Russia's Use of Uncrewed Systems in Ukraine

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Abstract

The use of uncrewed system in the Ukraine conflict has profoundly affected the nature of combat operations by both sides. This report looks at the Russian military's use of uncrewed systems. It details what systems we expected to see in the conflict and which ones we have seen. It describes Russia's attempts to meet battlefield challenges with cheap inexpensive as well as foreign military drones.

Cover image: Russian soldier with Quadcopter, Aleksey Ramm, https://iz.ru/1414691/dmitrii-astrakhan/dron-sredi-iasnogo-neba-kak-bespilotniki-meniaiut-khod-svo.

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Executive Summary

- Consistent with Russian military doctrine, the Russian military has used uncrewed aerial vehicles (UAVs) extensively in intelligence, surveillance, and reconnaissance (ISR) operations in Ukraine. This has enabled them to play prominent roles in artillery, counter-battery, and precision strikes missions.

- While ISR drones play a central role in much of the Russian military's targeting process, it appears that the rate of response is slow, making it challenging to engage targets that are mobile.

- The lag in detection and targeting time highlights the lack of military-grade uncrewed combat aerial vehicles (UCAVs) in Russia's arsenal. These systems would enable a faster detection to kill time. While the Russian military is clearly investing in these systems as evidenced by military announcements before the war, they are not likely to appear on the battlefield anytime soon.

- Commercial drones have come to the fore in the Russia-Ukraine war to address pressing ISR needs and to serve as rudimentary loitering ammunitions. The Russian military and leadership were slow to accept the roles of the drones but are now encouraging their use by Russian forces.

- Despite the acknowledged importance of these drones, the Russian military industrial complex has been slow to produce them in the significant numbers required by Russian forces. Some of the lack of production likely comes from a lack of domestic capabilities, inter-organizational competition and lack of communication, and a lack of central Russian government leadership on this issue.

- One emergent solution to the commercial drone shortage is the rise of groups within Russia that are funding drones and drone parts for Russian units and acting as thought leaders in how to integrate and use commercial drones in military operations.

- Tactics, techniques, and procedures (TTPs) for using drones have been developed through experience on the battlefield. Observations of Russian and Ukrainian use of drones by domestic groups in Russia have prompted initiatives to provide Russian soldiers with standardized training and TTPs for drone use.

- Inexpensive commercial drones that are rigged with munitions are, in many ways, becoming more like munitions in their employment and loss rate; many are seen as expendable, single-use platforms for inflicting damage on military sites and platforms. This use has the added effect of making them expensive targets to counter for air-

defense systems, producing potential Ukrainian air-defense employment compromises between protecting military units and critical infrastructure.

- To address their military UAV challenges, the Russians are using Iranian-produced military drones extensively. With ranges in the hundreds of kilometers and antijamming systems, these drones have proved effective at targeting Ukrainian military platforms and critical infrastructure.

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Introduction

Uncrewed systems have played a major role in recent conflicts, and the Russia-Ukraine war is no exception. Uncrewed aerial vehicles (UAVs) in use by both sides have dramatically changed both how each conduct operations and the level of transparency exhibited in this conflict. Drone footage on social media platforms now plays a psychological role, undermining each side's sense of security. Small, commercially available drones, retrofitted with small bombs, can bring sudden, unexpected chaos and death to the battlefield away from the front line, while also providing surveillance and reconnaissance capabilities.

Keeping with a trend in militaries internationally, the Russian military has invested heavily in understanding the importance of uncrewed systems in modern warfare and devoted significant resources to their development. Prior to the war, the Russian military saw uncrewed systems playing a growing role in battlefield information gathering and management, support to command and control (C2), and the targeting process. For example, a year before the invasion, Russia's *Military Thought* (*Voennaya Mysl*), a military journal, published a review of combat drone use by several senior officers.[1] The responsibilities for drones, as stated in the article, include the timely identification of enemy field artillery positions, command posts, communication centers, strongholds, troop concentration areas, and training camps. Other responsibilities include timely infliction of return fire on enemy artillery platforms, effective destruction of exposed enemy targets, and "constant moral and psychological pressure and exhaustion" on the adversary from what the article refers to as "restless fire."

The Russia-Ukraine war has yielded both expectations and several surprises. Per Russian doctrine, we have seen the Russian military use UAVs in its sensor-to-shooter kill chain, referred to in Russian writings as reconnaissance and fire or strike complexes. We have also seen UAVs play a key role in the Russian military's battlefield awareness.

What has been unexpected is the prominence of both commercial and foreign UAVs in Russian military operations. Both sides have made extensive use of commercially available drones, modifying them for military purposes as needed. In addition, the Russian military has started using Iranian drones to make up for its lack of uncrewed combat aerial vehicles (UCAVs), the unexpected losses of UCAVs, and possible initial UAV shortages compared with the Russian Ministry of Defence's (MOD's) public statements leading up to the war. Given the clear

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[1] Alexander Nazarenko, Eduard Shakirzyanov, and Alexander Chogovadze, "UAV in reconnaissance and fire contours" (Александр Назаренко, Эдуард Шакирзянов, Александр Чоговадзе, БпЛА в разведывательно-огневых контурах), *Arsenal Otechestva* magazine, 5 (55): 2021.

importance of UAVs in the war, both sides will likely continue exploring new routes to maintain and improve upon their UAV fleets.

