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OCTOBER 2024 | THE RETURN OF GLOBAL RUSSIA

Assessing Russian Military Adaptation in 2023

Michael Kofman

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This publication was funded by the Russia Strategic Initiative,
U.S. European Command.

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The information in this study is current as of June 29, 2024.

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Carnegie Endowment for International Peace
Publications Department
1779 Massachusetts Avenue NW
Washington, DC 20036
P: + 1 202 483 7600
F: + 1 202 483 1840
CarnegieEndowment.org

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Cover photo by JUAN BARRETO/AFP via Getty Images

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Summary

Before Russia's full-scale invasion of Ukraine in February 2022, the Russian military had made choices and trade-offs in its force design that positioned it poorly for the type of war it ended up fighting. These choices were compounded by the unworkable concept of operations being executed during the invasion and the political assumptions that drove it. For most of 2022, the Russian military struggled with the consequences of these decisions, its own shortcomings, and a structural manpower deficit. Initial adaptations yielded poor results in the prevailing operating environment. But, by late 2022, the Russian political leadership committed to a prolonged conventional war. The military began to demonstrate a capacity for learning and adaptation, enabled by Russia's partial mobilization of 300,000 personnel, and increased defense-industrial production.

During the second year of the war, Russian military leaders revised prior decisions on force structure, experimented with small unit tactics, adopted new technologies, and developed specialized assault detachments. Initially, mobilization stabilized the front lines and closed manpower gaps within the Russian armed forces, but it did not restore offensive potential to the force, which continued to demonstrate tactical rigidity and doctrinal inflexibility. Yet, the monthslong battle for Bakhmut, fought primarily by the Wagner Group, led to the systematic adoption of assault groupings, and expendable convict-staffed formations across the Russian military. This eventually resulted in new types of assault tactics, and units, with those practices expanding across the force.

Russian forces proved more flexible and effective in the conduct of defensive operations in 2023 through a combination of maneuver and positional defense to halt Ukraine's offensive. Russian units expanded significantly, integrated new types of formations, and mounted a doctrinally modified defense with successful use of support elements. Despite this, the Russian military remained committed to the concept of an active defense, defending forward and aggressively counterattacking in a manner that proved costly to the force. Ukraine's offensive failed, but Ukrainian units were able to inflict significant losses to defending Russian forces over the course of four months.

In the Russian military combined arms integration improved at the lower unit level, but could not enable maneuver by larger formations. Russian forces also adapted relatively quickly in employing uncrewed aerial systems and deploying new types of electronic warfare systems on the battlefield. By late 2023, they were increasingly capable of dynamic targeting at the tactical level, with better integration of reconnaissance, fires, and electronic warfare. Despite this evolution, the Russian military struggled to attain a decisive advantage in offensive actions. Fundamental problems in force quality persisted, with offensives largely relegated to small scale unit action, or costly mechanized assaults that failed to achieve breakthroughs. Despite tactical adaptations, assaults on prepared defenses led to grinding battles. The net effect was incremental Russian gains at high cost, as Russian forces proved unable to attain operationally significant breakthroughs when possessing quantitative advantages in manpower, materiel, and munitions.

Introduction

Since Russia's full-scale invasion of Ukraine in February 2022, the Russian military has had to revisit its earlier assumptions about the kind of wars it should be prepared to fight, how it would fight them, and the trade-offs made prior to the war in Russian force design. Having conducted the invasion with a relatively brittle, peacetime force, the Russian military found itself in a prolonged conventional war, facing a motivated and mobilized opponent. Russia lost a significant percentage of its better-quality personnel and ground force equipment during the first few weeks of the war, which then left its military struggling to employ a variegated force comprised of increasingly depleted formations. Attempts to sustain offensive operations over the course of 2022 further degraded the force, draining it of manpower, and leaving it effectively broken by fall of that year.

Over the course of 2023 the Russian military steadily adapted, revisiting earlier decisions on force composition, and adjusting to weapons introduced by Western countries to the battlefield. The Russian armed forces steadily adopted commercial systems, developed and matured their own capabilities, and revised tactics for their employment. Russian forces proved more flexible, and capable in the conduct of defensive operations, than in the much harder task of mounting successful offensives. Despite these adaptations, and a demonstrated capacity to learn, the Russian military struggled with basic force quality issues, an inability to scale offensive operations, and could not translate materiel advantages into operationally significant gains on the battlefield. The Russian approach, whether on the offense or defense, remained costly in terms of manpower, materiel, and munitions.

Russia's performance in the first year of the war was heavily subject to the specifics of its initial invasion and the politically driven assumptions that underpinned it. In the second year of the war, the Russian military implemented changes and adaptations to its force structure and tactics, including significantly expanded use of uncrewed systems and electronic warfare. This paper focuses on that second year. One of the underlying assumptions driving this analysis is that in the second year, 2023, the Russian military can be observed in a post-mobilization context attempting to conduct both offensive and defensive operations following a series of changes to force structure and tactics. Notably, the Russian defense industry had also undergone change, with a steady militarization of the Russian economy, and significantly expanded procurement for the military's needs.¹ This stands in contrast to the Russian military's performance in 2022, which is also important but has already been studied more extensively.

Arguably, Russian military performance in 2023 serves as a more useful reference point about its potential performance in a large-scale conventional war and is more generalizable to other cases, because it is less context dependent. Although it is difficult to predict the peculiarities of a future invasion, the characteristics of a sustained, high-intensity war lend themselves better than the initial period of war toward generalized observations. The initial period is often a reconciliation of peacetime assumptions, plans, and force structures. Conversely, the follow-on phases may better reflect what a military looks like after adjusting, having taken account of the early surprises or disproven

assumptions and fully mobilized for the war. If 2022 is helpful in assessing the initial period of war, then 2023 is a better reflection of what the Russian military looks like in a prolonged conventional war. Therefore, observations from this period are likely to prove more salient in informing discussions on potential wars between major powers, which are rarely resolved during the initial phases.

Organization and Methodology

This paper proceeds by briefly reviewing the challenges faced by Russian forces in 2022 due to political assumptions driving the concept of operations, the force structure constraints, and prior trade-offs made in force design. The first section features an examination of Russian force employment during the winter offensive of 2022–2023, followed by an in-depth discussion of the battle for Bakhmut, the Wagner Group’s role, and the evolution of expendable forces within the Russian armed forces. The paper then discusses the subsequent development of assault detachments and formations within the Russian military, which came to play an outsized role in Russian offensives.

The second section delves into the Ukrainian offensive in the summer and fall of 2023, reviewing Russian force employment, force structure, and doctrinal aspects of the Russian defense. The third section looks at Russia’s tactical adaptation in uncrewed systems and electronic warfare. These two subjects were selected because of their prominent role on the battlefield in Ukraine and their interactions at the tactical level, with one typically used to counter the other. Rather than focus on vulnerabilities alone, or a single argument, the paper intends to provide observations on the adaptations observed and their implications.

This paper leverages a combination of primary and secondary sources. The author conducted six trips to Ukraine over the course of the war, involving fieldwork near the front lines and numerous interviews with members of the Ukrainian armed forces in October 2022, February and March 2023, July 2023, November 2023, February and March 2024, and June 2024. While the paper does not reveal any confidential military information, it uses interviews with military units and, in some cases, captured documents (some which have been made public). This approach has inherent limitations in reproducibility, but many of the findings have been corroborated by other researchers, whose fieldwork is also cited. The paper uses the work of several open-source analysis groups and their maps, much of which is also based on primary sources and fieldwork in Ukraine. They are identified as contributors in the acknowledgments section. In some cases, the analysis updates prior research on the events of 2023 by the author, improving the record.

Ultimately, this paper remains exploratory and is not intended to be comprehensive. Hence, it proceeds by looking at periods as vignettes, given the incomplete nature of the historical record, with an eye to drawing broader observations. Much is still unknown about the war, and this writing represents an early attempt at mapping that history.²

Russian Force Structure Before 2023

Following the Russian military's defeat at Kharkiv in September 2022, the country's political leadership conducted a partial mobilization, levying approximately 300,000 personnel.³ These personnel were used to raise the manning levels across depleted formations, expand the size of infantry battalions, and add additional infantry battalions, maneuver regiments, and brigades to the force. Mobilized personnel were also used to create a large number of additional formations under the framework of Territorial Troops.⁴ They established a reserve for the Russian military. To understand the mobilization's impact, it is important to briefly cover the problems in Russian force structure at that time. In late 2022, the Russian military faced glaring inadequacies in both the size and composition of its force in Ukraine because of the major trade-offs made in force design, which optimized the military poorly for this type of war, and the political decision to conduct the war as a "special military operation" without raising readiness or manning levels across the force.⁵ Simply put, the base Russian peacetime force structure was not designed to be used for territorial conquest of this scale, nor to engage in a high intensity war characterized by prolonged periods of attrition.

The Russian military conducted the initial invasion at peacetime force strength levels, with formations designed for a short duration armed conflict or local war. The implications of this decision were significant when the initial operation failed to achieve its objectives and the Russian military was left with little capacity to sustain a prolonged conventional war, occupy large tracts of terrain, or engage in manpower-intensive urban sieges. The force also lacked the ability to engage in effective combined arms maneuver in part because of severe shortages of infantry.

The Russian military faced such limitations because it is partially conscript-staffed, with about a third of the force comprised of conscripts who legally, and in many cases practically, cannot be used for extraterritorial operations outside a time of war.⁶ Conscripts were also considered ill-suited for the modern battlefield due to their brief period of training, used more cheap labor for the armed forces, and as a recruitment pool for follow-on contract service. Russian ground forces in particular are dependent on partial mobilization in the event of a regional or large-scale war, with typical manning rates in the range of 70–90 percent, though the actual figures in some military districts were likely lower at the time of the invasion with the average closer to 70–75 percent.⁷ The net effect was that only about 30–40 percent of the Russian Ground Forces, Airborne Troops (VDV), and Naval Infantry were available to generate forces for the invasion.⁸

This meant that maneuver formations generated two battalion tactical groups per brigade or regiment. Battalion tactical groups (BTG) are combined arms formations based around a maneuver battalion with attachments, staffed by contract servicemembers.⁹ These groups were historically intended to conduct short duration military operations at the scale of armed conflict or local war, not for sustained, large-scale military operations.¹⁰ The purpose of this formation was to have a way of generating combat power on short notice without having to use conscripts or conducting a partial

mobilization. By 2021, according to official statements, the Russian military supposedly had 168 BTGs that its forces could generate. The initial Russian invasion comprised perhaps 130 battalion tactical groups, along with the parent units' support elements and headquarters.¹¹ It therefore used most of the contract-staffed combat power available. This force was augmented by auxiliary units mobilized from the occupied Luhansk and Donetsk people's republics, and from RosGvardia (Russian National Guard).¹²

These battalion tactical groups included between 400 and 600 personnel and were heavily mechanized. This figure was below Russian official statements from before the war that suggested an 800 personnel average for battalion tactical groups. Although some were in the 700–800 personnel range, this was commonly true for the first BTG generated from a regiment or brigade, whereas the second was often much smaller due to the lower availability of contract personnel. Several years before the war, the Russian military expanded the number of groups it could generate, but did so by cutting their overall size, particularly the infantry component of the force.¹³ This is how they got to the official figure of 168, the number of BTGs increased on paper, while the size of the force plateaued.

The Russian military had significantly reduced the size of infantry battalions from an average of 500 personnel to 345. Consequently, many battalions may have had 230–280 soldiers.¹⁴ This, in turn, reduced the size of companies, platoons, and squads.¹⁵ In the run-up to the 2022 invasion, the military was in the process of creating new formations, converting brigades to divisions, but these lacked the requisite personnel, which meant that overall readiness and manning levels declined. The exact shortfalls and readiness were not publicly available, but it was clear that the military was relying more and more on a partial mobilization staffing model. The force was expanding the size and increasing the number of formations but not of personnel. The net result of these compromised a Russian peacetime force that was woefully understrength, brittle, and lacking in infantry.

These choices in force design were not just driven by an effort to balance resources but also by a coherent set of beliefs within the Russian military that the modern battlefield would be fragmented, with highly maneuverable formations engaging indirectly by detecting enemy forces and employing precision guided weapons or artillery against them under the conceptual rubric of reconnaissance-strike (dynamic employment of precision weapons at operational depths) and reconnaissance-fire (dynamic employment of fires at tactical depths) complexes.¹⁶ The view was that a high density of forces to hold large amounts of terrain was no longer required and that the initial period of war would not hinge on a strategic ground offensive. Much of the training and concept development for Russian ground forces emphasized maneuver defense alongside positional defense. Both approaches were meant to be characteristically 'active,' meaning persistent engagement of an opponent's force, and their support, throughout the course of the defensive operation. These ideas drove the belief that the Russian military required fewer infantry and logistical support for ground offensives and, instead, placed more emphasis on fires, strike systems, and supporting enablers in ground force formations.¹⁷

By late 2022, the Russian military was operating with severely depleted formations due to attrition and faced a structural manpower problem.¹⁸ Piecemeal efforts to recruit personnel failed to compensate for losses and many contract servicemen refused to deploy given the situation at the front. In essence, Moscow was attempting to wage a protracted, large-scale war using only volunteers, which was a sharp historical contrast to the combination of conscription and mobilization that had featured in previous conflicts of this type. Ukraine's offensive in Kharkiv overwhelmed an incohesive Russian grouping of forces with some units at 25–40 percent manning levels, as well as forward positions manned by elements from RosGvardia and Luhansk People's Republic. Following partial mobilization in September 2022, mobilized troops were used to bring the frontline units up to strength and, more importantly, to create a large infantry force comprised of Territorial Troops units. These augmented the existing active duty force. Territorial Troops were organized as regiments and battalions. According to one open-source analysis at the time, roughly 123 new military units were created, including seventy-seven regiments, eighteen independent motor rifle battalions, eleven artillery battalions, numerous anti-tank battalions, and several supporting engineer and tank regiments.¹⁹ The actual number of territorial troop units to date is likely much higher, and exact figures are difficult to come by.

Mobilized personnel were used not only to establish reserves in the form of Territorial Troop units (also referred to as Territorial Defense Forces), but also to redress the deficit of infantry across the force. Over time they would also serve to replace losses among active-duty units, occasionally serve as a combined-arms reserve, and by 2024 come to perform the same tasks and roles in combat operations as active-duty counterparts. This led to a change in the force's composition, with a significant expansion in size of infantry battalions back to an average of 500 personnel and the steady addition of infantry battalions to maneuver formations such as brigades and regiments. By 2023 the size of these units would grow significantly, as will be seen in the discussion of Ukraine's offensive during the summer of that year. Mobilization served to stabilize the force, but it was not effective at quickly regenerating offensive combat power. If anything, the process demonstrated that it would take Russian forces time to cohere new formations and employ them effectively for offensive purposes.²⁰ Establishing new units and pulling in mobilized personnel to hold defensive lines proved a much easier task than restoring the force's offensive potential.

One possible reason for this is the fact that Russia conducted mobilization seven months into the war. By that point, the available active-duty force had already been deployed to Ukraine, raising questions about who would train the newly mobilized reservists. In the Russian military, most training is conducted at the unit level, not at a centralized training center. Although military districts housed training centers, these were designed to train conscript and contract specialists, rather than conduct basic training for large numbers of troops. If officers and noncommissioned officers had already been deployed to replace combat losses and stand up new units, then the force would be hard pressed to absorb these personnel. Russian formations were also designed to have a third battalion that was often manned by conscripts and would be supplemented with called up reservists, which could deploy once manning levels were raised. This was a function of the first two maneuver battalions being primarily contract servicemen-staffed. However, the officers and equipment from

these “reserve” formations too had already been used, meaning the rest of the active force was already committed. Combined with the system’s general inexperience in conducting mobilization post-1945, the fact that almost no aspect of the mobilization process aligned with preexisting planning was undoubtedly a factor in how it unfolded.

Although this war represents one specific case, it raises questions about the extent to which military planning aligns with political realities in Russian decision making.²¹ From the 1990s through today, Russian political leadership has been loath to conduct mobilization, often willing to fight a war with a force inadequate, or barely adequate, to the task. This was best evidenced by the Chechen Wars of the 1990s, but the same tendency could be observed in the Russian invasion of Ukraine in 2014. The Russian military has consistently relied on partial mobilization and force-within-a-force concepts to manage the military in a way that would enable it to address contingencies ranging from local to large-scale war. One of the principal drivers is conscription, which grants the Russian military a cheap pool of manpower but makes it such that standing formations are unusable in many lower-end contingencies. This, in turn, leads to alternative force generation frameworks leveraging contract servicemembers, battalion tactical groups, and others. The evident problem for the military is that the Russian political leadership appears unlikely to authorize partial mobilization at times when planning assumes it should be conducted or raise manning levels across formations based on General Staff precepts. Political leaders in general are often optimistic about how quickly or easily their objectives can be achieved during the initial period of war, which interacts poorly with the fact that wars tend to go on longer than expected and often become protracted.

The result is that more often than not there may be a mismatch between the desired political ends and military means made available in the early period of the war, forcing the Russian military into a painful period of adaptation, restructuring, and reconstitution. This historical pattern was aptly observed by late General M. A. Gareev, former president of the Russian Academy of Military Sciences, who said in 2004 that

for 150 years now, the country’s political leadership has placed the army in extremely unfavorable, unbearable conditions at the start of the war, from which it has to extricate itself. Let us recall at least the Crimean, Russian-Japanese, World War I, 1941, Afghanistan and Chechnya in 1994–1995. . . . So what else needs to happen to us so that in the end we understand: political despotism and ignorance harm, first of all, the national interests of the country. At some point, we need to learn lessons from all this and conclude: yes, political considerations are paramount. But this does not indicate that political decisions should be developed in a narrow circle of politicians, in complete isolation.”²²

In reflecting upon Gareev’s comment, it is difficult to escape the conclusion that this is probably what took place during Russia’s planning for the invasion of Ukraine and that the historical pattern of decision-making he observed holds true today.

The Russian Winter Offensive

Prior to the launch of the 2022–2023 Russian winter offensive, the then commander of the Russian military effort, General Sergey Surovikin, pursued a largely defensive strategy premised on entrenchment and the construction of multiple defensive lines. This approach was paired with a strike campaign against Ukrainian critical infrastructure and a supporting effort by Wagner forces to capture the city of Bakhmut, which tied down a significant grouping of Ukrainian forces in that sector. Yet, the Russian leadership appeared impatient, replacing Surovikin with Valery Gerasimov, the chief of the General Staff of the Armed Forces, in January 2023. The Russian military was still recovering at this time and not in condition to conduct offensive operations while trying to field a large number of newly mobilized units. Hence, the offensive would have to be conducted by a thin slice of the Russian armed forces, primarily motor rifle units, but in prominent cases this included naval infantry, and airborne units, which were considered more elite. These units had already taken significant losses over the course of the war and were replenished with new replacements.²³ Replacing contract-staffed servicemen with mobilized personnel who lacked the same levels of training, reduced the quality of the units.

Mobilization stabilized, filled out, and expanded Russian forces, but it did not lead to success in the winter offensive. The Russian military attempted to attack along six axes: Avdiivka, Bakhmut, Bilohorivka, Kreminna-Lyman, Marinka, and Vuhledar. The intent appears to have been an effort to strain Ukrainian armed forces across a broad front, but the offensive appeared anemic and ultimately proved a failure. This multipronged approach would prove characteristic of Russian offensives under the command of Valery Gerasimov. Russian forces lacked the decisive advantage in artillery fire that they had enjoyed in 2022; meanwhile, the force had largely lost its capacity to conduct operations at scale. This led to offensive actions being prosecuted primarily by small detachments of more elite troops (naval infantry and airborne) who could not attain a breakthrough. The campaign saw Russian forces take thousands of casualties in exchange for little territory gained, apart from the battle for Bakhmut.

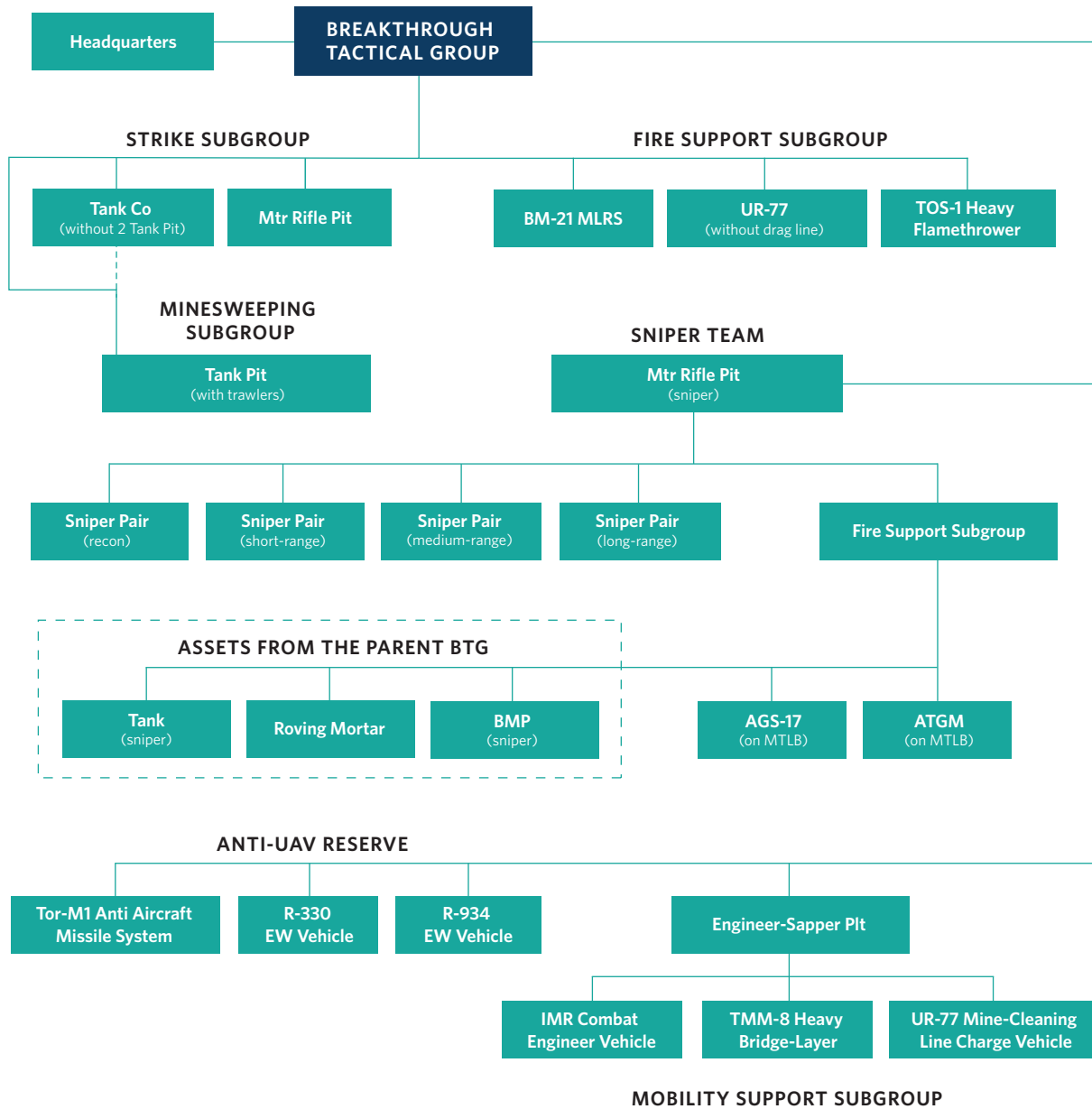
Russian attempts to attack well-prepared positions across minefields were best exemplified by the fighting at Vuhledar. There, Ukraine's 72nd Mechanized Brigade, which had been expanded significantly, held the lines surrounding the city across large swaths of open terrain. Repeated attempts to seize Vuhledar by Russia's 40th and 155th Naval Infantry Brigades, supported by units of the 3rd Army Corps, and elements from the Eastern Grouping of Forces such as 29th and 36th Army, yielded successive defeats. The central problem Russian units faced was not simply a deficit of assault capable formations, but they were also deploying combat power in very small packets that would prove unable to overcome Ukrainian defenses. Indeed, the story of Russian combat operations in 2022 through 2023 was one of a steady decrease in the unit size employed, including for battalion tactical groups, company tactical groups, modified tactical breakthrough groups, and eventually specialized assault detachments of various types.

