceal aircraft or a group of strike aircraft from enemy radar. The Tarantul ECM system is part of the modernization program for the Su-34 fighter bomber in the 2020s.

[166] Aleksandr Alexeev, '*Voyna v efire. Chast' 1,*' https://topwar.ru/116054-voyna-v-efire-chast-1.html, May 22, 2017.

[167] Author interviews with Israeli defense specialists, July 14, 2021.

miniature hit-to-kill missiles—similar to the systems under development for the US military by Lockheed Martin.[168]

Moscow-based military expert Vladimir Gundarov in an article in *Voyenno Promyshlennyy Kuryer*, referred to a report issued in 2019 by the Washington-based Center for Advanced Defense Studies, in which four Russian EW systems were identified as posing a threat to GPS. These are the Krasukha-4 at the Khmeimim airbase, the R-330Zh Zhitel jamming station deployed at the Aleppo airport, as well as the Samarkand and Rosevnik-AERO EW systems. The author explains, "The technical characteristics of the latter two are unknown, as are their locations in Syria, if they are present there. According to a representative of the United Instrument-Making Corporation, where Rosevnik-AERO is made, this complex simply hacks into the drone's onboard computer when it encounters a familiar system, and if it is unknown, it still takes it under its control in a few minutes." Gundarov uses this report to make two critically important points. First, he asserts that the US intelligence community has been unable to determine whether the R-330Zh Zhitel works as part of the R-330M1P Diabazol automated jamming complex or if it operates autonomously. Second, he draws attention to data from the International Space Station in the spring of 2018, showing that GPS signal spoofing was located at the Khmeimim airbase, "the nerve center of the Russian military campaign in Syria." Gundarov concludes, "The signals successfully mimicked genuine GPS satellites but did not carry reliable navigation information. In fact, the receivers receiving these 'fake' signals confirmed that they were in contact with the satellites, but

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[168] Vladimir Gundarov, '*Siriyskiye uroki REB Kuda uleteli 36 Tomagavkov s amerikanskikh esmintsev,*' *Voyenno Promyshlennyy Kuryer*, https://vpk-news.ru/articles/60891, February 16, 2021.

could not calculate their location or time, which effectively rendered the products inoperable."[169]

In a detailed September 2021 article in *Armeyskiy Sbornik*, the Russian EW officer authors examine the panning and deployment of EW Forces to a conflict zone based upon recent operational experience. Though the authors do not specifically refer to operations in Syria, this was the apparent operational environment they had in mind when they outlined the tasks performed by EW Forces and assets in contemporary armed conflicts. The authors state,

> The primary task was to protect groups of forces at assembly areas against radio-electronic intelligence gathering from space and also against possible strikes by tactical and carrier-borne aircraft. For this, they employed jamming stations that excluded intelligence gathering from space over an area of 200 km by 200 km. The stations were also able to determine aircraft types according to emissions from their onboard radars, and provide electronic jamming when instructed by air defense commanders. In order to degrade illegal combatants' command and control, electronic jamming was applied to satellite, cellular, and VHF radio communications.
>
> In the initial phase of the operation, guerrilla leaders made extensive use of satellite communications for command and control. To stop this, specialized EW devices were used that could intelligently affect satellite communications and block their operation across the entire conflict zone. Public cellular networks were used across the entire conflict zone for guerrilla command and control, but blocking these in an entire country was not feasible, because they were also used by the civilian population and armed forces. Total blocking was imposed only

[169] *Ibid.*

> in important areas and individual sectors where military operations were in progress. Illegal combatants also used classic analogue VHF radio for command and control, and effective jamming of these by mobile EW groups forced them to switch to modern digital forms of communication. When they did this, it was possible to test ways of disabling those communications in real-life conditions.[170]

Much of this overview of the type of EW roles and missions in a theater of military operations such as Syria primarily relates to force protection, or in EW terms: EP. In disrupting enemy C2, particularly among formations targeted in operations by the SAA with CAS (close air support) from the Russian VKS or on-the-ground assistance, these adversary formations depended on both satellite and analogue VHF radio. Only after these formations experienced the jamming of these communications did they switch to digital communications, which permitted the testing of EW systems designed to jam these. It is also worth highlighting that in the main, these instances of jamming are selective and targeted, only on rarer occasions did the Russian EW Forces opt to impose total blocking. This stemmed from enemy formations using public cellular networks for C2: "Total blocking was imposed only in important areas and individual sectors where military operations were in progress."[171]

While the Russian General Staff considers the involvement of its Armed Forces in operations in Syria as having provided a unique testing opportunity for equipment, weapons systems and military personnel that far outstrips Russia's experience in Ukraine, it should be noted that in terms of EW experimentation it also permitted testing

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[170] Nikulin, Koval, Koban, '*Soglasovannoye primeneniye. Osobennosti radioelektronnoy bor'by v sovremennykh vooruzhennykh konflikt*,' *Op.Cit*.

[171] *Ibid*.

systems in an EMS contested environment. In numerous presentations and lectures that this author has delivered to audiences in NATO capitals, EW officers frequently raise the objection as to how much the Russian General Staff may learn from testing EW systems in Ukraine or Syria, since the opposition was not technologically advanced in either case. Yet it is precisely this aspect in the case of Russia's involvement in Syria that distinguishes its operational experience compared to Ukraine.[172] In Syria, Russian systems could test their ability to passively track, jam or disrupt communications among United States and coalition air forces flying missions; though the Russian military was, of course, not in direct conflict with the US or coalition forces, its presence there was made known to Western air platforms operating in the EMS.

Evidence of the challenges presented to the United States Air Force operating in Syria following the deployment of Russia's Armed Forces in September 2015 are numerous and certainly credible. These frequently appear in US defense publications, and many of these are picked up by Russian defense journalists for coverage within the Russian media. An example of this relates to comments by General Raymond Thomas, the then-head of US Special Operations Command, made during the GEOINT 2018 symposium in April 2018. General Thomas complained that the "enemy" was jamming American aircraft systems in Syria. He described the situation with electronic warfare as "the most aggressive in the world." Thomas

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[172] '*Rossiyskiye stantsii REB v Sirii sveli s uma protivnika*,' *Moskovskiy Komsomolets*, https://www.mk.ru/politics/2021/02/25/rossiyskie-stancii-reb-v-sirii-sveli-s-uma-protivnika.html, February 25, 2021; Anatoliy Tsyganok, '*Primeneniye sil i sredstv REB v voynakh i konfliktakh KHKHI veka,*' *Nezavisimoye Voyennoye Obozreniye*, https://nvo.ng.ru/wars/2019-09-20/6_1062_reb.html, September 20, 2019; Aleksandr Stepanov, '*Polet vslepuyu,*' *Rossiyskaya Gazeta*, https://rg.ru/2019/08/14/rossijskie-kompleksy-reb-sposobny-oslepit-samolety-nevidimki-f-35.html, August 14, 2019.

asserted: "They are testing us every day, they are jamming our communications, and they are incapacitating the AC-130 (fire support aircraft)."[173]

Arsenal Otechestva (*Arsenal of the Fatherland*) editor Aleksei Leonkov considered this unsurprising: "In actual fact, the Americans' custom of fighting with a weak opponent has manifested itself. Since 1991, the US has conducted all of its military conflicts against states, whose electronic warfare systems were very weak or were not used at all." Former US Army Electronic Warfare Division Chief, Colonel Lorie Bakhut noted, "Our main problem is that we have not fought in conditions of jammed communications for several decades so we have no idea how to fight like that. We have not only no tactics, algorithms of actions, or the procedures to accomplish them, but not even training for the conduct of combat operations in the absence of communications." The Moscow-based military expert Dmitry Drozdenko explained that Russian systems jam communications channels, and jamming emerges in the frequencies used by US military personnel for the exchange of information: "As a result, information does not flow between the C2 centers and the combat units, and the armed forces actually turn out to be blind. If a radar installation is conducting a target search and is tracking the space around it, it sees not only actual targets but also a large number of decoys." Leonkov stressed that all EW systems operate based upon a single principle: they accomplish reconnaissance missions, in other words, they determine the frequencies, the operating modes of the communications and navigation systems, and their location. After this, they begin to jam the signal: "The output of these signals is greater than that of the transceivers, and therefore, the reliable

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[173] Andrei Rezchikov, Nikita Kovalenko, '*Kak rossiyskiye kompleksy REB meshayut amerikanskim voyennym v Sirii*,' *Vzglad*, https://vz.ru/politics/2018/4/26/919811.html, April 26, 2018.

jamming of communications, reconnaissance, and navigation systems is carried out."[174]

US General Thomas pointed out that the AC-130 aircraft is vulnerable to the impact of EW. The Lockheed AC-130 is an airborne close-support battery for ground forces subunits on the battlefield; it is based upon a C-130 transport aircraft and is equipped with several artillery pieces. This aircraft is dependent on the support of allied forces, and if the communications channels to it are blocked, it cannot identify targets at night or distinguish foreign forces from their own during the day. Moreover, in the general's opinion, there is a danger of Russian EW systems impacting on the EC-130H Compass Call EW aircraft.[175] The detection of enemy jammers and the transmission of data to conduct a strike is one of the EC-130H's missions. However, enemy EW systems are capable of hacking it. Blocking the signals of GPS transmitters and receivers using EW can make it impossible not only to attack targets but even create problems with navigation. Furthermore, it is possible to use electronic systems to disrupt the communications of operators with UAVs, which results in their loss. General Thomas also stressed that Russia was not using EW systems at full strength in Syria, but were it to, the US would lose all communications in the region. In turn, former US Army EW Division Chief Lorie Bakhut pointed out that the US does not possess as extensive EW capabilities as Russia: "We have very good communications intelligence, and we can monitor everyone and

[174] *Ibid.*

[175] Colin Clark, 'Russia Widens EW War, 'Disabling' EC-130s oR AC-130s In Syria,' Breaking Defense, https://breakingdefense.com/2018/04/russia-widens-ew-war-disabling-ec-130s-in-syria/, April 24, 2018.

everything, but we do not possess one tenth of their capabilities to disable hardware."[176]

In the summer 2021 issue of the *Air and Space Power Journal*, USAF Captain Stefan Morell confirmed instances of Russian EW systems causing severe problems for US Air Force pilots operating in Syria in the period 2017–2019:[177]

> This author experienced the firsthand effects of degraded communications impacting centralized control in the permissive air environment over Syria in 2017–2019. On numerous occasions, this author could not establish both voice and digital communications with the AOC [Air Operations Command] due to Joint C2 equipment degradation and could not pass information or receive data from the AOC such as the commander's intent for a new tactical situation. When, for example, one is flying on a low illumination night while within the visual range of Russian fighters over Syria, and one is unable to pass mission-critical information to an AOC or receive authorization to execute certain tactics to lower risk, it is an extremely uncomfortable feeling. The Joint C2 enterprise needs a newer, more robust datalink and to be restructured away from the centralized control of air assets.[178]

Although the Russian EW deployments to Syria were not mainly calculated to play cat-and-mouse with US military platforms, this was an unanticipated benefit of operating in the same theater of

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[176] Rezchikov, Kovalenko, '*Kak rossiyskiye kompleksy REB meshayut amerikanskim voyennym v Sirii*,' *Op.Cit*.

[177] Stefan Morell, 'Optimizing Joint All-Domain C2 in the Indo-Pacific,' Air and Space Power Journal, Special Edition, Summer 2021, p. 67.

[178] Ibid.

operations. Furthermore, the US military in Syria primarily used air-based EW systems, but Russia also deployed numerous ground-based complexes there for force protection. Ground-based EW complexes are more powerful and stronger than airborne systems due to their power-producing capabilities. Russia's deployment of EW assets to support its operations in Syria was primarily focused on force protection, aiding air defense, and facilitating on-the-ground operations spearheaded by its Special Forces and the SAA. Many of these systems were deployed to test and further refine EW capabilities. Equally, a degree of testing network-centric operations occurred, with critical support from EW Forces, while additional testing related to how to construct sufficient layered zonal air defense in the vicinity of Russian military assets in Tartus, Latakia and at temporary forward operating bases.[179] In the context of force protection, Russian EW systems played a significant role in reducing aircraft combat losses as well as protecting relatively small numbers of Russian ground forces deployed in support of the SAA.

EW Forces as a Future Arm of Service

The testing and experience gained in Ukraine and, even more so, in Syria, undoubtedly greatly boosted the confidence of Russia's EW Forces, contributed to their force development, and advanced their systems and equipment. Consequently, as of the beginning of 2022, Russian EW specialists saw a bright future ahead for the EW Forces, expecting continued investment, modernization and an expanded role for the service.[180] Shortly after the deployment of the VKS and Russia's entry into the conflict in Syria in September 2015, Russian

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[179] O. V. Tikhanychev, '*O roli sistematicheskogo ognevogo vozdei'stviya v sovremennykh operatsiiakh*,' *Voyennaya Mysl'*, No. 11, November 2016, pp. 16–20.

[180] R. S. Anosov, Yu. Ye. Donskov, S. G. Zelenskaya, V. A. Orlov, '*Sovremennyye voyenno-ekonomicheskiye usloviya razvitiya sistemy vooruzheniya radioelektronnoy bor'by VS RF,*' *Voyennaya Mysl'*, No. 9, 2021, pp. 76–84.

EW specialists started advancing the idea that there should be a marked change to the status of the EW Forces within the Russian military structure. This relates to the distinction between the Russian terms *vid* and *rod*. In the structure of Russia's Armed Forces, a service branch, *vid*, is higher than an arm of service, *rod*. To illustrate the point, the Ground Forces, VKS and VMF are all service branches of the Armed Forces, each with the designation *vid*; while the arms of service are the RVSN and the VDV, individually identified by the term *rod*. Although the EW Forces, as already noted, function throughout the branches and arms of service in a combat support role, since late 2015 leading Russian EW officers have promoted the idea that the EW Forces should be upgraded to the status of an independent arm of service (*rod*).[181]

Evidently this aspiration implies the utmost confidence in the growing capabilities provided by the EW Forces. Of course, it could easily be dismissed as an effort to secure greater funding in the future or simply as an abstract theoretical discussion among an elite core of serving EW officers.[182] Yet on the funding issue, it should be recalled that few Western analysts had foreseen the downgrading of the RVSN in June 2001 from a branch of service to an arm of service; but no one would argue today that the RVSN is any less well funded as a result. And far from merely representing an internal discussion at the level of military theory, the push to upgrade the EW Forces in the future to the level of a combat arm contains something fundamentally revolutionary about

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[181] Yu. Ye. Donskov, A. S. Korobeynikov, O. G. Nikitin, '*K voprosu o prednaznachenii, meste i roli voysk radioelektronnoy bor'by v armeyskikh operatsiyakh*,' *Voyennaya Mysl'*, No. 12, 2015, pp. 20–24.

[182] This was touched upon, though only indirectly, in A. S. Korobeynikov and S. I. Pasichnik, '*Osobennosti metodicheskogo obespecheniya otsenki effektivnosti REB pri modelirovanii kompleksnogo porazheniya informatsionno-upravlyayushchikh sistem protivnika*,' *Voyennaya Mysl'*, No. 11, 2015, pp. 58–64.

the role of EW in contemporary Russian military thought: that EW can achieve the same objective as that provided by force structures based around the application of kinetic force.

This bold assertion first surfaced in an article in *Voyennaya Mysl'* in December 2015. Colonel Yu. Ye. Donskov, Colonel A. S. Korobeynikov and Lieutenant Colonel O. G. Nikitin, all specialist officers in the EW Forces, offered an updated definition of EW as an arm of the Ground Forces, perspectives on EW targeting, and the use of EW in fighting electronic and information war during a Ground Forces operation. In the same issue of *Voyennaya Mysl'*, the chief of the EW Forces, Lieutenant General Yury Lastochkin, also strongly advocated the upgrading of the EW Forces to an arm of service. It appears that the placing of these articles involved coordination between the authors.[183] In their piece, Donskov, Korobeynikov and Nikitin assert,

> The authors have familiarized themselves with the definitions of the purposes fulfilled by the other arms of the Ground Forces and with the requirements they have to meet, and, as a summary of the arguments they have made throughout this text, they suggest their own definition of the EW Forces' purpose. The EW Forces are an arm of the Ground Forces in the Russian Federation's Armed Forces that *has been activated to disorganize the information support for the adversary's combat actions and to protect the troops and assets of joint forces (formations) of their own Ground Forces from attack by guided weapons*.[184] The wording of this definition gives a clear indication that the adversary's system of information support for his combat actions

[183] Yu.I, Lastochkin, '*Rol' i mesto radioelektronnoy bor'by v sovremennykh i budushchikh boyakh,*' *Voyennaya Mysl'*, No. 12, 2015, pp. 14–19.

[184] Author's emphasis. Note that the writers of the cited article stress the roles of electronic attack (EA) and electronic protection (EP).

> and employment of his guided missiles are the EW forces' principal targets in a defensive army operation. In turn, the adversary's electronic and information technology facilities and assets serving various purposes in the reconnaissance, communication, and data collection, processing, distribution, and storage subsystems are the immediate targets of the friendly forces' attacks.[185]

It should be stressed that the authors believe the EW Forces were already functioning *de facto* as an arm of service subordinate to the Ground Forces, but they add that this fact provides the main qualification for considering EW as a combat arm in its own right:

> The status of an arm of the service, the second highest in the hierarchy of military echelons, qualifies its command to conduct combat actions (typically, on a scale it is equipped for and capable of). The biggest and most important arms of the Ground Forces (motorized infantry and armor, missiles and artillery, and air defense) engage in operations to destroy enemy armor, armored vehicles.[186]

Here, the authors are not suggesting that the EW systems' application in combat can directly equate to using "traditional" means to attack a target by kinetic force, but EW can effectively disable the target, they argue, implying something other than temporary jamming. This also reflects the changing character of modern warfare, with the rapid advances in information and electronic technologies, widescale use of electronic and information-based capabilities by military forces, their reliance on the principles of network-centric information support in

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[185] Donskov, Korobeynikov, Nikitin, '*K voprosu o prednaznachenii, meste i roli voysk radioelektronnoy bor'by v armeyskikh operatsiyakh*,' *Op.Cit.*

[186] *Ibid.*

combat, and the development of modern EW assets by every branch and arm of service.[187]

Other Russian EW Forces officers soon followed with articles lobbying for the upgrade to the service's status. For example, in a September 2016 article written by a group of Russian EW specialists in *Voyennaya Mysl'*, the evolution of EW was placed in this context, and the authors assert that in the future, EW will transform into an arm of service—meaning it would move from a combat support role into a full-fledged combat arm. I. Korolyov, S. Kozlitin and O. Nikitin note,

> The first decade of the 21st century was marked by several factors that indirectly influenced not only the EW forces and assets composition and place in operations, but also their combat use methods, accordingly. The first factor is related to a qualitatively new material base for the information support to the troop command and control. Passing to network-centric information support for combat actions, including that for the troop command and control, realized by the leading foreign armies, together with forming a Common EW Information and Communications Environment, based on these principles, not only significantly complicated the conditions for combating the adversary's radio communication system and information-driven assets but also revealed an inadequacy in existing approaches to disorganizing the troop command and control.[188]

Korolyov, Kozlitin and Nikitin highlight the growing importance of EW in Russian operations, its transformative character, and its

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[187] *Ibid.*

[188] I. Korolyov, S. Kozlitin, O. Nikitin, '*Problemy opredeleniya sposobov boyevogo primeneniya sil i sredstv radioelektronnoy bor'by*,' *Voyennaya Mysl'*, No. 9, 2016, pp. 14–19.

potential to shape the battlespace in an information era to argue that it may well merit elevation to a combat role in itself.[189] These themes were also covered in detail in additional articles in *Voyennaya Mysl'* and *Vestnik* in 2019, either directly or indirectly advocating the upgrading of the EW Forces to a combat arm.[190] However, since his first article in *Voyennya Mysl'*, putting his weight behind the drive to boost the role of the EW Forces within Russia's Armed Forces, Lastochkin, the chief of the EW Forces, has proved both consistent and quite prolific.[191]

Lastochkin's undoubted contribution to promoting service interests has also culminated in presenting a set of arguments in favor of raising the EW Forces to the status of an arm of service. In December 2020, the lieutenant general, no doubt aiming to reach a senior General Staff readership, again chose *Voyennaya Mysl'* as the platform for this latest effort. His article, "*Perspektivy razvitiya voysk radioelektronnoy bor'by Vooruzhennykh Sil Rossiyskoy Federatsii*" ("Prospects for the Development of EW Forces in the Armed Forces of the Russian

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[189] *Ibid*.