Methodology

CNA's Russia Studies Program has been monitoring and writing about Russian uncrewed systems for several years, and the methods used in previous studies were also applied here. The team relies on a wide range of open-source resources, mainly in Russian and Ukrainian. Some of these sources have been vetted over years, while others are new given the Russia-Ukraine war and the amount of transparency afforded to open sources. In particular, the research includes Russian-language Telegram channels covering the war. These have emerged as some of the most detailed sources on combat, force training and structure, weapons and technology, and tactics used by the Russian military in Ukraine. Specifically, several notable Telegram channels devoted to uncrewed aerial systems and vehicles (uncrewed aerial systems (UASs) and UAVs) are cited throughout the paper.

For this effort, the team also compared our pre-Ukraine war reports to what we are seeing in the current conflict. One of the main challenges with open-source reporting is that both sides of the conflict are using social media as a tool of information warfare to further their own narratives. This requires vetting and using multiple, corroborating sources where available. The team understands that some of the Russian-language social media sources likely have a bias in their reporting, even if they seem critical of official military policies and tactics. At the same time, this paper includes official state-sponsored media outlets such as RiaNovosti, Izvestia and Tass that include an increasingly detailed coverage of UAV development and use in the war.

We have exercised caution in using drone footage, making sure that it is, indeed, from this conflict and is genuine based on geolocation. Where possible, we relied on multiple independent sources, geolocation, and chronolocation when investigating uncrewed systems reporting.

This paper covers Russian use of UAVs while noting other uncrewed weapon types used by both sides. We recognize the existing and rapidly growing body of research on the use of uncrewed systems in Ukraine and have incorporated these data into our analysis. Given the importance of these developments to the US, its partners, and allies, this paper should be treated as preliminary and part of ongoing analysis of the development and impact of this technology in this war and in combat in general.

Russian Military Strategy and UAVs

Russian use of uncrewed systems in the Russia-Ukraine war got off to a slow start, likely because of the political decision to move rapidly on the capital, Kyiv, in the belief that the Ukrainian military and government would fall quickly.[2] This political decision, along with the likely belief that these systems would not be needed in significant quantities, may have led to a lack of planning or organization for their use, as well as the lack of evidence in initial reporting and media coverage of the Russian invasion. As the conflict moved into its more attritional stages, greater Russian use of uncrewed systems was in evidence in ways that the military had previously seen in exercises and discussed in its military journals. This section explains the primary ways Russia talked about using UAVs in a conflict such as Ukraine prior to the war. Following this doctrinal discussion, we focus on what we have seen in Ukraine, including which systems are in play and how they are being used.

The Russian Reconnaissance Strike and Fire Complex

One of the key roles for Russian UAVs in combat is to serve as critical links in real-time intelligence fusion and rapid target acquisition and destruction. Within the Russian military, this activity is referred to as reconnaissance-strike/reconnaissance-fire complexes, with strike and fire referring to operational and tactical operations, respectively. Broken down, the complex refers to different combinations of sensor and strike platforms that increase their accuracy and lethality by using linked information pathways and real-time battlespace awareness and intelligence fusion.[3] In many ways, these complexes incorporate the Western notion of conducting intelligence, surveillance, and reconnaissance (ISR) operations into a broader strike operation. The Russian military heavily emphasized these operations prior to the war, and they served as the cornerstone for Russian targeting. The Russian miliary

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[2] Olesya Gerasimenko, "They Just Drove in a Column, Like They Were Going to a Parade. How an Employee of Navalny's Headquarters Got into the War and Refused to Continue It" (Просто колонной ехали, как на парад. Как сотрудник штаба Навального попал на войну и отказался ее продолжать), BBC.com, May 12. 2022. https://www.bbc.com/russian/features-61415343.

[3] Lester W. Grau and Charles K. Bartles, The Russian Reconnaissance Fire Complex Comes of Age, University of Oxford, Changing Character of War Center, May 2018, https://www.ccw.ox.ac.uk/blog/2018/5/30/the-russian-reconnaissance-fire-complex-comes-of-age.

envisioned highly mobile maneuver units moving in noncontiguous battlespaces where time and battlefield information dominance were key to winning.[4]

The reconnaissance strike and reconnaissance fire complexes were evident in Russia's invasion and subsequent operation in eastern Ukraine in 2014–2015. This is especially true during and after Russia's transition from supporting separatists to actively joining the conflict with Russian military units in late August 2014.[5] Russian artillery and maneuver units would use Russian ISR UAVs, such as the Orlan-10 and Eleron-3 platforms, to coordinate artillery strikes against Ukrainian units.[6]

Unlike its operations in Ukraine in 2014, the Russian military has emphasized its use of UAVs in operations in Syria, given the overt nature of the Russian intervention. It has showcased examples of using UAVs to provide target designation and adjusting fire—all aspects of the reconnaissance-fire complex. In addition to specific operations, UAVs have been used for around-the-clock monitoring of areas of interest. [7] By July 2018, the Russian MOD claimed to have conducted 23,000 UAV missions with over 140,000 hours.[8] Much of this was in support of reconnaissance-fire operations against Syrian insurgent forces.

Prior to the invasion of Ukraine in February 2022, Russian state media reported that Iskander-M and Tochka-U long-range missile systems were enabling their own Orlan-10 drones and short-range quadcopters for improved ISR to detect and hit targets more effectively. The quadcopters were intended to be used for reconnaissance while missile complexes are on the move and to provide targets for the missile systems' deployment.