In the summer of 2022, Russian forces began to adjust their tactical-level formations. These changes were initially unsuccessful, but eventually led to the formation of assault companies, and assault detachments. The modifications included breakthrough tactical groups, a concept that had already been in development before the war, and early versions of Storm (assault) groups.²⁴ These combined arms formations pulled assets both from a battalion tactical group and the parent brigade or regiment. To bolster the firepower of these groups and effectively neutralize well-defended enemy positions, they would assemble a fire support subgroup, which in addition to tanks and anti-tank systems could include the BM-21 multiple launch rocket system (MLRS), the TOS-1A heavy flamethrower system, and the UR-77 mine-clearing vehicle.

In November 2022, a video showcased the practical application of breakthrough tactical groups.²⁵ A Russian assault featured a company-sized formation comprising seven vehicles, spearheaded by the UR-77 mine-clearing charge launcher system as the breaching element. Doctrinally, a breaching group should consist of at least ten combat vehicles (including tanks, infantry fighting vehicles, and specialized engineering equipment), backed by artillery, additional systems such as TOS-1 and UR-77, and tanks equipped with trawls. Notably, the concept behind the breakthrough group as discussed in Russian military writing was not to break through a prepared positional defense, but more for route clearance, overcoming a hasty defense, held by weak formations. Hence, the issue was not the manning levels of breakthrough tactical groups, which sought to make use of available manpower and equipment from existing under strength BTGs, but more that the grouping was unsuitable for the defenses it often encountered and was structurally inadequate for the tasks it was being given.

The breakthrough tactical group concept proved short-lived, primarily because of its inefficacy when confronted with stronger Ukrainian units mounting a prepared defense with persistent reconnaissance at tactical depths. Russian forces not only struggled to achieve surprise, but Ukrainian forces also had ample time to prepare anti-tank guided missiles (ATGMs), artillery, and drone defenses against incoming formations. Many assaults were stopped and then effectively defeated by artillery. Moreover, the general reliance on small formations—primarily company-sized attacks—proved insufficient to overwhelm Ukrainian forces. Not only did the deficit of manpower contribute to these challenges, but also the limitations in Russian forces' ability to coordinate the employment of larger formations. As a result, for much of 2022, Russian units fought as company tactical groups, typically employing reconnaissance by force with small groupings of mechanized units and smaller breaching formations that could not effectively project combat power. The loss of just a few combat vehicles could significantly diminish a breaching group's overall effectiveness and reduce its likelihood of success.

Figure 1: Variation on the Structure of the Breakthrough Tactical Group



Source: Lester W. Grau and Charles K. Bartles, "The Russian Breakthrough Tactical Group," U.S. Army Maneuver Center of Excellence, https://www.moore.army.mil/infantry/magazine/issues/2022/Fall/PDF/8_Grau_txt.pdf.

Doctrinal Inflexibility and Inability to Scale

Several problems contributed to the Russian military's failure during the winter offensive. The first of these was a lack of battlefield flexibility and initiative. This section focuses on the battle of Vuhledar as a case, although these problems were exhibited by troops conducting assaults in other areas as well.²⁶ At the outset of the offensive operation, the assault by the 155th Naval Infantry Brigade, benefiting from an element of surprise and favorable weather conditions, enabled Russian forces to capture a small residential area on the outskirts of Vuhledar. The brigade's units secured multiple residential buildings close to houses occupied by Ukrainian soldiers, making Ukrainian artillery fire risky. However, despite this advantage, other elements of the assaulting forces approaching from different directions failed to adapt their plans and continued with unsuccessful attacks against Ukrainian defenses in their respective sectors. Rather than seizing the opportunity, and expanding the breach, ground units rigidly adhered to the approved plan, avoiding significant deviations, and thus failed to take advantage of an opportunity.

Weak coordination among units plagued Russian efforts since the early days of the full-scale invasion. Despite deploying a sizable concentration of troops for this operation, including motivated and prepared brigades, such as the 40th and the 155th, overall coordination was poor. When one unit faced difficulties in their assigned direction while another unit made progress, there was often a failure to adjust or synchronize actions between them. This lack of coordination ultimately prevented the translation of tactical gains into broader operational successes. One of the most glaring issues was the loss of control over units in the event of injury or death of platoon or company leader. During assaults against Ukrainian positions, Russian units frequently lost coherence and control over their environment as soon as their leader was lost.²⁷ The rigid hierarchical system—where junior officers and sergeants functioned primarily as plan executors rather than as semi-independent leaders capable of adapting to the current battlefield situation to achieve objectives—often led to loss of combat control.

Ukrainian forces had extensively mined the main attack routes and areas leading to Vuhledar. They had persistent overwatch via drones and organic interaction between supporting artillery and drone reconnaissance units.²⁸ Despite encountering minefields and losing vehicles, Russian commanders made little to no adjustments. Some evidence suggests that upward of 300 Russian naval infantry were killed in the first four days of the battle.²⁹ Ukrainian forces continued to lay mines at night in areas where Russian forces had conducted demining efforts, catching them by surprise the next day. Additionally, Russian nighttime intelligence gathering at the time was limited, even with drones. Adverse weather conditions, such as fog and strong winds, further hindered Russian drone operations, preventing them from observing the battlefield and detecting Ukrainian sapper teams deploying new mines. While Russia's intelligence, surveillance, and reconnaissance capabilities improved significantly by the end of 2023, they were poor at the beginning of the year, especially at night.

This situation persisted for several months, until the winter offensive culminated in April 2023. Although much of the fighting was done by motor rifle units, the battle for Vuhledar in particular proved costly to the two naval infantry brigades fighting there. Russian forces adjusted poorly to battlefield conditions, with some commanders becoming nefarious for repeatedly ordering attacks despite lacking effective means of overcoming minefields and well-prepared defenses. It demonstrated that senior Russian military leadership, namely Valery Gerasimov, did not understand the state of the force, grossly overestimating what it could do. The central problem in Russian military strategy remained unresolved; there was a mismatch of military means available to attain Moscow's desired political goals. The force quality, and the way in which Russia was employing it, was unsuitable to attain the objectives put before it. The winter offensive expended manpower and ammunition in return for little in the way of gains, save for the progress made by the Wagner Group, and supporting airborne units at Bakhmut.

Wagner and the Battle for Bakhmut

Russia's use of convicts proved a significant development in the war. This was a natural outflow from the observed tendency to employ expendable forces and auxiliaries to offset casualties and perform more hazardous tasks. These types of forces were typically used in urban combat and as assault infantry. From the outset of the full-scale invasion, the Russian military depended heavily on mobilized personnel from the occupied regions in Donetsk and Luhansk (LDNR). These units were initially mobilized prior to the invasion (whereas the Russian armed forces were not) and were employed extensively in the battle for Mariupol and Severodonetsk and initial offensives west of Donetsk city. They may have comprised 20–25 percent of the initial invasion force. These formations were exhausted by fall of 2022 and the Russian military still had no way to address its structural deficit of manpower without resorting to mobilization. Russian units were depleted of infantry and woefully understaffed.

Piecemeal efforts over the spring and summer of 2022 to organize regionally funded volunteer battalions and contract personnel under short-term service agreements were insufficient to address the decline in manning levels. Moscow maintained that the war was a special military operation, and therefore wartime conditions were not declared until September of 2022. In the absence of wartime conditions, which extended service terms and prohibited soldiers from tearing up contracts, the number of those refusing service increased, further depleting the force as some refused to deploy or tore up their military contracts. All the same, Russian President Vladimir Putin declined to authorize a partial mobilization until the Russian defeat at Kharkiv in September 2022. One initiative that came to influence further developments in Russian force structure was Wagner leader Yevgeny Prigozhin's effort to recruit convicts from Russia's prison system. This effort began in summer 2022, with approval and support from the Russian government, and continued into 2023.³⁰

The use of convicts transformed Wagner's role in the war, which went from a brigade-sized force to something closer to a corps-sized formation with its own support components.³¹ Wagner had its own artillery, logistics, and even contracted air support. Wagner's size expanded from a few thousand to approximately 50,000 personnel by January 2023, including 10,000 fighters serving under contract and perhaps 40,000 or more convicts.³² This made it an operationally significant formation, which was supported by several Russian airborne units. Russia created a group of forces structured around the formation that was led by a lieutenant general. This group of forces prosecuted the battle for Bakhmut, which roughly occurred from August 2022 to May 2023, with the expanded Wagner force playing a decisive role from December 2022 onward.



Ukrainian forces in Bakhmut, March 2023. Author's photo.

Russia used Wagner, comprised of over 80 percent convict-staffed formations, to fix Ukrainian forces around Bakhmut and engage in a prolonged attritional fight.³³ The operational effect of this approach was twofold. The Russian military could entrench and use the time to raise manning levels via mobilization. It generated additional regiments, independent battalions, and a host of territorial troops to supplement the existing combat formations. Second, it attritted some of the more experienced formations that were available within the Ukrainian armed forces. The attrition ratio was favorable to Ukraine, at an average rate of one to four in terms of those killed or seriously wounded, with the bulk of Russian casualties coming from convict-staffed formations employed by Wagner.³⁴ Publicly available sources suggest that 88 percent of Wagner's losses over the course of the battle for Bakhmut were among convicts.

Although the battle appeared to be favorable to Ukraine based on the raw numbers, it still had significant implications for Ukraine's ability to manage forces and prepare for the summer 2023 offensive. The fight drained experienced personnel on the Ukrainian side, while the Russian military could concentrate artillery, and expendable infantry formations around Bakhmut in a grinding attritional battle. Concurrently, Russian engineering brigades erected fortifications and defensive lines in the east and the south of the occupied regions with little risk of Ukrainian offensive action over the course of fall 2022 to spring 2023.

Evolution of Expendable Forces

Wagner—and the battle for Bakhmut, to some extent—became a test bed for Russian forces to determine how best to exploit convicts as an expendable force. Wagner’s methods were brutal and coercive, but effective. The Russian military was interested in the latter and less concerned with the former. Wagner was more innovative and flexible than the regular army, untethered from doctrine, centralized command and control, and the strictures of military bureaucracy. The organization developed a method for using minimally trained and poorly equipped convicts. These tactics depended on simplicity and severe punishment to enforce compliance. For example, Wagner executed convicts who surrendered to Ukrainian forces, refused to advance, or retreated.³⁵ Returning from an assault with anything other than serious wounds was commonly punished.

Convict units were given cheap commercial cell phones without SIM cards. The phones had offline maps installed with numerically indicated waypoints and GPS.³⁶ Wagner commanders would order assault groups to move forward with these preset waypoints over cheap, unencrypted radios, and the convict assault groups would pass back their locations with code words.

Some Wagner convicts operated in eight-man assault groups armed with as many hand grenades and RPG-7 munitions as possible. According to Ukrainian units that fought in the city of Bakhmut, Wagner forces typically operated with two or more assault groups of fourteen to sixteen men; a fire support group equipped with RPG-7, RPO-A, and AGS-17 automatic grenade launchers, mortars, and machine guns; and an evacuation group.³⁷ Wagner regulars (non-convict staff) were used to perform command and control for the convicts—in some cases, as the commander for each group—and operated in their own specific assault groups. In other cases, Wagner regulars determined who

the best convicts were during training, and they would be appointed as the commanders of assault groups. Hence, the small units could be entirely convict-led. Wagner employed convict groups as primary echelon, but often made gains through follow-up attacks with better equipped veteran units. In some parts of the front these units attacked early in the morning, others would seek to infiltrate at night, employing night vision. Multiple waves of convict assault groups would wear down Ukrainian positions, degrade the defending force, and deplete its ammunition. Then, veteran Wagner units would begin an attack against weakened positions.



Ukrainian forces in Bakhmut, March 2023. Author's photo.

In battles in the open surrounding Bakhmut, Wagner units tried to limit the effectiveness of Ukrainian artillery. They attempted to crawl as close as possible to Ukrainian positions to prevent them from using defensive artillery fire. Utilizing concealment to approach Ukrainian positions was critical, as was conducting proper reconnaissance with uncrewed aerial vehicles (UAVs) to determine the best route of advance. For example, in the battle for Soledar, Wagner formations operated in relatively small groups of three to five fighters so as not to draw artillery fire.³⁸ Assaults involved wave after wave of small group attacks from multiple directions for several hours. Wagner forces attempted to attack Ukrainian positions from their flanks as they engaged separate assault groups. This was designed to wear down and exhaust Ukrainian defenders and locate weak points in their lines. Wagner artillery would suppress a part of the line. Then assault groups would move forward toward defensive positions, with their own fire support section taking over suppression. Execution was tactically flexible, with units changing course of action depending on the conditions. If a position was too strong, they could switch to another.

For Ukraine, fighting against Wagner in open fields was much easier because Ukrainian forces could more effectively employ artillery, machine guns, tanks and other forms of fire support. Wagner units had to cross larger distances as dismounted infantry without cover and concealment or armor support. One Russian military correspondent said that Wagner sustained heavier losses fighting in the fields on the flanks than in the city itself, primarily because of a lack of armored vehicles.³⁹ This intuitively makes sense given the composition of the Wagner force. Since Wagner was mostly comprised of infantry formations with a mix of veterans and minimally trained convicts, it performed better in an urban environment than in open terrain.

Observed Limitations

The challenges faced by Wagner units fighting in the open exposed the limitations of what expendable forces could achieve for the Russian military. They proved more useful as assault infantry, especially in urban environments and complex terrain because these areas privilege small unit tactics and employment of light infantry under rudimentary command and control structures. They were much less effective when employed across open terrain, where the distance to be covered proved a major impediment. UAS based means of surveillance made it easy to call in defensive fire support, pinning and suppressing any units attempting to assault in the open. Rudimentary training made them poorly suited to mechanized operations because they were unable to execute complex maneuvers or combined arms actions. Either way, such resources would not be dedicated to convict-staffed formations. While Wagner veterans could operate as combined arms companies or battalions, the convict force they relied on were unsuited to maneuver warfare or force employment beyond the small assault detachment.

There were other costs as well. Convicts used in Wagner's assault units who survived their tours returned as free men, with negative consequences for society.⁴⁰ Whether the Russian state cared that felons and murderers were allowed to reenter society after a few months of fighting is another matter, but the social costs of employing convicts under such conditions also raised questions about scalability. This was perhaps part of the reason why, post-Wagner, the Ministry of Defense changed convict service terms and employed them under a new set of conditions that did not offer parole after service. The initial system also created internal resentment, since mobilized personnel and contract servicemen had no way to end their deployments, whereas Wagner convicts could be paroled and freed from service within six months. Paradoxically, it meant that convicts, despite the inherent hazard, had a better deal within Wagner than those mobilized to serve in the regular army. This Kafkaesque situation persisted until the MoD's Storm-Z and Storm-V detachments were formed later in 2023.

What this suggests is that expendable forces have greater utility in specific contexts and as auxiliary forces, but they have significant limitations and are more a supplement to, rather than a substitute for, regular forces. Even in the context of sieges, urban battles in Ukraine typically involved two contests: one for the city and one to encircle it to cut off ground lines of communication. The need to break through defensive lines outside the city and exploit to effect an encirclement is therefore unavoidable. Here, Wagner fared more poorly and at high cost to the formations employed. Furthermore, Wagner had a tense and often competitive relationship with the regular Russian military throughout the course of the campaign, with mutual recriminations, and a fair deal of resentment. Both Wagner and the Russian army tried to take credit for battlefield successes, while blaming the other for any failures. The resulting relationship became acrimonious, foreshadowing Prigozhin's subsequent mutiny.

It is also notable that Wagner required significant support from the Russian military in terms of artillery and aviation during the battle for Bakhmut. A common feature on the flanks and in Bakhmut was that Wagner required a large artillery advantage to make gains. The Russian artillery advantage over Ukraine over the course of this battle was approximately five to one.⁴¹ Indeed, the fires advantage was an important component of Wagner's incremental gains in the fight for Bakhmut, and it is also why Prigozhin complained about a deficit of artillery ammunition (despite the fact that he had a significant fires advantage and likely received more than any other Russian grouping of forces at the time). A shell shortage left Ukraine without effective counterbattery fire. In Bakhmut itself, Russian artillery collapsed entire buildings with a saturated volume of fire. Because convicts were expendable, Wagner could send these assault groups closer to Ukrainian positions while suppressing them with artillery than the Russian military could with regular forces.

Russia's employment of a parastatal entity, such as Wagner, was also not without limitations when it came to the veteran or professional cadre. Wagner was sparing with its veterans. Mercenaries are in it for the money and are less willing to sacrifice themselves. Similarly, Wagner, which represented a public-private partnership, had other considerations beyond the war in Ukraine. Prigozhin was

keen not to lose the better part of Wagner's veteran cadre since these fighters would be important for lucrative operations in Africa and the Middle East. Ukraine was politically significant for Prigozhin, but the organization's revenue came primarily from extraterritorial operations in other parts of the world. This meant that Wagner was profligate in its use of convicts, but sparing in deploying the veteran cadre of fighters.

The main factors enabling Wagner's operations were availability of expendable convicts from Russia's prison system, artillery support from the Russian army which provided a fires advantage, and the presence of supporting Russian units holding Wagner's flanks to secure their campaign.⁴² Consequently, the effectiveness of Wagner should be considered within the broader context and observed constraints.

The Wagner mutiny in June 2023 represents an important postscript to this story. It suggests that the Russian military and the Kremlin's various security clans can only coexist with another force and its leadership for so long before competing ambitions, personalities, and the desire to take credit create tensions. The Russian political system is fundamentally predatory, and like most institutionalized militaries, Russian commanders loathe having another force in their area of responsibility that is not directly subordinate to them. Employing an expendable force in this manner, on a large scale, proved both a benefit and a vulnerability. The autonomy that Wagner enjoyed came with aspirations, ambition, and resentment vis-à-vis the regular armed forces. Whereas the regular Russian military, especially Russian military intelligence (known as the GRU) included some Wagner supporters, the military leadership saw the organization as a threat and sought to subordinate it completely.

This came to the fore when Wagner seized Bakhmut in May 2023 and announced its plans to turn the city over to the Ministry of Defense, which meant that it had served its purpose. Arguably at that point Prigozhin became more of a liability than an asset. Subsequently, the Ministry of Defense issued Wagner an ultimatum to sign contracts on June 13, effectively ending its autonomy. This precipitated the Wagner mutiny. Contrary to popular belief, it was not the battle for Bakhmut that led to the mutiny, but the conclusion of the battle and Wagner's withdrawal to the rear. Prigozhin's ambitions, and the threat he posed to other patronage networks, rather than the battle for Bakhmut specifically, was the underlying cause for the crisis. He was building popularity nationally at the expense of the Russian military leadership, with allies in the Kremlin. This led the Russian Ministry of Defense, headed by Sergei Shoigu, to act in an effort to preempt Prigozhin's ambitions and assert control over the war.

Beyond Wagner: Assault Detachments, Storm-Z, and Storm-V

In 2023, Russia introduced new types of assault formations, influenced by battlefield needs and constraints due to high rates of equipment loss. The role played by Wagner in the battle for Bakhmut also paved the way for new approaches to how Russia employed infantry in the attack. Arguably

some of these adaptations can be described as negative in character, resulting from the inability to successfully break through prepared defenses and restore the ability to maneuver with regular formations. Assault units were about finding ways to overcome a well-prepared defense on a battlefield that had become entrenched and static. They also represented an institutional effort to offload a significant percentage of the casualties suffered in assaults onto a politically expendable convict force. The adoption of assault detachments has a rich history in Soviet and Russian military history. Various types of assault units were formed during World War II, and the use of Storm formations is not new to the Russian armed forces. As the preceding section indicates, the Russian military was experimenting with Storm units and breakthrough groups in 2022. Despite the heavy losses suffered by Wagner recruits, most of whom were convicts, they demonstrated the ability to achieve tactical objectives.

Consequently, the Russian Ministry of Defense decided to replicate this experience and implement it across the army, leading to the creation of several new structures. These new structures were to some extent a “Wagnerization” of the Russian armed forces. To be clear, this process began well before the battle for Bakhmut had ended. The first of these efforts was Storm-Z, a penal infantry unit composed of incarcerated convicts. This was later transformed into Storm-V. The second were assault detachments, which could be reinforced by Storm-Z/V companies. The third were a mix of so-called Volunteer Reconnaissance-Assault Brigades. These were primarily composed of infantry, with few vehicles or heavy equipment, assigned to conduct assault operations. These brigades were frequently sponsored and supplied by third parties and informal assistance networks, including major state enterprises.

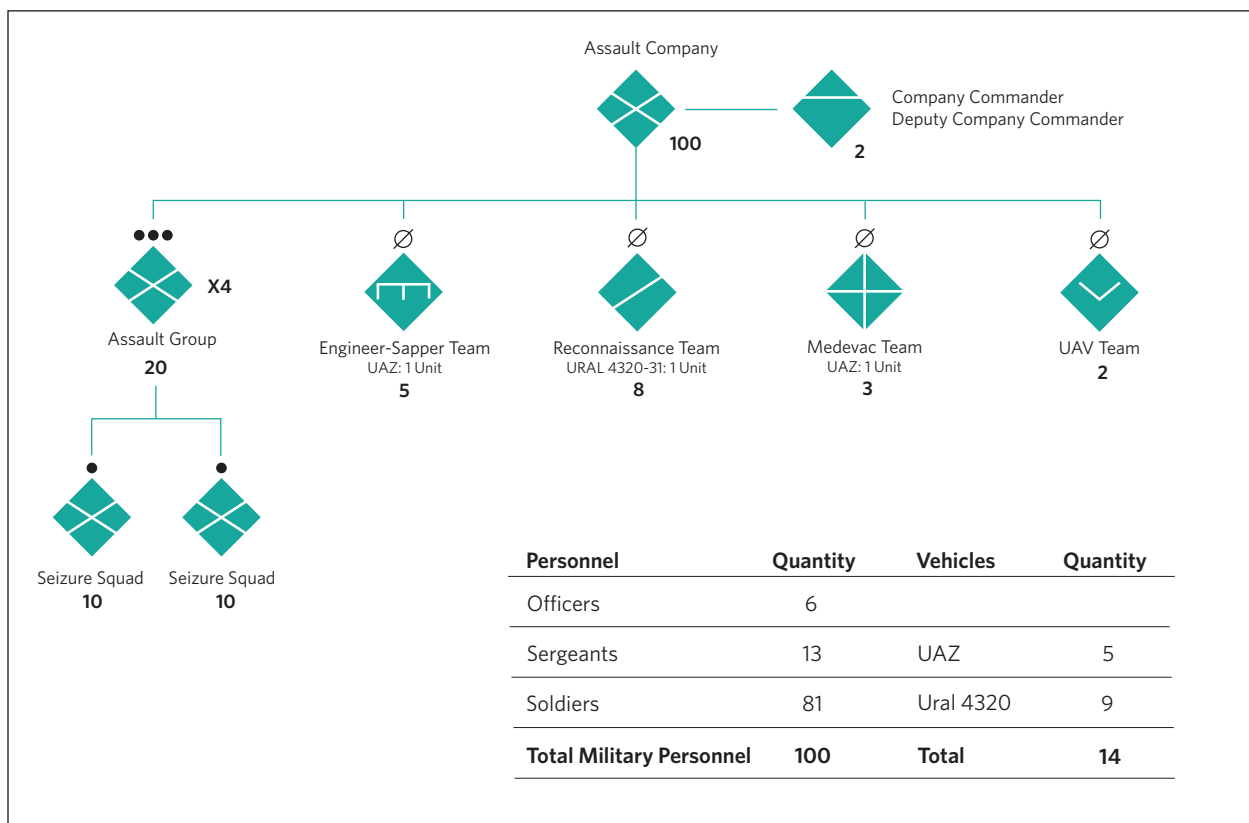
Storm-Z units were designed as temporary formations that could be distributed to regular units for the purpose of conducting assaults against enemy fortified positions or combat in urban environments. These consisted of approximately 100 personnel. These companies were typically broken down into an assault group, a second echelon for clearing and entrenchment, and a reserve group. The Russian military expressly prohibited mixing regular units with convicts in Storm-Z units. Convicts comprising these groupings served under a special six-month contract and were eventually given the status of volunteers under Russia’s reserve system (BARS).⁴³ They could be used to supplement an army assault detachment (described later in this section), consisting of 161 personnel, as a separate auxiliary force of 100 convicts. This combination was important, as Storm-Z and assault detachments could be too brittle on their own but together represented a more robust formation.