[190] G. V. Konstantinov, A. V. Chizhankov, I. A. Shishechkin, '*Razvitiye teorii primeneniya formirovaniy radioelektronnoy bor'by v interesakh protivovozdushnoy oborony voysk i ob'yektov,' Voyennaya Mysl'*, No. 10, 2019, pp.49–55; V. K. Novikov and S. V. Golubchikov, '*Formy radioeletronnoy bor'by v sovremennykh usloviyakh,' Vestnik*, No. 2, 2019, pp. 139–143.

[191] Yu. I. Lastochkin, '*Metodicheskoye obespecheniye obosnovaniya sposobov boyevogo primeneniya sil i sredstv radioelektronnoy bor'by pri protivodeystvii radioelektronnoy razvedke v operatsiyakh ob'yedineniy Sukhoputnykh voysk,' Voyennaya Mysl'*, No. 6, 2018, pp. 58–67; Yu. I. Lastochkin, '*Sistema pokazateley dlya kompleksnogo analiza sostoyaniya i perspektiv razvitiya sil i sredstv voysk radioelektronnoy bor'by VS RF,' Vooruzheniye i Ekonomika*, No. 4, 2017, pp. 21–32; Yu. I. Lastochkin, '*Rol' i mesto radioelektronnoy bor'by v sovremennykh i budushchikh boyakh,' Voyennaya Mysl'*, No. 12, 2015, pp. 14–19.

Federation"), examines the external and internal factors within the system that affect the long-term progress of the EW Forces. Lastochkin analyzes the fundamental features of an arm of service before again advocating the EW Forces should become a combat arm.[192]

Of particular note, he confirms that the content of the GPV to 2027 facilitates, among other features, the EW Forces' capability to conduct "systematic actions" and deliver "electronic strikes" to destroy "electronic and information-technical enemy targets," and it provides a basis for playing a leading role in the operational tasks of disrupting enemy C2. These processes are set to continue in the GPV to 2033. Lastochkin also highlights the need to further develop military art and tactics for the EW Forces, and he recommends changing the algorithms for organizing and conducting EW based on decision support systems.[193]

On the basic elements of an arm of service, Lastochkin states that they must have:

- Their own operational task or dominance in its implementation;
- Their own forms and methods of combat use in the performance of tasks assigned to them in the operations of operational-strategic formations of the services of the Russian Armed Forces;
- The availability of an appropriate set of formations, including formations equipped with heterogeneous means;

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[192] Yu. I, Lastochkin, '*Perspektivy razvitiya voysk radioelektronnoy bor'by Vooruzhennykh Sil Rossiyskoy Federatsii,*' *Voyennaya Mysl*', No.12, 2020.

[193] *Ibid*.

- The level of organization of the combat use of balanced groupings of corresponding types of forces both to the level of organization inherent in the main elements of an operational structure, and reflecting the specifics of planning the implementation of an operational task.[194]

Lastochkin then outlines the goal for the future of the EW Forces as follows:

> The long-term goal of reforming the forces and means of electronic warfare of the Russian Armed Forces can be defined as: "the creation of a branch of the Russian Armed Forces with sufficient potential to fulfill tasks for effective electronic defeat (suppression) of the enemy in all spheres (in space, in the air, on the ground and at sea), for the entire depth of its operational formation in the theater of operations, as well as for electronic protection of its troops (forces) in peacetime and wartime.[195]

To achieve this goal, he suggests the EW Forces must achieve the following:

- Development of the fundamentals of the operational art and tactics of the EW Forces;
- Formation of a regulatory and legal framework for the creation of a new type of force: the radio-electronic troops;
- Improvement of the organizational structure of the EW Forces;
- Improvement of the EW Forces armament system.[196]

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[194] *Ibid.*

[195] *Ibid.*

[196] *Ibid.*

He points to the ongoing improvement of systems for the EW Forces through the introduction of modern information (digital) technologies, focused on processing large amounts of data, use of AI, virtual reality, and other areas of science and technology, which is increasing their overall effectiveness and capabilities. However, in order to successfully raise the status of the EW Forces, further structural changes will be required, as well as proving their effectiveness as a combat arm compared to traditional means of destruction:

> To improve the organizational structure of the EW Forces, the following is required: a set of formations and units of EW Forces at a strategic level on the one hand, must ensure the completeness and comprehensiveness of the impact on complex electronic and information-technical objects, and on the other hand, it must minimize the dependence on the effectiveness of the application means of fire destruction. With this in mind, military scientific research is being conducted to substantiate sets of heterogeneous forces and means of EW Forces in combat arms formations, taking into account the dynamics of entry into service of promising equipment.[197]

Conclusion

Modern military operations conducted by the militaries of the most technologically advanced countries are accompanied by the use of electronic warfare, including radio, radar, radio-technical intelligence or reconnaissance; active and passive jamming with specialized aircraft, onboard aircraft, and sea-based and ground-based systems; as well as the physical destruction of enemy electronic assets. Nevertheless, EW systems cannot be characterized as a "miracle weapon" capable of ultimately deciding the success or failure of any

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[197] *Ibid.*

given military operation. Still, a skillful application of EW assets can certainly provide an edge on the battlefield, supplying the opportunity to first see or identify enemy forces and hardware and then sever communications, disrupt C2 and even to destroy adversary targets.[198]

In this analysis, an explanation and dissection of Russian EW capabilities along with its emergence as a key instrument in the application of hard power in the modern and future battlespace has shown its burgeoning role in contemporary Russian military thought. EW within Russian military theory contains an elasticity of definition that reflects the evolution of its role in Russian military thought combined with ongoing changes in the character of war itself. The term *radioelektronnaya bor'ba* (electronic warfare) has grown in the Russian military lexicon to encompass a range of attributes, from military-technical to its place among the wider set of military capabilities at the disposal of the Russian state.[199] As part of these complex processes, EW has over time emerged as an important combat support element. And seen in the context of its broader military modernization and adoption of network-centric approaches to warfare harnessing information-based systems, EW has metastasized into an add-on support capability to critical military capabilities such as air defense or artillery fires.[200] Similarly, attempts to clearly define the precise meaning of EW in Russian military thought depend on the prism through which any particular Russian

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[198] Kolesova, Nasenkova, (Eds), *Radioelektronnaya bor'ba. Ot eksperimentov proshlogo do reshayushchego fronta budushchego*, *Op.Cit*, pp. 41–42.

[199] Novikov, Golubchikov, '*Formy radioeletronnoy bor'by v sovremennykh usloviyakh*,' *Op.Cit*; *Voyennyy Entsiklopedicheskiy Slovar'*, *Op.Cit*.

[200] Chizhankov, Shishechkin, '*Razvitiye teorii primeneniya formirovaniy radioelektronnoy bor'by v interesakh protivovozdushnoy oborony voysk i ob'yektov,*' *Op.Cit;* Donskov, Korobeynikov, Nikitin, '*K voprosu o prednaznachenii, meste i roli voysk radioelektronnoy bor'by v armeyskikh operatsiyakh*,' *Op.Cit.*

specialist or theorist examines its functions; it can appear symbiotic with information warfare, information confrontation, cyber warfare, and the use of airpower or maritime platforms.

EW played a role in Russian military operations as far back as its defeat in the Russo-Japanese War (1904–1905), with ongoing development in its importance and exploitation especially in Soviet operations during the Great Patriotic War (1941–1945); it was also a feature of Soviet forces during the Cold War.[201] In more recent history, from its experiences of low-intensity conflicts in Chechnya or its short conflict in August 2008 in Georgia, Russia had used EW with limited successes and failures. But the reorganization and reequipping of the EW Forces following the decision to reform the Armed Forces in late 2008 has resulted in force transformation into a credible combat support element, tried and tested in operations in Ukraine and Syria.[202] The restructuring has infused Russia's EW Forces throughout all branches and arms of service, accompanied by the reorganization of the defense industry base for EW development and the construction of the necessary training infrastructure.

During the military modernization initiated following the beginning of the 2008 reform process, Russia's EW Forces have received into service EW systems across the branches and arms of service, testing these in combat training and in specialist tactical exercises or operational-strategic level exercises; this has also included force integration training with non–defense ministry security forces. These EW systems, largely benefiting from Soviet-era designs, have

[201] A. I. Kupriyanov and L. N. Shustov, *Radioelektronnaya borba. Osnovy teorii,*' *Op.Cit*.

[202] '*Rossiyskiye stantsii REB v Sirii sveli s uma protivnika*,' *Op.Cit*; Tsyganok, '*Primeneniye sil i sredstv REB v voynakh i konfliktakh KHKHI veka,*' *Op.Cit*; Stepanov, '*Polet vslepuyu*,' *Op.Cit*.

demonstrated credible capability to achieve the desired effects across the range of EW application. R&D evidently envisages building on these achievements to introduce a new generation of systems to displace existing models. The focus for future R&D relates to automation, AI and robotic technologies to enhance speed and performance characteristics. Some aspects of work in the Air Force Academy in Voronezh, for example, such as creating the training and research foundation to develop systems and approaches to combat enemy robotic EW complexes, confirm the extent to which the long-term vision for military modernization includes EW.[203]

The conflicts in Ukraine and Syria provided opportunities to combat test a wide range of EW systems, including prototypes. EW Forces were used in the annexation of Crimea, in early 2014, to swiftly sever communications between Ukrainian Armed Forces units on the peninsula and their command centers in Kyiv; as the operation unfolded, EW Forces were involved at every stage. The subsequent destabilization of southeastern Ukraine also supplied a testing ground for EW complexes over the coming years, either in support of Russian-led separatists or directly by Russian forces; this was most evident in the decisive battles of Ilovaysk and Debaltseve. Russia's Armed Forces have also briefly rotated EW systems into Donbas prior to the outbreak of full-scale war in 2022, most likely to rehearse conflict escalation control and contingency planning for containing any surge in the fighting. By far the most important testing ground, however, was provided as a result of Russia's intervention in Syria in September 2015; a much broader range of EW systems were tested there, including air-based assets.[204] Despite the overriding use of EW

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[203] Zhirnov, '*Organizatsiya podgotovki spetsialistov radioelektronnoy bor'by k dezorganizatsii sistem upravleniya nazemnymi robototekhnicheskimi sredstvami inostrannykh armii*,' *Op.Cit*; Lastochkin, Falichev, '*Kupol nad Minoborony*,' *Op.Cit.*

[204] Gusarov, '*Osobennosti organizatsii i vedeniya radioelektronnoy bor'by v boyakh za Ilovaysk. Analitika IS*,' *Op.Cit*; Gusarov, '*Taktika rossiyskikh grupp REB v boyakh za*

in Syria revolving around force protection, it also allowed the General Staff to gain deeper insight into how these systems might function in a conflict with a technologically advanced peer adversary.

Numerous publicly available accounts by serving and retired US military personnel confirm that Russian EW systems presented challenges for US air platforms operating in an EMS contested environment. To be clear, Russian EW systems can certainly jam and disrupt US/NATO C4ISR, which has been amply demonstrated in Syria.[205] In fact, these systems are not only capable of disrupting US/NATO C4ISR, disorganizing C2 and jamming sensors and C2 nodes, they were designed to do precisely this. Over the past 20 years, as US and NATO forces were involved in combating international terrorism, engaging in counter-insurgency operations in Afghanistan and Iraq and elsewhere, the notion of large-scale inter-state warfare has never been far from Russian military thought and planning. Since Russia's Military Doctrine (2014) depicts the US and NATO as the principal potential threats to its security, it is unsurprising that R&D and defense procurement focuses on systems development to counter these potential threats; it is clearly visible in the modernization of the EW inventory.

The Russian EW Forces' senior officer leadership is undoubtedly buoyed with a high level of confidence about the value and role of EW in modern armed conflict, following more than a decade of sustained state investment in modernizing the inventory and the increased

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Debal'tsevo. Analitika IS,' Op.Cit; '*Razvedyvatel'nyye samolety, sistemy radioelektronnoy bor'by i vysokotekhnologichnaya voyna Rossii v Sirii,' Op.Cit*; '*Radioelektronnaya bor'ba, Voyna v Sirii,' Op.Cit*; '*V Siriyu pribyli noveyshiye rossiyskiye kompleksy radioelektronnoy bor'by 'Krasukha-4,' Op.Cit*; Saltykov, '*Bitva za efir: rossiyskiye sistemy REB pokazali v Sirii svoyu effektivnost',' Op.Cit.*

205 Rezchikov, Kovalenko, '*Kak rossiyskiye kompleksy REB meshayut amerikanskim voyennym v Sirii,' Op.Cit.*

importance attached to this combat support service by the General Staff. Indeed, this has been furthered by the successful exploitation of Russian EW assets and specialists operating in Syria. The articles and interviews by these EW officers in professional military journals or media is characterized by a high level of confidence. Moreover, this confidence has given rise, as already detailed, to these officers advancing the idea that the EW Forces should, in the future, be elevated to the role of an arm of service, thus fulfilling a combat role rather than restricted to combat support. It appears to go beyond merely lobbying for greater state investment in EW, which is already occurring.[206] This not only exudes confidence in existing EW capabilities; it also raises the issue of application of EW systems to jam, disrupt and disorganize enemy systems and C2 as well as to cause their destruction. The use of the Murmansk-BN EW system in southeastern Ukraine, for instance, according to Ukrainian sources, suggests this capability already exists in some cases and could doubtlessly be even more commonplace in the future.[207]

Whether or not Russia's EW Forces eventually emerge as an arm of service with assigned combat roles, the EW capability that has been forged over more than the past decade is certainly formidable. In presentations and discussions this author has had with US/NATO EW officers, a common view is that Russia's EW Forces are several years ahead of their Western counterparts.[208] This can only be corrected if there is sufficient understanding among the political leadership of the significance of Russian EW advances and a consequent willingness to

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[206] Donskov, Korobeynikov, Nikitin, '*K voprosu o prednaznachenii, meste i roli voysk radioelektronnoy bor'by v armeyskikh operatsiyakh,*' *Op.Cit*.

[207] Kremenetsky, 'EW Lessons Learned: Russian Hybrid Warfare in Ukraine,' *Op.Cit*.

[208] Author presentations in NATO capitals, 2017–2019; Author Interviews by VTC, June 4, 2021.

guide Western defense companies to re-orientate priorities toward countering such systems in potential conflicts with peer adversaries. Another aspect that is commonplace among US/NATO EW officers is their surprise that Russian EW officers appear to think so much in terms of using these systems for offensive operations.[209] In reality, within Russian military culture and military strategic thought, the distinction between "offensive" versus "defensive" is a misnomer.

This is not to argue that technologically, system for system, there is a clear Russian advantage over individual US/NATO EW systems. The real strength of Russian EW is that it is designed to combat specific enemy systems and capabilities, and Moscow's political-military leadership is open about the identity of that potential adversary. Moreover, this capability strength stems from the extent to which it infuses the Russian Armed Forces' organic structure, located across the branches and arms of service at strategic, operational and tactical levels; it permeates the entire combat system. As such, it simultaneously fulfills the role of combat support, force enabler and force multiplier. Moreover, EW has become an intrinsic feature of contemporary Russian military thought on the conduct of combat operations. As Russian EW officers have succinctly observed: "Electronic warfare achieves its aims to the greatest effect when used in coordination with firepower."[210]

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[209] *Ibid.*

[210] Nikulin, Koval, Koban, '*Soglasovannoye primeneniye. Osobennosti radioelektronnoy bor'by v sovremennykh vooruzhennykh konflikt,*' *Op.Cit.*

7.

Russia’s UAVs and UCAVs: ISR and Future Strike Capabilities

As Moscow has modernized Russia’s conventional Armed Forces over the past decade or so, the technological aspects in this process have included the adoption and introduction of unmanned aerial vehicles (UAV).[1] UAVs have routinely been present in Russian combat training and annual operational-strategic military exercises, used in operations from Ukraine to Syria, and frequently highlighted in statements by Defense Minister Sergei Shoigu.[2] These systems have come to play an essential role across the branches and arms of service, forming a symbiotic relationship with both air defense and electronic

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[1] Ananyev, A.V, Rybalko, A.G, Filatov, S.V, Lazorak, A.V, ‘*BPLA v sostave aviatsionnykh formirovaniy*,’ *Arsenal Otechestva*, No.5, 2020, pp.70–76. The author wishes to express his gratitude to the following individuals for reviewing and commenting on an earlier draft of this paper: Charles K. Bartles, Dara Massicot, Nicholas Myers, Guy Plopsky, Carolina Vendil Pallin and Vasily Zatsepin.

[2] In the Russian military lexicon Unmanned Aerial Vehicles are denoted as *Bespilotnyye Letatel’nyye Apparaty* (BLA/BPLA) or Shock/Strike Unmanned Combat Aerial Vehicles are referred to as *Udarnyye Bespilotnyye Letatel’nyye Apparaty* (UBLA). However, for simplicity throughout this chapter the English acronyms will be used: UAV and UCAV.

warfare (EW).[3] How and why these processes were put in place by the defense ministry leadership forms the basis of this chapter.

To better understand the place, role and potential future of unmanned aerial systems (UAS) in Russia's Armed Forces, it is worth tracing their Soviet origins, noting the hiatus that occurred in the attention paid by the defense leadership to such systems, and the reasons for why they re-emerged as a high priority in the military modernization agenda. It is also necessary to contextualize the role of UASs in Russia's military by outlining the country's defense-industry capacity to support such efforts, its structure and level of specialist knowledge, as well as how these fit into network-centric approaches to warfare and find their niche within Armed Forces structures.[4]

The use of Russian UAVs in contemporary conflicts has offered the General Staff a vast quantity of practical data to assess future requirements and priorities in procuring unmanned aerial systems; this also extends to programs aimed at producing unmanned combat aerial vehicles (UCAV) to offer operational strike options.[5] These initiatives and continued modernization in this field will be examined by reference to what the General Staff may be learning from the use of UAVs in conflicts involving Russia's Armed Forces in Ukraine and Syria, and additionally drawing upon the experience of foreign militaries to ascertain a more rounded interpretation of the role and future capabilities offered by such advanced systems.