Leading up to the February 2022 Ukraine invasion, the Russian military had organized its drone fleet by companies that are divided into platoons delineated by the size and range of the UAVs they operate. This organization more easily facilitates C2 and maintenance. Although likely exaggerated by Russian sources, UAVs were claimed to be present across the Russian

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[4] V. Litvinenko and S. Voronkov, "Artillery Fire and Maneuver: The Role of New-Type Tactical Artillery Elements in Armed Conflicts of the Late-20th, Early-21st Centuries" (Роль артиллерии тактических формирований нового типа в вооруженных конфликтах конца XX - начала XXI), *Army Digest,* Feb. 2017, 34-38.
[5] Michael Kofman, Katya Migacheva, Brian Nichiporuk, Andrew Radin, Olesya Tkcheva, and Jenny Oberholtzer, *Lessons from Russia's Operations in Crimea and Eastern Ukraine*, RAND Corporation, 2017, https://www.rand.org/pubs/research_reports/RR1498.html, 33.
[6] Amos Fox, "The Russian-Ukrainian War: Understanding the Dust Clouds on the Battlefield," Modern War Institute at West Point, Jan. 17, 2017, https://mwi.usma.edu/russian-ukrainian-war-understanding-dust-clouds-battlefield/.
[7] "Russian Drones Conduct Round-the-Clock Control in Syria, Said Shoigu" (Российские беспилотники ведут круглосуточный контроль в Сирии, заявил Шойгу), Ria.ru, Oct. 27, 2017, https://ria.ru/20171027/1507669571.html.
[8] "Russian Drones During the Operation in Syria Spent in the Air More than 140 Thousand Hours" (Российские беспилотники во время операции в Сирии провели в воздухе более 140 тысяч часов), Official Website of the Russian MOD, July 6, 2018, http://syria.mil.ru/news/more.htm?id=12184627@egNews.

military force structure, with UAV company units based in motorized rifle, tank brigades and divisions, and separate reconnaissance brigades. There were UAV units in the artillery, engineer-sapper, missile, reconnaissance and railway brigades, with UAV squadrons also present in the Aerospace Forces. Russia's naval fleets also had UAVs serving in ISR roles. According to the MOD, ISR UAVs had become a part of all major Russian forces and formations—a fleet of around 2,000 drones and one of the largest operational drone fleets in the world.

Figure 1. Translated graphic showing Russia's concept of reconnaissance fire and reconnaissance strike concepts

Source: https://www.cna.org/reports/2022/02/russian-military-autonomy-in-a-ukraine-conflict.
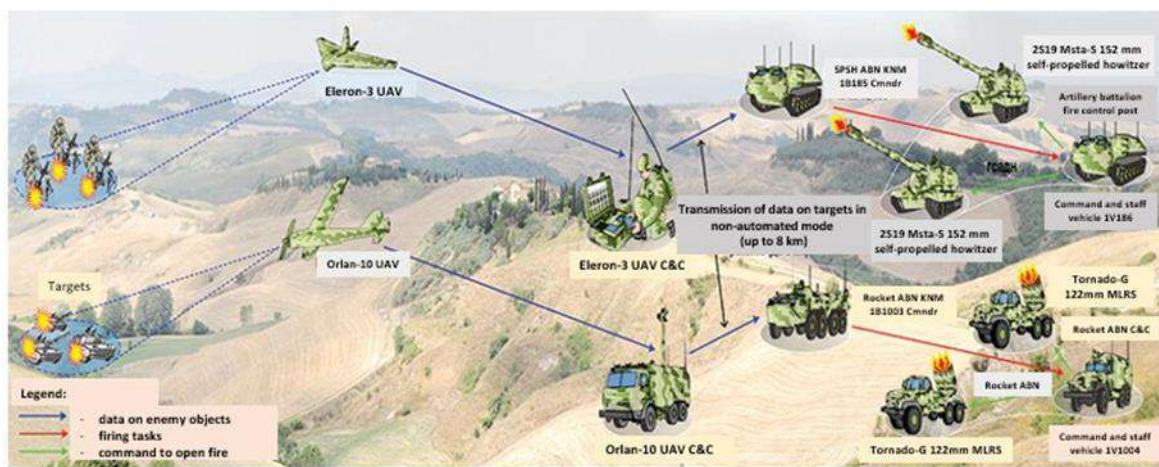
Much of the Russian concepts of strike and fire missions fit within broader Russian military concepts about battlefield information dominance. These types of missions, according to Russian military writings, depend on having a detailed understanding of the battlespace and having that understanding distributed across a "unified information space," wherein Russian units can strike high-value targets within the decision cycle of their adversary while also creating "disorganization" within its ranks.

Russian media outlets have highlighted the reconnaissance strike and reconnaissance fire complexes in Ukraine, noting the advanced equipment that has made them successful.[9] According to a source for one article,

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[9] Ria Novosti, "Strelets-M Provides High Accuracy of the Russian Aerospace Forces in Ukraine" (Источник: высокую точность ВКС России на Украине обеспечивает "Стрелец-М"), Ria.ru, June 7, 2022, https://ria.ru/20220607/strelets-m-1793625976.html.

> A UAV group detects the position of the MLRS in Ukraine, this data is sent via automatic communication systems to the command post, which decides on whether to strike and assigns an artillery battery [which] fires, and the drone assesses the defeat and corrects the fire.[10]

Russian media outlets also regularly highlight platforms such as Orlan-10 and Zala, Russian ISR drones, being used together with artillery and rocket systems to target Ukrainian systems.[11] In an interesting pairing of UAVs and tanks, TASS reported that Russian tanks were able to fire in indirect mode between 4-12 kms by using information provided by drones, perhaps real-time information used to adjust fire onto targets.[12]

But, as with Russian concepts for military operations, Ukraine has proven that translating complex concepts into practice is difficult at best. Separating the impact of political decisions from actual Russian military vulnerabilities is a continual challenge in assessing Russian military operations in the war. For reasons mentioned earlier, it does appear that the Russian military's ability to execute the reconnaissance strike complex, as envisioned in military writings, was severely challenged and not properly organized at the outset of the war. However, it has proven that it can coordinate artillery and drone use effectively, even if this is constrained by ammunition supplies.[13] For example, according to Ukrainian forces, the Orlan-10 was used as an ISR asset for incoming missiles, likely for battle damage assessment.[14] In addition, Iskander cruise missiles were observed along with Orlan-10s in Dnipropetrovsk in September 2022.[15] It is also evident that Russian forces have the ability to dynamically target—

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[10] Ria Novosti, "Russian Military Showed High Efficiency in Ukraine" (российские военные показали высокую эффективность на Украине), Ria Novosti, Apr. 7, 2022, https://ria.ru/20220407/effektivnost-1782204038.html.