A Storm-Z company might consist of a command section, drone section, and four assault groups consisting of twenty personnel each. These assault groups were further divided into a ten-man assault section and a ten-man fire support section. Other support elements in the company included a sapper engineer section (five personnel), a reconnaissance group (eight personnel), and a medivac section (three personnel). The Russian military allocated ten to fifteen days for Storm-Z unit cohesion and training in three stages.⁴⁴ The first stage involved individual training in basic tasks and specialized

roles, such as use of relatively simple drones for reconnaissance. The second stage developed cohesion in small fighting detachments, two-man and three-man groups, or sections. The third stage prepared the units for movement and offensive action at the level of a platoon, including assault, as well as fortification.

The period allocated for training was grossly insufficient for individuals to develop skills in even basic combat tasks, let alone squad- and platoon-level action, especially in assault roles. The typical time required to develop specialized skills and unit cohesion is measured in months. This conveys the gap between expectations and reality of what expendable convict units could achieve given the low investment in training. These units were distributed to commanders who could employ them as they pleased and were often used in frontline roles either for assault or defense of forward positions. The units were motorized, meaning armored fighting vehicles were not allocated for their use, and they made do with light support weapons.

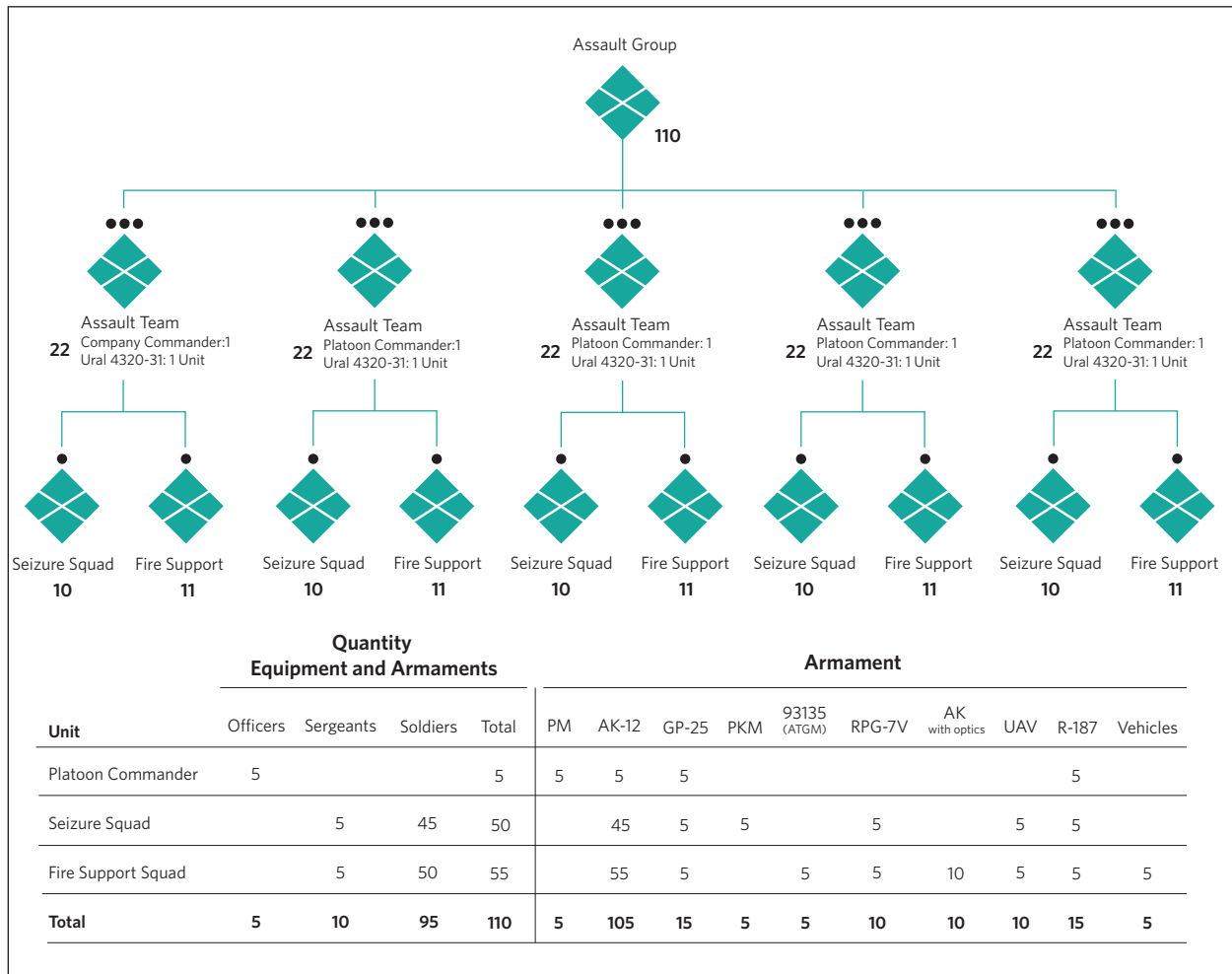
Figure 2: Storm-Z Detachment Structure



Source: Russian training manuals for employment of assault detachments, 2023.

The Russian Ministry of Defense then developed a follow-on convict-based unit, Storm-V, comprised of 110 personnel.⁴⁵ The company was organized into five assault groups (compared to Storm-Z's four), each consisting of twenty-two individuals (an increase of ten compared to Storm-Z). Each group was led by a group commander and was further divided into an assault group (ten people) and a fire support team (eleven people). The primary transportation used by these groups is the Ural 4320 truck. Certain components present in Storm-Z, such as the reconnaissance group, company command, and combat engineering group were disbanded. The commander of the first assault group also served as the company commander in Storm-V. The aim of the assault group in Storm-V remained unchanged: conducting assault operations with a focus on attacking strong points in open fields, tree lines, and urban areas.

Figure 3: Assault Company-V Structure

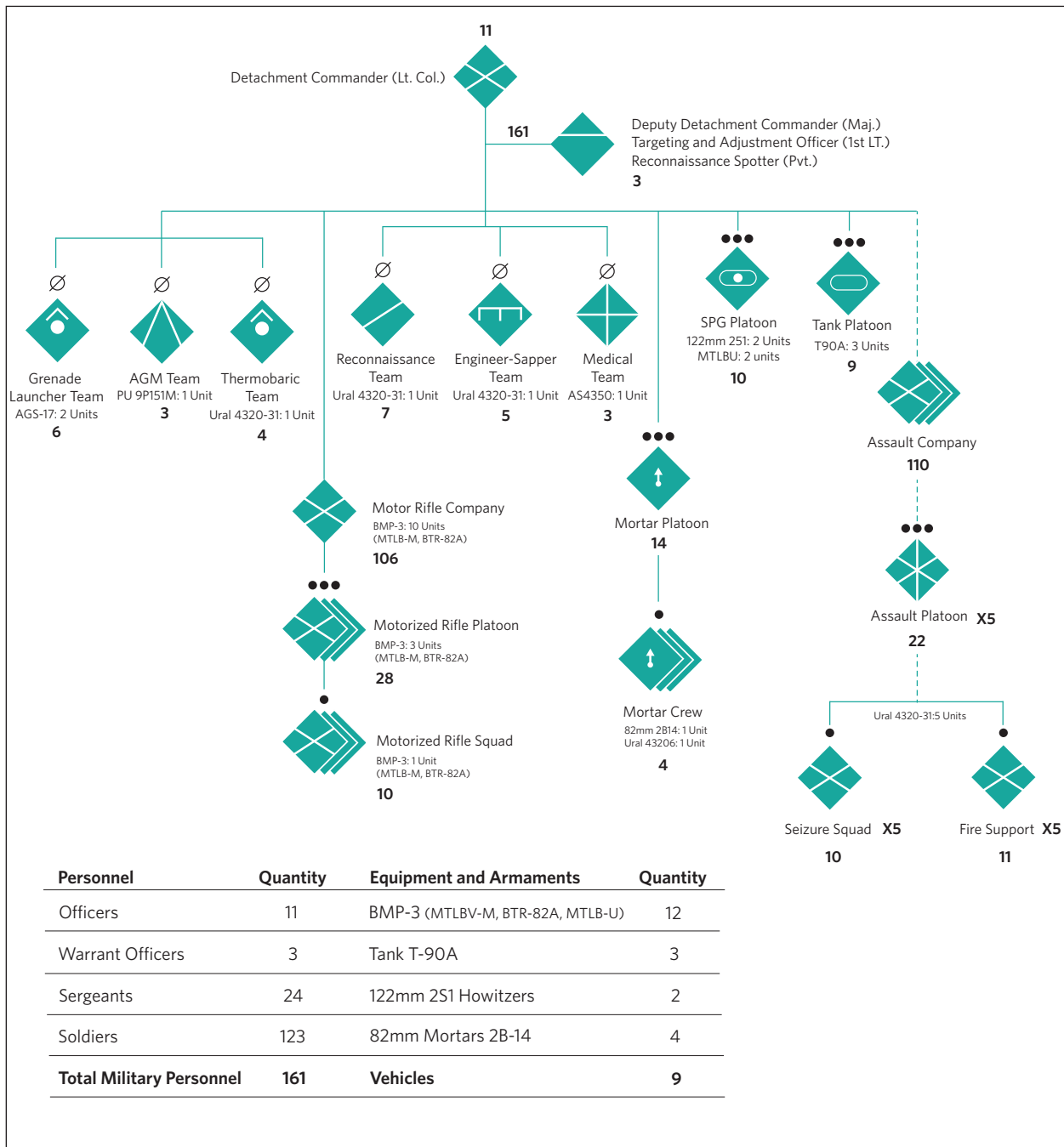


Source: Russian training manuals for employment of assault detachments, 2023.

The larger force structure employed by regular forces was the assault detachment, a reinforced company-sized force specifically designed for conducting assaults in fortified tree lines, trenches, and urban environments. This was not a convict-staffed unit, but one typically comprised of those volunteering for higher pay for performing more hazardous tasks. This unit had a base number of 161 personnel, was adaptable to mission requirements, and typically included one Storm-V assault company, a self-propelled howitzer platoon, a tank platoon, and a motor rifle company. More Storm-V companies could be added as needed and in more recent versions of this formation the size can grow to a total of 491 troops, with three Storm-V companies, a motorized rifle company, and supporting elements. Although the structure assumed that the detachment was equipped with BMP-3 infantry fighting vehicles, MTLB tracked carriers, BTR-82A armored personnel carriers, and T-90A tanks, in reality, this was rarely the case. Assault detachments often used whatever resources were available to them, including older model tanks, trucks, civilian vehicles, and even BMP-1 infantry fighting vehicles. As mentioned earlier, assault detachments could be reinforced with Storm companies, significantly increasing their size.

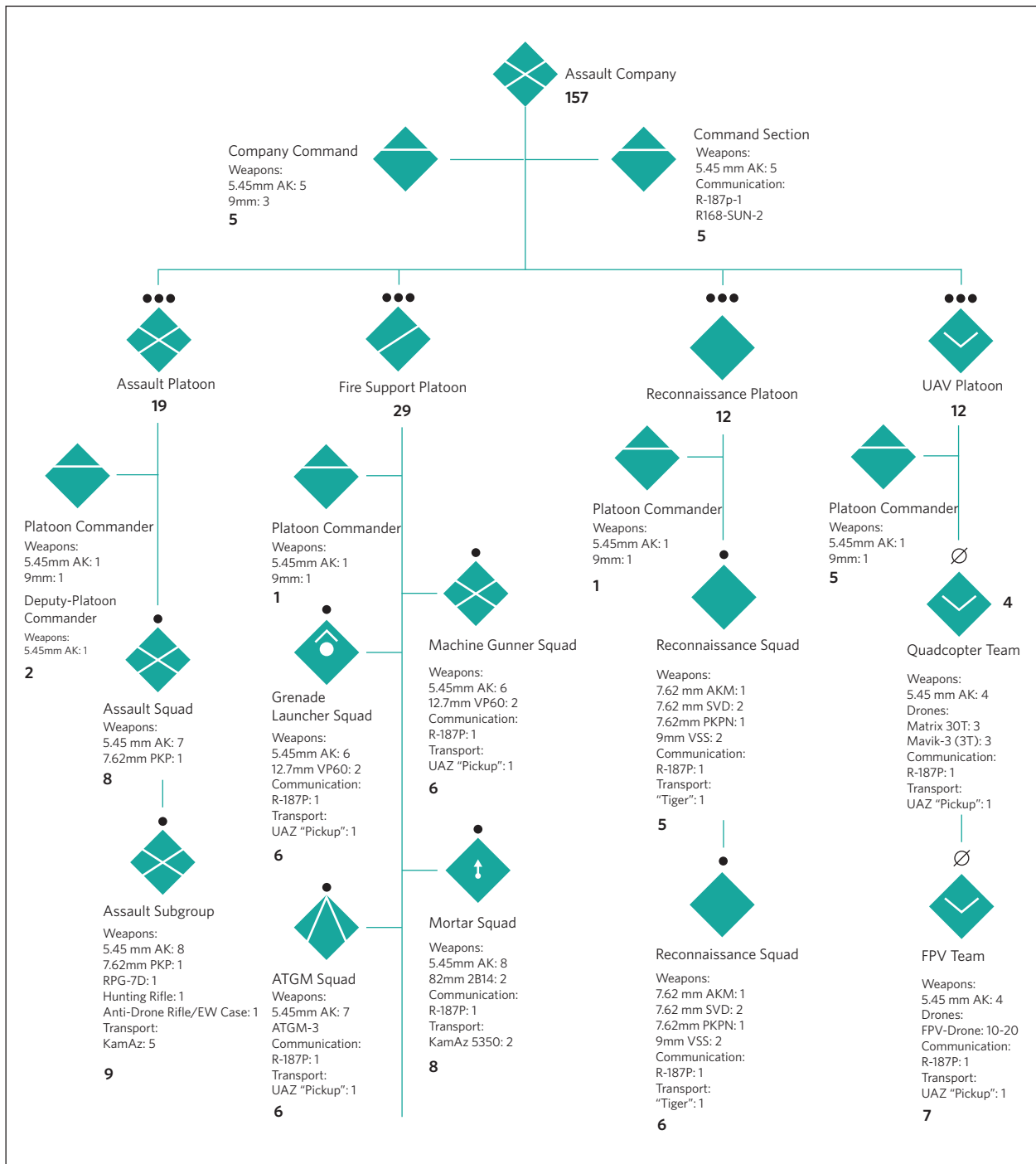
The Russian Airborne Troops (VDV) also established assault detachments. Like the army assault detachments, these were meant to seize fortified points and trenches. The assault detachment commander was a battalion commander grade position with the unit comprised of several assault companies and support elements. An assault company consists of 157 personnel, including a command section, four assault platoons of nineteen personnel, a fire support platoon of twenty-nine personnel, a reconnaissance platoon with twelve personnel, and a twelve-person UAS section (equipped with Mavic, Martice, and FPV drones). An alternative reduced staff variant of the assault company has 110 personnel. Instead of four assault platoons it features five assault groups with twelve personnel each, a ten-person reconnaissance section, ten-person fire support section, seven-person UAS section, and a twelve-person support section. Per Russian writing, the basic tactics for assaults with these formations are meant to employ the force via dispersed three-man fire teams, advancing from cover to cover. Assault companies are designed to sustain combat operations independently for no more than two days, with an active assault phase lasting from one to three hours.⁴⁶ Russian airborne assault units operated in this manner during the Kharkiv offensive of 2024, with assault platoons broken down into three-man fire sections, which could then conduct assaults with two to five sections at a time.⁴⁷

Figure 4: Assault Detachment Structure



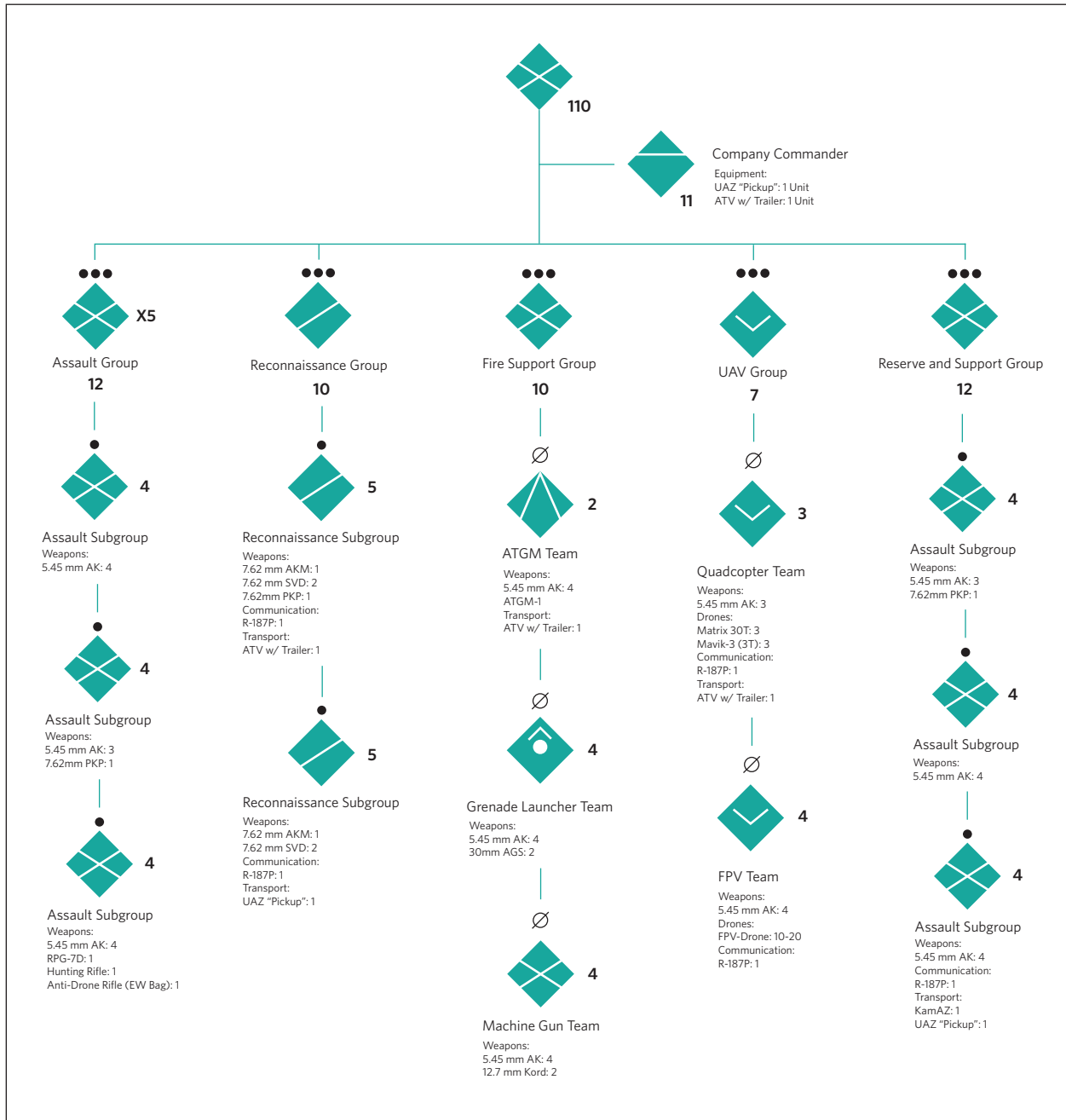
Source: Russian training manuals for employment of assault detachments, 2023.

Figure 5: Airborne Assault Company Structure



Source: A.G. Kontsevo, ed., "Training Manual: Combat Employment of Assault Company (Group) in Offensives," Russian Airborne Troops Command, June 16, 2024.

Figure 6: Airborne “V” Assault Company Structure



Source: A.G. Kontsevogo, ed., "Training Manual: Combat Employment of Assault Company (Group) in Offensives," Russian Airborne Troops Command, June 16, 2024.

Besides the assault company and assault detachment structure, the Russian military also formed a variegated volunteer force organized as a volunteer corps. In the first half of 2023, the Russian military established the “First Expeditionary Volunteer Army Corps,” which served as an umbrella formation uniting various so-called volunteer units that either existed or were in the process of formation. This expeditionary volunteer corps absorbed the so-called Reconnaissance-Assault Brigades.⁴⁸ At least thirteen different units were known to be included in this volunteer corps, though there could be more. These volunteer units were originally formed outside of the regular Russian Army structure, and they exhibited significant variation in size and armament. Despite these differences, they shared a common characteristic: a heavy emphasis on infantry components with relatively few armored vehicles compared to standard motor rifle units. For instance, the 1st Recon-Assault Brigade “Wolves” is believed to consist of between 1,100 and 1,400 personnel and is supported by only three armored fighting vehicles.

Over the course of 2023, the Russian military steadily adapted its use of expendable forces, standardizing force structure and integrating a motley mix of volunteer units and specialized units. These units were expendables of a different stripe, because for quite some time they were not considered part of the regular military structure. Many were privately funded or regionally organized within Russia. The main drawback of this approach was that while the Russian military found a way to optimize small units for assault purposes and offset casualties by using expendable forces, these adaptations were necessary to resolve larger problems. Mechanized assaults against a well-prepared defense, with minefields covered by anti-tank guided missiles, supporting fires, and UAS, were incredibly costly. The Russian military lost large amounts of armored fighting vehicles often in exchange for paltry gains. Russian forces struggled to coordinate maneuver operations at a larger scale. They also lacked the necessary enablers such as mine clearing equipment, to support the force in assaults against prepared defenses.

Prior formations were optimized for a maneuver-based offense, or defense, on a fragmented battlefield. Russian tactics also heavily relied on attaining a decisive fires advantage, which the Russian military no longer enjoyed after 2022, and whose net effect was reduced by the increasingly positional manner in which the war was being fought. Despite having more enablers than most Western militaries, Russian forces struggled to overcome Ukrainian defenses. Dealing with massed precision in the close-in fight was a significant part of the challenge. Russian forces, and the stereotypically lower-survivability design of Soviet equipment, struggled to adjust. The Russian military adapted to this environment, but in a manner that could at best press Ukrainian forces from one set of defensive positions to another. This did not enable it to achieve major breakthroughs on the battlefield.