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[3] *Radioelektronnaya bor'ba v Vooruzhennykh Silakh Rossiyskoy Federatsii – 2019,* http://reb.informost.ru/2019/index.php.

[4] V.B. Zarudnitskiy, '*Faktory dostizheniya pobedy v voyennykh konfliktakh budushchego*,' *Voyennaya Mysl'*, No. 8, 2021, pp, 34–47.

[5] Anton Lavrov, '*Bespilotnaya gonka*,' *Izvestia*, https://iz.ru/627546/anton-lavrov/rossiia-proigryvaet-bespilotnuiu-gonku, August 25, 2017.

In this regard, Russian air-defense and UAV specialists' analytical attention to the conflicts in Syria and Karabakh in 2020 will be explored to elaborate the extent to which the General Staff may be using these to develop fresh approaches to UAV usage over the modern-day battlefield or address how they impact on other areas of Moscow's defense planning. Since the reform process for Russia's Armed Forces was ordered by the political leadership in late 2008, the Armed Forces witnessed considerable transformation and modernization. In the specific field of UAS development, Moscow has come a long way, but equally it still has a long way to go to correct the historical chasm into which Soviet UAV development fell victim.[6]

Soviet Interest and Development of UAVs

To understand the principal drivers of modern post-reform efforts and programs to populate Russia's Armed Forces with UAS, it is necessary to root this in the Russian context.[7] A tendency exists on the part of non-Russian commentaries or analyses of the development of UASs in Russia's Armed Forces to explain these advances in terms of simply playing catch-up with leading Western militaries or, worse still, to imply that Moscow's defense leadership is reduced to copying such foreign trends. In a *de facto* confirmation of the dearth of domestic technological expertise and allegedly awestruck by advances in drone technology on the part of the United States military, such an approach reduces the understanding of these processes within Russia's Armed Forces and the domestic defense industry to that of mere copycats.

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[6] Karpenko, A.V, '*Bespilotnyy letatel'nyy apparat Feniks*,' *Voyenno-Tekhnicheskiy Sbornik Bastion*, http://bastion-karpenko.ru/phoenix-bla, No.11, 2019.

[7] Ivanov Yu.L, (Ed), *Bespilotnyye letatel'nyye apparaty: sostoyaniye i tendentsii razvitiya*, Moscow, LA Varyag, 2004.

Nonetheless, such an approach is inconsistent with both the Russian military culture and, arguably, the mindset among its cadre of planners. Like much of the main elements of the reform and modernization of the conventional Armed Forces since late 2008, the origins are primarily domestic and driven by major corrections to the Soviet legacy force. The themes of continuity and self-correction in these complex processes, which have resulted in Moscow building credible conventional military capabilities over the past decade, are omnipresent within the corpus of professional Russian military literature. Unsurprisingly, therefore, even in the area of exploiting UASs for military purposes, there is considerable evidence of strong research and development (R&D), scientific advances and state-level orchestration of innovating in the field of UAVs in the Soviet era.[8]

This is not to argue that the broad range of modern Russian R&D and procurement in the area of UAS capabilities can be explained solely by reference to this historical legacy. Clearly, the contemporary military and defense leadership is open to learning from foreign examples and approaches, based upon domestic analyses of these trends in modern warfare.[9] However, in Russian military culture, history does matter; and this Soviet military-scientific legacy is consequently viewed by many Russian writers as the backdrop—if not an inspiration—to ongoing and future projects in this field. Similarly, compared with the origin, development and exploitation of EW, Russian interest in UASs is almost as old as aviation itself. Within the specialist Russian literature, for example, the history and

[8] Kuznetsov G.A, *Bespilotnyye letatel'nyye apparaty s porshnevymi dvigatelyami: istoriya sozdaniya, primeneniye i perspektivy razvitiya*, *Nauchnoye Obozreniye*, No. 2010, pp. 40–45; Vilkova N.N, (Ed), Sukhachev, A.B, *Bespilotnyye letatel'nyye apparaty: sostoyaniye i perspektivy razvitiya*, Moscow, MNITI, 2007.

[9] Pavlushenko, M.I, Yevstafev, G.M, Makarenko, I.K, *Natsional'naya i global'naya bezopasnost'. Bespilotnyye letatel'nyye apparaty: istoriya, primeneniye, ugroza rasprostraneniya i perspektivy razvitiya*, Moscow, Prava cheloveka, 2005.

manufacturing of early and later advances in drone technology has attended similar research trends that connect to modern UAV and UCAV analysis.[10]

It is this history that provides much of the context for the "catching-up" and defining the challenges stemming from the degree of threat posed by potential adversary use of UASs: the catch-up is arguably a national military self-correction to reestablish the place of such systems in advanced R&D.[11] It is also an inherent element in the Russian Armed Forces' variant of network-centric warfare capability, and the ongoing exploitation of battlefield sensors to radically enhance intelligence, surveillance and reconnaissance (ISR) for target acquisition and accuracy of fires.[12] In this complex defense-planning environment, reflecting the changing character of war, close analytical attention is undoubtedly paid to the innovations and advances in

[10] Matusevich, A.N, *Sovetskiye bespilotnyye samoletyazvedchiki pervogo pokoleniya*, Moscow, AST, Minsk, Kharvest, 2002; Ganin, S.M, Karpenko A.V., Kolnogorov V.V., Petrov G.F, *Bespilotnyye letatel'nyye apparaty*, St.Petersburg, Nevskiy bastion, 1999.

[11] Ivanov, M.S, (Ed), *Bespilotnyye letatel'nyye apparaty. Spravochnoye posobiye*, VUNTS VVS VVA. Voronezh, Nauchaya kniga, 2015; Badekha, V.A, (Ed), *Bespilotnyye aviatsionnyye sistemy. Sovremennoye so- stoyaniye i opyt primeneniya*, Moscow, Pero, 2014; Fetisov, V.S, (Ed), *Bespilotnaya aviatsiya: terminologiya, klassifikatsiya, sovremennoye sostoyaniye*, Ufa, Foton, 2014.

[12] Colonel (ret.) S. G. Chekinov, Lieutenant-General (ret.) S. A. Bogdanov, "*Priroda i soderzhaniye voyny novogo pokoleniya*," *Voyennaya Mysl'*, No. 10, 2013, pp. 13–24; V. I. Slipchenko, *Voyna Budushchego*, Scientific Reports edition 88 (Moscow: Social Science Foundation), 1999.

foreign military application of UASs; but it is not the only factor in this process.[13]

Unmanned systems first made an appearance in the early Soviet period, through the late 1930s. Soviet advances in this area began with exclusively military-based research to develop unmanned systems in the early 1920s; and over almost two decades, they succeeded in fielding several examples.[14] On July 28, 1927, the first Soviet unmanned experimental flight took place with the U-1. From a ground controller, the U-1 made turns, flew straight and carried out descents and climbing maneuvers. By 1933, the TB-1 bomber was outfitted with an autopilot system, and further improvements led to modified upgrades with the U-2 and the TB-2. The process was furthered both during the Great Patriotic War (1941–1945) and in the early years of the Cold War, with systems manufactured by the Yakovlev and Tupolev Soviet aerospace companies.[15]

In 1949, for example, Yakovlev manufactured the Yak-9V, which flew an unmanned mission through the mushroom cloud produced during an atomic bomb test in Semipalatinsk, Kazakh Soviet Socialist Republic (SSR). In the 1960s and 1970s, Soviet aerospace companies produced additional unmanned systems.[16] Indeed, the late-Soviet era

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[13] Pavlushenko, M.I, Yevstafev, G.M, Makarenko, I.K, *Natsional'naya i global'naya bezopasnost'. Bespilotnyye letatel'nyye apparaty: istoriya, primeneniye, ugroza rasprostraneniya i perspektivy razvitiya*, *Op.Cit*.

[14] These were the U-1, TB-1, U-2, UT-1 and TB-3.

[15] These were the Yak-9V, La-17, La-17A, La-17M, MiG-15M, MiG-15bisM, M-17M, M-17F, Yak-25MSh and the Yak-25RV. Bychkov, V.N, *Letopis' aviatsii i vozdukhoplavaniya*, Moscow, Academia, 2006.

[16] These were: Tu-123 Yastreb, La-17R, La-17RM, La-17MM, La-17K, M-19, M-21, Il-28M, Tu-4M, Tu-16M, Tu-141 Strizh, Tu-143 Reys, with further development in the late Soviet period of the Pchela-60S, Pchela-1T, Krylo-1, Tu-243 Reys-D, Ye-85, Shmel'-1, R-90 and Tu-300 Korshun. Yankevich, Yu, *Bespilotnyye razvedchiki OKB*

and into the 1990s saw the first strategic UAVs, with the Tu-300 Korshun, as well as a range of tactical short-range UAVs, including the Pchela-60S and Pchela-1T; while Kamov began manufacturing short-range unmanned helicopters, such as the Ka-37 and Ka-137, among others.[17]

Interest in and the development of domestic capacity to manufacture UAVs clearly had a Soviet pedigree; yet after the dissolution of the Soviet Union, drone R&D almost vanished from the Russian military landscape. This was not limited to unmanned aerial systems. Much of the conventional military modernization programs and force enhancements envisaged in the latter Soviet period—most notably the ideas championed by Marshal Nikolai Ogarkov (chief of the Soviet General Staff, 1977–1984) in what became known as the *Revolyutsiya v Voyennom Dele* (Revolution in Military Affairs, or RMA)—fell into abeyance following the 1991 Soviet collapse.[18]

Russia's Soviet-legacy Armed Forces experienced a prolonged hiatus in military modernization during the 1990s and into the 2000s. This, combined with Moscow's experience of small wars during this time, resulted in a modernization black hole that temporarily subsumed such historical ideas and research priorities—including UAS development and thought on how to employ drones over a

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A.S. Yakovleva. Obshcherossiyskiy nauchno-tekhnicheskiy zhurnal Polet, No.3, 2000, pp.25–31; Makarov, Yu.V, *Letatel'nyye apparaty MAI*, Moscow, Izd-vo MAI, 1994.

[17] Vasilin, N.Ya, *Bespilotnyye letatel'nyye apparaty*, Minsk, Popurri, 2003.

[18] Henrik Olsen Nordal, "Thinking of Revolution in Military Affairs (RMA): Towards a Common Understanding of RMA," Master's Thesis, University of Oslo, 2013.

battlefield.[19] Even though Russian military specialists and military theorists were painfully aware of the burgeoning evolution of such systems in the approaches to warfare pursued by foreign militaries, with the United States military leading the way, the exploitation of UAV technology was both under-developed and largely ignored in the pre-reform era. That situation would not change until the genuine reform drive ordered by the political leadership in late 2008.[20]

Recasting Russia's UAVs for ISR and Automation

Notwithstanding the R&D gap and military force decline caused by the financial difficulties of post-Communist transition during the first two decades of the Russian Federation, Moscow's interest in UAV development is well established. Modern UAV production had begun in the 1980s, and the first Soviet-built models were used by the Russian Armed Forces during operations in Chechnya; though they did not always perform well. New models began entering service in the 2000s, with Dozor-85 as one of the first reconnaissance platforms. In the aftermath of the Russia-Georgia War in August 2008, the defense ministry markedly increased its interest in re-equipping the Armed Forces with modern UAV complexes, initially relying upon foreign imports from Israel. During operations in southeastern Ukraine since 2014, the Russian-led Donbas "separatists" have frequently been observed using modern Russian UAVs such as the Orlan-3M and Orlan-10, launched by catapult and landing by parachute. The Orlan-10 UAV features as part of an advanced EW system, the Leer-3 RB-341V, which has been operated in both Ukraine and Syria. In addition to its reconnaissance functions and EW missions, it appears to be used to carry out psychological operations

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[19] See: Carolina Vendil Pallin, *Russian Military Reform: A Failed Exercise in Defence Decision Making*, Routledge, 2008.

[20] Fetisov, V.S, (Ed), *Bespilotnaya aviatsiya: terminologiya, klassifikatsiya, sovremennoye sostoyaniye*, *Op.Cit*.

(PSYOPS): the Leer-3 blocks enemy cell phones and can then transmit its own messages to them, as was recorded in the earliest stages of the Russian-initiated destabilization of Donbas.[21]

Denis Fedutinov, a Moscow-based specialist in UASs, explained why the role of UAVs in modern conflict was underestimated for so long: "The Russian military, as well as the political authorities of the country, who successfully slept through the unmanned revolution, suddenly realized in the late 2000s the importance and significance of these systems for themselves." Consequently, this realization has prompted several large-scale programs to address these issues. Nonetheless, Fedutinov noted that in the current circumstances, it is not possible to act consistently, moving from simple to complex systems. Fedutinov argued, "If foreign companies that create UAVs act as system integrators, using the most suitable solutions for subsystems, then in our country, at the start of these large-scale works, such an approach was simply impossible due to the lack of not only ready-made technical solutions in many areas but also the lack of scientific and technical groundwork for them."[22]

An integral element, therefore, of the post-2008 reforms was to engage in this national military self-correction as part of a complex modernization process with the integration of command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) as a central and critical feature. Indeed, to date, the overwhelming priority in terms of the use of Russian drones is firmly focused upon battlefield sensors to markedly enhance the

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[21] Ivan Zhukovskiy, '*Bespilotnik-smertnik: Kalashnikov pokazal miru novinku*,' Gazeta.ru, https://www.gazeta.ru/army/2019/02/17/12190375.shtml?updated, February 17, 2019.

[22] Mikhail Khodarenok, '*Vperedi dazhe Turtsiya: Rossiya prospala bespilotnuyu revolyutsiyu*,' Gazeta.ru, https://www.gazeta.ru/army/2020/10/31/13340929.shtml, November 1, 2020.

UAVs' ISR utility. However, before turning to the more directly military-scientific foundations and drivers of this process applied to Russia's military UAV procurement priorities, it is also important to avoid isolating these developments from other factors. Domestic models and the rapid growth of Russian companies involved in the R&D and manufacture of UAVs has significantly expanded since around 2000. This not only relates to the manufacturing of particular UAV types but their serial production; of course, this is not exclusively for military purposes. The increase in domestically produced UAVs for both military and civil use coincided with a sharp growth in the number of companies engaged in UAV development work; an increase in the specialist literature on UAV R&D, testing and trends in production; research work on UAVs conducted in universities across the Russian Federation; and the rise in domestic demand and export of UAVs.[23]

UAV development in Russia is not principally beholden to military demands. Production can equally be driven by commercial organizations, small specialized enterprises, research institutes, design bureaus, universities or private individuals. Although the actual statistics on the overall number of domestic developers of Russian UAVs is not publicly available, the table in **Addendum 1** (p. 465) is presented to offer a sense of the scale of domestic capacity; while many of these are directly contracted to carry out R&D and production of UAVs for the defense ministry or security agencies, they also cover dual-use organizations.[24]

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[23] Yerokhin, Ye, '*Armeyskiye bespilotniki. BLA rossiyskikh Vooruzhennykh sil na forume Armiya-2017*,' *Vzlet*, No.11-12, 2017, pp.20–23; Fetisov, *Bespilotnaya aviatsiya: terminologiya, klassifikatsiya, sovremennoye sostoyaniye*, *Op.Cit.*

[24] G.A. Kuznetsov, I.V. Kudryavtsev, Ye.D, Krylov, 'R*etrospektivnyy analiz, sovremennoye sostoyaniye i tendentsii razvitiya otechestvennykh bespilotnykh*

The leading R&D center tasked with conducting work on UAV development for the defense ministry is the 924 State Center for UAV Aviation (*Gosudarstvennyi Tsentr Bespilotnoy Aviatsii*—GTsBA), with its headquarters in Kolomna, Moscow Oblast. In 2009, the forerunner of the 924 GTsBA was relocated to Kolomna on the base of the disbanded higher military artillery command school. Two regiments, a separate UAV squadron and an aviation technical base were reorganized into an aviation base. At the same time, there was a reassignment of the center's various governing bodies: these included the Air Force (*Voyenno-Vozdushnye Sily*—VVS) intelligence service, 4th State Center for the Training of Aviation Personnel and Military Tests in Lipetsk, 467 Inter-Service District Training Center of the Western Military District in Kovrov. In 2013, the center was reorganized as the 924 GTsBA, which made it possible to clearly structure the management of UAVs on the scale required for the Armed Forces, to resolve issues of training specialists, and assist in the formation of UAV units. It also has an airfield facility in Stupino, Moscow Oblast, to conduct full-fledged flight training for UAV specialists.[25]

The 924 GTsBA has the following organizational structure:

- Management and services of the center;
- Center for training specialists in unmanned aviation;
- Research center, focused on the combat use and testing of unmanned aircraft;

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letatel'nykh apparatov,' *Inzhenernyy Zhurnal: Nauka i Innovatsii*, No. 9, 2018, pp.1-22.

[25] V.V. Frolov, '*Sostoyaniye, zadachi i funktsii gosudarstvennogo tsentra bespilotnoy aviatsii ministerstva oborony Rossiyskoy Federatsii*,' Bodrova, A.S, Bezdenezhnykh, S.I, Yashina, A.V, Yarygina N.S, (Eds), *Perspektivy razvitiya i primeneniya kompleksov s bespilotnymi letatel'nymi apparatami,* Kolomna, 2016, pp-8-9.

- Center for combat and flight training of aviation personnel of unmanned aircraft.[26]

The head of the 924 GTsBA in 2021 is Lieutenant Colonel Sergei Zolotukhin, and the main tasks of the center are:

- Military scientific support for the creation, operation and modernization of complexes with UAVs;
- Investigation of the issues of the combat use of UAV units, the development and improvement of methods of conducting combat operations, their all-round support, and the organization of interaction;
- Investigation of the issues of interaction between UAV units and units of the services and combat arms of the Armed Forces of the Russian Federation, the Ministry of Internal Affairs, the Ministry of Emergency Situations and the Federal Security Service (FSB);
- Research of issues of combat training of UAV units, development and improvement of its content, forms and methods of conducting, methods and standards of assessment;
- Investigation of the issues of organizing, conducting and ensuring the safety of UAV flights;
- Participation in the development and substantiation of tactical and technical requirements for complexes with UAVs;
- Participation in tests and pilot operation of complexes with UAVs, as well as samples of weapons and military equipment developed for unmanned aircraft.[27]

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[26] *Ibid.*

[27] Russian Defense Ministry, https://mil.ru/924gcba/stucture/cibpviba.htm, Accessed December 12, 2021.