[11] Aleksandr Pinchuk, "Self-propelled howitzers strike without fail "(Самоходные гаубицы бьют без промаха), Krasnaia zvezda, No. 77, July 18, 2022. https://dlib.eastview.com/browse/doc/78826190; Vladimir Linyov, "Uragans are destroying Ukrainian positions" («Ураганы» сносят позиции всу), Krasnaia zvezda, No. 76, July 15, 2022, https://dlib.eastview.com/browse/doc/78737752.

[12] "How a Special Operation in Ukraine Changed Russian Weapons and the Military-Industrial Complex" (Как спецоперация на Украине изменила русское оружие и оборонно-промышленный комплекс), TASS.ru, February 23, 2023. https://tass.ru/armiya-i-opk/17115401.

[13] Jack Watling and Nick Reynolds, *Ukraine at War: Paving the Road from Survival to Victory*, RUSI, July 2022, https://rusi.org/explore-our-research/publications/special-resources/ukraine-war-paving-road-survival-victory.

[14] "Enemy 'Orlan-10' UAV Shot During Russian Rocket Attack in Kyiv Region" (В КИЕВСКОЙ ОБЛАСТИ ВО ВРЕМЯ РАКЕТНОЙ АТАКИ РФ СБИТ ВРАЖЕСКИЙ БЕСПИЛОТНИК "ОРЛАН-10"), TSN.ua, Dec. 31, 2022, https://tsn.ua/ru/ato/v-kievskoy-oblasti-vo-vremya-raketnoy-ataki-rf-sbit-vrazheskiy-bespilotnik-orlan-10-2234683.html.

[15] "AFGU shot down three cruise missiles over Dnipropetrov region, (ВСУ СБИЛИ ТРИ КРЫЛАТЫЕ РАКЕТЫ НАД ДНЕПРОПЕТРОВЩИНОЙ), Novosti.dn.ua, Sept. 16, 2022, https://novosti.dn.ua/ru/news/332012-vsu-sbili-tri-krylatye-rakety-nad-dnepropetrovshhinoj.

to engage targets of opportunity that were not on the original mission—but that their time to engage is slow.[16]

Regarding response times, some Russian reports are asserting that the main difference between the use of commercial drones by Russian and Ukrainian forces is quadcopter integration into each forces echelons and command-and-control systems. According to these reports, Russian drones are used at the battalion or below. In contrast, Ukrainian forces broadcast in real time the received data from a drone to a higher command and control level and, as a result, artillery strikes against identified targets are much faster.[17]

Figure 2 on the next page displays a translation of a graphic from a Russian professional military journal detailing one specific organization for conducting reconnaissance fire and strike operations. As we detail below, we have seen parts of this scheme executed by the Russian military in Ukraine. For example, we have seen the use of UAVs for extending C2 and the enabling of artillery by UAV ISR missions.

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[16] "The Ministry of Defense Showed the Work of the Orlan-10 Complex in the SVO" (Минобороны показало работу расчета БПЛА «Орлан-10» в зоне проведения СВО), Iz.ru, Dec. 2, 2022. https://iz.ru/1434536/2022-12-02/minoborony-pokazalo-rabotu-rascheta-bpla-orlan-10-v-zone-provedeniia-svo.

[17] Game of Drones Telegram Channel, December 22, 2022. https://t.me/droneswar/5218.