As the Russian force expanded, it learned to operate via smaller groupings and detachments while conserving armored fighting vehicles. This was not always the case, as the rather costly offensive actions in the battle for Avdiivka show, in late 2023. Russian forces have fluctuated between

conducting mechanized assaults, dismounted infantry assaults, and those based on light utility vehicles or motorcycles. The latter started to emerge in fall 2023 and became a more prominent feature of Russian tactics by spring 2024. Tactical evolution and developments in infantry tactics leading to specialized assault units is hardly new. This pattern was observed in World War I and World War II. The development of German assault units was seen as a fairly positive and effective adaptation to the entrenchments that dominated the Western Front in World War I. The Soviet Army adapted various types of assault formations during World War II. While in the Russian case assault units made good use of expendable formations that could offset casualties, it also circumscribed Russian offensive potential such that even when Russian forces held the initiative across the entire front line with advantages in manpower, equipment, and artillery, the gains were incremental at best.

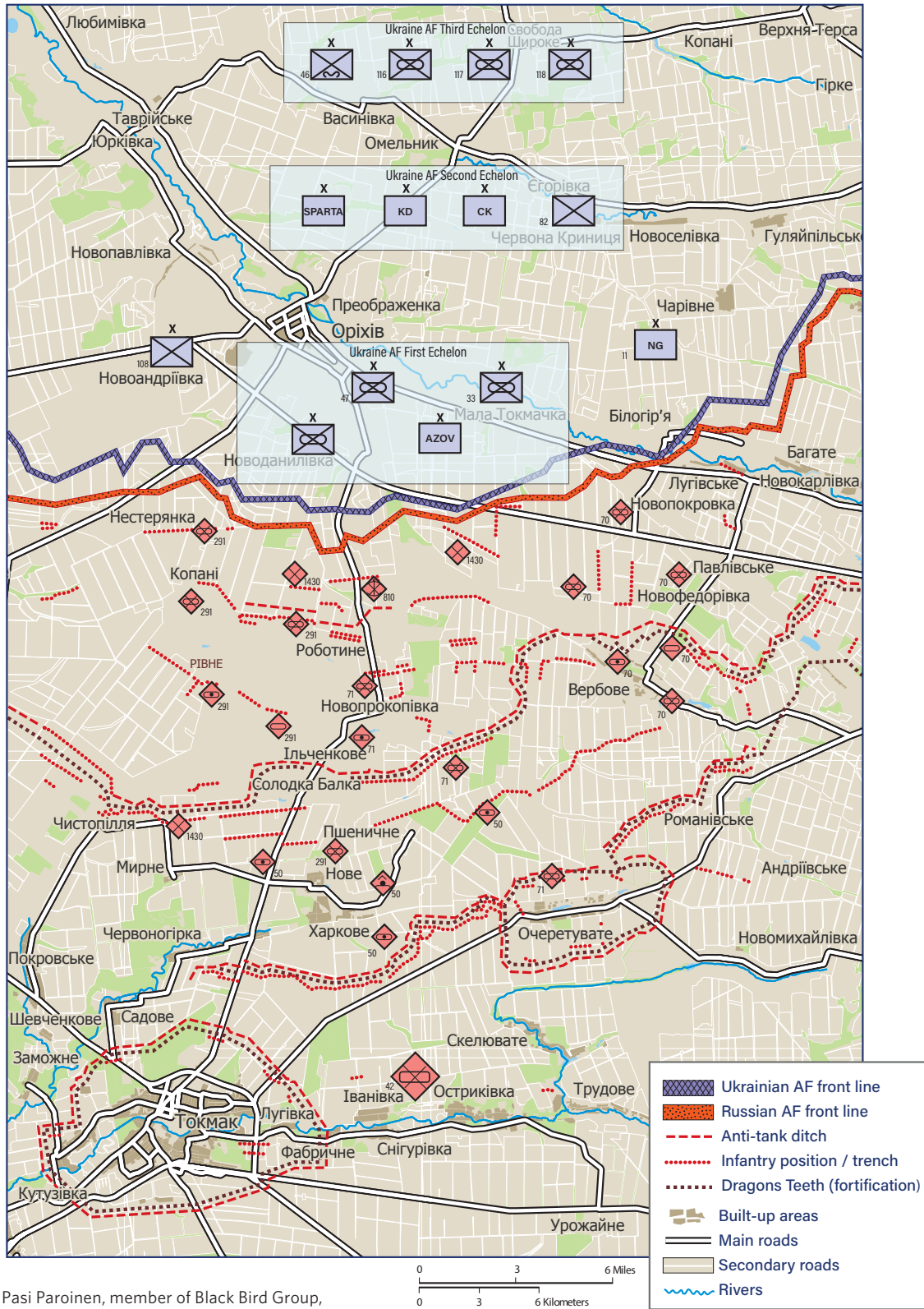
Russian Defense in Summer and Fall 2023

In 2023, Russian military performed better when conducting defensive operations compared to offensive operations. This is not a surprising finding, land warfare tends to favor defense over offense, with the latter more difficult and complex to organize. Changes to Russian force structure and composition enabled the Russian military to effectively defend against Ukraine's 2023 offensive. From the fall of 2022 through the spring of 2023, Russian forces built layered defensive lines in the south in anticipation of a Ukrainian offensive there. Forces were distributed relatively equally along the main possible axis of advance, with reserves established in the rear.

Ukraine's offensive began with shaping operations in May, followed by an initial attack around Bakhmut designed to fix Russian forces there. Ukraine then launched offensive operations from Velyka Novosilka toward Berdyansk, which were meant to pressure Russian forces east of the main axis of advance. Shortly after, in the beginning of June, Ukrainian forces launched the main effort: an advance from Orikhiv toward Tokmak. The plan envisioned breaking through Russia's initial line of defense quickly with the first echelon of forces (the 9th Corps), then punching through the remaining defensive lines with the second echelon (10th Corps) and exploiting that breakthrough with the reserve (Taskforce Marun). In the best case scenario, Ukraine hoped to reach the city of Melitopol in the south and sever the Russian ground lines of communication from Crimea, though just reaching Tokmak would have been considered a relative success.⁴⁹

Ukrainian forces ran into a host of problems with planning and execution. They were not provided with a sufficient quantity of enablers to overcome the prepared defenses. Notably, Ukraine also lacked airpower, and was limited to long-range precision fires that could not reach Russian tactical aviation, or attack helicopter bases in the Russian rear. Though overall Ukraine likely enjoyed a precision fires

Figure 7: Organization of Ukraine's Summer Offensive and Russian Defense



Source: Pasi Paroinen, member of Black Bird Group, a Finnish OSINT organization.

advantage based on the MLRS systems provided by Western countries, precision guided artillery munitions, and extensive Western intelligence and targeting support. The overall strategy—attacking Russian forces where they were most fortified, had the least degraded troops, and had anticipated the main axis of advance—was also questionable. It was essentially accepting a set piece battle against an entrenched force in the absence of significant advantages or permissive conditions. The concept of operations may have made sense in theory, but looking at the correlation of forces and the geography of the battlefield, it did not make sense in practice by May 2023.⁵⁰ Ukraine's decision to split forces and supporting fires along three fronts (Bakhmut, Velika Novosilka, Orikhiv) also did not pay off.

The decision to use newly trained Western units who were inexperienced was another factor contributing to the offensive's failure. This choice was influenced by the decision to keep experienced formations fighting at Bakhmut, expending the qualitatively better part of the force both in defense of the city, and in subsequent counterattacks that summer. Ukraine's units were split almost evenly between the main offensive in the south, and those fighting in the east from Bakhmut to Kharkiv. The main challenges on the Ukrainian side can be summarized as lacking a clear advantage in fires, an inability to employ forces at scale or effectively coordinate breaching efforts, and an overall deficit of enablers required to overcome a prepared defense.⁵¹

After the initial breaching effort failed in June, Ukraine switched to a destruction-oriented approach, with advances via small unit infantry attacks. Ukrainian artillery attempted to establish fires superiority, attriting the Russian defense and reducing Russian fires. The overall campaign was characterized by a series of small unit actions fighting from tree line to tree line over the course of four months.⁵² This approach preserved equipment, but resulted in incremental gains without breakthroughs. The offensive culminated at the end of September when Ukrainian forces grew exhausted and ran out of assault-capable infantry. Drained of combat power, Ukraine had few units of action available, and at that point was cobbling together assault groups. However, it had already been clear two months earlier that the tactics employed could at best push Russian forces from one prepared defensive line into another without the ability to establish momentum or exploit those gains.

By August, Ukraine was forced to commit its reserves, which were originally the exploitation force, making it clear that even in the event of a breakthrough, there would be no additional capacity for significant battlefield gains. Despite a significant reduction in available ammunition, and little offensive-capable infantry remaining, Ukrainian forces continued to try and push along the Orikhiv-Tokmak axis until November.

Organization of the Russian Defense

In the south, along the main axis running from Orikhiv to Tokmak, the Russian military's defense was organized under the 58th Combined Arms Army, with supporting units from the Naval Infantry and numerous territorial troop regiments. Airborne units served as the operational reserve. In preparing their defense, Russian forces laid down overlapping minefields, concrete-reinforced trenches, bunkers, and multiple defensive lines with communication trenches between them.⁵³ Although the so-called Surovikin lines appeared doctrinally laid out, the Russian army established a strong forward defensive line in the scrimmage zone. Defensive fortifications were anchored in towns such as Robotyne and Verbove. Russian forces elected to defend forward of the main defensive lines, focusing on the anchoring towns and initial defensive networks. This stymied Ukrainian forces, preventing them from gaining momentum during the initial assault, but came at the price of much higher levels of attrition among defending Russian units.

Russian forces employed decoy trenches mined with explosives that could be remotely detonated once they were occupied by Ukrainian soldiers.⁵⁴ Russian anti-tank guided missile teams had extensive surveillance forward of their positions. Russian units regularly counterattacked lost positions, given that attacking units are most vulnerable when they have taken a defensive point and have not yet had time to consolidate. Minefields presented a critical challenge to Ukraine's offensive.⁵⁵ The defense deployed far more mines than doctrinally specified and in innovative patterns.⁵⁶ These were expanded from 120 meters to 500 meters, making them difficult to breach by vehicles with line clearing charges.⁵⁷ Individual Russian companies had minefields with hundreds, or thousands, of TM-62M anti-tank mines in front of their positions.⁵⁸ Russian units stacked three TM-62M mines on top of each other specifically to destroy trawls used by breaching vehicles. These were supplemented by smaller numbers of TM-83 anti-tank mines placed in tree lines to target armored vehicles from the side as they drove down dirt paths that frequently ran parallel.

These anti-tank mines were mixed with anti-personnel mines to inflict greater losses when vehicles were disabled, including PMN-4 pressure plate mines, OZM-72 bounding mines, and MON-50 and MON-200 directional fragmentation mines.⁵⁹ Russian forces supplemented these mines with buried FAB-100 and FAB-250 aerial bombs, which were used in a similar improvised role. This was partly due to insufficient mine availability to meet minefield depths that were well beyond those originally stipulated by doctrine. Russian forces also proved effective in remotely deploying mines with artillery, using ISDM Zemledeliye mine-laying systems, and even dropping mines such as the POM-3 and PFM-1 anti-personnel mines via drones.⁶⁰ These were used to saturate lanes cleared by Ukrainian sappers and to mine roads behind Ukraine's front lines. Ukraine struggled in employing mine-clearing vehicles, including those that carry mine-clearing line charges. These vehicles are typically soft-skinned, packed with explosive line charges, and are often insufficient to clear a path

through the depth of the minefield. Firing from an exposed position, such vehicles were a priority target for Russian antitank guided missile teams.

Russian defenses were more successfully concealed because Russian troops determined disposition and visibility of defenses from Ukrainian forces' perspectives. In other words, they had better quality control. They utilized tactical drones to ensure fortifications and weaponry were concealed from the opponent's perspective. These drones allowed Russian forces to improve concealment and fix errors. Their widespread use of nets and camouflage techniques, including properly incorporating natural elements like branches and leaves, effectively concealed individual and squad positions from drones and satellites. As Ukraine's offensive progressed, it became clear that areas adjacent to tree lines were also well-prepared, with concealed defenses. While the visible echeloned defenses of the Surovikin line easily stood out and drew attention to themselves, the forward defensive lines were much better prepared than they appeared. These enhancements likely played a role in misleading planning, causing Ukrainian and Western planners to underestimate the true extent of Russian defenses.

Mines turned the advance into a slog. Even when infantry units could advance on foot, lanes had to be cleared to bring up vehicles. This complicated casualty evacuation for advancing infantry units and made it difficult to bring other supporting capabilities critical for sustaining momentum, such as air defense or logistics, closer to the front line. When paths were cleared, the presence of mines had a psychological effect on traversing forces that made most combat tasks more difficult.⁶¹ Other pernicious tactics involved preparing trenches for demolition and detonating them as Ukrainian units entered into fighting positions.⁶² This meant that assaulting infantry would proceed cautiously and wait to clear a trench under the assumption that it might be mined for detonation.

Ukraine's initial breaching effort in the south failed in part because Russian forward positions were much stronger than expected.⁶³ Russian units fielded densely deployed anti-tank guided missiles along the forward line. These were supported by artillery, as well as Ka-52 attack helicopters, Lancet attack munitions, first-person-view drones, and glide bombs dropped from Russian bombers.⁶⁴ Russia employed modernized Ka-52M helicopters, which could launch Vikhr-1 and longer-range LMUR anti-tank missiles beyond the range of Ukrainian short-range air defenses. These were supplemented by Mi-35Ms employing Ataka anti-tank guided missiles and helicopters equipped with directional electronic warfare pods to suppress air defense targeting radars.⁶⁵ In many cases, a tank or armored vehicle would be immobilized after hitting a mine and then would be destroyed by attack helicopters or drones. Although Russian units were forced to ration the use of artillery due to ammunition shortages, they had sufficient supplies initially stocked ahead of the offensive to disrupt advances.

Doctrinal Orthodoxy and Flexibility

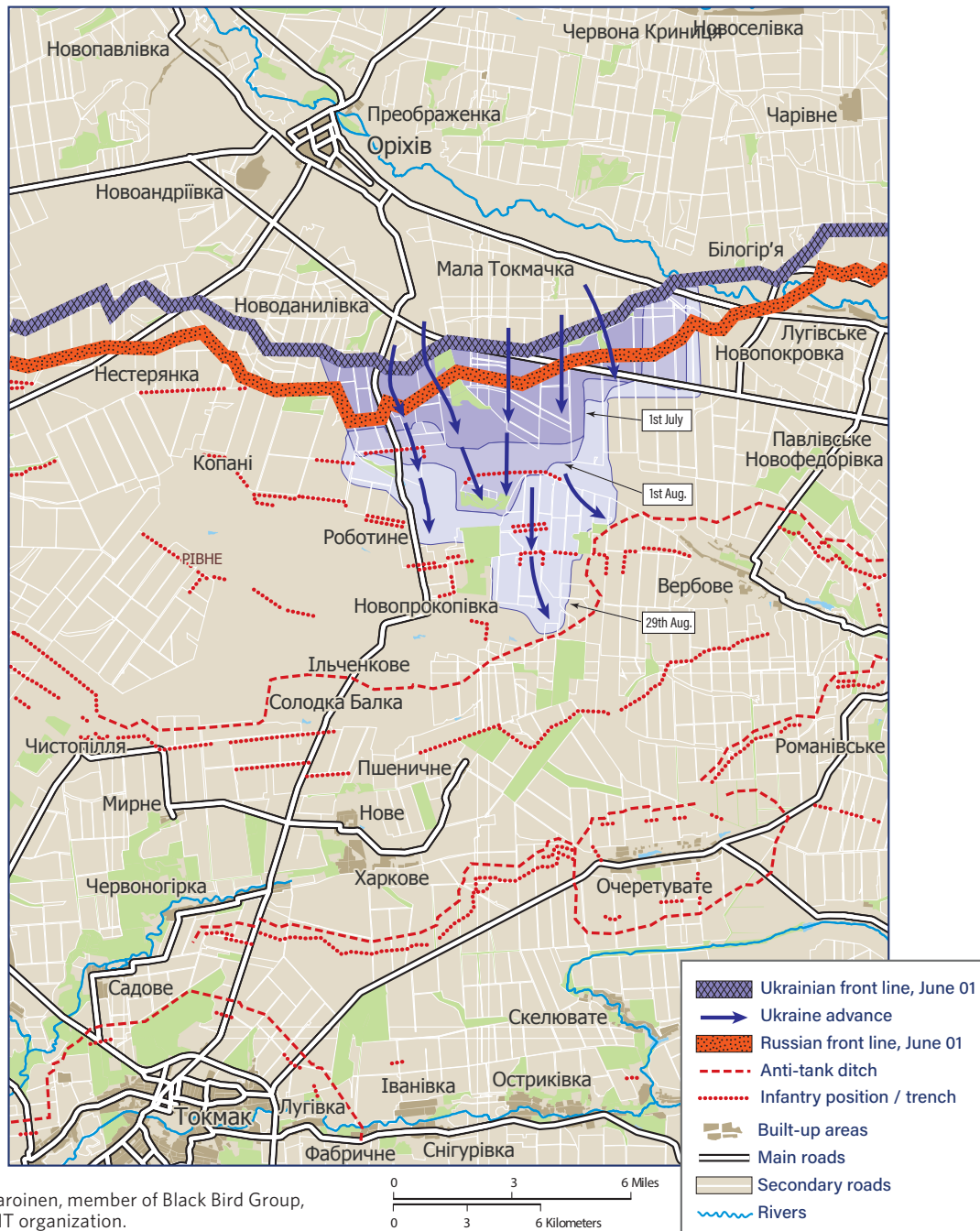
Russian forces appeared to be pursuing an “active defense,” with persistent engagement of the opponent over the course of the defensive operation, and frequent counter attacks. This was independent of whether they were engaging in a positional defense along fixed lines, or a more flexible maneuver defense.⁶⁶ In practice, this translated to regular counterattacks and efforts to retake lost positions. That depleted Russian armor in counterattacks, rather than trading terrain to degrade advancing Ukrainian forces. Although Russia had established an extensive defense in depth south of Orikhiv, and Velika Novosilka, it was not using it as such.

The Russian approach was aggressive and expensive in terms of manpower, given that Russian forces had well-established, machine-dug defenses they could retreat to. However, this did track somewhat with the prevailing concepts in Russian military thought prior to the war: that it should execute a maneuver defense, in combination with positional defense, steadily drawing the opponent into a fire cauldron (or fire sack).⁶⁷ Russian forces in forward positions sought to avoid being decisively engaged. Units would at times retreat while others counterattacked. As Ukrainian forces advanced, they could increasingly be ranged from different sides of the pocket by Russian artillery, while Ukraine’s fire support would be vulnerable in trying to reach the outer edges of the advance. Over time, shorter range Russian artillery would be able to engage longer-range Western artillery systems fielded by Ukrainian units. Not only were Russian forces entrenched on higher terrain, with better topography south of Orikhiv, but the geometry of the battlefield came to favor Russia once a salient was established.

The map below illustrates the resulting effect, as advancing forces had to not only overcome prepared defense but were increasingly surrounded by fires on three sides as a result of their progress.

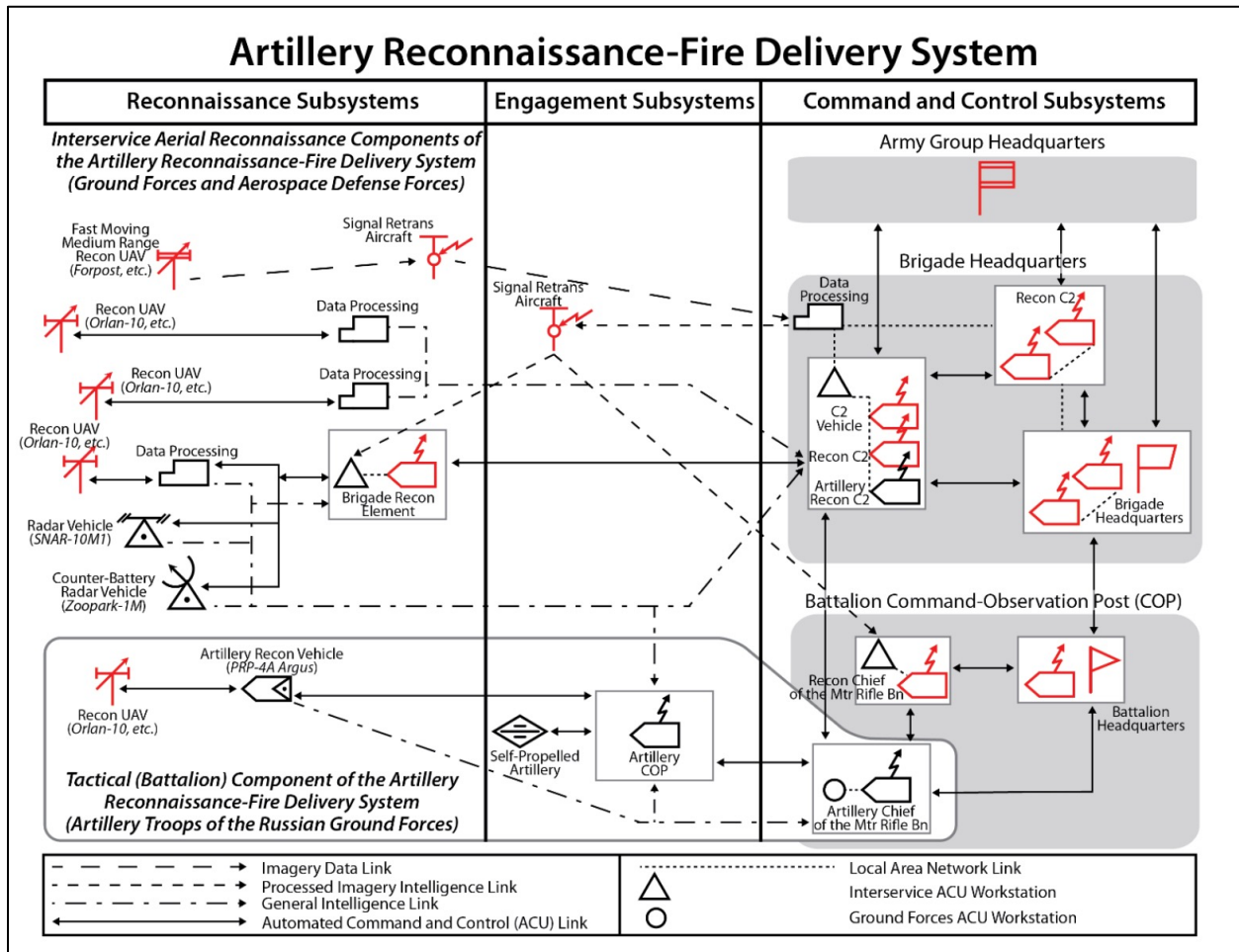
While Russian forces stuck close to the operational concepts previously outlined, there were doctrinal modifications and adaptations at the tactical level besides defense organization. Russian artillery units began to shift toward greater precision compared to a volume of fires approach. Volume of fire was tasking on barrels and required large numbers of artillery rounds to be expended to suppress attacking units. This led to improved employment of a reconnaissance fire approach in employing fires at the tactical level.⁶⁸ This was always Russia’s intention, going back to Soviet thinking in the late–Cold War period, during which the concepts of reconnaissance fire and reconnaissance strike complex emerged.⁶⁹ However, the Russian military struggled to implement these concepts at scale in the first year of the Russia-Ukraine war. Multiple factors could explain Russia’s early failures to execute a more information-driven or sophisticated way of war: weak organizational capacity, inexperience in scaling and operating in a contested environment, and poor force quality, with forces lacking the requisite skills to turn theory into practice. A combination of the above is arguably why the Russian military struggled at first to effectively integrate reconnaissance and fires to enable dynamic targeting on the battlefield in a more precise manner.

Figure 8: Map of Ukraine's Offensive Thrust South of Orikhiv, June 5-August 29, 2023



Source: Pasi Paronen, member of Black Bird Group, a Finnish OSINT organization.