The main functions of the research center are to facilitate the use of UAVs in the interests of the branches and arms of service of the Armed Forces, special services, and other power ministries. The center also assists in the process of introducing new UAV complexes within the Armed Forces. In 2017, the Center's UAV armament for training purposes consisted of a variety of complexes. These included short-range UAVs manufactured by IZHMASH enterprises (Granat 1, -2, -3, -4, Takhion) and by ENIKS (Eleron-3). A Special Technological Center in St. Petersburg, part of the 924 GTsBLA, handled Orlan-10 and Leer-3. The Ural Civil Aviation Plant manufactured the Zastava and Forpost medium-range UAVs, manufactured from foreign-made components. Both are also used for training purposes.[28]

Against this background, since the reform of 2008, there has been an exponential increase in the number of UAVs across the Russian military. The process has been fueled by modernization priorities, the adoption of C4ISR, the need for improving target acquisition (with linkages to improvements in operational-tactical air defense and EW), as well as automation of C4ISR. These processes have also been furthered dramatically by the experience gained by the Armed Forces in the use of UAVs in Ukraine and Syria, as well as while operating in environments where adversary UAVs posed a threat to Russian facilitates and personnel.[29]

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[28] Frolov, '*Sostoyaniye, zadachi i funktsii gosudarstvennogo tsentra bespilotnoy aviatsii ministerstva oborony Rossiyskoy Federatsii*,' *Op.Cit*.

[29] '*Sborka BLA Forpost i Zastava na UZGA*,' Bmpd.livejournal.com, https://bmpd.livejournal.com/658798.html, November 13, 2013; A. Sokov, '*Novoye serdtse dlya razvedyvatel'nogo Forposta*', *Oruzhiye Rossii*, January 9, 2020, '*Kontrakt na postavku BLA Forpost-R i sozdaniye tyazhelogo BLA Altius-RU*,' Bmpd.livejournal.com, https://bmpd.livejournal.com/3925235.html, February 7, 2020; Yu. Shepovalenko (Ed), *Siriyskiy Rubezh*, 2nd ed, Moscow: Center for Analysis of Strategies and Technologies, 2016.

In February 2014, Defense Minister Sergei Shoigu, during a meeting with students at the Siberian Federal University, stated that Russia's Armed Forces at that time had around 500 UAVs in their inventory. Shoigu added that the program to re-equip the Armed Forces with UAVs to 2020 envisaged spending approximately 320 billion rubles (around $4.6 billion).[30] In 2014, Tu-243, Pchela-1T, ZALA 421-08 and Orlan-10 models were the workhorses of the UAV inventory, and by 2017 nine types of medium-range and short-range drones were procured: Forpost, Orlan-10, Granat-1, -2, -3, -4, Takhion, Eleron-3SV and Zastava. These were displayed during the Armiya 2017 forum. Although the precise details concerning the number of procured UAVs is not officially disclosed, it appears that by 2018 the number had increased to around 1,800.[31] By November 2021, according to President Vladimir Putin, this number had exceeded 2,000.[32]

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[30] Fetisov, *Bespilotnaya aviatsiya: terminologiya, klassifikatsiya, sovremennoye sostoyaniye*, *Op.Cit.*

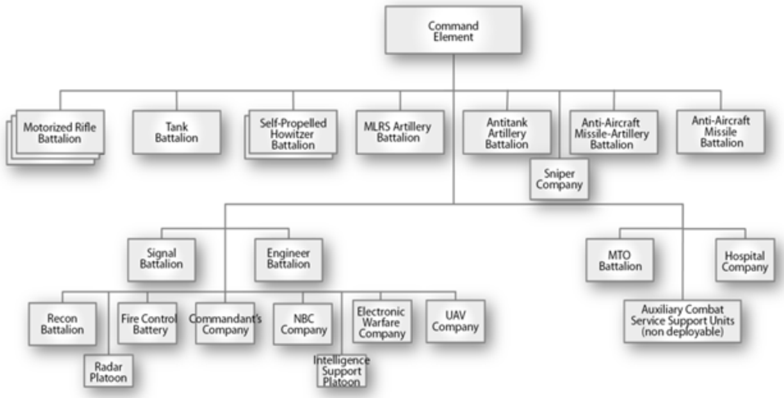
[31] Yerokhin, Ye, '*Armeyskiye bespilotniki. BLA rossiyskikh Vooruzhennykh sil na forume Armiya-2017*,' *Vzlet*, No.11-12, 2017, pp.20–23.

[32] '*Putin nazval chislo nakhodyashchikhsya na vooruzhenii rossiyskoy armii bespilotnikov*,' *Izvestia*, https://iz.ru/1244385/2021-11-02/putin-nazval-chislo-nakhodiashchikhsia-na-vooruzhenii-rossiiskoi-armii-bespilotnikov, November 2, 2021. In December 2018, Shoigu stated that more than "2,100" UAVs had entered service and that the defense industry had made sufficient progress on advanced reconnaissance and strike UCAV drones to permit procurement to commence. "The creation of unmanned, reconnaissance, medium-range attack complexes is coming to an end. From next year, they must begin to reach the troops. Each year, as part of the fulfillment of the state defense order, the troops will receive more than 300 medium-range and short-range [drone] aircraft," Shoigu asserted. '*Shoigu: armiya s 2019 goda nachnet poluchat' razvedyvate'no-udarnyye bespilotniki*,' TASS, https://tass.ru/armiya-i-opk/5926445, December 18, 2018.

While the numbers tell only part of the story, and by no means establish the extent of UAV exploitation in the Russian military inventory, it is useful to delineate how these actually populate the service branches and arms. All branches of service have been re-equipped with UAVs, though by far the most prominent of these is the Ground Forces. The backbone of these UAVs in the Ground Forces is made up of the Orlan-10 family of UAVs, and also the Granat, Eleron and Takhion. Similar to the reformed organic structure of the maneuver brigades possessing EW companies, the motorized rifle and tank brigades and divisions have organic UAV companies, with similar subunits located within the reconnaissance brigades (**Figure 1**). These Ground Forces motorized rifle and tank brigades and divisions all contain a UAV company; the UAV company comprises of two platoons. The first UAV platoon is the short-range platoon, armed with Orlan-10 and Takhion-4 UAVs. The second platoon is a close-range (*blizhnego deystviya*) platoon, and its main weapons are the Granat-1, 2, 3 and 4, Zastava, Takhion and Eleron.[33]

[33] Aleksandr Tikhonov, '*Bespilotniki nabirayut vysotu. I ves*,' *Krasnaya Zvezda*, http://redstar.ru/bespilotniki-nabirayutvysotu-i-ves/, February 12, 2021.

Figure 1: Motorized Rifle Brigade (MRB) Structure: UAV Company



UAV companies also function along similar lines within the Airborne Forces (*Vozdushno-Desantnye Voyska*—VDV) divisions, as well as in the Naval Infantry. The Missile and Artillery Troops (*Raketnyye Voyska i Artilleriya*—RV&A) brigades use UAVs to select suitable positions for Iskander systems, and also to protect them. UAV subunits in the artillery brigades have a distinctive organizational structure. In addition to Orlan-10-based platoons, they have teams equipped with the latest Orlan-30 UAVs and specialist platoons for artillery UAV reconnaissance.[34]

Several UAV squadrons, both separate and as part of aviation regiments, operate within the Aerospace Forces (*Vozdushno Kosmicheskikh Sil*—VKS). These VKS units and subunits operate the Forpost family of UAVs, while this has also more recently been extended to include the Orlan-10. A separate aviation squadron was

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[34] Aleksei Ramm, '*Kuda letit bespilotnaya aviatsiya*,' *Nezavisimoye Voyennoye Obozreniye*, https://nvo.ng.ru/armament/2021-01-21/1_1125_aviation.html, January 21, 2021.

formed in 2020 to support training at the Plesetsk airfield, and alongside its helicopters and aircraft are Orlan-10 UAVs, tasked with ensuring the security of rocket launches from Plesetsk.[35]

Russia's navy, the Military-Maritime Fleet (*Voyenno-Morskoy Flot*—VMF), has separate UAV regiments. These are armed with the Forpost drone family and the Orlan-10. Orlan teams have been based onboard Russian corvettes and frigates since 2018. Forpost UAV squadrons also constitute part of several Naval Aviation regiments, such as the 689th Fighter Regiment in Kaliningrad and the 318th (Crimea) and 71st (Kamchatka) composite aviation regiments. The VMF UAV regiments and squadrons work with surface ships and submarines; they support separate artillery and coastal missile and artillery brigades, and also coastal defense units.[36]

If there was any doubt as to the utility and purpose behind the drive to equip the Ground Forces in particular with UAVs, it was made clear by the head of the RV&A, Lieutenant General Mikhail Matveevskiy, during an *Izvestia* interview in November 2021. In the piece, he talked about the development of promising military equipment; progress in rearmament, guided missiles and artillery shells; and how UAVs help RV&A units strike their targets faster and more accurately. In passing, Matveevskiy estimated the share of modern or new weapons and equipment in the RV&A inventory had reached 60 percent and the rearmament of missile formations with the modern operational-tactical complex Iskander-M was almost complete. However, his comments on UAVs and their role in the RV&A stressed their overriding value lying in ISR:

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[35] *Ibid.*

[36] *Ibid.*

> All our artillery formations are already equipped with unmanned aerial vehicles. The experience of local wars and armed conflicts in recent years has shown that the full implementation of the combat capabilities of the RV&A is impossible without the use of reconnaissance assets to the entire depth of the zone of responsibility of combined-arms formations. UAVs, as one of the most effective means of obtaining reconnaissance information, are included in reconnaissance and strike (fire) complexes created on the basis of missile forces and artillery units. This allows us today to hit the identified targets in a time mode close to real time.[37]

Matveevskiy not only confirmed the critical role played by Russian UAVs in ISR for the RV&A, but highlighted the significance of such battlefield sensors in Russia's variant of network-centric warfare, namely the Reconnaissance-Fire System (*Razvedyvatel'no-Ognevaya Sistema*—ROS) and the Reconnaissance-Strike System (*Razvedyvatel'no-Udarnaya Sistema*—RUS), which serve to integrate C4ISR to include fires across operational-tactical levels.[38] Moreover, in terms of the use of UAVs in aiding target acquisition for artillery systems in the RV&A, Matveevskiy's comments are also borne out by reference to specialist educational literature used for training purposes within this arm of service.

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[37] Anton Lavrov, '*Bespilotniki pomogayut nam porazhat' tseli v rezhime real'nogo vremeni*,' *Izvestia*, https://iz.ru/1251874/anton-lavrov/bespilotniki-pomogaiut-nam-porazhat-tceli-v-rezhime-realnogo-vremeni, November 19, 2021.

[38] Anan'yev, A.V, Filatov, S.V, '*Obosnovaniye neobkhodimosti sozdaniya mezhvidovogo razvedyvatel'no udarnogo kompleksa bespilotnykh letatel'nykh apparatov malogo klassa dlya aviatsionnogo formirovaniya*,' *Vozdushno-Kosmicheskiye Sily: Teoriya i Praktika*, No.13, 2020.

These military-scientific publications[39] analyze existing and prospective reconnaissance and fire complexes of tactical artillery, including a range of UAV types and how these integrate into automated command and control (C2). Mathematical models and methods of control of UAV platforms, target designation and selection of the initial drone parameters (envisaging vertical ascent/descent and horizontal flight) also form the basis of such analysis. The general information technology of reconnaissance, target designation and application of UASs as part of a Reconnaissance-Fire System were also detailed by the monograph's authors. Some specialist military-scientific works in the formative years of the reform also specifically examined UAVs in the existing theory of using guided artillery shells, offering models and methods for their optimal planning. These military theorists consider methods for overcoming the active protection zones of targets with controlled artillery shells and planning a simultaneous strike on a target with both unguided and guided artillery shells. Models and methods of organizing target acquisition from UAVs are described.[40]

As previously noted, the UAV component is an important and essential element in the Russian Armed Forces' network-centric warfare capability. In 2018, Sergei Makarenko and Maksim Ivanov published a lengthy study, *Setetsentricheskaya voyna—printsipy,*

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[39] *Ibid.*

[40] Moiseyev, G.V, Moiseyev, V.S, *Osnovy teorii sozdaniya i primeneniya imitatsionnykh bespilotnykh aviatsionnykh kompleksov*, *Monografiya. – Kazan': RTS MKO,* 2013; Kozar, A.N, Moiseyev, V.S, *Informatsionnyye tekhnologii optimal'nogo primeneniya upravlyayemykh artilleriyskikh snaryadov*, *Monografiya, – RTS MKO,* 2012; Borzov G.Ye, Kozar, A.N, Moiseyev, V.S, *Primeneniye bespilotnykh razvedyvatel'no-korrektirovochnykh vertoletov v perspektivnykh kompleksakh avtomatizirovannogo upravleniya ognem artillerii takticheskogo zvena*, *Nauchnoye izdaniye, Kazanskoye vyssheye voyennoye komandnoye uchilishche (voyennyy institut)*, 2009.

tekhnologii, primery i perspektivy (*Network-Centric War—Principles, Technologies, Examples and Perspectives*), in which the authors amplified the role of UAVs among other components of battlefield sensors. Makarenko and Ivanov explained the concept of "global intelligence support" of the battlespace as follows:

> Global intelligence support (literally from the English "deep sensory penetration"). This principle of network-centric warfare requires an increase in the number and improvement of the quality of reconnaissance sensors and channels for obtaining information, both in the combat area and outside it. Global intelligence support is implemented through:
>
> - Unification into a single database of information received by intelligence, surveillance and recognition systems;
> - Massive use of highly mobile multi-sensor technical means (UAVs, robotic systems, perimeter security sensors, etc.) as reconnaissance sensors;
> - The use of sensors and observation points as an instrument of moral influence on the enemy;
> - Supplying each combat means (complex), from an individual soldier to a satellite, with a variety of sensors and information sensors.
>
> Global intelligence support means that information is collected from different sources, while different combat units are equipped with the maximum amount of surveillance equipment.[41]

[41] Makarenko, S.I, Ivanov, M.S, *Setetsentricheskaya voyna – printsipy, tekhnologii, primery i perspektivy, Monografiya – SPb: Naukoyemkiye tekhnologii*, St.Petersburg, 2018. pp-149-150.

It is precisely this role—as a prime means of battlefield sensors to provide ISR and aid target acquisition and accuracy of fires—that is the key characteristic of Russian unmanned aerial systems to date. More recent efforts to re-balance lies in the field of heavy-strike UCAVs. Nonetheless, the weight of priority in Russia's UAS inventory is likely to remain heavily tilted in favor of ISR. In addition to issues that serve to hamper the domestic defense industry in UAV/UCAV development, such as design and the production of engines for these complexes, a number of factors mitigate the potential to exploit unmanned systems in the inventory of Russia's Armed Forces.[42] V. A. Agamalyan, the general director of YuVS Avia, co-authored an article among a collection of papers from a 2017 scientific conference in Moscow, in which the issues reducing the effectiveness of UAV use were elaborated.[43] The authors based this on the results of tests and use in real operating conditions in relation to UAVs being utilized by the Ministry of Defense and the Ministry of Emergency Situations. Moreover, these trends are of a systemic nature and can be generalized to include all types of small UAVs. These were characterized as:

1. In terms of unification and standardization: complete incompatibility of the payload, onboard communications, ground control stations, batteries and chargers, information-linguistic and software of various UAV manufacturers between products with similar functions. Each manufacturer selects the specified equipment based on the available resources and

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[42] Aleksei Ramm, Bogdan Stepovoi, '*Drony v beskozyrkakh*,' *Izvestiya*, https://iz.ru/732935/aleksei-ramm-bogdan-stepovoi/bezliudnyi-flot, April 24, 2018,

[43] V.A, Agamalyan, Lapshin, P.L, '*Razrabotka i ispytaniya kompleksov s BLA*,' Bodrova, A.S, Bezdenezhnykh, S.I, (Eds), *Perspektivy razvitiya i primeneniya kompleksov s bespilotnymi letatel'nymi apparatami. Sbornik nauchnykh dokladov i statey po materialam II Nauchno-prakticheskoy konferentsii*, Kolomna, 2017, pp.13-14.

> capabilities, which leads to incompatibility, an increase in the cost of both the work performed and the final cost of products, and a narrowing of the range of tasks that can be solved using UAVs;
>
> 2. In terms of control, telemetry and information transfer: functioning under the conditions of a directed effect of enemy EW means (electronic suppression, control interception, blocking of communication lines or networks) on UAV control channels and data flow from the payload, blocking of GNSS signals;
>
> 3. Regarding the control system, intelligence and communications: the lack of integration of the UAV control system into automated systems of various control levels. The active development of automated control systems for planning and controlling troops and weapons at various levels of control does not currently imply the use of UAVs in their control loops;
>
> 4. In terms of planning the use: independent planning of the use of each individual UAV. As a result, the impossibility of redistribution (including concentration) of UAV resources, depending on the tasks to be solved and the current situation.[44]

Agamalyan's specialist and firsthand knowledge of the UAV dimension of the Armed Forces, as well as his close proximity to the R&D and procurement of UAVs, testify to the credibility of these observations. They are a sobering reminder that, like other systems, UAVs in and of themselves do not represent a game changer for the Russian military. After the gap that opened in this area compared to UAV adoption in operations by foreign militaries, it is unsurprising that such issues are present and persistent within the Russian military

[44] *Ibid.*

modernization process. What is particularly worth noting is the reference to using UAVs in an electromagnetic contested operational environment; not only are some Russian UAV platforms integral to certain EW systems, but they must also take notice of the potential for adversaries to deploy EW assets to target Russian drones in any given conflict. Moreover, the task of integrating these complexes into the overall automated C2 architecture is also highlighted.[45]

A no less challenging task, and undoubtedly a high priority for the senior defense leadership, relates to the need to integrate UAV and future UCAV systems with existing and in-development automated C2. Again, Agamalyan's co-authored conference paper notes the intricacy of such integration, which lies close to the heart of the ROS and RUS and ongoing adoption of C4ISR. The authors state:

> To ensure the integration of UAV control systems into existing and developed automated C2, it is proposed:
>
> A) As part of the UAV software, to have:
>
> - General and special software of the automated control system in using the UAV;
> - Special software that implements the unique functions of planning and control of the UAV, its maintenance and repair;
> - Technological software from the onboard control system and the ground control station, which implements the functions of direct control of the flight, takeoff and landing of the UAV;
>
> B) Develop information and linguistic support for the planning of the use and control of the UAV on the basis of the appropriate

[45] *Ibid.*

provision of the automated C2 system in the interests of which it is used;

C) Include provisions on the installation of this equipment in the control and communications facilities (mobile and/or stationary) in the documentation for the ground control equipment of the UAV and the payload.[46]

In a comparatively short period, Moscow has made significant progress toward remedying the technological gap that developed in unmanned systems, which represented a fracture in the continuum with the Soviet era; as this gap developed, the leading foreign militaries made further strides in the direction of harnessing UAVs. Moscow has furthered this aspect of its military modernization by building domestic defense-industry capacity to furnish the Armed Forces with modern UAVs and, thus, has removed its earlier dependency on foreign procurement. As part of this process, the Armed Forces have been populated with UAV complexes to help fill the void in ISR, with their primary role as battlefield sensors aiding target acquisition and accuracy of fires. The complex processes of introducing new systems, rebalancing between unmanned aerial assets designed for ISR to also include reconnaissance-strike and strike systems, will take time and continued modernization, as will wider efforts to fully integrate these with the developing C4ISR architecture.[47]

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[46] Agamalyan, Lapshin,'*Razrabotka i ispytaniya kompleksov s BLA*,' *Op.Cit*, p.15.