Figure 2.   Translated graphic of Russian reconnaissance-fire and reconnaissance-strike concepts
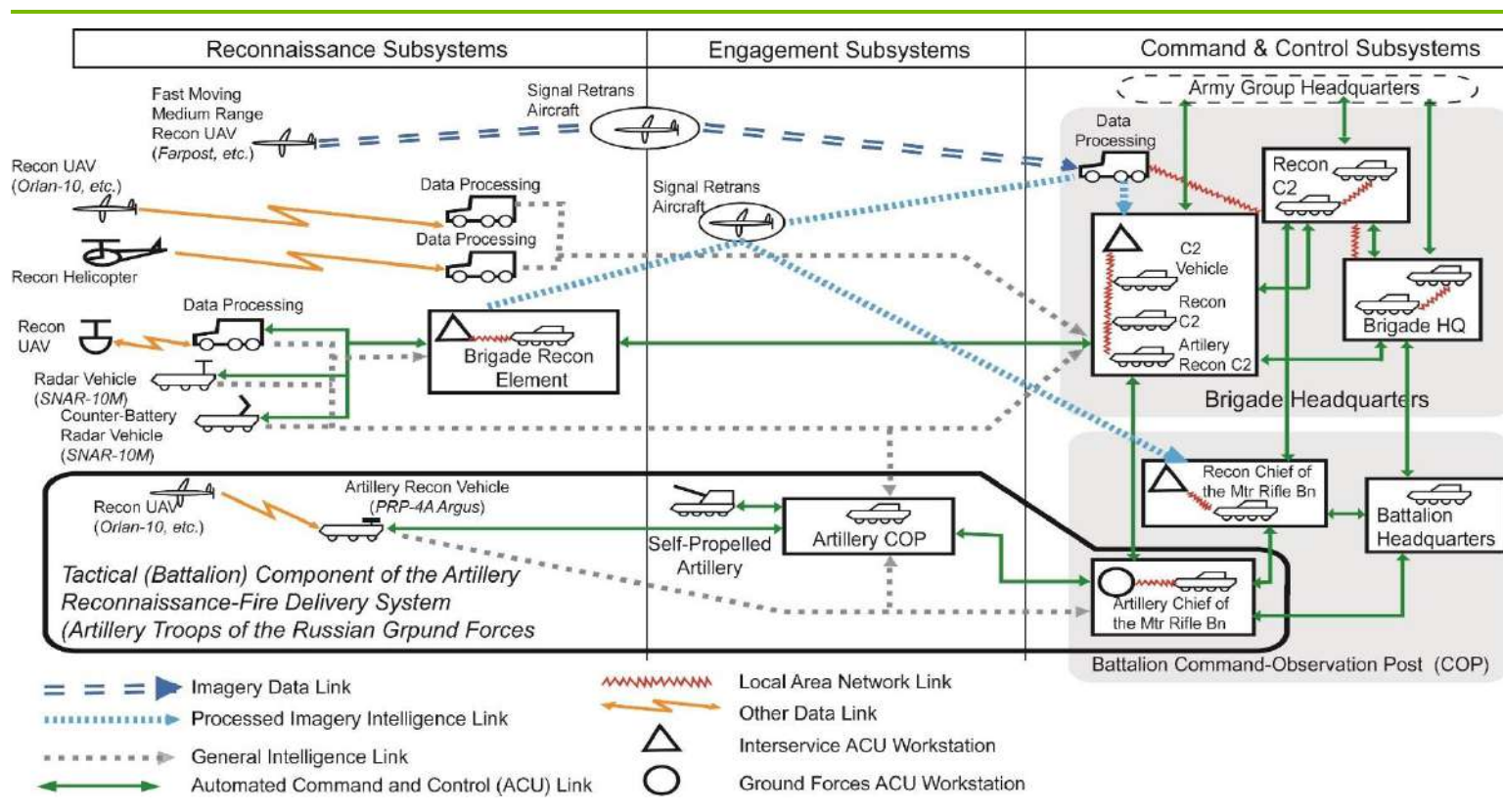
Source: CNA reproduction of graphic from Litvinenko and Voronkov, also found in Grau and Bartles. (V. Litvinenko and S. Voronkov, "Fire and Artillery Maneuvers: The Role of Artillery of Tactical Formations of a New Type in Armed Conflicts of the Late XX–Early XXI Centuries," Огонь и маневр артиллерии: Роль артиллерии тактических формирований нового типа в вооруженных конфликтах конца XX - начала XXI в.в, Armeiskii Sbornik, no. 2 (2017), https://varb.mil.by/nauka/sbornik/Sbornik_31-2016.pdf; Lester Grau and Chuck Bartles, *The Russian Reconnaissance Fire Complex Comes of Age*, The Foreign Military Studies Office, U.S. Army, 2018).

This section has provided a brief overview of how the Russian military talked about the integration of uncrewed systems into their central military concepts for fighting. In the following sections, we will discuss what systems Russia took to the fight, how these systems have been used, the challenges the Russian military has faced, and the steps it is taking to mitigate those challenges.

Russian Attacks Against Critical Infrastructure

Another Russian military doctrinal mission that has come to the forefront of the war is Russia's targeting of Ukraine's critical infrastructure with ballistic and cruise missiles and drones such as the Iranian Shahed-131 and 136. The Russian military has five *strategic operations* that are intended to link operational actions with Russian military strategy.[18] One of these operations is the *strategic operation for the destruction of critically important targets* (SODCIT). SODCIT is defined as the following:

> The creation of conditions to counter threats and prevent aggression and, in the case of the beginning of military action, the infliction on the adversary (the coalition) of damage, during which they would give up the continuation (escalation) on conditions beneficial to Russia. The infliction of necessary damage to the adversary could be achieved through damaging key targets of military and military-economic potential of the adversary to a level, the achievement of which the adversary could discontinue (the escalation of) military actions.[19]

While SODCIT is thought of as occurring mostly just before or during the beginning stages of a conflict, the targeting of critical infrastructure with the intent of deterring further action fits within the purview of SODCIT. Although attempting to undermine Ukraine's will to continue in the war, it also creates conditions for the long-term weakening of Ukraine's defense and economic viability. These strikes are also intended to make Ukraine reliable on the West (and, therefore, a burden) and to weaken the West's resolve in supporting Ukraine.[20]

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[18] Michael Kofman, Anya Fink, Dmitry Gorenburg, Mary Chesnut, Jeffrey Edmonds, and Julian Waller, *Russian Military Strategy: Core Tenets and Operational Concepts*, CNA, Aug. 2021, https://www.cna.org/reports/2021/08/russian-military-strategy-core-tenets-and-operational-concepts.

[19] V. Roldugin and Yu. Kolodko, "General Elements of the Methodology of Selection of Combinations of Adversary Critical Objects for Strikes," (Общие положения методики выбора поражаемых комбинатций критически важных объектов противника,) Strategic Stability, no. 4 (2014).

[20] Natalya Prikhodko, "Critical Infrastructure of Ukraain Subjected to Missile Crash Test," Nezavesimaya, Oct. 10, 2022, https://www.ng.ru/cis/2022-10-10/1_8561_ukraine.html.

Russian Military UAVs in the Ukraine War

The Russian military had developed a diversified fleet of UAVs prior to the Russia-Ukraine war. Most of these systems were designed for ISR, but the production of UCAVs lagged that of ISR drones given their more sophisticated designs. Table 1 shows Russian-produced UAVs that have seen service in Ukraine, along with their role and operational range.