Figure 9: How Reconnaissance Systems Integrate With Automated Command and Control Systems



Source: See Lester W. Grau and Charles K. Bartles, "The Russian Reconnaissance Fire Complex Comes of Age," Oxford Changing Character of War Centre, May 30, 2018, <https://static1.squarespace.com/static/55faab67e4b0914105347194/t/5b17fd67562fa70b3ae0dd24/1528298869210/The+Russian+Reconnaissance+Fire+Complex+Comes+of+Age.pdf>.

While all of these may have been true, it merits noting again that in the initial February 2022 invasion Russian forces did not deploy in a doctrinally sound manner. Individual formations may have had the capabilities and relevant unit types in their BTGs, but their instructions were to rapidly advance, seize key infrastructure, encircle cities, and block Ukrainian forces. That army was decimated by losses in early weeks of the war, leaving a broken force that could not reassemble itself in a manner that would have permitted execution of more complex concepts, or tactics. In short, the Russian army at first was not executing reconnaissance fire or strike at scale because of how it was told to operate, and by the time it adjusted the state of the force was not conducive to realizing this way of fighting.

Shortages of artillery ammunition, growing barrel wear, and a deficit of counterbattery radars that could enable a more traditional volume of fire approaches invariably forced the Russian military toward precision. This trend began well before the summer of 2023, but the use of Lancet-3/3M munitions for counterbattery purposes, Krasnopol-M laser guided artillery shells, and first-person view (FPV) drones became more prominent during the offensive. Russian forces fielded more types of drones capable of surveillance behind the front lines and in numbers such that Ukrainian short-range air defense would be reticent to fire to preserve ammunition. By the end of the summer, FPV drones proliferated on the battlefield, denying mobility in daytime within several kilometers of the front line, as a cheap form of precision strike that did not require lines of sight. Artillery unit behavior changed accordingly. Both sides entrenched, spread out their guns to wait in so-called cold points, and then drove out to a hot point to fire. Both sides became far less concerned with traditional counterbattery fire, instead parking their guns in protected anti-drone shelters.

Russian Force Structure Adaptation During Ukraine's Summer 2023 Offensive

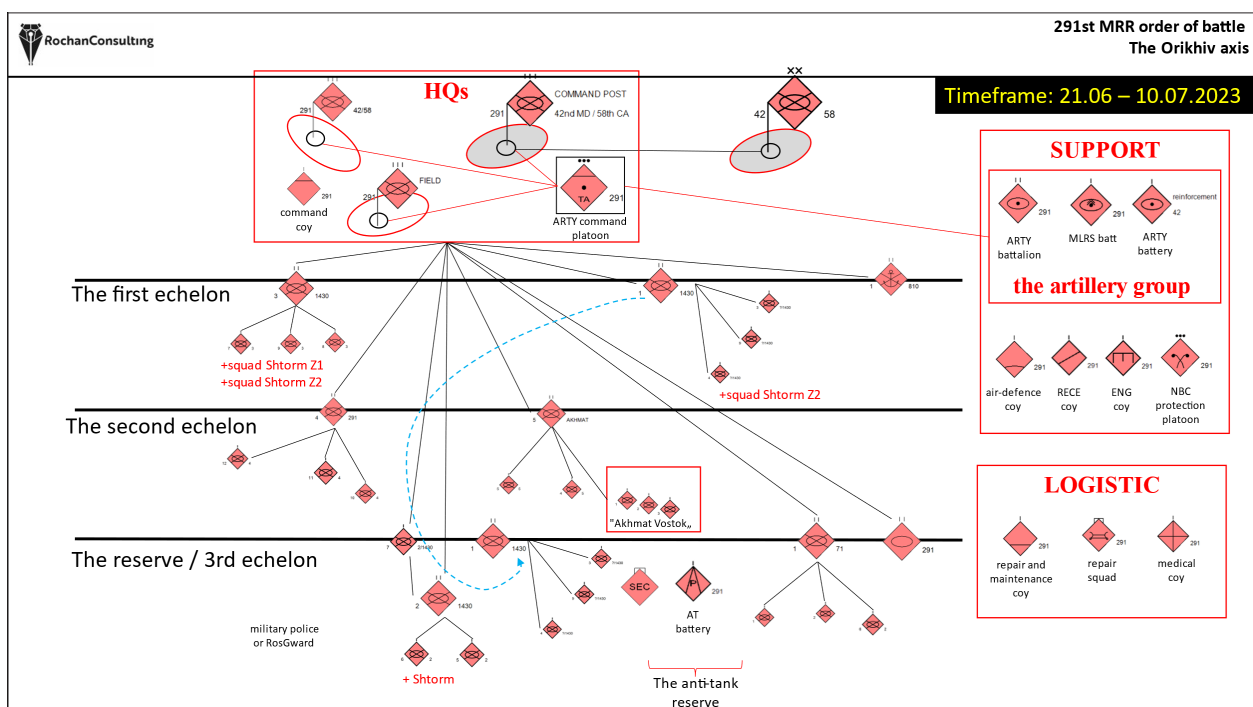
By the time Ukraine had launched its summer offensive, Russian force structure had evolved considerably following a period of mobilization and stabilization. Along the Tokmak axis, the Russian units holding positions included the 503rd Motor Rifle Regiment, the 291st Motorized Rifle Regiment, and the 71st Motor Rifle Regiment. Russia's 291st Motorized Rifle Regiment (42nd Division, 58th Combined Arms Army) defended a key part of the front south of Orikhiv that included the town of Robotyne.⁷⁰ They were supported by 70th MRR, and several territorial troops regiments 1429th, and 1430th. By late June, the 291st MRR was reinforced with a Storm detachment, two Storm-Z convict detachments, multiple companies and reconnaissance groups from the mobilized Territorial Troops' 1430th Motorized Rifle Regiment, a company from the 71st Motorized Rifle Regiment, an Akhmat motorized rifle battalion, and a battalion from the 810th Naval Infantry Brigade.

The regiment itself had been expanded. Russia added a fourth motorized rifle battalion to the regiment's table of organization, which lacked armored vehicles like the other battalions, to provide more infantry. Compared to its prewar structure of three motorized rifle battalions, the 291st defended with a force closer to the size of six or more infantry and motorized rifle battalions, plus a tank battalion and other supporting assets.⁷¹ Notably, the size of these infantry battalions had also increased back to 500 personnel from the prewar reduced formations.

The regiment defended with two echelons and a strong anti-tank reserve. In fall of 2022, the Russian military generated several dozen reserve anti-tank battalions which were deployed to reinforce these lines. The first echelon was held by two of its motorized rifle battalions reinforced with the less-well-equipped and -manned companies from the 1430th Motorized Rifle Regiment and several Storm-Z detachments, as well as a battalion from the more elite 810th Naval Infantry Brigade, which was

defending Robotyne. The second echelon was composed of two motorized rifle battalions, and the tank battalion was held in reserve. The regiment's other motorized rifle battalion was rotated to the rear to receive new equipment and personnel, and additional companies from the 1430th Motorized Rifle Regiment were used to replace losses in the first echelon. The presence of this regiment suggests that at this point Russian forces appeared comfortable deploying mobilized formations to undertake key defensive tasks along forward positions.⁷² Elements from the 22nd Spetsnaz Brigade were also operating along the regiment's front.

Figure 10: Order of Battle Showing 291st Motor Rifle Regiment and Attached Units at the Time of the Offensive

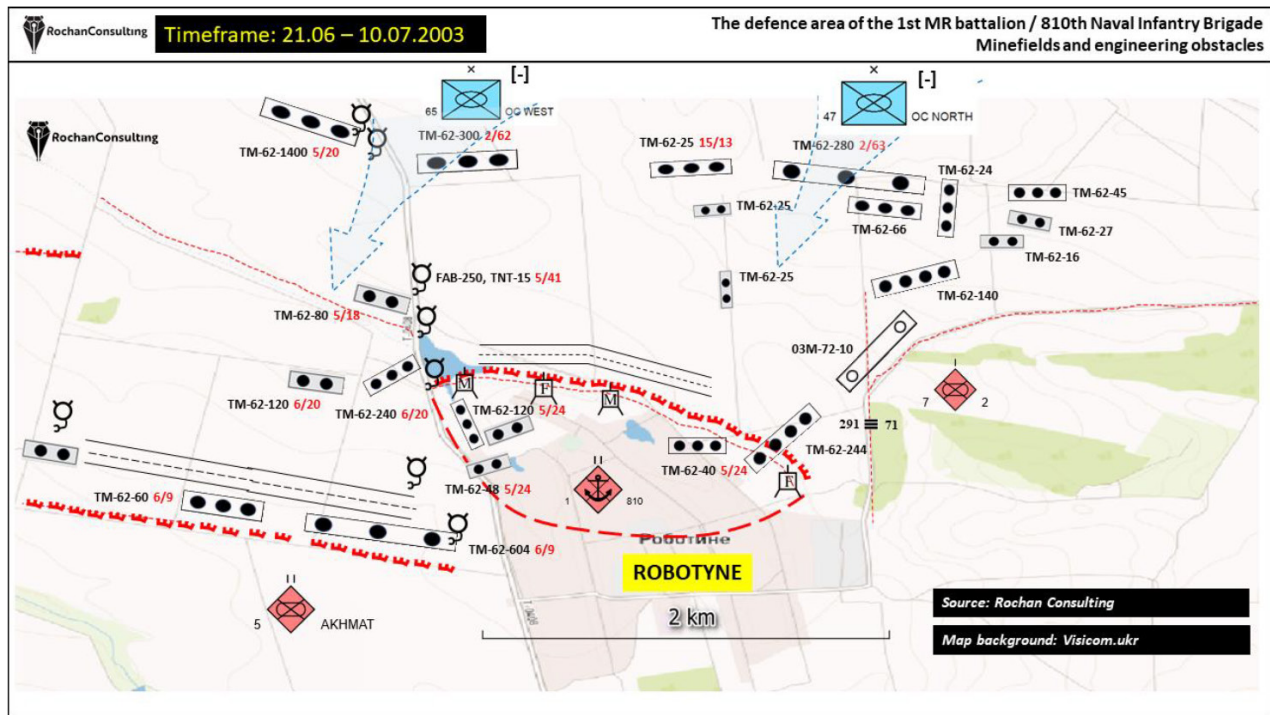


Source: Rochar Consulting.

Compared to Russian defenses earlier in the war, the 291st Motorized Rifle Regiment defended significantly less frontage, approximately 11 kilometers (6.8 miles) across and 16 kilometers (9.9 miles) in total depth. With additional reinforcements, it had sufficient forces to maintain a second echelon of defenses as well as a reserve. The width of the frontage covered by regiments was smaller than what existing Russian doctrinal norms dictate, which suggests the force density was intentionally increased in anticipation of the attack along this axis. The 291st could also afford to rotate

battalions when they sustained attrition, so the exact units and composition have varied over the past two months. Indeed, it appears the Russian military had decided to not rotate the regiments holding the front line but instead to rotate companies and battalions from other formations. This is true for both elite naval infantry units and the mobilized territorial troops regiments. The 291st regiment, along with its multitude of attachments, was situated behind well-fortified prepared positions, dense minefields, anti-tank ditches, and other obstacles.

Figure 11: Illustration of the Defense of Robotyne by 810th Naval Infantry Brigade Along With Defensive Fortifications and Minefields



Source: Rochan Consulting.

Over the course of its offensive, Ukraine eventually deployed its reserves—task force Marun, which consisted of several airmobile brigades. Having seen Ukraine’s reserves committed and the rest of its force engaged along the other two axes (Velika Novosilka and Bakhmut), Russian forces also deployed its reserves, namely elements from 7th Air Assault Division and 76th Air Assault Division. The 76th rotated in and began to take over defense at Verbove and south of Robotyne. Although Ukrainian forces eventually took the town, its offensive culminated without a major breach of the Russian lines further east or south. Ukrainian forces continued small unit attacks through

November, which were counterattacked by Russian airborne units that took on the role of quick reaction forces. Russian forces showed doctrinal flexibility at the tactical level, including better integration between combat arms and air support. However, their decision to prosecute an active defense with frequent counterattacks proved costly. The fairly narrow salient created by the Ukrainian advance did not prove vulnerable to counterattack either. Ukrainian forces continued to hold much of the terrain they initially took in the south well into 2024. The Russian military was better served establishing a fire cauldron, combining maneuver defense with positional defense, rather than seeking to regularly contest the initiative.

One of the glaring differences between Russia's failed winter offensive and its successful defense in the summer and fall was that in the winter the Russian military relied on a small slice of its force. The reservists it mobilized were not capable of offensive action, while the rest of the army was trying to recover and stabilize its front lines. In the conduct of defensive operations, the Russian military engaged its entire force. Units of different types were attached to regiments, with reservists participating. Support elements were better integrated, reserves established, and frontline units could be rotated because the force had been replenished by May-June of 2023. Russian forces also had substantially more time by that point to absorb mobilized personnel and cohere new units. When on offense, the Russian military struggled with scaling operations and combined arms integration. On defense, this was much less the case and only reemerged as a problem during counterattacks. Nonetheless, Ukraine was able to inflict significant losses on Russian forces and made good use of long-range precision fires against Russian artillery.

Limitations and Vulnerabilities

Ukraine effectively used Western provided long-range precision strike systems during the offensive. While the deep battle was insufficient to compensate for the lack of success in the close battle, precision strike did attrit the Russian defense over time. Ukraine employed large numbers of guided multiple launch rocket system (GMLRS) missiles in counterbattery fire and long-range air-launched cruise missiles against Russian command posts. Yet, by this stage, the Russian military had hardened many of its command posts, dispersed logistics, and relied significantly on trucking without large ammunition dumps near the front line. There were still some successes in striking Russian commanders, but nothing comparable to the impact when these types of capabilities were first introduced in 2022. Russian units had taken the time to wire communications, and the defensive network as a whole was far less vulnerable to Western precision-strike capabilities. Russian electronic warfare systems also proved increasingly effective against Western precision-guided munitions, significantly degrading their overall impact by this point in the war. For example, by August 2023, the observed effectiveness of Excalibur precision-guided artillery rounds was 6 percent.⁷³

Ukraine could not attain more than a two-to-one fires advantage over the course of the offensive, which proved to be notional parity. Ukrainian forces at the point of contact were qualitatively better, but small unit attacks could not generate larger effects. One lesson from this could be that Ukrainian forces simply did not mass, and their inability to scale offensive action was the core issue. While this is true, the combination of maneuver and positional defense offered by Russian forces, combined with force structure and doctrinal alterations, proved challenging. Ukraine also lacked the key enablers necessary to overcome defensive emplacements, including mine breaching equipment, mine clearing systems, support for electronic warfare capabilities, and short-range air defense. (Western militaries are likely to come up short in the same departments when looking at their force structures.) It is unclear if massing would have enabled Ukrainian forces to achieve a breakthrough or simply to breach Russian defensive lines with very high losses and still culminate well short of their objective.

Russian units that were defending, including forward positioned Storm-Z convict detachments, often held the line. Some Russian units fled during the initial attack, but this was not a widespread phenomenon. On balance, the Russian military's morale and staying power proved better than anticipated. This raises difficult questions about the presumed low morale at the time, which figured heavily into planning for the offensive. Maneuver did not induce shock, or the requisite cognitive effects to break the Russian force. The case reinforces the challenge of integrating intangibles, such as morale into assessments and plans, given observed effects are highly inconsistent. Some Russian units were defeated by smaller Ukrainian elements, some abandoned positions, and others held the line. Yet, in aggregate, the Russian military's morale held and was not a critical factor. What proved more important was the fact that Ukraine lacked a fires advantage, could not effectively scale force employment in offensive operations, and was not provided sufficient enablers to overcome a complex network of prepared defenses.

What may have transpired is that planners misinterpreted Ukraine's breakthrough at Kharkiv in September 2022, which occurred because of severe manpower shortages across Russian forces, and presumed that morale would be an important factor.⁷⁴ The Russian retreat at Kharkiv turned into a rout, but due to conditions established through high rates of attrition, structural manpower deficits, and an incohesive grouping of forces.⁷⁵ The situation south of Orikhiv and elsewhere along the front line in 2023 was almost completely the opposite of the conditions at Kharkiv in 2022. Russia had a high density of forces that were cohesively assembled and held well-defended terrain.⁷⁶ Ukrainian forces did not positively shape the conditions through attrition or effective employment of fires to attain shock and suppression. Coordination between fires and assaulting troops during the initial breaching operation was poor, with some formations moving forward hours behind the sequencing in the plan. The qualitative advantage derived from Western long-range precision capabilities was insufficient to prove decisive and could not establish fire control, even within a few kilometers of the

front line. There was also no element of surprise, given the assault and likely vectors were telegraphed in advance. The overall result should prove sobering for advocates of decisive cognitive effects attained by successful maneuver in the context of a prepared defense.

Postscript: The Russian Offensive in Avdiivka

Before Ukraine's 2023 offensive ended, Russia launched its own offensive operation on October 10, in and around Avdiivka, a city in Donetsk. Avdiivka had long been held by Ukrainian forces, with well-established forward defenses. However, the city was in a salient, with Russian lines stretching around it, making it a likely target for an envelopment by pressuring the flanks. It also lay along a route towards the transit hub of Pokrovsk. Russian forces launched a large-scale mechanized assault in an effort to break through the flanks of the city in October 2023. The attack involved multiple reinforced companies, employing what were essentially battalion sized formations. An offensive effort of that scale had not been attempted by Russian forces since spring 2022.

The initial assault made gains but failed to achieve a breakthrough, leading to several months of fighting, and an eventual Russian success in taking Avdiivka by February 2024. However, the Russian military paid a high price in losses of armored fighting vehicles equivalent to more than one combined army. The battle for Avdiivka demonstrated that Russian forces could, over time, restore the ability to conduct offensive operations at scale but all the same lacked the ability to convert those advantages into successful breakthroughs. This was in large part due to a deficit of means to overcome minefields and a lack of counters to Ukraine's UAS. It is quite possible that the failure to breakthrough at Avdiivka, and the high price paid over those months of fighting, drove Russian forces to focus more and more on small-scale unit tactics as a way of mitigating costs. The force itself appeared more capable of larger operations by fall of 2023, but it lacked answers to the same challenges Ukrainian units faced over the course of the summer. Fielding larger formations resulted in higher losses, but not significantly greater gains. The rate of attrition was arguably too costly to sustain, and in the absence of a better warfighting concept, Avdiivka only reinforced the overall trend in 2023. This saw Russian forces keep assaults largely at the assault group/detachment level with occasional attacks by mechanized company sized formations.

Russian fires advantage was not sufficient to prove decisive, despite the added firepower provided by standoff aerial strikes. Russian tactical aviation conducted intense bombardments of Ukrainian positions with glide bombs in the city, and its large industrial zone. These had a suppressive effect, negatively impacting morale. Yet the glide bomb strikes remained inaccurate forms of bombardment and were not well integrated into ground operations. This was not a form of close air support. Over time Russian airstrikes would become more accurate, and effective, but by themselves they did not offer a decisive advantage.

The situation in Avdiivka had temporarily stabilized in December 2023, before Russian forces continued to press in and make gains over the course of January, eventually forcing a Ukrainian withdrawal in mid-February. A shortage of combat capable infantry, combined with shell hunger, and an inability to counter Russian air strikes ultimately forced Ukrainian units to retreat. The primary issue for Ukraine was insufficient manpower, forcing a variegated grouping of forces to defend the sector alongside the 110th Mechanized Brigade. It was common practice for the Ukrainian Armed Forces to redeploy more capable brigades or a few battalions from them to firefight a deteriorating situation. In this case the reinforcements included the 47th Mechanized Brigade, which was pulled out from Orikhiv, along with elements of 3rd Assault Brigade which was reconstituting after fighting at Bakhmut. In addition, Ukraine deployed special forces units and some of the more elite UAS formations to stem the Russian assault. Yet over time the Russian attacks wore down the defending grouping of forces, eventually breaking through in the eastern part of the city and threatening to sever Ukrainian units holding the southernmost positions. Capturing Avdiivka proved a costly victory for the Russian army and, if anything, demonstrated that given Russia's ambitious war aims, the military could not afford equipment losses of that size for a single battle over a city in Donetsk.

Tactical Adaptation and Innovation: Uncrewed Systems and Electronic Warfare

This section focuses on the evolution in Russian employment of uncrewed systems of various types and electronic warfare systems.⁷⁷ Both represent areas of innovation that were mentioned, but not covered extensively in the preceding discussion on tactical adaptation and force structure. They are also interrelated because electronic warfare systems were one of the principal counters developed to address the proliferation of uncrewed systems on the battlefield.

Russian forces spent years developing uncrewed aerial systems (UAS), along with tactics, techniques, and procedures for their employment. These were first used in a rudimentary fashion during conflicts in the preceding decade, such as the Russia-Georgia War of 2008, and then more visibly in support of artillery units during the 2014 Russian invasion of Ukraine. Russian forces employed uncrewed systems much more extensively during the intervention in Syria in 2015. Over the course of Russian operations in Syria, which continue to present day, Russian forces steadily matured the employment of UAS for intelligence, surveillance, and reconnaissance purposes (ISR). Many of the systems initially used then to support Russian air operations were license production Israeli variants. These were contexts in which drones were used in support of relatively small-scale operations and under permissive environments. Opponents did not have capable counter-UAS capabilities, or electronic warfare systems. The Russian military also followed closely the decisive role that Turkish and Israeli drones played in the Nagorno-Karabakh war of 2020.

Prior to the full-scale invasion of Ukraine, Russian military officials emphasized the necessity of procuring and integrating UAS.⁷⁸ Russian force structure changed to accommodate drone companies, and the use of drones grew across Russian exercises. These systems were seen as the central reconnaissance component of the aforementioned reconnaissance strike and reconnaissance fire complexes. However, in the early days of the 2022 invasion, Russian armed forces did not employ these systems effectively. Russian units attempted a lightning advance without supporting components deployed or fires organized. Many were in the rear of stretched out Russian columns, which were sticking to roads. This resulted in a poor situational awareness among Russian forces, particularly at lower command levels.⁷⁹ Initially, Russian forces had limited quantities of reconnaissance systems and only a handful of medium endurance strike drones, such as the Orion UAS.⁸⁰

The Orlan uncrewed aerial system, the so-called workhorse of the Russian military, was described as one of the most valuable sensors in the Russian reconnaissance system.⁸¹ But the system was not well integrated. Data transfer depended on the availability of other systems, such as Strelets, and proper training.⁸² The Orlan was intended to be used for target identification, laser guidance for precision-guided munitions, and electronic warfare applications.⁸³ Yet, Russian forces struggled to engage in dynamic targeting and effective employment of drones, compared to the organic proliferation of commercially available systems across the Ukrainian military. This gave Ukraine a decisive advantage early on as it engaged in bottom-up adaptation and rapidly adopted commercially available UAS for intelligence, surveillance, and reconnaissance purposes. Within a few months, Russian forces began to adopt Ukrainian approaches, procuring commercially available systems and pursuing similar tactics.⁸⁴ Russian units also turned to informal assistance networks, seeking drone contributions from volunteers and allowing citizens to procure drones for military units.⁸⁵ Commercial drones supported combat operations by providing real time reconnaissance of one's own and the opponent's positions, and they acted as cheap strike systems capable of carrying mortars or grenades.⁸⁶

The Proliferation of Drones

Over the course of 2022, several cycles of adaptation led to the proliferation of UAS across the Russian military, the widespread use of commercial systems for reconnaissance and strike purposes, and the greater integration and experience of operating them in contested environments. Ukraine often led in terms of battlefield innovation, leveraging civilian developed software, hardware, and tactics, but the Russian military copied successful tactics and expanded their use across the front line fairly quickly. Russia was advantaged in cheap, but effective military UAS systems that had greater endurance, like the Orlan. These it had in larger numbers compared to Ukraine's military and production increased after 2022. Russia also invested heavily in remotely operated strike munitions, such as the Lancet, which would evolve to become an effective counter-battery system on the battlefield.