[47] Khodarenok, '*Vperedi dazhe Turtsiya: Rossiya prospala bespilotnuyu revolyutsiyu*,' *Op.Cit*; Frolov, '*Sostoyaniye, zadachi i funktsii gosudarstvennogo tsentra bespilotnoy aviatsii ministerstva oborony Rossiyskoy Federatsii*,' *Op.Cit*; '*Putin nazval chislo nakhodyashchikhsya na vooruzhenii rossiyskoy armii bespilotnikov*,' *Op.Cit*; Ramm, '*Kuda letit bespilotnaya aviatsiya*,' *Op.Cit*; Agamalyan, Lapshin, '*Razrabotka i ispytaniya kompleksov s BLA*,' *Op.Cit*; Koziratskiy, A.Yu, Kapitanov, V.V, Sudarikov, G.I, '*Vozmozhnosti primeneniya vertoletov armeyskoy aviatsii pri nanesenii*

Russian Dependence Upon Foreign Technologies

Since Russia's armed entry into Ukraine in 2014, the subsequent conflict has witnessed a profusion of deployed Russian weapons and equipment; Russian UAVs proved to be no exception, with almost every system in service featuring in the fighting in Donbas. An assumption within Western analyses of the development of Russian military UAVs is that Russia's domestic defense industry is significantly hampered by the impact of the international sanctions regime imposed in the aftermath of Moscow's annexation of Crimea. This is an over simplification, however, which does not take into account the numerous workarounds Russian defense companies had employed to gain access to foreign dual-use technologies. Documented examples have emerged of Russia's domestic arms producers accessing foreign technologies even in the highly sensitive area of military UAV technology, despite the allegedly tight and restrictive nature of international sanctions. In November 2021, the United Kingdom–based company Conflict Armament Research (CAR) issued a report, covering a three-year period, that details Russian weapons and equipment involved in the Ukraine conflict.[48]

Among the wide range of military technology observed in Donbas, the CAR report focuses on a half a dozen systems:

> CAR documented six different models of Russian military UAVs that Ukrainian defense and security forces recovered from armed formations in Ukraine. All six UAVs were recovered in Donetsk region. Each of these military UAVs is made of

aviatsionnogo udara,' *Vozdushno-Kosmicheskiye Sily. Teoriya i Praktika*, No.5, 2018, pp.99–104.

[48] 'Weapons of the War in Ukraine', Conflict Armament Research (CAR), November 2021., pp.130-146.

> commercial and dual-use components such as GPS modules, electronic parts, cameras, and engines. CAR identified companies with headquarters in ten countries (outside of the Russian Federation) that produced components documented in these six UAVs: the Czech Republic, France, Germany, Israel, Japan, South Korea, Spain, Switzerland, the United Kingdom, and the United States.[49]

The six Russian UAVs were the Zastava, an unknown model (resembling the Orlan-10), Eleron-3SV, Granat-2, Orlan-10 and Forpost. These Russian manufactured UAVs were identified as the remains of such complexes operating in southeastern Ukraine between October 2016 and November 2020.[50]

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[49] According to the CAR website: "CAR comprises a group of companies. Its parent company, Conflict Armament Research Ltd (CAR – UK), is a for-profit entity, registered in England and Wales in 2011. CAR has since incorporated various entities to implement regionally focused areas of activity, including: Conflict Armament Research – Support Ltd. (CAR UK – Support), established in 2016. Conflict Armament Research BV (CAR – EU), established in 2018. Conflict Armament Research US – Support Inc. (CAR US – Support), established in 2021." The company "supplements formal weapon tracing with analysis of physical evidence gathered from the weapons themselves and that of related materiel; obtaining government, commercial, transport, and other documents; and interviewing individuals with knowledge or experience of the equipment transfers under scrutiny. CAR does not undertake undercover work or use other clandestine investigation methods. For privacy reasons, CAR's publications do not refer to private individuals by name, except in the case of well-known public officials. Unless specified, no reference to the names of countries of manufacture, manufacturing companies, intermediary parties, distributors, or intended end users implies illegality or wrongdoing on the part of that named entity." Conflict Armament Research (CAR), https://www.conflictarm.com/methodology/, Accessed on November 24, 2021.

[50] *Ibid.*

The report details the dates and UAV type in each instance as:

Zastava

On 12 October 2020, CAR documented a Zastava UAV with the number 405. Ukrainian defense and security forces recovered the UAV near Svitlodars'k (Donetsk region) on 5 April 2020. Ural Works of Civil Aviation manufactured the UAV, a licensed copy of the Israeli IAI BirdEye, in or around 2013.

Unknown model (resembling the Orlan-10)

On three separate dates—17 December 2018, 11 May 2019, and 10 November 2020—CAR documented a single intelligence, surveillance, and reconnaissance UAV of unknown designation and with the number 2166. Ukrainian defense and security forces downed the UAV on 8 February 2017 near Mariupol (Donetsk region). This model resembles the Orlan-10 in some ways but the two UAVs are fundamentally different. On 18 May 2021, CAR documented a UAV model in Lithuania that was identical to one recovered in Ukraine in 2016. According to Lithuanian security forces, the UAV entered the country's airspace near the border with Latvia and Belarus, flew to Poland, and subsequently crashed in north-western Lithuania on its return journey, where authorities recovered it in October 2016.

Eleron-3SV

On 12 December 2019, CAR documented two Eleron-3SV UAVs, manufactured by JSC 'ENICS'. Ukrainian defense and security forces recovered the first of these near the town of Horlivka (Donetsk region) on 29 June 2019 and the second near the town of Svitlodars'k (Donetsk region) on 11 July 2019. Based on marks found on internal components, CAR's assessment is that the UAVs were manufactured in or around 2015.

> **Granat-2**
>
> On 10 November 2020, CAR documented a Granat-2 UAV manufactured by Izhmash Unmanned Systems. Ukrainian defence and security forces recovered this UAV near Chermalyk (Donetsk region) on 18 November 2018.
>
> **Orlan-10**
>
> On 26 September 2018, CAR documented an Orlan-10 UAV bearing the number 10264. Bar code stickers on the UAV indicate that it was manufactured in or around 2014.
>
> **Forpost**
>
> On 26 September 2018, CAR documented a Forpost UAV bearing the number 923. Ukrainian defense and security forces downed the UAV near Pisky (Donetsk region) on 18 May 2015. The UAV's Hobbs meter (the airframe flight hours counter) indicates that the UAV was flown for a total of 723 hours before Ukrainian defense and security forces recovered it. Ural Works of Civil Aviation manufactured the Forpost, which is a licensed copy of the Israeli IAI Searcher. Date marks on some of the components documented by CAR indicate that they were produced in Israel in mid-2013.[51]

The CAR report found foreign components in the Zastava UAV:

> A German company, Hacker Motor, manufactured the engine. CAR also documented an electronic component manufactured by the US company VWeb Corporation, and an autopilot unit

[51] *Ibid.*

> manufactured by the Spanish company UAV Navigation. In the unidentified UAV, components were manufactured by companies with headquarters in Germany, Japan, South Korea, Switzerland, the UK, and the United States.[52]

In the case of the Eleron-3SVs,

> The circuit board of one of the UAVs' main camera features a 32-bit microcontroller unit. The manufacturer, STMicroelectronics, replied to a CAR trace request, confirming that it had assembled and shipped the unit in 2014. The circuit board itself also bears a 2014 date mark. The main camera in one of the Eleron-3SV UAVs is a Sony FCB-EX11DP. Inside both UAVs, CAR investigators found secondary Olympus Stylus TG-860 point-and-shoot cameras manufactured in 2015. Both Sony and Olympus have yet to provide more information about the items CAR documented.[53]

The Granat-2 contained an array of foreign components:

> **Intel Corporation (US)** replied to a CAR trace request, stating that the lot number and trace code marks on the component – labelled 'Altera' – did not exactly match any Altera products, and that the component that CAR documented could be one of six Altera products, and that Intel was unable to identify the recipient of the item that CAR had documented.
>
> **Pulse Electronics (US)** confirmed that they had manufactured the PC Card LAN Magnetic Module at a facility in China in 2013. The company confirmed that it produced 11,360 units of this

[52] *Ibid.*

[53] *Ibid.*

> component with the same date code, and sold them to four distributors in December 2013. Subsequent tracing efforts with those distributors have not yet established the onward chain of custody for this component.
>
> **Max Amps (US)** confirmed that it had manufactured the LiPo 1100 18.5v battery that CAR documented in the Granat-2 UAV in Ukraine, but that the company had sold thousands of similar batteries and that the item that was being traced did not have the unique identifying information to enable traceability. However, MaxAmps did confirm that it does not ship batteries directly to Ukraine.
>
> **Model Motors (Czech Republic)** also confirmed that it had manufactured the AXI 2826/10 Gold Line engine that CAR documented in Ukraine. The company stated that it manufactured this model between 2005 and 2017, which was sold for use in model aircraft constructed by hobbyists. Model Motors also stated that 99 per cent of its buyers are located in Austria, the Czech Republic, Germany, the UK, and the United States, and that it did not distribute its products directly to the Russian Federation or Ukraine.[54]

In the case of the Orlan-10, CAR discovered:

> The UAV is fitted with a GPS module produced by a company called u-blox AG, which is headquartered in Switzerland. The same circuit-board that contains the u-blox component also holds an MNP-M7 GPS receiver, produced by the Russian company Izhevsk Radio Plant. While the Forpost UAV contained components from France and the United States, and ties to the Israel Aerospace Industries: CAR also documented the

[54] *Ibid.*

> GPS antenna of the UAV, which was produced in the United States. The manufacturer, Antcom Corporation, produced it in March 2013 and sold it to another company, NovAtel, which subsequently transferred it to Israel Aerospace Industries in Israel in May 2013. IAI has yet to respond to CAR's trace request, which sought information on the onward supply of this item.[55]

The CAR report examining the foreign component parts found in these Russian manufactured UAVs concluded:

> CAR's tracing of components of Russian-manufactured UAVs recovered in Ukraine identified independent Russian electronics and component distributors as conduits for foreign technology acquisition on behalf of Russian defense and security entities.
>
> These commercial and dual-use components were manufactured by companies with headquarters in ten different countries: the Czech Republic, France, Germany, Israel, Japan, South Korea, Russian Federation, Spain, Switzerland, the United Kingdom, and the United States.
>
> In some cases detailed here, disagreements between European governments and industry actors pose challenges for the enforcement of embargoes. Opaque licensing requirements for dual-use components, combined with a lack of clarity over the ultimate end use or end user of those components, appear to facilitate the integration of key [European Union]-made technology into Russian military UAVs, despite an EU arms embargo that was imposed on the Russian Federation in 2014.[56]

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[55] *Ibid.*

[56] *Ibid.*

While such details concerning the presence of foreign components within Russian UAVs have implications for the enforcement of international sanctions, they also reveal an unflattering image of the domestic defense industry. Despite several years of sanctions against Russia, in sensitive areas such as UAV development, domestic companies still depend on acquiring parts and electronics from foreign suppliers.[57] An Orlan UAV recovered in southeastern Ukraine in January 2018 was found to have a Japanese model aircraft engine.[58] Although these foreign dependencies are likely to lessen in the future, as the domestic defense industry finally adjusts to these realities, it also provides context for the extent to which existing R&D programs on UAVs and particularly UCAVs are somewhat slow to yield successful completion. This is especially evident in the drive to re-balance the UAV inventory beyond ISR to cover reconnaissance-strike and strike systems.

Future Unmanned Aerial Strike Capability

Attack UAVs (*Udarnyye Bespilotnyye Letatel'nyye Apparatiy*—UBLA) are becoming an increasingly powerful factor in the initial period of war. Based on the constantly changing and growing role played by such strike systems in modern warfare, these are constantly developing and improving; this requires careful and thorough analysis of all aspects of their application. Within the Russian literature considering such strike systems, they are categorized into:

- Attack UAVs designed to combat ground targets using airborne weapons;

[57] '*Forpost i Zastava na UZGA*,' *Op.Cit*.

[58] '*Rossiiskii BPLA Orlan-10 sostoit' iz detalei proizvodstva SShA i drugikh stran – fotootchet*,' POLITua, https://politua.org/novosti/34865-rossijskij-bpla-orlan-10-sostoit-iz-deta/, January 31, 2018.

- UAVs using electronic warfare (*Bespilotnyye Letatel'nyye Apparaty-Radioelektronnoi Bor'by*—BLA-REB), used to disable ground and air communications and enemy C2;
- UAV-fighters (*BLA-istrebiteli*—UAV-I) to combat unmanned and manned aircraft;
- Auxiliary UAVs designed to perform certain functions to support Ground Forces combat operations.[59]

Within the Russian military literature on UAVs, these are commonly and interchangeably referred to as attack/strike or even shock UAVs. They feature increasingly in modern conflict; as such, Russia's senior defense leadership also pays close attention to those developments and prioritizes the R&D and procurement of "shock UAV" capabilities for the Armed Forces. In Russia, various defense industry companies are developing strike UCAVs, including Dan'-Baruk, Zenitsa, Al'tair, Skat, Proryv-U, and the S-70 Okhotnik UCAVs. These developments remain at various stages. An experimental strike version of the Tu-300 Korshun-U UAV has been publicized as a system in development.[60] The NPO Aviation Systems, in conjunction with the Flight Research Institute named after M.M. Gromov, has developed an attack helicopter–type UAV—the Skymak-3001—with a take-off weight of 800 kilograms. Taking into account the geographic scale of Russia, it can be noted that in the military sector there is a need for unmanned reconnaissance vehicles with a long flight duration. Thus, at the MAKS-2017 airshow, the Kronstadt company presented the first Russian aerial reconnaissance complex with a long flight duration and a takeoff weight of about one ton—the UAV Orion-E. It appears to be not only designed for reconnaissance

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[59] Zaydullin, S.S, Moiseyev, V.S, *Matematicheskiye modeli i metody upravleniya territorial'no raspredelènnymi sistemami,* Kazan: Master Line, 2005.

[60] Yerokhin Ye, '*Debyut Oriona*,' *Vzlet*, No.9-10, 2017, pp.30–34; Yerokhin Ye, 'V*ertolety Rossii pokazali novyy bespilotnik*,' *Vzlet*, No.9-10, 2017, p.12.

but as a reconnaissance-strike platform.[61] According to the defense aviation magazine *Air Force Technology*, ongoing Russian R&D on strike UCAVs include the following:

> **Sukhoi S-70 Okhotnik-B (Hunter)**
>
> The S-70 Okhotnik-B (Hunter) is a stealth-capable combat drone being developed by Sukhoi Design Bureau and Russian Aircraft Corporation MiG. The drone made its first flight in August 2019. The unmanned combat aerial vehicle (UCAV) is expected to be delivered to the Russian armed forces in 2024.[62]
>
> **Grom (Thunder)**
>
> Grom (Thunder) is a new stealth combat drone designed by Kronstadt. A mock-up of the UCAV was presented during the Army-2020 trade show held in Moscow, in August 2020. The Thunder UCAV is intended to operate, along with the Su-35 and

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[61] *Ibid.*

[62] "Anticipated to serve as a 'loyal wingman', the stealthy drone incorporates a flying wing design, while its composite fuselage is covered with […] radar-absorbing paint. It is designed to offer a lower radar cross-section. Powered by an AL-31 turbojet engine, the UCAV can be installed with electro-optical targeting, communication, and reconnaissance payloads. With the maximum take-off weight of 20 [tons], the Okhotnik-B combat drone is significantly bigger than its Western counterparts such as Dassault nEUROn and Northrop Grumman X-47B. The length and wingspan of the Hunter UCAV are 14m and 20m, respectively. The attack drone features two internal weapon bays to accommodate up to 2,000kg of guided and unguided munitions, including air-to-surface missiles and bombs. It is expected to fly at a speed of 1,000km/h and attain a maximum range of 6,000km." 'Russia's top long-range attack drones,' Air Force Technology, https://www.airforce-technology.com/features/russias-top-long-range-attack-drones/, November 27, 2020.

Su-57 fighter aircraft, to provide reconnaissance data and fire missiles upon receiving commands from the manned jet.[63]

Altius-U

The Altius-U medium altitude long endurance (MALE) drone is being developed by Ural Civil Aviation Plant (UZGA). The attack and reconnaissance capabilities of the drone are believed to be comparable to that of RQ-9 Reaper and RQ-4 Global Hawk UAVs.[64]

[63] "With its dorsal inlet and V-shape tail, Russia's long-range attack drone bears a striking resemblance to the Kratos XQ-58 Valkyrie stealthy unmanned combat aerial vehicle. The Grom combat UAV measures 13.8m-long and 3.8m-high while its wingspan is 10m. The drone has a maximum take-off weight of 7t and can carry a maximum payload of 2,000kg. It has four hard-points including two under the wing consoles and two inside the fuselage. It can carry Izdeliye 85, KAB-250-LG-E, KAB-500S-E, and X-38MLE munitions. The stealthy drone can fly at a cruise speed of 800km/h and reach a maximum altitude of 12,000m. It has a maximum speed of approximately 1,000km/h, while the combat radius of the UAV is 700km." *Ibid.*

[64] "The Altius-U MALE UAV made its first flight in August 2019. It flew for 32 minutes at a maximum altitude of 800m in fully autonomous mode. The drone is expected to perform reconnaissance, strike and electronic attack missions for the Russian Air Force and Navy. The fixed-wing design of the unmanned aerial vehicle incorporates a large high-mounted wing, a V-tail configuration and a three-leg retractable landing gear. Built using the composite materials, Altius is powered by two new VK-800C turboprop engines developed by the Klimov Design Bureau. The 7t drone can carry 2t of combat payload, including a family of Grom 9-A-7759 gliding bombs which can engage targets at a distance of 120km. The drone can target headquarters, radars, missile and air defence units and land-based cruise missile launchers while supporting low-intensity conflicts and counter-terrorism operations." *Ibid.*

Kronstadt Sirius

The Sirius medium-altitude long-endurance (MALE) attack UAV from Kronstadt is touted to be the biggest Russian drone with a wingspan of 30 [meters]. It is intended to support the surveillance missions at the borders and the Russian exclusive economic zone (EEZ) in the Arctic and the Pacific.[65]

Kronshtadt Orion

Orion is a medium-altitude combat-capable UAV developed by Kronstadt, a part of Sistema JSFC. Kronstadt showcased the Orion drone, along with a full range of weapons, during the Army-2020 defence exhibition held in August 2020.[66]

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[65] "A full-size mock-up of the 5t drone was presented for the first time at the MAKS-2019 International Aviation and Space Salon held at Zhukovsky International Airport near Moscow, Russia. It was also on display at the Army-2020 international military-technical forum held in August 2020. The long-range reconnaissance and attack drone will have a length of 9m and a height of 3.3m. It will also feature a satellite communications complex, allowing it to perform long-range reconnaissance and combat missions. The drone will have the capacity to carry a maximum combat load of 450kg, allowing it to carry guided bombs or air-to-ground missiles. It will cruise at a speed of 295km/h and fly at an altitude of 12,000m. The endurance of the Sirius UAV with full payload will be 40 hours." *Ibid.*

[66] "The fixed-wing design of the Orion drone integrates V-shaped tail fins. The drone is made of carbon plastic composite materials to reduce the weight of fuselage. It is also equipped with an electric impulse anti-icing system for operation in low temperatures. The drone can carry four guided bombs or four missiles, including the KAB-50 bombs and UPAB-50S 50kg guided munitions. The UPAB-50S missile can strike personnel and objects at a maximum distance of 30km. It can be attached with high-explosive (HE) fragmentation, cluster, and fuel-air explosive warhead types. The combat UAV is also installed with a new weapon guidance system. The Orion UAV has a maximum speed of 200km/h while its maximum flight duration with the standard payload is 24 hours. Orion-E, the export version,

The Sukhoi heavy-strike UCAV S-70 Okhotnik, the highest-profile of these strike systems, works together with the Su-57 fifth-generation fighter. The experimental version was first publicly seen in early 2019 and underwent its first test flight in August 2019. The S-70 Okhotnik remains at its testing stage, yet advances in its design—which include a fitted stealth nozzle on its single engine—suggest it will offer a formidable strike capability for the VKS.[67] The reported development of the Su-57 focuses on its strike potential. It differs from the United States Air Force (USAF) F-22 and China's People's Liberation Army Air Force (PLAAF) J-20 since it is designed to be much more versatile, less focused on gaining air superiority, and with greater ability to engage ground and sea-based targets. The Su-57 will have an array of weapons systems at its disposal. In particular, the PBK-500U Drel allows the Su-57 to strike ground targets at a distance of 30–50 kilometers based on the "fire and forget" principle.[68] The GLONASS-guided cluster glide bombs use inertial and satellite guidance for maximum accuracy. Long-range strike for the Su-57 involves the use of Kh-59MK2 cruise missiles with a warhead weighing 320 kilograms. These can destroy targets at distances of up to 285 kilometers.[69]

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has a maximum take-off weight of 1,000kg and can carry a 200kg payload, including four 50kg or two 100kg munitions." *Ibid*.