Table 1.   Russian-made UAVs used in Ukraine

Name	Function	Range (in km)
Eleron-3	ISR	30
Orlan-10	ISR and combat	120
Orlan-30	ISR	300
Korsar	ISR and combat	250
Takhion	ISR	40
Zastava	ISR	10
Zala variants	ISR	15-100
Granat variants	ISR	10-70
Lastochka	ISR and combat	25
Kartograf	ISR	120
Sibir-1 quadcopter	ISR	10
Griffon quadcopter	ISR	10
Forpost	ISR and combat	250
Orion	ISR and combat	250
KUB	Loitering munition	40
Lancet variants	Loitering munition	40 [21]

Source: CNA Internal database.

The main role for most of the Russian drones is providing ISR and battle damage assessment capabilities to the Russian ground forces, including Rosgvardia units and Wagner PMC (private military corporation) formations. Russian platforms that support this role include Eleron-3, Takhion, Orlan-10 and Orlan-30, and the Zala and Granat UAVs. As of December 2022, despite their depleted numbers, the Orlan-10, with a range up to 120 kilometers, was still supporting targeting for Russian artillery, mortar, and Multiple Launch Rocket System (MLRS) forces. Russia's tactical ISR capability is also provided by many commercial drones, discussed in a later

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[21] From CNA's database on uncrewed systems in Ukraine.

section. Enabling these ISR capabilities by replacing drones lost to Ukrainian air defenses and electronic warfare (EW) is now one of the MOD's priorities.

The Orlan-30 plays an important role in Russian military operations, specifically in the use of precision-guided munitions. With its laser designator-rangefinder, it can accurately illuminate targets for guided munitions, such as 240-mm Smelchak mines from Tyulpan mortars, or 152-mm Krasnopol shells fired by artillery.[22] The Russian media started publishing videos of Orlan-30 integration into Russian artillery starting in November 2022, but use of Krasnopol artillery shells for strikes could be identified visually as early as March 2022.[23] This suggests that an illuminator platform was deployed with Russian units within the first weeks of the war.

Published videos from Russian journalists show Orlan-30-enabled Krasnopol strikes on US-provided M777 howitzers in service with the Ukrainian forces.[24] Public sources also indicate that the Orlan-30 can be equipped with 80-megapixel cameras with image stabilization system and equipment for electronic intelligence, including the detection of communication devices.[25] While the Orlan-10 numbers were estimated in the hundreds throughout the Russian force structure, there are no accurate estimates of Orlan-30 numbers, which are likely to be small.

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[22] "Ukrainian Military Captured Orlan-30, the Most Modern Russian Drone," (ВСУ захватили самый современный дрон РФ "Орлан-30": в чем его особенности), Focus.ua, Aug. 6, 2022, https://focus.ua/digital/524625-vsu-zahvatili-samyy-sovremennyy-dron-rf-orlan-30-v-chem-ego-osobennosti.

[23] "'Krasnopol' Projectiles Hit Targets when Adjusted with Orlan-30 UAV" (Снаряды «Краснополь» поражают цели при корректировке БПЛА «Орлан-30»), Anna-news.info, Nov. 9, 2022. https://anna-news.info/snaryady-krasnopol-porazhayut-tseli-pri-korrektirovke-bpla-orlan-30/.

[24] Military Correspondent Sladkov Estimated the Power of Strikes via Russian Orlan-30 Drone" (Военкор Сладков оценил мощность ударов российского беспилотника «Орлан-30»), Lenta.ru, Nov. 24, 2022, https://lenta.ru/news/2022/11/24/sladkov/.

[25] "Ukrainian Military Captured Orlan-30."

Figure 3.   Russian chart depicting the Russian-made Orlan-30

Многоцелевой БПЛА «Орлан-30»

- Макс. скорость 170 км/ч
- Дальность 300 км
- Продолжительность полёта 5 часов
- Может использоваться как ретранслятор
- Наводит на цель авиацию и артиллерию
- Высота полёта 4500 м
- Макс. взлётная масса 27 кг
- Полезная нагрузка
  ► фотокамеры
  ► видеокамеры
  ► тепловизоры

Source: 47 News, "The New 'Orlan-30" Will Indicate Targets for Corrected Projectiles and Air Bombs with a Laser" (Новый "Орлан-30" лазером укажет цели для корректируемых снарядов и авиабомб), Feb. 10, 2019, https://47news.ru/articles/163080/.

The Russian military went into Ukraine with a limited number of mid-range Forpost-R and Orion combat drones. With probably no more than several dozen in service, they had limited impact on Russia's initial operations. Despite combat capabilities, both drones fly primarily as ISR platforms, especially Forpost, which was first fielded in 2012. Their combat capabilities were tested on a limited scale in Syria and in Russia's domestic drills and exercises.[26] Both drones have a range out to 250 kilometers, and although they worked well for the Russian military against antigovernment forces in Syria, they are not equipped with robust defenses, making them vulnerable to Ukraine's counter-drone and air defense systems. After some initial combat sorties, the Forpost-R and Orion drones now seem confined to ISR missions because of

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[26] "Russia's Forpost UAV is Lost in Syria" (Российский беспилотный летательный аппарат "Форпост-Р" потерян в Сирии), BMPD blog, Aug. 4, 2021. https://bmpd.livejournal.com/4365482.html.

their initial low numbers and concerns over further UAV losses if used on attack missions, according to a Russian MOD broadcast. [27]

Other combat UAVs used in Ukraine include the armed Orlan-10 and the new Lastochkla light drone, both capable of dropping small unguided munitions. Orlan-10 is chiefly an ISR platform, rudimentary and cheap, but can be modified to deliver a modest combat payload. However, Russian media highlighted the armed version of these drones only a few times during May, June, and July 2022. Orlan-10's combat role was first revealed in late 2021 and presented the possibility of enabling additional combat capacity by perhaps hundreds of drones, augmenting a limited but growing Russian UCAV fleet. However, there is no evidence that the Russian military has such capacity after sustaining significant Orlan-10 losses during the first 10 months of its invasion of Ukraine.