Overall, Ukraine was better at innovation across a fragmented defense sector comprised of many small companies, entrepreneurs, and civil society innovators. They quickly generated solutions which could be adopted by parts of the force. The most innovative UAS strike units were started by entrepreneurs, run by volunteers, and only later integrated into regular Ukrainian military structures. Many developed their own drones, munitions, and systems specialized to their needs. Conversely, Russia's state dominated enterprise, and more centralized decisionmaking could rapidly scale production once they chose which types of UAS or strike munitions to invest in. Russia's defense sector could also iterate over the course of several months, producing newer versions of strike drones, or one-way attack munitions. Both Russia and Ukraine benefited heavily from being able to import Chinese commercial UAS, but most importantly large volumes of cheap Chinese components that could be used to quickly produce new types of UAS or EW systems.

Over the course of 2022–2023, Russia fielded Chinese-made commercially available drones same as those employed by Ukrainian forces. These included DJI's Mavic, Matrice, and Autel quadcopter UAS. Orlan-10 and Orlan-30 variants became the workforce of the Russian fleet, alongside the Zala 421-16 and the Supercam UAS. These medium endurance UAS proved a significant challenge for the Ukrainian military.⁸⁷ Orlan variants operate at higher altitudes, often beyond the range of many electronic warfare systems, while older air defense systems are not optimized to counter them. These types of drones are also less susceptible to man-portable air defense systems (MANPADS) and are often cheap enough to make engagement cost prohibitive over time. They are slow moving, and produce a weak heat signature, such that legacy MANPADS miss at a higher rate.

Still, shooting down UAS was common in 2022, but in 2023, the Ukrainian military's greater scarcity of air defense ammunition began to intersect with the Russian military's higher availability of UAS platforms. This created a dilemma for Ukrainian forces: should they permit persistent intelligence, surveillance, and reconnaissance to the enemy, or expend air defense munitions and shoot the system down, knowing it would be replaced in a matter of minutes? The inevitable result was that Russian Orlan or Supercam began to operate over Ukrainian front lines, offering persistent visual coverage at 50-100 kilometers depth from the front.

One of the roles UAS took over relatively quickly in the Russian armed forces was that of counter-battery fire. Russian artillery using unguided munitions had not proven to be particularly effective in a counterbattery role throughout most of the war. Ukraine targeted Russian counter-battery radars to further reduce effectiveness, especially during offensive operations in 2023. By mid-2023, the primary threat to Ukrainian artillery was from Lancet loitering munitions. At the beginning of its full-scale invasion, Russia possessed a small amount of these munitions. But, over time, the Russian government significantly scaled up Lancet production. As a result, many Russian units have Lancet support. They have proven difficult to counter given the high rate of production, relative ease of use, and effectiveness. Visual evidence of Lancet strikes grew significantly from 2022 to 2023, suggesting a many fold increase as the system became commonplace along the front line.⁸⁸ Alongside the

Lancet, Orlan-30s were commonly used with laser designation to target for Krasnopol-M artillery rounds. Krasnopol-M proved effective against positions designed to stop Lancets and other types of strike UAS.

The Lancet has evolved over the course of the war, with new variants such as Izdeliye 53 and 55 deployed, extending the weapon's range. There are isolated cases of Lancet munitions striking targets to a depth of 80 kilometers. Lancets operate as part of a reconnaissance strike system that relies on other less specialized drones for target identification, typically Orlan-10 or Supercam UAS. Once a target is located, a Zala 416-16 UAS is deployed to provide targeting guidance for the Lancet operator. These systems are not easily targeted because of their high mobility and low-profile setup. Lancet and Zala UAS are launched employing catapults, towed by light utility vehicles. Occasionally Ukrainian forces have been able to strike these units while deployed, but they have to be located in the open well behind the front line.

The most common counter to Lancet systems is a combination of metal screens welded onto vehicles and large anti-drone nets covering artillery shelters. By 2023, Ukraine had housed most artillery systems in a camouflaged shelter with layers of anti-drone nets. Another approach is to set up realistic decoys to fool the reconnaissance drone operator into believing they have detected a high-value target. Compared to other systems, the Lancet is much more resistant to electronic warfare, although the command signal from the other UAS in its kill-chain can be detected, providing some warning that it is inbound.

Adoption of First-Person View Strike Drones

Following Ukrainian success in employing first-person view (FPV) UAS in late 2022 and early 2023, Russian forces also began to adopt them. Russia used them sporadically during the Ukrainian offensive in early summer of 2023 but not decisively. Their use increased over the course of three months, and by the end of the Ukrainian offensive, they became one of the principal factors on the battlefield denying mobility typically to a depth of 5–10 kilometers. This necessitated Ukrainian forces to



Example of a Ukrainian Panzerhaubitze 2000 self-propelled artillery piece parked in anti-drone shelter. (November 2023. Orikhiv-Tokmak direction.)

resupply at night, with units moving to their positions typically on foot and in small groups by day. It also hampered Ukrainian mine clearing efforts, since sappers could become priority targets. Mine clearing had to be done by smaller groups, and often at night, to avoid the threat of FPV strikes.

By mid-2023, FPVs had emerged as indispensable assets in the arsenals of both Ukrainian and Russian military forces, significantly enhancing both offensive and defensive operations. They provided greater flexibility for smaller units, such as squads, platoons, or companies on the tactical level. Initially, this referred to quadcopters which were primarily engaged in reconnaissance, and artillery fire adjustment. Later, the term “FPV” became associated with racing drones, that were operated by pilot worn helmets. These drones were equipped with explosive charges, and rudimentary fuses, flown directly into targets at high speed. Both suicide drones and reconnaissance quadcopters became essential battlefield tools.

The initial adoption of FPVs happened rather organically. It took time for these drones to be prioritized for scaled up industrial production in the summer of 2023. An official guide designed for Russian troops defines FPV drones as tools that enhance the capabilities of units in targeting enemy personnel, vehicles, and other objects, as well as providing situational awareness for commanders and management bodies during combat actions.⁸⁹ Russian forces emphasized that the compact geometrical dimensions of FPVs, low thermal contrast, and high flight speed distinguish small-sized UAS. Their economical cost and diminutive size make these types of UAS challenging targets for conventional anti-aircraft systems.

Below is the fairly broad list of roles that the Russian military defines for FPVs.⁹⁰

- Reconnaissance: Detecting and surveilling enemy objects, tracking routes of enemy personnel and vehicles, and identifying evacuation and rotation points.
- Artillery fire correction: Adjusting artillery fire during combat.
- Direct fire engagement: Targeting both stationary and moving personnel and providing fire support for advancing and defending forces.
- Airborne engagement: Intercepting enemy drones.
- Demonstrative and misleading actions: Confusing the enemy about true intentions or to deter specific enemy behaviors.
- Remote mining: Deploying mines.

FPV drones are quite cheap and easy to make. But they are also vulnerable to jamming and frequency interference from other drones and are heavily dependent on pilot skill. As will be discussed in the next section, Russian units became proficient at detecting the command signal frequency of opposing FPVs and tuning electronic warfare systems to jam that spectrum. FPVs also interfere with each other and can cross video feeds with opposing FPVs in close vicinity, making massed employment impossible in any short radius. The standard lightweight FPV can only carry payloads weighing 2 to 5 pounds (0.9 to 2.3 kilograms). The operator has to attach the payload, and fuse the munition, which is quite dangerous. Payloads themselves were typically improvised in 2023 (lightened rocket propelled grenades, fragmentation, or thermite munitions) although both Russia and Ukraine have shifted to specialized payload production for FPV strike drones. FPVs have evolved since 2023, with improved performance, and more standardized munitions.

Specialized Applications

Another commonly used tactic that became widespread in 2023 was Russia's deployment of drone-dropped gas canisters. The tactic involved artillery or mortar fire on positions, forcing defenders to take cover. Once defenders were concealed in confined spaces, Russian forces deployed two drones: one with a payload containing an explosive device and the other with an aerosol grenade K-51 containing tear gas. Drone operators would try to drop the grenade at the entrance to the shelter, with the goal of using gas to induce panic among the defenders and force them out of cover. Once this occurred, they were targeted by drones with explosive payloads, FPV drones, or other means of attack.

Beyond their application in strike reconnaissance and strike roles, UAS have been increasingly used to drop mines. These include the scatterable PTM-3 anti-tank and POM-2 and POM-3 anti-personnel mines. In this manner, drones have been used to compensate for a lack of scatterable mines that can be deployed with artillery or multiple launch rocket systems. Russian engineers also used UAS, including FPVs, to emplace mines, including POM and PMN-4 anti-personnel mines and heavier PTM-3 and PTM-4 anti-tank mines. Ukrainian drone units have also proven adept at mine laying using UAS. These were employed widely in defense of the marine lodgment held at Krynky in the fall and winter of 2023.

These types of UAS offset artillery ammunition requirements for both sides and proved particularly useful in the support of defensive operations, but they were not a serviceable replacement for artillery or other major weapon systems. By late 2023, Russian forces had reestablished superiority in fires. They increased production of FPVs to establish a degree of quantitative superiority in strike drones as well, pursuing both rather than treating one as a ready substitute for the other. The Russian rate of artillery fire grew as munitions became more available; at the same time, the number of Russian drone strikes reported by Ukrainian forces also increased significantly.⁹¹ Ukraine's success was in

large part due to integration of UAS into its military ecosystem by leveraging commercial technology, and indigenously developed software applications. These applications offered web-based interfaces for units to monitor drone feeds. Starlink terminals provided connectivity, which enabled Ukraine to integrate forward deployed UAS operators, with command posts, and supporting units in real time.

However, in 2023 Russia was overall better at scaling production and distributing FPV drones in large numbers to its units across the front. That assessment should be caveated when it comes to FPVs, because in late-2023 Ukraine ramped up its own production, attaining relative parity in 2024. It is perhaps more accurate to say that the Russian defense industry was better able to scale specific systems, like the Lancet, or longer-range reconnaissance UAS. Both sides relied on components from China in the assembly of FPVs, but Russia's defense industry was able to import these more easily. The overall Russian advantage in medium-endurance drones became significant in the latter part of 2023, and early 2024, leading to improvements in dynamic targeting behind the front line. The ability to conduct persistent surveillance behind the front line aligned with growing organizational capacity and experience in the Russian armed forces, which in turn enabled them to improve the effectiveness of reconnaissance strike and reconnaissance fire contours.

Russian Force Structure Adaptations

Prior to the war, UAS companies multiplied across the Russian armed forces, with one allocated per brigade. There were several thousand UAS systems in the overall force.⁹² This figure may seem impressive, but compared to loss rates in 2022, the number of UAS initially available was relatively paltry. Between 2014 and 2022, the Russian military added UAS squads, platoons, and companies to extant force structure. This was a process born of experimentation with how best to organize UAS units. In 2023, the Russian military further evolved this force structure to accommodate a greater role for UAS related missions and tasks. UAS are more force structure intensive than may appear, with several personnel required for a FPV section, more to pilot the signal retransmitting drone, others for reconnaissance UAS, and so on. For strike UAS, a pilot, copilot, technician and weapons specialist may be required. For example, new reinforced assault motorized rifle battalions formed in some brigades had an organic UAS platoon with twelve soldiers. This included a reconnaissance UAS team and an FPV squad. FPVs were also organically integrated into the UAS companies at the brigade level.⁹³ Specialized UAS units saw expanded use, including various types of irregular formations such as the Pavel Sudoplatov battalion. This approach mirrored the Ukrainian experience, expanding existing drone platoons and companies to accompany FPV squads, and developing specialized UAS units that could deploy to different parts of the front.

Given the diversity within Russian forces deployed in 2023, there was unlikely to be a standardized structure for UAS units, though this will likely emerge after the war. Volunteer units had greater

freedom to experiment and access to informal assistance networks. Although this applies more to post-2023 developments, the Russian Ministry of Defense has been experimenting with new types of formations.⁹⁴ Russia also began forming larger UAS formations, such as regiments, likely as future army or division-level assets. These regiments are slated to have four strike or reconnaissance-strike UAS battalions.⁹⁵ The trajectory appears to be to create formations that give army commanders sizable UAS assets that can then be distributed in support of tactical formations, and higher level ISR capabilities to support strikes at more operational depths. These are likely to be paired with observable delegation of long-range strike capabilities, making them accessible to lower echelons, such as Iskander-M short range ballistic missile units. The driving constraint on Russia establishing more UAS units could be the training pipeline.

In examining technological innovation, tactical adaptation, and force structure changes, it is clear that UAS have entrenched themselves within the Russian military and are one of the critical factors enabling the way it fights. However, the context in which UAS emerged and came to prominence on the battlefield has been one where maneuver was heavily constrained, with front lines largely static over the course of 2023. Both sides were already struggling to mass combat power, and employ forces at scale, prior to the spread of tactical strike drones. This made strike drones much more effective in denying maneuver to the relatively small detachments conducting assaults. Furthermore, fighting had become static and routinized, enabling FPV teams and reconnaissance units to defend or attack much more easily.

Despite the lengthy front line spanning over 1,000 kilometers (620 miles), fighting typically occurred in only a few sectors at a time. This meant that specialized drone units could firefight, deploying where they most needed to counter advances. Skill and proficiency in employment of UAS was a major differentiator in 2023, with some units pursuing a more systematized way of fighting, integrating UAS with electronic warfare, and other capabilities. These more elite formations were not representative of the whole and, as is often the case, their approach proved difficult to scale across a variegated force. Hence there was a considerable range in performance of UAS units depending on the level of training, funding, technical sophistication, and experience. These considerations are useful in evaluating whether these types of UAS, or the tactics as seen in 2023, would play the same role in a different war. Would they prove as relevant during the initial period of a future war, where maneuver formations operate more freely in the absence of prepared defenses and forces are employed on a much larger scale? Could assaulting formations be effectively protected from these types of systems, overrunning defenses and forcing drone teams to displace? Will future counter-UAS capabilities include offensive reconnaissance-strike means that can detect and engage emitting drone units? Will different classes of UAS to some extent counter themselves? For example, FPVs are increasingly used as interceptors to counter multi-rotor drones, and larger winged ISR platforms. These questions are worth considering in evaluating the potential impact of UAS, both their advantages and limitations, under different future contexts.

Evolution of Electronic Warfare on the Battlefield

Electronic warfare (EW) was a priority for the Russian armed forces well before the war, with numerous capabilities already deployed. In addition, electronic warfare troops within the Russian military and various electronic warfare units were already formed, such as EW battalions in combined arms armies and EW companies in divisions.⁹⁶ These capabilities were distributed across maneuver formations, within specialized EW brigades that were allocated per military districts, in fleets, and EW units in the Russian Aerospace Forces. EW has quickly evolved in this war, partly in response to the widespread use of UAS, which led to a multitude of counter-UAS technologies (C-UAS). As is often the case when new capabilities are deployed, they drive cycles of adaptation and new counters. UAS and EW have therefore coevolved on the battlefield in a sustained contest against each other. Russian EW systems are now smaller and more capable than in the past, with defensive modules for vehicles, trench EW units for individual soldiers, and hand-held EW systems to counter FPV drones or detect them on approach. Both Russia and Ukraine became more adept in integrating EW into the fight, employing systems to intercept drone signals and communications, improving their ability to triangulate emissions, and leveraging EW in fire support roles.

Early on, Russia's inability to fully utilize EW systems, which had been originally seen as a major advantage of the Russian military, matched the lackluster performance of its drone units. Much of this can be tied to the nature of the initial Russian operation, where units did not deploy as combined arms formations, but rather raced in an almost administrative fashion to seize key junctions and blockade cities.



but rather raced in an almost administrative fashion to seize key junctions and blockade cities. In those early weeks, Russian forces had not coordinated and deconflicted operations across the force, leading to a myriad of problems between communications units, EW units, air defense, tactical aviation, and others. However, in contrast to UAS for reconnaissance purposes, Russian forces did employ EW extensively to suppress Ukrainian air defense systems.⁹⁷ In subsequent months, Russian forces actively increased the use and effectiveness of their EW capabilities.⁹⁸ They employed systems like Krasukha to counter Ukrainian aircraft and UAVs,⁹⁹ Zhitel variants to interfere with satellite communication,

A Bradley Infantry Fighting Vehicle, which had withstood multiple FPV and Lancet strike munition hits over the course of the war (47th Separate Mechanized Brigade, outside Pokrovsk, June 2024).

GPS navigation, and telephone networks,¹⁰⁰ and Leer-3 systems to intercept GSM signals and locate enemy combatants.

The early part of the war also saw a great deal of EW fratricide among Russian units, which affected everything from communications to weapons performance. Aircraft struggled with interference from their defensive electronic counter measures in their wingtip pods. EW units jamming was particularly disruptive to communications, given many units had to switch to unencrypted radios early on due to an inability to make encrypted communications work across a variegated force. The Russian military struggled to employ EW effectively because of these issues, a failure to properly deconflict operations, and the added complexity of having numerous auxiliary forces involved in the operation who themselves were not interoperable with the regular army.

As a general trend, EW has since become distributed across the front line. These capabilities are less tied to vehicles or larger platforms, becoming smaller, cheaper, and more expendable like the UAS. Before the war, Russian EW systems were largely modernized versions of late-1980s Soviet equipment that employed tracked or wheeled vehicles. Emitters were tied to larger platforms, such as the Zhitel R330-Zh. Russian Zhitel systems proved effective, operating up to 30 kilometers (19 miles). They successfully disrupted GPS-guided munitions and impacted the accuracy of GMLRS Excalibur rounds, and joint direct attack munitions (JDAM).¹⁰¹ At the same time, over the course of 2022 and 2023, Russian forces lost at least twenty systems from the Zhitel family of EW, equivalent to the potential of several EW companies. Around fifteen of these were destroyed either in 2023 or early 2024, usually within 10 to 30 kilometers of the front line. Given the vulnerability of such systems to precision strikes and their visibility on the battlefield, Russian forces shifted to lighter platforms and dismounted the antenna from their vehicles.¹⁰² This exposed the antenna but not the platform itself. Pole-21 emerged as one of the best performing Russian electronic countermeasure systems, often deployed with the antenna detached, rather than being mounted on its large parent platform.

This evolution of EW was a logical response to the expansion of UAS in reconnaissance and strike roles. To counter the drone threat, Russian forces established multiple layers of defense. Within 1 kilometer from the front line, observation posts equipped with visual and radio detection tools, including small EW devices (anti-drone guns, Groza 04, and drone suppressor Harpy), were deployed to detect and notify forces of enemy drone usage and destroy enemy drones. Infantry units along the front line also used portable trench EW systems, which provide limited coverage within a few dozen meters. About 1–3 kilometers from the front line, battalion-level stationary radio interference posts equipped with small EW tools (Silok and Groza 04) were used to detect and disrupt enemy drones using radio frequencies. EW systems have also proven effective in detecting and locating transmissions from communication systems, particularly those provided to Ukraine by the West, like L3 Harris radios.¹⁰³ Approximately 3–5 kilometers from the front line, Russian mobile anti-drone posts equipped with visual and radio detection tools, EW systems, and firearms were positioned along

main drone flight routes to detect and notify forces of enemy drone usage and disrupt enemy drone radio signals. During assault operations, a mobile EW group could be deployed to cover assault groups by advancing to the deployment line and activating an EW system. This then created a small area of defensive EW coverage to protect the advancing formation from enemy FPV drones.

In 2023, there was a surge in Russian EW systems dedicated to countering UAVs, such as Repellent and Shipovnik-Aero. Portable systems such as the LPD-801 were extensively deployed to lower-level echelons, saturating the battlefield with EW equipment.¹⁰⁴ According to the London-based Royal United Services Institute, such or similar systems reached the majority of Russian platoons.¹⁰⁵ They were also prominently used in support of defensive operations during the Ukrainian offensive.¹⁰⁶ The effectiveness of Russian EW systems varied depending on where the systems were used. For instance, in open terrain, the Kupol-PRO EW system—used to interfere with the UAS navigation, control, and data link channels—proved effective in Zaporizhzhia Oblast, resulting in fewer FPV strikes on vehicles carrying the system. Meanwhile, near the Kreminna forest in Luhansk, Ukrainian FPV drones managed to hit protected vehicles on numerous occasions.¹⁰⁷ Terrain affects UAS and EW employment alike: In forests or areas with more complex topography, FPV drones are restricted by signal strength and lack of propagation beyond lines of sight. Similarly, EW systems can prove less effective depending on where they are employed.

In 2023, Russia used EW systems extensively to support strikes. For example, the Leer-3 UAS-based electronic warfare system was regularly employed to detect cellphone signals, after which Russian forces would call in air support to drop UMPK glide bombs. The targeting cycle with EW systems is usually much longer than with visual forms of detection, but it nonetheless poses a significant risk to troops on the battlefield, especially if they are clustered near the front line and emitting. The net effect is a perpetual state of awareness required near and behind the front line that emissions from communications systems and personal devices can lead to strikes.

EW systems themselves are a high-priority target, and their emissions can be detected by the other side. That means that many EW systems cannot always remain on, and they need to change positions multiple times per day. Battery power also limits how often trench EW systems can be used unless they are supported by a generator; in that case, the limiting factor becomes fuel. This puts a premium on systems that can detect inbound FPVs and other UAS first, which can buy time for infantry to turn on their counter-UAS systems. Identifying which frequencies the enemy's UAS use is also a priority. By late 2023, Russian forces became adept at detecting the inbound frequency of FPVs, quickly changing their EW systems to that frequency and blocking it across an area. Another approach was to detect the exact source of the signal and turn high-power directional jammers across multiple frequencies to it.¹⁰⁸ This placed a premium on radio-electronic forms of reconnaissance, being able to detect, and intercept incoming drone command signals and the typically unencrypted video feed being sent back to the operator (in commercial UAS, like FPV drones).

By 2023, Russian forces became much better in deconflicting operations at the tactical level with the use of EW. For example, they would drop EW suppression to enable the use of attack helicopters or specific type of munitions, such as Lancets. Hence, a fair degree of the adaptation in Russia's employment of EW did not come from technological developments but from better integration, and experience with force employment. Prior to the war, Russian forces had only operated such systems during exercises and in permissive environments such as the Donbas and Syria. They lacked the organizational capacity, experience, and skills necessary to operate them on a broad front and deconflict operations with the rest of the force. The relatively poor performance demonstrated by Russian precision-strike capabilities in the early period of the war, which had notably improved by 2023, was partly due to successful Ukrainian employment of EW in defense as well as the unmitigated EW fratricide among Russian forces.

There was also a shift in the general modality of EW employment. Russian and Ukrainian troops typically tried to keep interference to a narrow band of frequencies sufficient to disrupt the opponent's operations, rather than jamming all frequencies possible across a wide area. Both sides focused on targeted or directed effects where possible, as opposed to area-wide impact that would affect their own operations. With EW systems becoming smaller and more personalized, the range of effect shrunk significantly, allowing troops to employ them at will without disrupting other systems. Trench EW units offered coverage for no more than a few hundred meters. They are also cheap. While FPVs may cost \$400–500 per drone, the trench EW systems that counter them are also relatively cheap, costing less than \$2,000 to build or purchase. Keeping in mind that FPVs are one-way attack UAS, intended to be lost in large numbers, whereas the EW systems that counter them are inherently reusable. These developments continued to drive innovation on the UAS side of the equation. As EW systems prove adept at disrupting UAS, Russian forces increasingly experimented with FPVs that can change preset frequencies in midflight as well as artificial intelligence (AI)-based terminal guidance.