[67] Anton Valagin, '*Klyuchevuyu osobennost' drona S-70 Okhotnik pokazali na video*,' *Rossiyskaya Gazeta*, https://rg.ru/2021/10/10/kliuchevuiu-osobennost-drona-s-70-ohotnik-pokazali-na-video.html, October 10, 2021.

[68] A version of the AL-41F1 engine for the Su-57 is installed on the Okhotnik. The UACV has only one engine, which imposes special requirements for its reliability. The applied systems allow its engine to work even in the event of a complete failure of its automation—it will simply go to idle speed, according to Sergei Vakushin, the chief designer of UEC-UMPO for products at the P. Lyul'ka Design Bureau. *Ibid*.

[69] '*Rossiyskiy udarnyy bespilotnik S-70 stanet nezametnym dlya vraga*,' Topwar.ru, October 19, 2021; '*Rakety Su-57 raznesut lyuboy natovskiy korabl' v kloch'ya*,' VPK-news.ru, https://vpk-news.ru/news/64284, October 18, 2021.

In relation to the S-70 Okhotnik's stealth nozzle, the layout is new for domestic aviation and clearly differs from the first prototype. Unlike the commonplace round nozzles, the Okhotnik will use a rectangular (flat) nozzle. This design feature was not previously employed in Russian aviation, but it has been notably implemented in the USAF F-22 and the supersonic heavy stealth strategic bomber B-2 Spirit, produced by Northrop. The flat nozzle design makes it possible to increase the stealthiness of an aircraft's signature, thus boosting its survivability. According to Sergei Kuzmin, a deputy general designer at the Motor Design Bureau, the S-70 Okhotnik's flat nozzle will allow for more efficient dissipation of the heat trace from the engine. Consequently, the Okhotnik will be less vulnerable to guided missiles with infrared homing heads.[70]

An analysis published in a Russian aviation website argues that the S-70 is intended almost exclusively for large-scale warfare. Noting the lack of strike capability in Russia's UAV/UCAV military inventory, with the current focus on ISR, the commentator alleges that the S-70 appears designed for high-end conflict with a peer adversary; it would be tasked with suppressing long-range air-defense systems as well as destroying important targets in the operational depth of the enemy, or providing cover to manned aircraft from ground-based attacks.[71]

Moscow is increasingly seeking to diversify its unmanned aerial inventory beyond heavy-strike UCAVs as well. In April 2021, Russia's defense ministry released video footage from Syria of the country's Special Operations Forces employing a Lantset loitering drone to

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[70] *Ibid.*

[71] Viktor Kuzovkov, '*Kopiya protiv originala: chem nash dron Orion ustupayet amerikanskomu originalu*,' Newizv.ru, https://newizv.ru/news/tech/30-10-2020/kopiya-protiv-originala-chem-nash-dron-orion-ustupaet-amerikanskomu-originalu, October 30, 2020.

conduct strikes against moving and stationary ground targets.[72] While the Lantset illustrates the increased diversity of Russian UAV technologies and substantial interest in fielding unmanned platforms for strike operations, Moscow-based military specialists note the limits of such systems.[73] The Lantset UAV acts as a loitering munition (*barrazhiruyushchiy boyepripas*), sometimes referred to as a "kamikaze drone." The first of these systems appeared in Russia's military inventory in 2019. Kalashnikov Concern announced that the Lantset strike UAV had completed tests in July 2019. Its novelty for the Russian Armed Forces lies in the UAV carrying out both reconnaissance and strike missions similar to a high-precision missile. Such UAVs have an integrated warhead, are capable of long flights, and can loiter for lengthy periods over the battlefield while fixing and locating the target before destroying it. Similar drones are produced

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[72] A unique feature of the Lantset is the x-shaped aerodynamic tail configuration. In June 2019, on the eve of the Army-2019 forum, the Kalashnikov concern presented a more improved version of the Kub UAV: the Lantset. The Lantset-1 and Lantset-3 are reportedly capable of carrying payloads of up to 3 kilograms. "The double-x is our absolute know-how. When diving and maneuvering, such a scheme behaves much better; besides, the dimensions of the product are greatly reduced," according to Alexander Zakharov, the general director of the weapons design studio Zala Aero. He added, "We also managed to reduce the weight, which is only 12 kg due to the maximum use of plastic and composites in the structure." Moreover, the Lantset UAV is highly accurate in terms of precision-strike capability, with a video communication channel aiding guidance. According to Rostec, "The complex includes not only a striking element, but also a reconnaissance, navigation and communication module. It is able to determine coordinates from various sources and objects. So the fundamental difference between the Lantset and the previous generation and many foreign analogues is that it does not need any satellite navigation." '*Udarnyy bespilotnik Lantset: kop'ye XXI veka*,' Rostec.ru, https://rostec.ru/news/udarnyy-bespilotnik-lantset-kope-xxi-veka/, August 30, 2019.

[73] Anton Valagin, '*Primeneniye rossiyskogo drona-kamikadze pokazali na video*,' *Rossiyskaya Gazeta*, https://rg.ru/2021/04/17/primenenie-rossijskogo-drona-kamikadze-pokazali-na-video.html, April 17, 2021.

internationally and, notably, featured in Azerbaijan's military operations in Karabakh in 2020.[74]

UAV systems such as the Lantset certainly provide Russia's Armed Forces with a new capability, especially in the area of conducting non-contact strikes. Vladimir Shcherbakov, the deputy editor of *Nezavisimoye Voyennoye Obozreniye*, notes that the Lantset can inflict operational strikes on important targets and reduce the costs per kill. Such UAVs are also highly adaptable in the applied trajectory and the ability to significantly reduce the possibility of losses among the personnel of their forces by increasing the accuracy in the use of munitions. Equally, the Lantset benefits from the simplicity of its design and the possibility of combat use by advanced formations of Ground Forces units or special forces groups behind enemy lines: in the minimum configuration, a combat complex based on a loitering munition can include one or two kamikaze UAVs, a wearable launcher (launch tube or catapult) and a portable control station. Nonetheless, Shcherbakov is realistic in his assessment of the Lantset's limitations. These primarily relate to the small mass of the warhead and "irrecoverable nature" of these UAVs. "If, for some reason, it is not used against the enemy, it must either be transferred to another target, or withdrawn to a safe area to self-destruct. In the latter case, the option of 'disarming' is also possible; but all the same, the munition must be diverted for this to a safe area. However, a number of modern samples of such devices, it is said, allow them to be returned by removing the warhead," Shcherbakov explained.[75] While

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[74] Vladimir Karnozov, '*Barrazhiruyushchiye boyepripasy reshayut sud'bu Karabakha*,' *Nezavisimoye Voyennoye Obozreniye*, https://nvo.ng.ru/realty/2020-10-09/2_1112_karabakh2.html, October 9, 2020).

[75] Vladimir Shcherbakov, '*Vsplesk novoy voyennoy revolyutsii*,' *Nezavisimoye Voyennoye Obozreniye*, https://nvo.ng.ru/armament/2021-03-11/1_1132_drones.html, March 11, 2021.

the UAV/UCAV types in Russia's Armed Forces are proliferating, the roles assigned to these platforms in future conflicts are also being influenced by the use of such systems in the inventories of foreign militaries.

Additional areas of interest for the diversification and development of Russian UAVs extend to complexes for conducting strikes against enemy forces and targets using compact thermobaric and incendiary munitions. In October 2021, the Russian defense ministry approved plans for new UAVs for the Radiation, Chemical and Biological Protection Troops (*Radiatsionnoy, Khimicheskoy i Biologicheskoy Zashchity*—RKhBZ). These will add UAV flamethrower systems to the inventory of the RKhBZ based on small unmanned aircraft or quadcopters. According to Russian military experts, such capabilities could prove useful in urban warfare and also during the destruction of enemy reinforcements. Moscow-based military expert Viktor Murakhovskiy explained their utility: "UAVs will permit the rapid destruction of targets in urban area, and also targets that are hidden in terrain folds or are located in fortifications. They are needed in order to destroy important facilities in the enemy tactical rear."[76]

According to Murakhovskiy exploiting such systems using incendiary and thermobaric munitions will "permit the minimization of collateral damage during the course of combat operations. Those unmanned aerial vehicles will be invaluable in house-to-house fighting. They will permit us to avoid the destruction of structures, which are not related to the military infrastructure, and to also reduce losses among the peaceful population and servicemen. It is better to

[76] Anton Lavrov, Bogdan Stepovoy, '*Letyashchey navodkoy: rossiyskaya armiya zakazala bespilotnyye ognemetchiki: Novaya sistema pozvolit nanosit' po protivniku udary termobaricheskimi i zazhigatel'nymi bombam*i,' *Izvestia*, https://iz.ru/1230786/anton-lavrov-bogdan-stepovoi/letiashchei-navodkoi-rossiiskaia-armiia-zakazala-bespilotnye-ognemetchiki, October 5, 2021.

lose two drones or robots than one soldier." Small UAVs such as the latest Lastochka complex were tested in the role of strike UAVs during Zapad 2021. These UAVs dropped anti-personnel and hollow-charge bombs on their targets. Small multi-copters, capable of dropping small bombs with various warheads on targets, are also under development. These hover over a target to achieve greater accuracy. The capability for a hollow-charge bomb to strike a mockup of a tank was confirmed in tests. Flamethrower drones can be used to destroy and ignite larger facilities.[77]

Moreover, Moscow is paying greater attention to measures to counter UAVs. In the September 2021 issue of *Armeyskiy Sbornik*, the growing role of EW in air defense to counter UAVs is addressed in detail. Colonel M. Mitrofanov, Lieutenant Colonel D. Vasyukov and Major V. Anisimov note the extent to which drones are part of the threat landscape in modern warfare. Referring to the experience of countering UAVs in local conflicts, the authors explain that "when they are airborne, their data transmission channels are visible to signals intelligence and vulnerable to electronic jamming. The data transmission channels include: the operator's control channel to the drone, the drone's channel for transmitting data to its control station and the satellite navigation channel." In this setting the authors introduce the role of EW to target adversary UAVs:

> Countering drones does not necessarily mean their physical destruction. Electronic jamming can be used to disable a drone's data transmission channel, also the channel for controlling it. Apart from disabling the control and data channels, you also need to disable the channel that receives the satellite navigation signals. Satellite data is used not only to plot the drone's route but also by weapons for target acquisition… Russian electronic warfare developers are actively working on ways of countering

[77] *Ibid.*

> drones. For example, at the Dubai Airshow in 2019 the Rosoboronexport corporation displayed the design of a layered defense system that included Russia's latest counter-drone technologies, such as the Repellent-1, Sapsan Bekas, Kupol, Rubezh Avtomatika, Luch, and Pishchal. Particular attention is also being paid to portable devices for fighting drones. For example, the Luch and Pishchal systems, which can emit electromagnetic signals to disable drones 6 and 2 km away respectively, were displayed for the first time at the Dubai Air Show in 2019. The Pishchal weighs just 3.5 kg and is one of the lightest counter-UAV devices of its class on the market today, so it can form part of a soldier's personal kit.[78]

Mitrofanov, Vasyukov and Anisimov state that Russian EW manufacturers are developing portable counter-UAV devices, most of which are in the form of a firearm:

> They comprise modules for detecting a drone's radio signals and creating the jamming to disable the control and navigation channels. Among these devices is the Personal Drone Countermeasures Complex made by the Special Technology Center company, which can disable drone control channels from at least 2 km away and radio navigation channels from at least 10 km. Or the Rex 1 and Rex 2 portable counter-UAV systems made by the company Zala Group Unmanned Systems.[79]

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[78] Colonel M. Mitrofanov, Lieutenant-Colonel D. Vasyukov, Major V. Anisimov, '*Prakticheskiye Rekomendatsii Zashchita Elementov Sistemy Svyazi Ot Bespilotnykh Letatel'nykh Apparatov*,' https://army.ric.mil.ru/Stati/item/343042/, *Armeyskiy Sbornik*, No.9, 2021.

[79] *Ibid*.

These counter-UAV EW devices also work against UAV control and navigation channels. In addition, Russia's defense industry is working on a variety of means to combat enemy UAVs. The authors summarize the existing methods to counter drones:

1. Destroy them using air-defense or other fire assets;
2. Destroy their control stations;
3. Capture them (with nets or by intercepting their control channels);
4. Use electro-optical countermeasures (advanced directed-output laser weapons);
5. Electronically jam their control channels, reconnaissance data transmission channels, or their geopositioning systems;
6. Distort the navigation coordinates in the vicinity of a protected site.
7. Conceal protected sites;
8. Create dummy protected sites (deception).[80]

While initiatives to expand the military use of UAVs beyond ISR to achieve a greater range of capabilities for Russia's conventional Armed Forces are ongoing, with heavy-strike UCAVs likely to feature increasingly by the mid-2020s, the question remains as to how these advances may change Russian approaches to war fighting. The most likely observable trend is toward more integration and fuller exploitation of such systems in support of the ROS and the RUS. Surprisingly, such approaches harnessing ISR for accuracy of fires was not an inherent feature of Russia's military operations in the Russia-Ukraine War 2022. However, some Russian military theorists see the potential to further increase the effectiveness of unmanned systems in combat and conceptualize this as a new philosophy on the use of these assets. For example, writing in *Vozdushno-Kosmicheskiye Sily: Teoriya i Praktika*, V.P. Kutakhov, a professor in the National Research

[80] *Ibid.*

Center, Zhukovsky Institute (Moscow), and his colleague A.E. Titov argue that Moscow may be able to harness UAV/UACV assets in conjunction with other technologies to achieve a modern variant of the *Revolyutsiya v Voyennom Dele* (Revolution in Military Affairs).[81]

In essence, these authors base their argument on the extent to which modern warfare is undergoing constant change. These changes include *inter alia*: the complexity and intensity of the conduct of hostilities in new conditions (high dynamics of changes in the combat situation, the complexity and transience of the ongoing hostilities), informationization of weapons marked by "rapid growth in the quality of technologies based on AI [artificial intelligence]," recognizing the limits imposed on unmanned capability linked to human operators, and the transition to the conduct of hostilities using UASs in organized groups. In the near future, they add, groups of homogeneous UAVs with intelligent group management within the framework of solving a common (joint) problem will supersede mixed aviation groupings using manned aircraft as its leaders. "AI is by far the most promising direction in the development of control technologies and the use of UAV complexes, which is reflected in many guidance documents," Kutakhov and Titov assert.[82] This is not

[81] V.P, Kutakhov, A.Ye, Titov, '*Krupnomasshtabnyye aviatsionnyye sistemy s bespilotnymi letatel'nymi apparatami – novaya paradigma boyevykh deystviy*,' *Vozdushno-Kosmicheskiye Sily. Teoriya i Praktika*, No.19, September 2021, pp.212-221.

[82] Although the authors assert that the AI national guidance documents lay the basis for such developments, these in fact contain no reference to the military use of AI. Kutakhov, V.P, '*Intellektualizatsiya aviatsionnykh kompleksov*,' *Materialy zasedaniya Mezhvedomstvennoy rabochey gruppy po podgotovke predlozheniy, napravlennykh na vyyavleniye perspektivnykh i proryvnykh napravleniy nauchno-tekhnicheskogo i innovatsionnogo razvitiya aviatsionnoy otrasli*, 2018, pp.34–36; *Ukaz No. 490*, '*O razvitii iskusstvennogo intellekta v Rossiyskoy Federatsii*,' http://www.garant.ru/products/ipo/prime/doc/72738946, 2019; *Rasporyazheniye Pravitel'stva Rossiyskoy Federatsii, No.2129-r*,

about using AI in individual UAV/UCAV platforms. Rather it envisages exploiting AI technologies to apply unmanned systems in large-scale combat groupings.[83]

In the early stages, however, of Russia's large-scale invasion of Ukraine initiated on February 24, 2022, among a range of high-tech capabilities either missing or minimal in the Russian force mix and application of military force was the role of UAV/UCAVs. This partly reflected planning failures, flawed political-military assumptions and how the early period of war was construed by the Russian General Staff. Moreover, it also stemmed from the failure in the very earliest days of the war to establish air superiority/supremacy by the VKS. As the Israeli independent defense analyst Guy Plopsky observed:

> The Russians did not appear to exploit the partial success of their initial missile strikes and follow them up with large fixed-wing strike packages. One explanation is that the Russians probably overestimated their own capabilities and underestimated the Ukrainians. They may have believed that their ground forces would be able to seize key objectives swiftly, and that the extensive use of operational-tactical aviation would therefore not be necessary. This is supported by the fact that the opening phase of missile-aviation and artillery attacks that preceded the ground offensive was quite short. Many analysts expected it to be much

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http://publication.pravo.gov.ru/Document/View/0001202008260005, August 19, 2020; *Federal'nyy zakon No. 123-FZ, 'O provedenii eksperimenta po ustanovleniyu spetsial'nogo regulirovaniya v tselyakh sozdaniya neobkhodimykh usloviy dlya razrabotki i vnedreniya tekhnologiy iskusstvennogo intellekta v sub'yekte Rossiyskoy Federatsii – gorode federal'nogo znacheniya Moskve i vnesenii izmeneniy v stat'i 6 i 10 Federal'nogo zakona O personal'nykh dannykh,'* http://ivo.garant.ru/#/document/73945195/paragraph/1:0, October 24, 2020.