The Orion combat drone's arsenal includes an air-launched version of the Kornet antitank guided munition known as the Kh-BPLA as well as the KAB-20 guided bomb.[28] The Orion was also observed in Syria deploying OFAB-100-120 "dumb" bombs.[29] These same weapons are used on the Forpost-R. Military observers note that the use of the KAB-20 falls far short of achieving the accuracy of munitions such as the Turkish MAM-L used on its UAVs.[30]

At the time of this report, there is evidence that Russia's highly secret Korsar drone used for ISR, strike, and electronic attack missions has seen service in Ukraine, with one downed in November.[31] Despite their appearance on the battlefield, these combat drones have not been produced in large numbers by Russia.[32]

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[27] "Game of Drones," Russian Telegram channel, https://t.me/droneswar/2538, July 28, 2022.

[28] Oryx, "Nascent Capabilities: Russian Armed Drones over Ukraine," Apr. 7, 2022. https://www.oryxspioenkop.com/2022/04/nascent-capabilities-russian-armed.html.
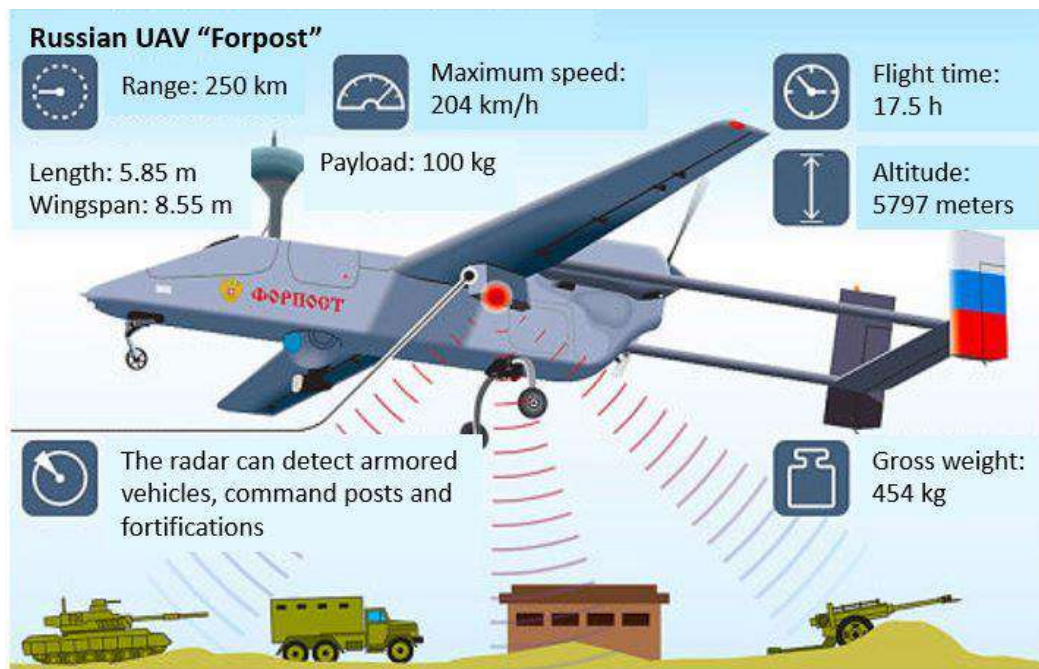
[29] Oryx, "Nascent Capabilities."

[30] Oryx, "Nascent Capabilities."

[31] Focus, "Piece by Piece: The Armed Forces of Ukraine Shot Down a Rare Russian Drone 'Korsar,'" (Поштучное количество: ВСУ сбили редкий российский беспилотник "Корсар"), Focus Online, Nov. 10, 2022 (focus.ua).

[32] "UZGA Took the Corsair UAV under Its Wing: The Motors Will Be Taken out of the Cabinet" (УЗГА взял БПЛА "Корсар" под крыло: моторы достанут из шкафа), MashNews.ru, March 3, 2021, https://mashnews.ru/uzga-vzyal-bpla-korsar-pod-kryilo-motoryi-dostanut-iz-shkafa.html.

Figure 4.   Russian graphic depicting the Forpost UAV

Russian UAV "Forpost"

- Range: 250 km
- Maximum speed: 204 km/h
- Flight time: 17.5 h
- Length: 5.85 m
- Wingspan: 8.55 m
- Payload: 100 kg
- Altitude: 5797 meters
- The radar can detect armored vehicles, command posts and fortifications
- Gross weight: 454 kg

Source: https://vpk.name/news/204840_dron-razvedchik_zaglyanet_pod_oblaka.html.

Although the Russian military produced concepts for the high-altitude, long-range Altius and Okhotnik combat drones, both exist as single models undergoing state testing and evaluation and are highly unlikely to appear in Ukraine any time soon. Their serial production is scheduled for 2023 to 2025, with the possibility of further delays because of ongoing Western sanctions against Russian defense and high-tech industries.[33] The Altius was scheduled to enter service in the fall of 2021.[34] Kronshtadt Enterprise, Orion's manufacturer, inaugurated a factory in Dubna, outside of Moscow, which is supposed to come online later this year to produce military drones around the clock starting in 2024.[35] Interestingly, there has been no indication from

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[33] "Source: Okhotnik Drone Used Su-57 Guided Missiles in Tests" (Источник: дрон "Охотник" применил на испытаниях управляемые ракеты от Су-57), Ria.ru, May 28, 2022, https://ria.ru/20220528/okhotnik-1791355512.html.