Russian EW systems have proven effective against Western-provided precision-guided munitions, including artillery rounds and GMLRS missiles fired by HIMARS rocket launchers.¹⁰⁹ Over time, these EW systems' deviation increased significantly, and some munitions proved sensitive in their fusing functions. They were less effective against air-dropped munitions, such as JDAM and the Small Diameter Bomb; however, that assessment is based on the situation in 2023.¹¹⁰ Notably, when the Ground Launched Small Diameter Bomb was introduced in the winter of 2023, its impact proved lackluster, most likely because by this point Russian EW was already sufficiently adapted to GMLRS. Russian EW also had success interfering with Ukrainian counterbattery radar systems that were provided by Western countries. That said, adversary EW is commonly used on the battlefield as the presumptive culprit when there are other issues at play, such as the role of friendly EW, and weaponizing errors. The effect of Russian EW in specific cases may be overstated.

Ultimately, these findings should not be unexpected. Precision-strike systems were effective when first introduced at scale, but their effectiveness eventually degraded—steeply in some cases, but over the span of many months. Therefore, the degradation should not be overstated, but the overall pattern suggests that Western capabilities are likely to prove effective in the initial period when they are introduced, and much depends on whether a force can exploit this advantage during that time period. This suggests that sometimes it is better to introduce a capability when the force is in a position to exploit it, rather than when it is developed and available in small amounts. The latter approach simply gives the opponent time to adapt and develop counters before the systems are available in sufficient scale to make a meaningful impact.

Russian forces began widespread use in 2023 of vehicle-mounted counter-UAS jammers, such as the Volnoretz, the Saniya, and the RP-377 Lesochek.¹¹¹ These were employed to shield the vehicles from FPVs as they were often mounted with counter-UAS screens and other forms of passive protection.¹¹² Consequently, active protection EW systems became widespread and were increasingly observed on Russian vehicles, particularly those involved in breaching or assault operations. Although FPVs retained their utility, EW-equipped vehicles would sometimes have to be struck by another weapon before FPVs could engage it. This has driven investment in technologies that overcome EW protection modules, including home-on-jam guidance for UAS and AI-based terminal guidance that does not require the operator to maintain a video link with the system. (As a caveat, this paper was written when software- and hardware-based countermeasures to the aforementioned EW counters were being developed, and it remains unclear what UAS-EW interactions will look like in late 2024 and in 2025.)

In the second year of the war, Russian forces made notable adjustments to how they employed UAS and EW systems by adopting new technology, changing tactics, and improving force employment. Specialized units spread across the force, as UAS became one of the primary tools on the battlefield, employed for offensive and defensive purposes. In general, Russian forces were reactive in adaptation of smaller UAS systems and tactics but benefited from a better defense-industrial base than Ukraine that could scale solutions relatively quickly. When systems performed well, such as the Lancet, the Russian military began to invest significant resources into their production and evolve new variants to counter defenses. EW systems followed a similar process. Despite Russia's reputation for centrally directed decisionmaking and vertical integration in the defense-industrial complex, the evolution of these systems appeared to be more organic. In interviews, Ukrainian colleagues frequently described the EW landscape as a "jungle" where new systems or tactics emerged quickly.

Despite the attention garnered, UAS systems did not displace or replace major legacy conventional weapon systems. They proved important as complementary capabilities, and enablers for offensive and defensive operations. Yet, the Russian military has not shifted from a fires-driven and destruction-centered approach. Despite tactical innovation, adopting new EW and UAS systems, the

Russian military struggled to overcome prepared defense or conduct offensive action above company level. The proliferation of UAS only made the battlefield more static, enhancing the defense, and reducing the capacity of opposing forces to maneuver. These systems exacerbated traditional challenges posed by mine fields, trenches, bunkers, ditches, and other types of defenses. Hence the Russian military focused on specializing in employing small packets of combat power, essentially “majoring in the minors,” rather than being able to restore combined arms maneuver on a larger scale.

Russian forces experimented extensively with force structure adaptations, which proved easier after 2022 given the variegation in the overall force. This likely made the Russian military more accommodating to new types of UAS and EW formations. As the force underwent expansion, commanders also had greater flexibility in how and where they would allocate newfound manpower. Mobilization in 2022, and the expansion of the contract-staffed force in 2023 was an important factor in subsequent Russian force structure adaptations. The interaction between force availability and structure modifications is perhaps an obvious one but particularly relevant in this case, given UAS employment is manpower intensive, requiring commanders to make choices on force allocation.

Conclusion

Over the course of 2023, the Russian military demonstrated both its significant limitations, and the ability to adapt, or learn from the battlefield. This adaptation was apparent in its rapid adoption of new technologies and tactics, particularly the use of uncrewed aerial systems and electronic warfare. Russian armed forces developed new types of force structures for the conduct of assault operations, leveraging the use of expendable forces and evolving those formations. They similarly evolved the force to better integrate UAS, and EW, and deployed new systems across the force. They redressed a number of the problems demonstrated in their force design choices and conduct of operations in 2022. These included significant adjustments and reconsideration to prior force design, deployment of new types of capabilities, and doctrinal modifications, especially in the conduct of defensive operations. The Russian military and the Russian state as a whole invested in adjustments to conduct a protracted conventional war, addressing structural manpower issues, increasing munitions production, facilitating equipment repair, and to an extent mobilizing the defense industry (although some sectors continued to struggle).

In general, the Russian military appeared more capable in conducting defensive operations than in restoring its offensive potential in 2023. Mobilization in 2022 and a successful national recruitment campaign enabled Russian force structure expansion. This created the conditions for force structure adjustments and allowed Russia to generate new units. Throughout the year, the Russian military expanded the use of convicts on the battlefield, instituting convict formations as a post-Wagner phenomenon, as well as volunteer units of various types. Use of convicts by Wagner was seen as a

successful way to field expendable forces on the battlefield, with many of the tactics and practices adopted by the Russian military. Dependency on convict-staffed formations, and assault units of various stripes, engendered greater specialization in small-unit assault tactics. Despite occasional large-scale attacks by mechanized formations, much of the day-to-day fighting was carried by small detachments in the absence of a better capacity to conduct offensive operations at scale.

The Russian military proved effective at copying successful Ukrainian tactics or adopting the types of systems employed and scaling defense-industrial production to deploy them across the force. Ukrainian forces were advantaged in bottom-up innovation and integration via indigenously produced software. The interaction between Ukrainian civil society, and a military that empowered junior leadership, led to greater ease of adoption and use in conjunction with existing commercial applications, or those developed by Ukrainian companies. The Russian military took longer to adapt, but the defense-industrial complex was overall better at scaling up production when directed to provide solutions. The likely reason is Russia had more capital, more industrial capacity, and much greater state control over both parts of that equation. Western support for Ukraine did not translate into funding for its industry or defense sector. Russia was also able to expand production lines of successful systems or develop new variants over the course of the war. Much the same could be said for the Russian deployment of counters to Western precision-strike capabilities and steady improvement of its ability to engage in dynamic targeting on the battlefield. On the whole, in 2023 the Russian military fared better in its ability to implement operational concepts and translate into practice some of the tactical approaches that the force could not execute in the first year of the war.

However, the net effect of these changes was insufficient to restore Russian ability to conduct ground force operations at scale, overcome prepared defenses, or break through Ukrainian lines to achieve operationally significant gains. The Russian military continued to struggle with force quality and the loss of experienced officers, particularly as Ukrainian defensive capabilities and tactics matured. Neither force has been standing still, and as both improved their ability to mount an organized defense, the challenge of conducting offensive operations grew in proportion. In 2022 and early 2023, the Russian military conducted its assaults with formations that cobbled together what fighting capacity remained across the force. This further wasted remaining combat power and degraded the force quality, which would take time to recover. This was evidenced by the steady transition of Territorial Troop units from being used to replace losses, to holding parts of the defensive line, and eventually evolving to conduct offensive operations alongside the regular active duty force. Leveraging convicts, developing new tactics and structures for their employment, and expanding the use of expendable units was a successful, but ultimately negative adaptation during this period. These approaches have persisted and were expanded in 2024. But despite a significant advantage in manpower, only a small portion of the Russian military is being used in any given time to conduct offensive operations.

Although, notably, the Russian military restored its ability to integrate combined arms at lower echelons (the platoon, company, and in some cases battalion levels), conducting such operations at scale remained challenging. One possible reason is that force regeneration creates a catch-22 whereby the most experienced formations are often exhausted, and short of assault capable units while newly generated formations are well-equipped but inexperienced. Units are given Storm assault companies to use in offensives, but these are largely limited to small unit infantry tactics. Experienced formations seek to minimize their losses, preserving equipment, and therefore tend to use expendable combat power where possible. Newer units have the personnel, and equipment, but are likely to suffer high losses early on because they are inexperienced and led by green officers.

Russian forces have also not been able to regenerate the necessary enablers to overcome a prepared defense, and heavy investments in UAS only deepened the static nature of the fight over the course of 2023. Rather than providing a decisive advantage, the expansion of UAS in various roles on the battlefield reinforced the observed preference for destruction-oriented approaches and a war characterized much more by attrition than maneuver. Superficially, Ukraine's recent Kursk offensive may seem a counterpoint to this overall assessment. Ukraine's breakthrough at Kursk does suggest the direction that force employment is taking with better integration of novel capabilities, but Kursk is not reflective of the prevailing conditions and density of defenses typically encountered in this war. Neither side has enjoyed great success in overcoming a prepared defense when properly organized, manned, and backed by fire support.

Russian forces continued to experiment with ways to attain breakthroughs, but these remained focused on small formations, employing improvised assault vehicles on the basis of modified tanks or infantry fighting vehicles. Assault vehicles were used to clear lanes through mines and soak up FPV drone strikes ahead of those vehicles delivering troops. Other experiments involved high mobility in open terrain, using motorcycles or all-terrain vehicles to deliver troops quickly to assault defense positions. Both approaches showed limited effectiveness and were quite costly to either men or equipment. To be clear, the Russian military has not abandoned mechanized assault backed by fire support as a means of effecting breaches in opponent's lines. Through 2023 and 2024 Russian forces continued to mount mechanized assaults, typically as reinforced companies, but these often led to losses rather than breakthroughs. The loss of equipment and personnel would then force a shift back to small-unit tactics, and efforts to incrementally shift the line of control.

Yet, Western planners and military leaders would do themselves a disservice to interpret this war as one of two forces struggling with challenges that Western militaries could easily overcome. The problems observed are not uncommon, and offer important observations, if not enduring lessons. Prolonged conventional wars come down to attrition, reconstitution, and defense industrial mobilization. They are also cycles of innovation and adaptation, as new capabilities are introduced and countered. The Russian military's degradation is a result of the attrition suffered and the difficulty

of restoring force quality. The need to replace losses competes with the requirements to generate new formations. This war illustrates the difficulty of scaling adaptation across an increasingly uneven force and translating tactical innovations into new warfighting concepts. Western militaries could face similar pressures and dynamics in a prolonged conventional conflict.

Overcoming a prepared defense remains a central challenge to consider after the initial period of any war. Western forces should review current capabilities, tactics, and assumption on how they would deal with traditional challenges, backed by UAS, and non-line of sight precision strike munitions. Geography continues to matter significantly, whether the difficulty of overcoming rivers, fighting in forests, or conducting sieges in urban terrain. Emphasis on long range precision strike can lead to a degree of blindness regarding difficulties observed in the close battle. In short, being effective in the “deep battle” represents only one piece of the puzzle. The absence of air superiority for either side should not be taken as an alibi, assuming that were it present it could have a talismanic effect on the battlefield. Airpower is one of the West’s principal advantages and areas of investment but air superiority needs to be achieved, and maintained. Some challenges, such as mass employment of small UAS at low altitudes for reconnaissance and strike purposes, do not have obvious airpower solutions.

Finally, after the Russian military’s initially dismal performance in 2022, it became commonplace among Western planners and military leaders to overcorrect previous assessments of the Russian military or presume that analysts simply did not know much about the Russian armed forces. In fairness, there was a large gap between predictions, and outcomes in the initial period of war. Knowledge of any adversary military is incomplete at best, and in some cases it is clear that Russia’s military leadership itself did not know or understand the weakness within their own force. Knowledge of any military does not necessarily translate to foresight in how it will perform in a specific context, given the need to factor in military strategy, political assumptions, choices made by individual leaders, the opposing force, and that which often comes down to contingency, among other variables. Initial impressions, as is often the case in war, were based on incomplete information and the anchoring effect of early diagnoses of Russian failures. Causality was not well-established, and little was known about the battles that proved decisive in shaping outcomes. Those interpretations had some evidentiary basis, but the narrative of Russian inability to learn was oversubscribed. Much of the same can be said about notional assumptions regarding Russian morale and its implications for the force’s staying power.

Looking at the Russian military’s shortcomings, adaptation, and capacity for learning in 2023 provides a useful corrective and helps balance the conversation. However, this remains an exploratory study, as much of the record is incomplete and will undoubtedly be revised or corrected over time. The Russian military continues to undergo periods of degradation and reconstitution. Operations provide new information from the battlefield for both sides. A given view of Russian military performance is not necessarily wrong, but needs to be mindful of context, and the period of war it is based

on. What was true in 2023 may not hold for 2024, and beyond. Therefore, the conclusions here should be taken with the appropriate caveats, rather than as an attempt at a definitive account or an appeal to sole authority on this subject.

About the Author

Michael Kofman is a senior fellow in the Russia and Eurasia Program at the Carnegie Endowment for International Peace, where he focuses on the Russian military, Ukrainian armed forces, and Eurasian security issues. Prior to joining Carnegie in 2023, he served as director of the Russia Studies Program at the Center for Naval Analyses, where he led a team conducting research on the capabilities, strategy, and military thought of the Russian Armed Forces. Widely recognized as one of the leading authorities on the Russian military and the Russian-Ukrainian war, Kofman has led foundational work in the field and is routinely cited in major publications.

Aside from his work at Carnegie, Kofman is a contributing editor at War on the Rocks, where he hosts the *Russia Contingency*, a bi-weekly podcast on the Russian military and the Russia-Ukraine war. He previously served as a research fellow and program manager at the National Defense University. Past fellowships have included the Modern War Institute at West Point, Center for New American Security, and the Woodrow Wilson Center.

Acknowledgments

The author is grateful to Rochan Consulting, Frontelligence Insight, and Black Bird Group for providing outstanding assistance with research and maps. The author bears sole responsibility for any remaining errors of fact or judgment.

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The Russia Strategic Initiative (RSI) is a U.S. Department of Defense organization that works with structures throughout the U.S. Government and with public and private think tanks around the world to develop a common understanding of Russian decision-making and way of war that supports the Coordinating Authority's integration that leads to integrated planning, assessments, and action recommendations.

Notes

- 1 A study of Russian defense industrial adaptation is beyond the scope of this report, but was a critical factor in enabling Russia to sustain the war.
- 2 The author acknowledges the work of other colleagues on these subjects who have conducted fieldwork in Ukraine—Rob Lee, Konrad Muzyka, and Franz-Stefan Gady—along with colleagues at the Royal United Services Institute: Jack Watling, Nick Reynolds, Justin Bronk, and Sidharth Kaushal. The author also acknowledges open-source research groups including the Black Bird Group, Rochan Consulting, and Frontelligence Insight.
- 3 Pjotr Sauer, “Putin announces partial mobilisation and threatens nuclear retaliation in escalation of Ukraine war,” *The Guardian*, September 21, 2022, <https://www.theguardian.com/world/2022/sep/21/putin-announces-partial-mobilisation-in-russia-in-escalation-of-ukraine-war>
- 4 There is a debate whether those mobilized can be considered reservists. They were not part of the BARS reserve system, instead colloquially referred to as *mobiks*, but they were individuals technically considered to be part of a strategic reserve.
- 5 Jack Watling, Oleksandr V Danylyuk and Nick Reynolds, “Preliminary Lessons from Russia’s Unconventional Operations During the Russo-Ukrainian War, February 2022–February 2023,” Royal United Services Institute, March 29, 2023, <https://www.rusi.org/explore-our-research/publications/special-resources/preliminary-lessons-russias-unconventional-operations-during-russo-ukrainian-war-february-2022>
- 6 Lester W. Grau and Charles K. Bartles, “The Russian Way of War: Force Structure, Tactics, and Modernization of the Russian Ground Forces,” Foreign Military Studies Office, August 22, 2017, <https://www.armyupress.army.mil/portals/7/hot%20spots/documents/russia/2017-07-the-russian-way-of-war-grau-bartles.pdf>
- 7 Captured documents show manning levels closer to 70-75% in even relatively high readiness units.
- 8 The issue is complex, in that two thirds of the available maneuver battalions took part in the invasion, but in terms of total troop strength this represented about a third of the active force. As an example, a brigade of 3,800 men might have generated two battalion tactical groups with 1,200-1,500 deployable personnel in total.
- 9 Lester W. Grau and Charles K. Bartles, “Getting to Know the Russian Battalion Tactical Group,” Royal United Services Institute, April 14, 2022, <https://rusi.org/explore-our-research/publications/commentary/getting-know-russian-battalion-tactical-group>
- 10 See Russian doctrinal distinction and typology of wars discussed here: Michael Kofman, Anya Fink, Dmitry Gorenburg, Mary Chesnut, Jeffrey Edmonds, and Julian Waller, “Russian Military Strategy: Core Tenets and Operational Concepts,” Center for Naval Analyses, August 2021, https://www.cna.org/archive/CNA_Files/pdf/russian-military-strategy-core-tenets-and-operational-concepts.pdf.
- 11 “Senior Defense Official Holds a Background Briefing,” U.S. Department of Defense, April 6, 2022, <https://www.defense.gov/News/Transcripts/Transcript/Article/2991787/senior-defense-official-holds-a-background-briefing/>
- 12 Pjotr Sauer and Andrew Roth, “115 Russian national guard soldiers sacked for refusing to fight in Ukraine,” *The Guardian*, May 27, 2022, <https://www.theguardian.com/world/2022/may/27/115-russian-national-guard-soldiers-sacked-for-refusing-to-fight-in-ukraine>
- 13 In 2021 the Russian MoD claimed to have 168 battalion tactical groups available which were contract staffed within the force. Igor Voron, “168 rossijskih batalonno-takticheskikh grupp mogut vyjti v boj za chas [168 Russian battalion tactical groups can enter battle in an hour],” Profil, June 5, 2024, <https://profile.ru/news/protection/army/168-rossijskih-batalonno-takticheskikh-grupp-mogut-vyjti-v-boj-za-chas-907406/>
- 14 See Michael Kofman and Rob Lee, “Not Built for Purpose: The Russian Military’s Ill-Fated Force Design,” War on the Rocks, June 2, 2022, <https://warontherocks.com/2022/06/not-built-for-purpose-the-russian-militarys-ill-fated-force-design/>
- 15 “Voenniye Prestupniki – voennosluzhushchiye 136 otdelnoy motostrelkovoi brigadi sovershayushchiye voenniye prestupleniya protiv mirnogo naselenniya Ukraini [War criminals - servicemen of the 136th separate motorized rifle brigade committing war crimes against the civilian population of Ukraine],” Main Directorate of Intelligence of the Ministry of Defense of Ukraine, March 18, 2022, <https://gur.gov.ua/content/voennosluzhashchye-136-otdelnoi-motostrelkovoi-bryhady.html>
- 16 Michael Kofman, Anya Fink, Dmitry Gorenburg, Mary Chesnut, Jeffrey Edmonds, and Julian Waller, “Russian Military Strategy: Core Tenets and Operational Concepts,” Center for Naval Analyses, August 2021, https://www.cna.org/archive/CNA_Files/pdf/russian-military-strategy-core-tenets-and-operational-concepts.pdf.

- 17 Michael Kofman, Anya Fink, Dmitry Gorenburg, Mary Chesnut, Jeffrey Edmonds, and Julian Waller, “Russian Military Strategy: Core Tenets and Operational Concepts,” Center for Naval Analyses, August 2021, https://www.cna.org/archive/CNA_Files/pdf/russian-military-strategy-core-tenets-and-operational-concepts.pdf.
- 18 See Mari Saito, Maria Tsvetkova and Anton Zverev, “Abandoned Russian Base Holds Secrets of Retreat in Ukraine,” Reuters, October 26 2022, <https://www.reuters.com/investigates/special-report/ukraine-crisis-russia-base/>.
- 19 “V ramkah mobilizatsii v Rossii sozdali bolee 120 novyh voinskih chastey. Tret prizvannyh otpravili v kadrovye chasti - vospolnyat boevye poteri. Glavnoe is isledovanniya Conflict Intelligence Team [As part of mobilization, more than 120 new military units were created in Russia. A third of those called up were sent to personnel units - to make up for combat losses. Main conclusions from the Conflict Intelligence Team study],” Meduza, October 5, 2023, <https://meduza.io/feature/2023/10/05/v-ramkah-mobilizatsii-v-rossii-sozdali-bolee-120-novyh-voinskih-chastey-tret-prizvannyh-otpravili-v-kadrovye-chasti-vospolnyat-boevye-poteri>
- 20 Ukrainian forces ran into similar challenges later in 2023.
- 21 Civilian-military alignment is a complex subject beyond the scope of this report. These challenges manifest across different systems and types of regimes.
- 22 Makhmut Gareev, “Slabye Mesta Nacionalnoy Bezopasnosti Bezopasnosti Rossii [Weak points of Russia’s National Security],” VPK-News.Ru, January 1, 2004, <http://www.vko.ru/koncepcii/slabye-mesta-nacionalnoy-bezopasnosti-bezopasnosti-rossii>
- 23 “Vsu utverzhdayut chto pod ugledarom razbili elitnyuyu rossiyskuyu brigadu morpehov odin iz voennyh rasskazal o gibeli 500 sosluzhivtsev [The Ukrainian Armed Forces claim that an elite Russian brigade of marines was defeated near Ugledar. One of the military spoke about the death of 500 colleagues],” Meduza, February 13, 2023, <https://meduza.io/feature/2023/02/13/vsu-utverzhdayut-chto-pod-ugledarom-razbili-elitnyuyu-rossiyskuyu-brigadu-morpehov-odin-iz-voennyh-rasskazal-o-gibeli-500-sosluzhivtsev>
- 24 For more details on this subject see: Lester W. Grau and Charles K. Bartles, “The Russian Breakthrough Tactical Group,” U.S. Army Maneuver Center of Excellence, https://www.moore.army.mil/infantry/magazine/issues/2022/Fall/PDF/8_Grau_txt.pdf
- 25 A Ukrainian position comes under heavy fire, with a UR-77 taking a hit and ceasing to exist.” X.com, November 9, 2022, <https://twitter.com/Osinttechnical/status/1590218781447839744>
- 26 Wagner’s campaign to capture Bakhmut is discussed in the next section of the report.
- 27 In principle, a Russian officer is trained and expected to lead in the position immediately above his own. This was a hierarchical system, but one in which heavy officer attrition was expected. How well the Russian officers actually adhered to this is not clear, but at this stage of the war the Russian military was largely a broken force.
- 28 Based on interviews conducted in Ukraine February-March 2023.
- 29 “Nas nazivali myasom. Kak v shturme pod Ugledarom gibli rossiyskie morpehi i vizhivali gorozhane [“They called us meat.” How Russian marines died in the assault near Ugledar and the townspeople survived],” BBC Russian Service, December 18, 2023, <https://www.bbc.com/russian/media-67745318>
- 30 Jakub Ber, “From Popasna to Bakhmut. The Wagner Group in the Russia-Ukraine War,” OSW, April 28, 2023, <https://www.osw.waw.pl/en/publikacje/osw-commentary/2023-04-28/popasna-to-bakhmut-wagner-group-russia-ukraine-war>
- 31 This section is adapted from a forthcoming article on Wagner and its composition by Rob Lee and Michael Kofman.
- 32 Natasha Bertrand and Katie Bo Lillis, “US to designate Russia’s Wagner mercenary group as a ‘transnational criminal organization,’” CNN, January 20, 2023, <https://www.cnn.com/2023/01/20/politics/us-russia-wagner-group/index.html>
- 33 Percentages derived from interviews in Ukraine February-March 2023 and July 2023.
- 34 See Michael Kofman and Rob Lee, “Beyond Ukraine’s Offensive: The West Needs to Prepare the Country’s Military for a Long War,” *Foreign Affairs*, May 10, 2023, <https://www.foreignaffairs.com/ukraine/russia-war-beyond-ukraines-offensive>.
- 35 In recorded intercepts during the battle of Bakhmut, Wagner commanders could be heard ordering one officer to proceed to another unit and execute their leader, then take over his command. If the officer refused to comply, his own life would be in jeopardy. Based on interviews conducted by the author in July and November 2023.
- 36 This section is adapted from a forthcoming article on Wagner and its composition by the author and Rob Lee.
- 37 Based on interviews in Ukraine during the battle of Bakhmut, February and March 2023.
- 38 Olga Kirylenko, Dmyrro Larin, “Brigadier General of the 45th Brigade Oleg Faydyuk: We definitely need more guns,” *Ukrainska Pravda*, February 7, 2023, <https://www.pravda.com.ua/articles/2023/02/7/7388192/>