[83] Kutakhov, Titov, '*Krupnomasshtabnyye aviatsionnyye sistemy s bespilotnymi letatel'nymi apparatami – novaya paradigma boyevykh deystviy*,' *Op.Cit.*

> longer and more intense. The apparent subsequent reluctance to commit large numbers of tactical aircraft may have been due to possible fears of suffering excessive losses, but, with Ukraine's air defense capabilities increasingly degraded and with Russia committing more forces, there is now, as I noted earlier, increased operational-tactical aviation activity.[84]

UAVs and UCAVs: Lessons From Syria and Karabakh

Future priorities in Moscow's R&D and procurement of UAVs and UCAVs will also be influenced by the General Staff's assessments of the role played by such systems in the inventories of foreign militaries during recent conflicts. This involves to a large degree Syria, not simply by examining the performance of Russian UASs in the theater of military operations but through paying close attention to how Russian air-defense systems coped with the challenges posed by enemy drones. Particularly, Russia's military has looked at how successfully Russian air-defense systems were utilized in the hands of the Syrian Arab Army (SAA). In 2019, Dmitry (Dima) Adamsky, a professor at the School of Government, Diplomacy and Strategy, at the IDC Herzliya, in Israel, highlighted the extent to which the Russian General Staff uses Syria to draw operational lessons to apply in the further enhancement of Russia's military capabilities. In the ISR element of this process, Adamsky reflects on the marked advances made since 2012 to introduce UAVs in greater numbers as well as on their ISR utility in conducting operations in Syria:

> Since 2012, the Russian Armed Forces have taken a huge leap forward in the quality and quantity of the UAV fleet. As part of the modernization in this field, the military established 38 new

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[84] Jacek Siminski, 'What The Air Campaign in Ukraine Tells Us About The Current State Of The Russian Air Force,' The Aviationist, https://theaviationist.com/2022/03/04/russian-campaign-in-ukraine/, March 4, 2022.

> UAV units and detachments, which together operated more than 1,800 drones of various types. The aim was to improve the ability of the forces to conduct ISR missions to a tactical-operational depth of up to 500 kilometers, and to deploy them for the sake of so-called Radio-Electronic Struggle (REB), C2 and strike missions, in frames of the various RS and RF complexes; and to significantly increase the combat capabilities and effectiveness of the general-purpose forces, artillery and operational-tactical aviation. The operation in Syria employed an unprecedented, in terms of types and numbers, fleet of UAVs. On average, at any given moment, 60–70 reconnaissance, strike and radio-electronic suppression UAVs have flown over the theater of operations. All branches have been using UAVs extensively in Syria in order to create reconnaissance-strike and reconnaissance-fire contours on the operational and tactical levels. As of this writing, in the midst of the lesson-learning process, the Russian high command does not envision future combat activities for any of the services that would not involve use of UAVs.[85]

Indeed, while the fact that Russia's General Staff views operational involvement in Syria as a massive learning exercise, with numerous statements from the defense leadership highlighting progress precisely cast in terms of "based on Syria," this has become the *sine qua non* of both Russian and Western studies of the conflict.[86]

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[85] Dmitry Adamsky, 'Russian Lessons Learned From the Operation in Syria: A Preliminary Assessment,'in Glen E. Howard and Matthew Czekaj (Eds), Russia's Military Strategy and Doctrine, The Jamestown Foundation, 2019, pp.385-86.

[86] See: Yu. Shepovalenko (Ed), *Siriyskiy Rubezh*, 2nd ed, Moscow: Center for Analysis of Strategies and Technologies, 2016; Robert E. Hamilton, Chris Miller, Aaron Stein, *Russia's War in Syria: Assessing Military Capabilities and Lessons Learned*, FPRI, 2020.

Nonetheless, though the role of UAVs/UCAVs in this theater of military operations has been well documented, as well as the deployment of Russian air-defense systems to protect its assets and facilities in Syria or the use of such systems by the SAA, it has often been a more obscure field of research on the specifics of the conflict.[87]

Analysis of the challenges posed to air-defense systems by drones has certainly drawn attention from Russian air-defense specialists. These military scientists, however, largely tend to downplay or underestimate the extent of the changing nature of the challenge posed by UASs due to a number of factors, not least the evolution in these platforms and continued innovation in their operational usages.[88] Yet given the wide range of UAVs in terms of flight speed and dimensions or mass, it is clear that they present a rather difficult target for existing and in-development Russian air-defense systems. Colonel Mikhail Khodarenok (retired), a Moscow-based military journalist with a background in air defense, notes this is due to the fact that:

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[87] R. N. Pukhov, *Burya na Kavkaze*, Moscow: Center for Analysis of Strategies and Technologies, 2021.

[88] Rostopchin, V. V, '*Udarnyye bespilotnyye letatel'nyye apparaty i protivovozdushnaya oborona – problemy i perspektivy protivostoyaniya*,' *Bespilotnaya Aviatsiya*, https://www.researchgate.net/publication/331772628_Udarnye_bespilotnye_letatelnye_apparaty_i_protivovozdusnaa_oborona_-problemy_i_perspektivy_protivostoania, 2019; Aminov, S, '*PVO v bor'be s BPLA*,' UAV.ru, *Bespilotnaya Aviatsiya*, http://www.uav.ru/articles/pvo_vs_uav.pdf, April 3, 2012; Lopatkin, D. V, Savchenko A. YU, Solokha N. G, '*K voprosu o bor'be s takticheskimi bespilotnymi letatel'nymi apparatami*, *Voyennaya Mysl*', No.2, 2014, pp.41-47; Godunov, A. I, Shishkov, S. V, Yurkov, N. K, '*Sistema upravleniya kompleksnymi metodami bor'by s malogabaritnymi bespilotnymi letate'nymi apparatami*,' *Trudy mezhdunarodnogo simpoziuma nadezhnost' i kachestvo,* Vol. 1, *Penza: Penzenskiy gosudarstvennyy universitet*, 2014.

- Until recently, UAVs for various purposes with a launch weight of up to 300 kg–400kg were not included in the nomenclature of air targets;
- Low flight speeds do not provide reliable target selection and tracking by modern air-defense radars for small UAVs;
- Kinetic weapons of modern and promising land or maritime and aviation air-defense systems cannot guarantee success against strike UCAVs, especially low-speed and small-sized ones;
- The use of groups and swarms of strike UAVs/UCAVs significantly reduces the efficiency of modern air defense.[89]

In the period 2018–2020, a growing number of reports in Russian military media and deeper research analyses by air-defense specialists turned attention to the duel between UAVs/UACVs and Russian air-defense systems in Syria. In this setting, the confrontation was between Turkish Bayraktar TB2s and Ankas and the Russian-built Pantsir-S1 surface-to-air missile (SAM) system, which was designed as a cruise missile interceptor. The Bayraktar is a Turkish medium-altitude long-endurance (MALE) UCAV capable of remotely controlled or autonomous flight operation. The Anka UAV is a Turkish MALE designed to fulfil surveillance and reconnaissance roles.[90]

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[89] Khodarenok, M, '*Boyevoy roy: v armiyu SSHA prizvali gremlinov*,' Vpk-name/news, https://vpk.name/news/215425_boevoi_roi_v_armiyu_ssha_prizvali_gremlinov.html, May 16, 2018.

[90] Orlov, V, '*Bayraktary protiv Pantsirey*,' *Voyenno Promyshlennyy Kuryer*, https://www.vpk-news.ru/articles/57318, No.21, 2020.

Bayraktar TB2 UCAVs have two main types of missions: reconnaissance and strike. For reconnaissance missions, these drones typically fly at an altitude of around 6 km. The Pantsir-S1 radar can detect the Bayraktar TB2 at a horizontal distance of at least 7 km, or, in certain circumstances, up to over 15 km. Nevertheless, the Bayraktar TB2 can perform its ISR roles beyond these distances; at distances of 20 km, the platform can still accurately pinpoint the air-defense system for detection/destruction purposes. Moreover, these UCAVs operated by the Turkish Armed Forces tend to be used in groups and supported by the KORAL and REDET EW complexes. This provision of EW interference decreases the detection range from the radar of the Pantsir-S1 and reduces the probability of correct target designation for its missile-defense system. Consequently, this diminishes the likelihood of striking the Bayraktar TB2 when it operates in the zone of destruction of the Pantsir-S1.[91]

The Bayraktar TB2 also uses the French Picosar mini radar with Active Field Array Radar (AFAR), which also provides additional advantages against the Pantsir-S1: terrain scanning with a resolution of one meter at a distance of 20 km, and at a distance of 14 km the radar offers a resolution of 0.3 m, ensuring the UCAV can detect the

[91] '*Protivostoyaniye ZRK Pantsir'-S1 i turetskikh BPLA: repetitsiya voyn budushchego*,' *Voyennoye Obozreniye*, https://topwar.ru/172126-protivostojanie-zrk-pancir-s1-i-tureckih-bpla-repeticija-vojn-buduschego.html, June 14, 2020; '*ZPRK Pantsir' protiv ataki BPLA slabyye mesta pri variante slaboy obuchennosti ekipazhey*,' *Voyennoye Obozreniye*, https://topwar.ru/171955-zrpk-pancir-protiv-ataki-bpla-slabye-mesta-pri-variante-slaboj-obuchennosti-jekipazhej.html, June 8, 2020; '*Udarnyye BPLA izmenili khod boyevykh deystviy v Sirii i Livii*,' *Voyennoye Obozreniye*, https://topwar.ru/172367-udarnye-bpla-izmenili-hod-boevyh-dejstvij-v-sirii-i-livii.html, June 23, 2020; Soyustov, A, '*Uspekh turetskikh bespilotnikov v Idlibe okazalsya dutym*,' *Federal'noye agentstvo novostey*, https://riafan.ru/1258020-uspekh-tureckikh-bespilotnikov-v-idlibe-okazalsya-dutym, March 11, 2020; Orlov, '*Bayraktary protiv Pantsirey*,' *Op.Cit*.

location of the Pantsir-S1 and provide target designation to its guided missiles.

During Turkish military operations in Syria, Russian analysts noted the innovative usage of Turkish UAVs/UCAVs against the SAA. These tactics involved the following features:

- Bayraktar TB2 UCAVs were used in large groups, operating under cover of the heavier Anka reconnaissance UAVs, equipped with radar, as part of their efforts to degrade enemy air defenses;

- Turkish EW deployed on the Anka UAV almost always succeeded in successfully suppressing the Pantsir-S1 radar, allowing the Bayraktar TB2s to enter the affected area of these air-defense missile systems and successfully attack them.[92]

While these observations concerning the role of Turkish UAVs/UCAVs against the Pantsir-S1 in Syria offer sobering insights for Russian air-defense planning, it appears that Russia's Armed Forces leadership may be deducing lessons from the course of the Karabakh war in 2020. This also featured a similar UAV/UCAV duel with the Russian-supplied air-defense systems to Armenia. In the fall of 2020, the military conflict between Armenia and Azerbaijan in Karabakh was characterized by the large-scale use of UAVs/UCAVs by Azerbaijan to destroy the weapons and manpower of Armenia's Armed Forces. The Bayraktar TB2 UCAVs, equipped with laser-guided Smart Micro Ammunition (MAM) air bombs, along with Israeli Heron TP, Hermes 4507, Sky Striker and Harop UAVs, entered service in Azerbaijan's Armed Forces prior to the start of the conflict. Azerbaijan, in a joint venture with Israel, had also fielded Aerostar,

[92] *Ibid.*

Orbiter-1K and Orbiter-3 drones. Armenia's air defense in the territory of occupied Karabakh was provided with the tactical Osa and Strela air-defense systems, designed to counter aircraft and helicopters. In this context, Azerbaijan's Armed Forces mounted large-scale attacks using UAVs/UCAVs, for which Armenian forces were unprepared to counter.[93] The resulting overwhelming air superiority rapidly achieved by Azerbaijan's forces in Karabakh had a decisive impact on the course of the conflict.

In an analysis of these developments in the conflicts in Syria, Libya and Karabakh, written by Ilya Afonin, Sergei Makarenko, Sergei Petrov and Aleksandr Privalov[94] and published in 2020 in *Sistemy Upravleniya, Svyazi i Bezopasnosti*, the authors argue that the large-scale exploitation of unmanned systems in these examples proved the case that local air defenses were unable to cope.[95] This was the

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[93] Aksenov, P, '*Voyna dronov v Karabakhe: kak bespilotniki izmenili konflikt mezhdu Azerbaydzhanom i Armeniyey*,' BBC News, https://www.bbc.com/russian/features-54431129, October 6, 2020; Rozhin, B, '*Nagornyy Karabakh stal pervoy voynoy epokhi udarnykh bespilotnikov*,' *Federal'noye agenstvo novostey*, https://riafan.ru/1320335-nagornyi-karabakh-stal-pervoi-voinoi-epokhi-udarnykh-bespilotnikov, October 12, 2020; '*V Karabakhe turetskiye Bayraktar TB2 unichtozhili sovetskiye Osy i Strely*,' Lenta.ru, https://lenta.ru/news/2020/09/29/bayraktartb2/, September 29, 2020.

[94] Ilya Afonin, Associate Professor at the Department of aviation and radio-electronic equipment. Krasnodar Higher Military School of Pilots, Sergey Makarenko, Leading Researcher St. Petersburg Federal research center of the Russian Academy of Sciences, Sergey Petrov, Lecturer at the Department of aviation and radio-electronic equipment, Krasnodar Higher Military School of Pilots, Aleksandr Privalov, Associate Professor of the Department of Management and Information Security. Russian University of Transport MIIT.

[95] Afonin I. Ye, Makarenko S. I, Petrov S. V, Privalov A. A, '*Analiz opyta boyevogo primeneniya grupp bespilotnykh letatel'nykh apparatov dlya porazheniya zenitno-raketnykh kompleksov sistemy protivovozdushnoy oborony v voyennykh konfliktakh v*

culmination of a series of articles examining recent developments in air defense and UAV/UCAVs based on recent conflicts.[96] However, their 2020 study provides analytical support for the assertion that the tide had turned in favor of advanced UAVs/UCAVs against Russian air-defense systems. Their findings are best illustrated in **Table 1**.[97]

Sirii, v Livii i v Nagornom Karabakhe,' *Sistemy Upravleniya, Svyazi i Bezopasnosti*, No.4, 2020, pp.163-191.

[96] Afonin, I. Ye, Yermakov, D. A, '*Nekotoryye aspekty analiza informatsionnogo konflikta v tekhnicheskoy sfere*,' *Innovatsionnyye tekhnologii v obrazovatel'nom protsesse. Sbornik materialov XX Yuzhno-Rossiyskoy nauchno-prakticheskoy konferentsii*, Krasnodar: KVVAUL, 2019, pp.42-46. Afonin, I. Ye, Makarenko, S. I, Mitrofanov D. V, '*Analiz kontseptsii Bystrogo global'nogo udara sredstv vozdushno-kosmicheskogo napadeniya i obosnovaniye perspektivnykh napravleniy razvitiya sistemy vozdushno-kosmicheskoy oborony v Arktike v interesakh zashchity ot nego*,' *Vozdushno-Kosmicheskiye Sily. Teoriya i Praktika*, No.15, 2020, pp.75-87; Afonin, I. Ye, Yermakov, D. A, '*Bystryy global'nyy udar i vozmozhnosti yemu protivodeystvovat'*,' *Innovatsionnyye tekhnologii v obrazovatel'nom protsesse. Sbornik materialov XXI Rossiyskoy zaochnoy nauchno-prakticheskoy konferentsii*, Krasnodar: KVVAUL, 2020, pp.241-247; Yermakov, D. A, Afonin, I. Ye, '*Osobennosti primeneniya sredstv radioelektronnoy bor'by v lokal'nykh voynakh i vooruzhennykh konfliktakh poslednikh let*,' *Mezhvuzovskiy sbornik nauchnykh trudov*, Krasnodar: KVVAUL, 2019, pp.99-104.

[97] Afonin, Makarenko, Petrov, Privalov '*Analiz opyta boyevogo primeneniya grupp bespilotnykh letatel'nykh apparatov dlya porazheniya zenitno-raketnykh kompleksov sistemy protivovozdushnoy oborony v voyennykh konfliktakh v Sirii, v Livii i v Nagornom Karabakhe*,' *Op.Cit*.

Table 1: Approximate Indicators of the Average Ratio of the Number of Destroyed UAVs to the Number of Destroyed Air-Defense Missile Systems[98]

Military Conflict	**Destruction Rate: Air Defense to UAV**
Syria, 2017–2019	1 Air-Defense System: 5 UAVs
Libya, 2019	1 Air-Defense System: 2.8 UAVs
Karabakh, 2020	2.25 Air Defense Systems: 1 UAV

The full significance of the study and its findings were noticed within only a few months by three prominent researchers in the Combined-Arms Academy in Moscow. They argue that profound changes are required to Russian Ground Forces tactics, particularly driven by the Second Karabakh War. In November 2021, in *Voyennaya Mysl'*, Colonel (Reserve) Pavel Dulnev (professor and chief researcher in the Research Center for Systemic Operational-Tactical Research of the Ground Forces at the Ground Forces Combined-Arms Academy in Moscow), Colonel Sergei Sychev (professor of the Department of Tactics in the Combined-Arms Academy), and Colonel Andrei Garvardt (associate professor and deputy head of the Department of Tactics in the Combined-Arms Academy) published *Osnovnyye napravleniya razvitiya taktiki Sukhoputnykh voysk (po opytu vooruzhennogo konflikta v Nagornom Karabakhe),* (*The Main Trends of Development of Ground Forces Tactics (According to the Experience of the Military Conflict in Nagorno-Karabakh)*).[99] The article and its

[98] *Ibid*.

[99] P.A. Dulnev, S.A. Sychev, A.V, Garvardt, '*Osnovnyye napravleniya razvitiya taktiki Sukhoputnykh voysk (po opytu vooruzhennogo konflikta v Nagornom Karabakhe),' Voyennaya Mysl'*, No.11, 2021, pp.49-62.

observations about the use of unmanned systems in the conflict draws heavily upon the earlier work by Afonin, Makarenko, Petrov and Privalov.

In their *Voyennaya Mysl'* article, Dulnev, Sychev and Garvardt note the main characteristic features of the 2020 Karabakh war:

- The conduct of hostilities in mountainous terrain in directions accessible to the movement of armored fighting vehicles, which to a large extent limited the maneuver by forces and means and excluded surprise;
- A significant difference in the level of equipment of military units with modern means of armaments and, accordingly, the combat capabilities of the opposing sides;
- Large-scale use of reconnaissance-fire and reconnaissance-strike complexes, formed on the basis of the widespread use of unmanned aerial systems (UAS);
- The creation of artillery groups intended for fire damage of the enemy in the directions of the decisive attacks of units by combined arms and services;
- Widespread use of UASs equipped with light weapons and designed to infiltrate the depths of enemy defenses to conduct active hostilities;
- Raiding operations of special-purpose units for capturing heights, road junctions in order to destroy the advancing enemy reserves;
- The use of blocking groups and attack groups, operating on foot with the support of artillery fire and UAS strikes, with the task of capturing enemy defended posts;
- Wide involvement of various kinds of irregular formations, including other states, operating on high

> mobility wheeled vehicles, in order to destroy the security posts, outposts and develop the offensive.[100]

On this basis, the authors deduce a series of tactical trends "to develop recommendations for improving the combat methods of the combined arms and services, military units and subdivisions" (**Figure 2**).