- 39 Svideteli Bayraktara, (@bayraktar1070,) [Telegram, May 17, 2023, https://t.me/bayraktar1070/1093](https://t.me/bayraktar1070/1093)
- 40 Polina Ivanova, “The Russian murderers sent home as free men after fighting in Ukraine,” *Financial Times*, January 3, 2024, <https://www.ft.com/content/9fdb5668-7e55-4b09-a6ca-6ba77999530b>
- 41 Based on interviews conducted during the battle of Bakhmut, February-March 2023.
- 42 Enot iz Khersona, (@HersonEnot,) [Telegram, April 13, 2023, https://t.me/HersonEnot/1081](https://t.me/HersonEnot/1081)
- 43 This was undoubtedly so as to not give them equal status with regular military servicemen, contract or mobilized. Nonetheless, given they had signed contracts with the MoD, they had to have some sort of military status within the military. Following their contracts they would be freed from military service and also from their penal sentence. This system was in place prior to the development of Storm-V units under different service conditions. See 8th Combined Arms Army, “Polozhenie: Ob shturmovih rotah ‘Z’ 8 obshevoiskovoi armii [On Storm-Z units in the 8th combined arms army,]” 2023, <https://sprotyvg7.com.ua/wp-content/uploads/2023/04/%D0%9F%D0%BE%D0%BB%D0%BE%D0%B6%D0%B5%D0%BD%D0%B8%D0%B5-%D0%BE-%D1%88%D1%82%D1%83%D1%80%D0%BC%D0%B0%D1%85-Z-1.pdf>
- 44 For more detail, see this document laying out the composition and organization of Storm-Z units. 8th Combined Arms Army, “Polozhenie: Ob shturmovih rotah ‘Z’ 8 obshevoiskovoi armii [On Storm-Z units in the 8th combined arms army,]” 2023, <https://sprotyvg7.com.ua/wp-content/uploads/2023/04/%D0%9F%D0%BE%D0%BB%D0%BE%D0%B6%D0%B5%D0%BD%D0%B8%D0%B5-%D0%BE-%D1%88%D1%82%D1%83%D1%80%D0%BC%D0%B0%D1%85-Z-1.pdf>
- 45 Center Podgotovki Primeneniya Shturmovih Podrazdeleniy I Podrazdeleniy, “Album-Schem deistviy sturmovih podrazdeleniy v osnovnih vidah boia [Album-schel for actions of assault units in basic types of combat,]” 2023, https://sprotyvg7.com.ua/wp-content/uploads/2023/12/%D0%9F%D0%94%D0%A4-%D0%B0%D0%BB%D1%8C%D0%B1%D0%BE%D0%BC-%D0%B4%D0%B5%D0%B9%D1%81%D1%82%D0%B2%D0%B8%D0%B9-%D0%B3%D1%80%D1%83%D0%BF-%D0%BF-1_053821.pdf
- 46 Ed A.G. Kontsevo, Training Manual: Combat Employment of Assault Company (Group) in Offensives, Russian Airborne Troops Command, June 16, 2024.
- 47 Based on interviews with Ukrainian troops in Kharkiv area, June 2024.
- 48 Roman Kretsul and Alexey Ramm, “Sistemnyi vzlom: v vs rossii poiavitsia novyi tip brigad, [System Hack: a new type of brigade will appear in the Russian Armed Forces],” *Izvestiya*, September 25, 2023, <https://iz.ru/1578825/roman-kretcul-aleksei-ramm/sistemnyi-vzлом-v-vs-rossii-poiavitsia-novyi-tip-brigad>.
- 49 See “Miscalculations, divisions marked offensive planning by U.S., Ukraine,” *Washington Post*, December 4, 2023, <https://www.washingtonpost.com/world/2023/12/04/ukraine-counteroffensive-us-planning-russia-war/>; “In Ukraine, a war of incremental gains as counteroffensive starts,” *Washington Post*, December 4, 2023, <https://www.washingtonpost.com/world/2023/12/04/ukraine-counteroffensive-stalled-russia-war-defenses/>
- 50 For more analysis of Ukraine’s counteroffensive and the challenges with the concept of operations as it was developed, see Jack Watling, Oleksandr Danylyuk, and Nick Reynolds, “Preliminary Lessons From Ukraine’s Offensive Operations, 2022-23,” RUSI, July 18, 2024.
- 51 For an expanded treatment of Ukraine’s offensive, and the challenges faced by Ukrainian forces see: Franz-Stefan Gady and Michael Kofman, “Making Attrition Work: A Viable Theory of Victory for Ukraine,” International Institute for Strategic Studies, February 9, 2024, <https://www.iiss.org/globalassets/media-library---content--migration/files/online-analysis/survival-online/2024/01/66-1-gady-and-kofman.pdf>; Jack Watling and Nick Reynolds, “Stormbreak: Fighting Through Russian Defences in Ukraine’s 2023 Offensive,” Royal United Services Institute, September 2023, https://static.rusi.org/Stormbreak-Special-Report-web-final_0.pdf; Michael Kofman and Rob Lee, “Perseverance and Adaptation: Ukraine’s Counteroffensive at Three Months,” *War on the Rocks*, September 4, 2023, <https://warontherocks.com/2023/09/perseverance-and-adaptation-ukraines-counteroffensive-at-three-months/>; Franz-Stefan Gady and Michael Kofman, “Franz-Stefan Gady and Michael Kofman on what Ukraine must do to break through Russian defences,” *The Economist*, July 28, 2023, <https://www.economist.com/by-invitation/2023/07/28/franz-stefan-gady-and-michael-kofman-on-what-ukraine-must-do-to-break-through-russian-defences>.
- 52 James Marson, “Inside a Volunteer Unit Driving Ukraine’s Counteroffensive Forward,” *Wall Street Journal*, August 10, 2023, <https://www.wsj.com/articles/ukraine-uses-small-unit-tactics-to-retake-captured-territory-from-russia-d9ef32a3>.
- 53 Based on author field work and interviews in Ukraine during the offensive, July 2023. This section is also adapted from and updated based on prior research and writing on the conduct of Ukraine’s offensive in September 2023. See Michael Kofman and Rob Lee, “Perseverance and Adaptation: Ukraine’s Counteroffensive at Three Months,” *War on the Rocks*, September 4, 2023, <https://warontherocks.com/2023/09/perseverance-and-adaptation-ukraines-counteroffensive-at-three-months/>.

- 54 Isabelle Khurshudyan, Sasha Maslov, Kamila Hrabchuk, “Ukraine’s elite forces rely on technology to strike behind enemy lines,” *Washington Post*, August 6, 2023, <https://www.washingtonpost.com/world/2023/08/06/ukraine-special-forces-alpha-counteroffensive/>
- 55 Marcus Walker, ‘Mines Everywhere’: Ukraine’s Offensive Is Proving a Hard Slog,” *Wall Street Journal*, June 16, 2023, <https://www.wsj.com/articles/mines-everywhere-ukraines-offensive-is-proving-a-hard-slog-270a1e4a>
- 56 Based on author interviews in Ukraine, July 2023.
- 57 See Jack Watling and Nick Reynolds, “Stormbreak: Fighting Through Russian Defences in Ukraine’s 2023 Offensive,” Royal United Services Institute, September 2023, p.15, https://static.rusi.org/Stormbreak-Special-Report-web-final_0.pdf.
- 58 Gerry Doyle, Han Huang, Jackie Gu, “What Lies Beneath,” Reuters, July 28, 2023, <https://www.reuters.com/graphics/UKRAINE-CRISIS/LANDMINES/myvmgnqbavr/>
- 59 Based on author interviews in Ukraine, July 2023.
- 60 Andrew E. Kramer, “Small, Hidden, and Deadly: Mines Stymie Ukraine’s Counteroffensive,” *New York Times*, July 16, 2023, <https://www.nytimes.com/2023/07/16/world/europe/ukraine-russia-land-mines.html>.
- 61 Emma Graham-Harrison, “Everything is ahead of us: Ukraine breaks Russian stronghold’s first line of defence,” *The Guardian*, September 2, 2023, <https://www.theguardian.com/world/2023/sep/02/everything-is-ahead-of-us-ukraine-breaks-russias-first-line-of-defence-in-stronghold>.
- 62 Jack Watling and Nick Reynolds, “Stormbreak: Fighting Through Russian Defences in Ukraine’s 2023 Offensive,” Royal United Services Institute, September 2023, p. 16, https://static.rusi.org/Stormbreak-Special-Report-web-final_0.pdf.
- 63 Vladyslav Smilianets, “The Russians were waiting for us’: Ukraine troops describe tougher fight than expected,” Reuters, July 31, 2023, <https://www.reuters.com/world/europe/the-russians-were-waiting-us-ukraine-troops-describe-tougher-fight-than-expected-2023-07-31/>.
- 64 Daniel Boffey, “Like playing a computer game’: on the frontline with one of Ukraine’s deadliest drone pilots,” *The Guardian*, August 7, 2023, <https://www.theguardian.com/world/2023/aug/07/like-playing-a-computer-game-on-the-frontline-with-one-of-ukraines-deadliest-drone-pilots>; “Lancet: The Russian Kamikaze Drone Blunting Ukraine’s Counteroffensive,” RFE/RL, July 8, 2023, <https://www.rferl.org/a/lancet-drones-russia-invasion-counteroffensive-kamikaze/32493513.html>.
- 65 Jack Watling and Nick Reynolds, “Stormbreak: Fighting Through Russian Defences in Ukraine’s 2023 Offensive,” Royal United Services Institute, September 2023, p. 17, https://static.rusi.org/Stormbreak-Special-Report-web-final_0.pdf.
- 66 For more on active defense, core tenets and operational concepts see: Michael Kofman, Anya Fink, Dmitry Gorenburg, Mary Chesnut, Jeffrey Edmonds, and Julian Waller, “Russian Military Strategy: Core Tenets and Operational Concepts,” Center for Naval Analyses, August 2021, https://www.cna.org/archive/CNA_Files/pdf/russian-military-strategy-core-tenets-and-operational-concepts.pdf.
- 67 For more on maneuver defense see: Lester W. Grau and Major Charles K. Bartles, “The Russian Army and Maneuver Defense,” *Armor*, Winter 2022, <https://www.moore.army.mil/armor/eARMOR/content/issues/2022/Winter/1Grau-Bartles22.pdf>
- 68 See Jack Watling and Nick Reynolds, “Stormbreak: Fighting Through Russian Defences in Ukraine’s 2023 Offensive,” Royal United Services Institute, September 2023, p. 18, https://static.rusi.org/Stormbreak-Special-Report-web-final_0.pdf
- 69 Lester W. Grau and Charles K. Bartles, “The Russian Reconnaissance Fire Complex Comes of Age,” *Age*, Oxford Changing Character of War Centre, May 30, 2018, <https://www.ccw.ox.ac.uk/blog/2018/5/30/the-russian-reconnaissance-fire-complex-comes-of-age>.
- 70 Adapted and updated from earlier research in Michael Kofman and Rob Lee, “Perseverance and Adaptation: Ukraine’s Counteroffensive at Three Months,” *War on the Rocks*, September 4, 2023, <https://warontherocks.com/2023/09/perseverance-and-adaptation-ukraines-counteroffensive-at-three-months/>
- 71 Based on interviews and documents seen during field work July 2023.
- 72 “Report I – The Russian 291st Motor Rifle Regiment in Defence: The Orikhiv Axis,” Rochan Consulting, <https://rochan-consulting.com/russian-291st-motor-rifle-regiment-in-defence-the-orikhiv-axis/>.
- 73 Isabelle Khurshudyan and Alex Horton, “Russian jamming leaves some high-tech U.S. weapons ineffective in Ukraine,” *Washington Post*, May 24, 2024, <https://www.washingtonpost.com/world/2024/05/24/russia-jamming-us-weapons-ukraine/>.

- 74 Author bases this on interviews in Ukraine July 2023–November 2023, and what is publicly known about the planning for the offensive.
- 75 See Isabelle Khurshudyan et al., ‘Inside the Ukrainian Counteroffensive that Shocked Putin and Reshaped the War’, *Washington Post*, 29 December 2022, <https://www.washingtonpost.com/world/2022/12/29/ukraine-offensivekharkiv-kherson-donetsk/>.
- 76 This was discussed by analysts in the months leading up to the offensive, based on observations of the Kherson offensive in fall of 2022. See Rob Lee and Michael Kofman, “How the Battle for the Donbas Shaped Ukraine’s Success,” Foreign Policy Research Institute, December 23, 2022, <https://www.fpri.org/article/2022/12/how-the-battle-for-the-donbas-shaped-ukraines-success/>; Michael Kofman and Rob Lee, “Beyond Ukraine’s Offensive: The West Needs to Prepare the Country’s Military for a Long War,” *Foreign Affairs*, May 10, 2023, <https://www.foreignaffairs.com/ukraine/russia-war-beyond-ukraines-offensive>
- 77 This section is based on several interviews in Ukraine over the course of 2023–2024, and on a forthcoming report focusing on this subject, co-authored with Rob Lee.
- 78 Victor Baranets, “Nachalnik Genshtaba Vooruzhenih sil Rossii general armii Valery Gerasimov: “Mi perelomali hrebet udarnym silam terrorisma [Chief of the General Staff of the Russian Armed Forces, Army General Valery Gerasimov: [We broke the back of the strike forces of terrorism,]” *Komsomolskaya Pravda*, December 26, 2017, <https://www.kp.ru/daily/26775/3808693/>.
- 79 Mykhaylo Zabrodskiy, Jack Watling, Oleksandr V Danylyuk and Nick Reynolds, “Preliminary Lessons in Conventional Warfighting from Russia’s Invasion of Ukraine: February–July 2022,” Royal United Services Institute, November 30, 2022, <https://static.rusi.org/359-SR-Ukraine-Preliminary-Lessons-Feb-July-2022-web-final.pdf>
- 80 Alexey Ramm, “Kuda letit bezpilotnaya aviaziya [Where is unmanned aviation going,]” *Nezavisimoye Voennoe Obozrenie*, January 21, 2021, https://nvo.ng.ru/armament/2021-01-21/1_1125_aviation.html.
- 81 Jack Watling, Oleksandr V Danylyuk and Nick Reynolds, “Preliminary Lessons from Russia’s Unconventional Operations During the Russo Ukrainian War, February 2022–February 2023,” Royal United Services Institute, March 29, 2023, <https://static.rusi.org/202303-SR-Unconventional-Operations-Russo-Ukrainian-War-web-final.pdf.pdf>
- 82 Blair Battersby, “Russia Struggling To Integrate Its Most Effective Unmanned System,” TRADOC G2, April 18, 2024, <https://oe.tradoc.army.mil/2024/04/18/russia-struggling-to-integrate-its-most-effective-unmanned-system/>.
- 83 Jeffrey A. Edmonds, Samuel Bendett, “Russia’s Use of Uncrewed Systems in Ukraine,” center for Naval Analyses, March 15, 2023, <https://www.cna.org/reports/2023/03/Russian-Uncrewed-Systems-Ukraine.pdf>.
- 84 “Drone wars: How UAVs became a decisive factor in the Russo-Ukrainian war,” *The Insider*, December 28, 2023, <https://theins.ru/en/politics/267970>.
- 85 “Mobilizovannie mogut vzyat s soboi kvadrokopter [Those mobilized can take a quadcopter with them,]” *RIA Novosti*, September 27, 2022, <https://ria.ru/20220927/kvadrokopter-1819744051.html>.
- 86 Dmitriy Astrakhan, “V Danniy moment bez kopterov nikuda [You can’t do without copters these days,]” *Izvestiya*, November 28, 2022, <https://iz.ru/1432143/dmitrii-astrakhan/v-danniy-moment-bez-kopterov-nikuda>.
- 87 Based on a forthcoming report with Rob Lee on FPVs and Tactical Uncrewed Aerial System Innovation in Ukraine.
- 88 Based on video footage posted to Russian telegram channels. Posted footage is never representative of all strikes, but simply a sample which showed significant increase in the number of Lancet systems employed.
- 89 General Staff of the Armed Forces of the Russian Federation, “Pamyatka po primeneniю FPV-dronov [Guide for the use of FPV-drones],” 2024, https://m.vk.com/wall-46943161_1598050
- 90 Ibid.
- 91 Based on interviews in Ukraine November 2023, February–March 2024. Ukrainian units collect meticulous data cataloguing their and the opponent’s UAS strikes.
- 92 “UAV Use in the Russian Armed Forces,” OE Watch, June 2018, https://community.apan.org/cfs-file/_key/docpreview-s/00-00-11-87-90/2018_2D00_06_2D00_01-UAV-Use-in-the-Russian-Armed-Forces-2800_Bartles_2900_.pdf
- 93 Based on a forthcoming report with Rob Lee on FPVs and Tactical Uncrewed Aerial System Innovation in Ukraine.
- 94 “V zone svo sozdali pervyi rossiiskii spetsbatalon dronshchikov minerov, [The first Russian special battalion of drone miners was created in the Northern Military District zone,]” *Izvestiya*, October 30, 2023, <https://iz.ru/1597200/2023-10-30/v-zone-svo-sozdali-pervyi-rossiiskii-spetsbatalon-dronshchikov-minerov>.

- 95 Based on a forthcoming report with Rob Lee on FPVs and Tactical Uncrewed Aerial System Innovation in Ukraine.
- 96 “A more nuanced view of Russian electronic warfare,” Swedish Defence Research Agency, March 6, 2019, <https://www.foi.se/en/foi/news-and-pressroom/news/2019-03-06-a-more-nuanced-view-of-russian-electronic-warfare.html> and Roger N. McDermott, “Russia’s Electronic Warfare Capabilities to 2025,” Rehusvaheline Kaitseuringute Keskus International Centre for Defence and Security, September 2017, https://icds.ee/wp-content/uploads/2018/ICDS_Report_Russias_Electronic_Warfare_to_2025.pdf
- 97 Justin Bronk, “Russian Combat Air Strengths and Limitations,” Center for Naval Analyses, April 17, 2023, <https://www.cna.org/reports/2023/05/russian-combat-air-strengths-and-limitations>.
- 98 Duncan McCrory, “Electronic Warfare in Ukraine Preliminary Lessons for NATO Air Power Capability Development,” *The Journal of the JAPCC*, Ed. 36, Summer 2023, https://www.japcc.org/wp-content/uploads/JAPCC_J36_screen.pdf
- 99 A.M. Akhapkina, V.D. Mozheiko, “Primenenie Sredstv REB v Obshevoiskovom Boiu [Application of EW Tools in Combined Arms Battle],” 59th Scientific Conference of Postgraduate, Graduate and Undergraduate Students of Belarusian State University of Informatics and Radioelectronics, 2023, https://libeldoc.bsuir.by/bitstream/123456789/52018/1/Ahapkina_Primenenie%20%282%29.pdf
- 100 Abduljalil Abdurasulov, “Ukraine’s invisible battle to jam Russian weapons,” BBC, August 3, 2023, <https://www.bbc.com/news/world-europe-66279650>.
- 101 Sam Skove, “Another US precision-guided weapon falls prey to Russian electronic warfare, US says,” Defense One, April 28, 2024, <https://www.defenseone.com/threats/2024/04/another-us-precision-guided-weapon-falls-prey-russian-electronic-warfare-us-says/396141/>; “Russia is starting to make its superiority in electronic warfare count,” *The Economist*, November 23, 2023, <https://archive.is/aRlJm>.
- 102 Jack Watling and Nick Reynolds, “Stormbreak: Fighting Through Russian Defences in Ukraine’s 2023 Offensive,” Royal United Services Institute, September 2023, p.18, https://static.rusi.org/Stormbreak-Special-Report-web-final_0.pdf
- 103 Based on interviews conducted in Ukraine November 2023 and February-March 2024.
- 104 Valerii Zaluzhnyi, “Modern positional warfare and how to win in it,” Athena Lab, November 1, 2023, https://athenalab.org/wp-content/uploads/2023/11/ZALUZHNYI_FULL_VERSION-2.pdf
- 105 Jack Watling and Nick Reynolds, “Meatgrinder: Russian Tactics in the Second Year of Its Invasion of Ukraine,” Royal United Services Institute, May 19, 2023, <https://static.rusi.org/403-SR-Russian-Tactics-web-final.pdf>
- 106 Abduljalil Abdurasulov, “Ukraine’s invisible battle to jam Russian weapons,” BBC, August 3, 2023, <https://www.bbc.com/news/world-europe-66279650>; Jack Watling and Nick Reynolds, “Meatgrinder: Russian Tactics in the Second Year of Its Invasion of Ukraine,” Royal United Services Institute, May 19, 2023, <https://static.rusi.org/403-SR-Russian-Tactics-web-final.pdf>; Joe Barnes, “Russia’s electronic warfare tactics are helping it turn the tide against Ukraine,” *The Telegraph*, December 27, 2023, <https://archive.is/alvSv>; A.M. Akhapkina, V.D. Mozheiko, “Primenenie Sredstv REB v Obshevoiskovom Boiu [Application of EW Tools in Combined Arms Battle],” 59th Scientific Conference of Postgraduate, Graduate and Undergraduate Students of Belarusian State University of Informatics and Radioelectronics, 2023, https://libeldoc.bsuir.by/bitstream/123456789/52018/1/Ahapkina_Primenenie%20%282%29.pdf
- 107 Interviews with Ukrainian military personnel in Zaporizhzhia and Luhansk Oblasts.
- 108 Based on interviews conducted in Ukraine November 2023 and February-March 2024.
- 109 Natasha Bertrand, Zachary Cohen, and Alex Marquardt, “Russia’s Jamming of US-Provided Rocket Systems Complicates Ukraine’s War Effort,” CNN, May 6, 2023,
- 110 Lara Seligman, “Russia Jamming U.S. Smart Bombs in Ukraine, Leaked Docs Say,” POLITICO, April 12, 2023, <https://www.politico.com/news/2023/04/12/russia-jamming-u-s-smart-bombs-in-ukraine-leaked-docs-say-00091600?2>.
- 111 “The Airborne Forces Use Lesochek Electronic Warfare Systems to Protect Against Drones in the NOW Zone,” RIA Novosti, January 1, 2024, <https://ria.ru/20240104/spetsoperatsiya-1919650906.html>.
- 112 “Russian Tanks Received a Complex of Electronic Protection from FPV Drones,” RIA Novosti, August 16, 2023, <https://ria.ru/20230816/triton-1890353904.html>.



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