Figure 2: Trends in the Development of Army Tactics and Recommendations for Improving the Methods of Hostilities of Combined Arms Formations at a Tactical Level

TRENDS	RECOMMENDATIONS
Expansion of the scale of the use of means of armed fight, created on the basis of technologies of military robotics, artificial intelligence, nanotechnology, and an increase in their influence on the course and outcome of hostilities.	Development of methods for the joint and independent use of tactical unmanned aerial systems (UAS) and ground-based robotic systems (GBRS), as well as for combating similar enemy systems in conditions of their massive use.
An increase in the combined arms operational space and an expansion of the environment for its conduct, as a result of which it acquires an even more dispersed, voluminous	Creation and use of integrated military systems allowing for transforming the totality of diverse forces and means into "united forces."

[100] *Ibid.*

character, covering all spheres of military operations along the front, depth and height.	
Transition from linear to spatially distributed combat formations by creating self-sufficient tactical groups within them, formed according to the principle of functional purpose.	Creation of combined arms formations of assault (position), attacking-maneuverable echelons, complex impact and support echelons, as well as an air echelon as part of combat formations.
Enhancing the role of reliable protection of troops from attacks by enemy air-attack weapons, and in the future from missile strikes.	Creation of a highly protected, jamproof network of the air-defense system within army tactical level, the use of GBRS within the network of the air-defense system, especially for combating small-sized targets at low altitudes.
The growing importance of reconnaissance, control, navigation and information support systems for hostilities.	Integration of automated systems for reconnaissance, control, navigation and information support of combat into a single functional space at the tactical level.

In relation to the first tactical trend the authors explain:

> ***The expansion of the use of means of armed fight, created on the basis of technologies of military robotics,***[101] artificial intelligence, nanotechnology, as well as weapons based on new physical principles and the increase in their influence on the course and outcome of hostilities was especially clearly manifested in terms of the introduction of UASs, which in their evolution reached the level allowing to combine real combat effectiveness with relative simplicity and affordability.
>
> Taking into account this trend, the army tactics were faced with the urgent task of developing forms and methods of joint and independent actions of tactical UASs, as well as combating enemy unmanned aviation in conditions of its massive use. In the short term, this task will also be relevant in relation to GBRS of various functional purposes, which by now in their evolution are reaching the line of serial industrial production.[102]

Turning to ***"The tendency to increase the role of reliable protection of troops from attacks by enemy air attack means,***[103] and in the future from missile strikes, should be especially taken into account when conducting hostilities with an enemy with a strong air component, which, along with manned aircraft, includes reconnaissance-fire and reconnaissance-strike complexes," the authors offer the following suggested developments:

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[101] Emphasis in the original.

[102] *Ibid.*

[103] Emphasis in the original.

> To combat them, it is required to create a well-prepared jamproof network of air-defense systems within the army tactical level, well protected from strikes by the forces and means of the enemy's aerospace assault weapons. It should be comprehensive—anti-aircraft, anti-missile and anti-satellite. In addition, in its composition, it is advisable, in our opinion, to envisage the use of tactical UASs (robotic means), which can be especially effective for destroying small air targets at low altitudes, including by setting up anti-aircraft ambushes in hard-to-reach terrain.[104]

The authors concluded their analysis by proposing changes to Russian combat tactics as follows:

> **Promising methods of combat operations by military formations of the army forces should, in our opinion, be characterized by the following main features:**[105]
>
> - Disorganization of the enemy's efforts by the use of the latest weapons against critical targets, the defeat of its main forces in a short time by the synchronized actions of assault;
> - Raid, reconnaissance and search and outflanking detachments, as well as tactical airborne assault forces operating in an expanded battlefield;
> - Organization of effective air-defense systems and tactical camouflage, providing reliable cover for troops from attacks by enemy air attack;
> - Realization of advantages in the speed of implementation of the "reconnaissance-defeat" cycle,

[104] *Ibid.*

[105] Emphasis in the original.

situational awareness, organization and maintenance of interaction of various (heterogeneous) forces and means, as well as in resistance to the influence of unfavorable factors of the security situation;

- Supplementing the capabilities of army forces with the use of GBRS of various functional purposes, especially when performing tasks associated with a predictably high level of losses;
- The formation of new order-of-battle elements, taking into account the specific conditions of the security situation, providing for the possibility of redistributing tasks between them during combat operations in real time on the basis of actual data about the state of each weapon, the status of completed and assigned tasks, as well as taking into account the results of operational modeling options for the development of the operation;
- Increasing the survivability of individual means due to the possibility of exchanging data about the enemy within subunits in the event of failure or suppression of any subsystems (communication with the command post, navigation, target designation, etc.);
- Organization of an effective system for all-out support for the actions of army forces.[106]

As a result of the application of UAVs/UCAVs in large-scale groups in conflicts including Syria and Karabakh, Russian air-defense and army specialists have not only taken notice of these advances, but recognized that this has serious implications for the future of Russian

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[106] *Ibid.*

tactical air-defense systems.[107] The vulnerabilities of tactical Russian air-defense systems—including the Pantsir-S1—were plainly and mercilessly exposed by the concerted deployment and use of UAVs and UCAVs for reconnaissance-strike and strike purposes in these conflicts. Of course, as seen in the zonal layered defense at the Russian Khmeimim airbase near Latakia in Syria, this did not rely exclusively upon kinetic means of air defense but also involved EW systems, used in repelling terrorist UAV swarm attacks against the base in January 2018.

What should be noted is that the insights offered by reference to the conflict in Karabakh in 2020 has resulted in an appeal by senior researchers in the Combined-Arms Academy in Moscow to make fresh changes to Ground Forces tactics for force protection in future conflicts, among other suggested improvements; they do not argue that these developments primarily influence the long-term development of Russia's UAV/UCAV modernization programs.[108] However, given the extent of General Staff attention to the lessons drawn from such conflicts it is remarkable to observe the lack of focus to air defense in the Russia-Ukraine War in 2022; Russian military theorists, air-defense specialists and senior officers were well aware of the dangers posed to their forces by the Turkish supplied Bayraktar TB2s. As Guy Plopsky noted, "The Russians are well aware of the threat posed by UAVs and the need to counter them. Their military

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[107] Colonel-General I.A, Buvaltsev, Colonel O.A, Abdrashitov, Colonel A.V, Garvard, '*Razvitiye taktiki v sovremennykh usloviyakh,*' *Voyennaya Mysl'*, No. 10, 2021, pp.30-37.

[108] Afonin, Makarenko, Petrov, Privalov '*Analiz opyta boyevogo primeneniya grupp bespilotnykh letatel'nykh apparatov dlya porazheniya zenitno-raketnykh kompleksov sistemy protivovozdushnoy oborony v voyennykh konfliktakh v Sirii, v Livii i v Nagornom Karabakhe,*' *Op.Cit;* Dulnev, S.A. Sychev, A.V. Garvardt, '*Osnovnyye napravleniya razvitiya taktiki Sukhoputnykh voysk (po opytu vooruzhennogo konflikta v Nagornom Karabakhe),*' *Op.Cit.*

journals are filled with articles on this and related topics. That said, there has always been a large gap between theory and practice in the Russian military, even though Russian air defenses do train to intercept UAVs."[109]

Conclusion

Russia's Armed Forces have made considerable progress in addressing the historical trough its defense industry and force development experienced in the aftermath of the dissolution of the Soviet Union in 1991. One important feature of this temporary development gap was ignoring the trends in modern warfare toward greater exploitation of unmanned aerial systems. In the wake of the reform program in late 2008, early steps were taken to remedy this by procuring UAVs from Israel for domestic production under license. Within a relatively short period, Moscow has promoted this element of its military modernization by facilitating the flourishing of domestic companies specializing in UASs, harnessing the R&D capacity and steadily introducing unmanned assets in larger numbers to boost capabilities throughout its Armed Forces.[110]

These processes occurred during a period of sustained modernization marking a shift toward a force structure built around C4ISR. UAV procurement has been weighted heavily in favor of ISR; a process that has benefited from testing and refinements during earlier operations

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[109] Siminski, 'What The Air Campaign in Ukraine Tells Us About The Current State Of The Russian Air Force,' *Op.Cit*.

[110] Zhukovskiy, '*Bespilotnik-smertnik: Kalashnikov pokazal miru novinku*,' *Op.Cit*; Frolov, '*Sostoyaniye, zadachi i funktsii gosudarstvennogo tsentra bespilotnoy aviatsii ministerstva oborony Rossiyskoy Federatsii*,' *Op.Cit*; Ivanov, *Bespilotnyye letatel'nyye apparaty. Spravochnoye posobiye*, *Op.Cit*; Fetisov, *Bespilotnaya aviatsiya: terminologiya, klassifikatsiya, sovremennoye sostoyaniye*, *Op.Cit*; Chekinov, Bogdanov, '*Priroda i soderzhaniye voyny novogo pokoleniya*,' *Op.Cit*.

in Ukraine and Syria. Such theaters of military conflict provided testing grounds for the General Staff to study and draw lessons from the role and potential utility of UASs. The longer-term UAS strategy, slowed by the internal challenges facing the domestic defense industry, lies in achieving an optimal balance between UAVs for ISR roles on the one hand, and those designed for reconnaissance-strike and strike missions, such as heavy-strike UCAVs, on the other hand.[111]

It should be noted that these aims and the high-profile testing of the S-70 Okhotnik pre-date the 2020 Second Karabakh War; the lessons drawn from the under-performance of Russian-built tactical air-defense systems fielded by Armenia in that conflict, exposed by the Azerbaijani Armed Forces' use of UAV and UACV reconnaissance-strike and strike systems in conjunction with EW, did not change the course of Russian UAS priorities or planning.[112] No evidence exists that the General Staff drew lessons from Karabakh that either influenced or sped up the existing programs to develop Russian reconnaissance-strike and aerial strike systems.

The Karabakh war in 2020 did, however, confirm and consolidate Russian military thinking in relation to these systems. Also notable is the fact that the future entry into service of the S-70 envisages that this platform will use unguided munitions—placing the Russian military in a tiny minority of global armed forces that utilize UCAV platforms

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[111] Anan'yev, A.V, Rybalko, A.G, Ryazantsev, L.B, Klevtsov, R.P, '*Primeneniye razvedyvatel'no-udarnykh grupp bespilotnykh letatel'nykh apparatov malogo klassa po ob'yektam aerodromnykh uchastkov dorog*,' *Voyennaya Mysl'*, No.1, 2020, pp.85–98.

[112] Afonin, Makarenko, Petrov, Privalov '*Analiz opyta boyevogo primeneniya grupp bespilotnykh letatel'nykh apparatov dlya porazheniya zenitno-raketnykh kompleksov sistemy protivovozdushnoy oborony v voyennykh konfliktakh v Sirii, v Livii i v Nagornom Karabakhe*,' *Op.Cit*.

to deliver unguided strikes against enemy targets.[113] The slowness in the S-70 Okhotnik prototypes to progress from R&D and testing phases may reflect issues with engine design or the vision to tie its operational role to the Su-57. However, the presence of multiple foreign components in downed Russian UAVs in southeastern Ukraine suggests that the domestic defense industry is continuing to struggle to achieve fuller self-reliance, despite what official defense ministry statements claim.[114]

Although the defense leadership in Moscow regularly refers to the numbers of UAVs entering the branches and arms of service, with "over 2,000" clearly offered in an effort to impress, it is these systems' role as critical battlefield sensors and essential parts of the military's ISR that marks the real tangible progress in UAV adoption.[115] In introducing UAVs into the Armed Forces in greater numbers primarily for target acquisition and accuracy of fires, the UAV dimension of the modern Russian military has emerged as integral. With its intrinsic links to air defense and electronic warfare, UAV technology and usage has become an essential feature of the Russian approach to war fighting. In the organic structure of the Ground Forces, for example, while it can be said that they cannot conduct operations without the presence of tactical air defense or EW, the same may be applied to UAV capability; the latter acts as a key enabler for air-defense and EW systems.[116] The long-term challenge is to

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[113] '*Rossiyskiy udarnyy bespilotnik S-70 stanet nezametnym dlya vraga*,' *Op.Cit.*

[114] 'Weapons of the War in Ukraine' *Op.Cit.*

[115] '*Putin nazval chislo nakhodyashchikhsya na vooruzhenii rossiyskoy armii bespilotnikov*,' *Op.Cit.*

[116] Filin, Ye.D, Kirichek, R.V, '*Metody obnaruzheniya malorazmernykh bespilotnykh letatel'nykh apparatov na osnove analiza elektromagnitnogo spektra*,' *Informatsionnyye Tekhnologii i Telekommunikatsii*, No. 2, 2018, pp.88–93.

square the circle by both extending this capability into strike systems and to narrow the gap between domestic expertise and the capacity of the defense industry to design and deliver future systems.[117] Moreover, Russian dependency on imports (not least of microelectronics) remains a critical challenge. Integrating unmanned systems in the C2 and ISR architecture, given the underdevelopment of Russia's microelectronics industry, exposes a potential vulnerability; Moscow cannot rule out the possibility that both Western and Chinese manufacturers could sell components with malicious codes.

Surprisingly, the real lessons for Russia's General Staff based on analyses of the Second Karabakh War are more likely to result in further changes to Ground Forces tactics, as noted by Dulnev, Sychev and Garvardt in their November 2021 article in *Voyennaya Mysl'*.[118] Indeed, such articles in the professional military publications provide strong evidence that the General Staff is thinking about the evolving role of unmanned systems, aerial, ground-based and sea or sub-surface-based types, how these may boost military capabilities and complement Russian military strategy, or fit into emerging perspectives on the future battlespace.[119]

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[117] Makarenko, S.I, Timoshenko, A.V, Vasil'chenko, A.S, '*Analiz sredstv i sposobov protivodeystviya bespilotnym letatel'nym apparatam*,' Part 1, *Bespilotnyy letatel'nyy apparat kak ob'yekt obnaruzheniya i porazheniya, Sistemy Upravleniya, Svyazi i Bezopasnosti*, No.1, 2020, pp.109–146.

[118] Dulnev, Sychev, Garvardt, '*Osnovnyye napravleniya razvitiya taktiki Sukhoputnykh voysk (po opytu vooruzhennogo konflikta v Nagornom Karabakhe)*,' *Op.Cit*.

[119] V.P, Kutakhov, A.Ye, Titov, '*Krupnomasshtabnyye aviatsionnyye sistemy s bespilotnymi letatel'nymi apparatami – novaya paradigma boyevykh deystviy*,' *Op.Cit*.

At the operational and tactical levels, Russian military operations during the early phase of its large-scale invasion of Ukraine in 2022 involved numerous errors and miscalculations. Equally, it appears that Russian operational design was not centered upon the exploitation of high-tech military capabilities, and this extended to the limited, sporadic and ineffectual use of UAV and UCAV platforms. However, UAVs and UCAVs in Russian military thought cover a broad and growing range of issues, including automation of C2, introducing more AI technologies, using unmanned systems on the offensive, countering adversary systems and the challenges presented to tactical air defense.[120] While future Russian UAV/UCAV capabilities may not constitute in and of themselves a new variant of the revolution in military affairs, they do mark a consistent trend in Russian military thought that traces its origins to Ogarkov's RMA.

* * *

Addendum 1: Russia's National Developers and Manufacturers of Unmanned Aerial Vehicles

No.	Developer, Manufacturer
1	Tupolev, PJSC, Moscow
2	A.S. Yakovlev Design Bureau, OJSC, Moscow
3	Irkut Scientific-Production Corporation, JSC, Moscow
4	MiG Russian Aircraft Corporation, JSC, Moscow
5	Sukhoi Design Bureau, PJSC, Moscow

[120] *Ibid.*

6	Vega Concern, OJSC, Moscow
7	Rostech State Corporation, Moscow
8	SRI Kulon, JSC, Moscow
9	ARCC Novik-XXI Century, LLC, Moscow
10	Modernization of Aviation Complexes, LLC, Moscow
11	R&DC Rissa, CJSC, Moscow
12	Impulse, Moscow
13	Research and Production Firm Kvand-ASHM, CJSC, Moscow
14	SKB Topaz, OJSC, Moscow
15	Research Institute of Applied Mechanics named after Academician V.I. Kuznetsov, Moscow
16	R&D Company Tayber, Moscow
17	Air Group, LLC, Moscow
18	Aviation Systems, SPA, Moscow
19	VR-Technologies, LLC, Moscow
20	YuVS Avia, LLC, Moscow
21	Aerospace systems, OJSC, Moscow
22	AFM-Service, LLC, Moscow

23	Nelk SPC, CJSC, Moscow
24	RTI Systems Concern, Moscow
25	DanFuture, Moscow
26	Aeroxo, Moscow
27	Blaskor, LLC, Moscow
28	Promtechnology, LLC, Moscow
29	Skolkovo Innovation Center, Moscow
30	AeroRobotics, LLC, Moscow
31	MAI's Iskatel Design Office, Moscow
32	Moscow Aviation Institute
33	Moscow State University of Geodesy and Cartography
34	Kamov, JSC, Moscow region
35	Mil Moscow Helicopter Plant, JSC, Moscow region
36	S.A. Lavochkin SPA, LLC, Khimki
37	Experimental Machine-Building Plant named after V.M. Myasishchev, JSC Zhukovsky
38	Aerokon, JSC, Zhukovsky
39	Istra Experimental Mechanical Plant, LLC, Moscow region

40	SPC Antigrad-Avia, LLC, Dubna
41	Tactical Missile Weapons Corporation, JSC, Korolev
42	Radar-MMS R&D Company, JSC, St. Petersburg
43	Special Technological Center, LLC, St. Petersburg
44	Transas, CJSC, St. Petersburg
45	Kronshtadt JSC, St. Petersburg
46	Kronshtadt Technologies, JSC, St. Petersburg
47	Plaza, LLC, St. Petersburg
48	Geoscan, LLC, St. Petersburg
49	Saint Petersburg State University of Aerospace Instrumentation
50	Sokol Experimental Design Bureau, OJSC, Kazan
51	M.P. Simonov Design Bureau, SPA, Kazan
52	Enix, CJSC, Kazan
53	Kazan National Research Technical University
54	ZALA AERO GROUP Unmanned systems, LLC, Izhevsk
55	Izhmash-Unmanned Systems, LLC, Izhevsk
56	Izhevsk Unmanned Systems SPA, LLC, Izhevsk

57	Multipurpose Unmanned Systems, Izhevsk
58	Autonomous Aerospace Systems – Geoservice R&D, LLC, Krasnoyarsk
59	Aviamekhanika R&D, LLC, Krasnoyarsk
60	Siberian Federal University, Krasnoyarsk
61	Luch Design Bureau, JSC, Rybinsk
62	Ricor Electronics, OJSC, Arzamas
63	Ural Civil Aviation Plant, JSC, Yekaterinburg
64	Smolensk Research and Innovation Center of Electronic Systems Zavant
65	Horizont, JSC, Rostov-on-Don
66	Stilsoft, LLC, Stavropol
67	Roboavia Unmanned Systems, LLC, Voronezh
68	Samara National Research University
69	Southern Federal University, Taganrog
70	Omsk State Technical University

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