[34] "Serial Deliveries of Altius Strike Drones to Begin in 2021—Manturov" (Серийные поставки ударных беспилотников "Альтиус" начнутся в 2021 году – Мантуров), MilitaryNews.ru, Aug. 22, 2021, https://www.militarynews.ru/story.asp?rid=1&nid=555675&lang=RU.

[35] Drone Production Facility Outside Moscow to Get into Top Gear in 2024," Tass.com, Feb. 1, 2022, https://tass.com/defense/1395835.

Forpost-R's manufacturer, UZGA, that it is increasing its production output substantially to meet wartime demand.

Figure 5.   Lancet-3 loitering munition

Беспилотник «Ланцет–3»

110 км/ч
максимальная скорость

12 кг
максимальная взлёт-ная масса

3 кг
полезная нагрузка

Оснащён несколькими типами систем наведения: координатный, с помощью оптикоэлектронных средств и комбинированный

40 км
радиус поражения целей

Оснащён телевизионным каналом связи, который передаёт изображение цели, что позволяет подтвердить успешность поражения

ЦЕЛЕВЫЕ НАГРУЗКИ

Тепловизор и видео-камера

Газоанализатор и видеокамеры

Система оповещения

Видеокамера, тепловизоры, лазерный целеуказатель

Дозиметр и видео-камера

The Russian military has used KUB and Lancet loitering munitions (also referred to as "kamikaze" drones) in Ukraine. As of October 2022, according to Russian sources, the Russian military had used several hundred KUB and Lancet drones against Ukrainian anti-aircraft systems, radar stations, and personnel since the beginning of the war.[36]

Russa-based military experts note that drones such as Lancet achieve maximum efficiency when used in tandem with a reconnaissance UAV, such as the Orlan-10 or Zala drones. The ISR drones can stay at a higher altitude and detect targets, transmitting coordinates to the operators of the "kamikaze" drone, who manually bring the drones into striking position.[37] The

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[36] Источник раскрыл данные о применении российских дронов-камикадзе на Украине, Ria.ru, Oct. 20, 2022, https://ria.ru/20221020/svo-1825258182.html.

[37] Военный обозреватель назвал особенности беспилотника «Ланцет», Iz.ru, Oct. 21, 2022, https://iz.ru/1413513/2022-10-21/voennyi-obozrevatel-nazval-osobennosti-bespilotnika-lantcet.

Russian military appears to be using Lancet drones with greater frequency as of December than at the beginning of the war, with sources claiming that the MOD has ordered 1,500 of them to frontline forces in October.[38] Reports are suggesting that this system is playing a key role in targeting Ukrainian artillery positions.[39] But these drones are not without vulnerabilities; for example, videos show these types of drones getting caught up and disabled in wooded areas.[40]

In addition, the Russian military is starting to field domestic heavy quadcopters, including larger drones for signals retransmission. In November 2022, the MOD released a video of soldiers using Sibir-1 and Griffon heavy quadcopters, noting that these drones carry repeaters that expand the communication coverage area, increasing C2 and enabling greater unit mobility. According to the MOD, using these drones as communication relays allows Russian forces to increase the security and survivability of their communication, as well as to increase data transmission in hard-to-reach areas.[41] It is not clear how many of these quadcopters are currently in Ukraine and what the Russian production capacity is for scaling up their deployment in the war. At the same time, their appearance is evidence of the Russian defense-industrial complex adapting and providing increased uncrewed capacity needed by their ground forces.

Finally, the Russian military is using its aerial drones for EW, most notably the Leer-3 EW modification of the Orlan-10 UAV, to jam Ukrainian mobile communications. While there was evidence of this modification's active use in eastern Ukraine between 2014 and 2021, there were only a few public appearances of this drone's use in Ukraine after February 2022, possibly because of low numbers or the relatively classified nature of its operations.[42]

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[38] Rybar, Telegram, https://t.me/rybar/40462.

[39] Starshe Eddy Telegram Channel, February 19, 2023, https://t.me/vysokygovorit/10805.

[40] "Russian Lancet Loitering Munition Perched on a Tree," YouTube.com, Dec. 24, 2022, https://www.youtube.com/watch?v=R2xOJPOk-zc.

[41] "The Russian Ministry of Defense Showed Footage of the Central Military District's Drones Used in Ukraine" (Минобороны РФ показало кадры применения беспилотников ЦВО в зоне спецоперации), Tass.ru, Nov. 3, 2022, https://tass.ru/armiya-i-opk/16234817.

[42] "Russian Troops Using Leer-3 Able to Jam Ukrainian Army Mobile Phone Signals Within 30 km," ArmyRecognition.com, Oct. 20, 2022, https://www.armyrecognition.com/defense_news_october_2022_global_security_army_industry/russian_troops_using_leer-3_able_to_jam_ukrainian_army_mobile_phone_signals_within_30_km.html; Matthew Roscoe , WATCH: Russian Armed Forces using Leer-3 complex to jam Ukrainian communications, EuroWeeklyNews.com, Oct. 19, 2022. https://euroweeklynews.com/2022/10/19/russian-leer-3-complex-jam-ukrainian-communications/.

Military-Industrial Challenges to Drone Production

The Russian military-industrial complex is still trying to match UAV production with need. This shortcoming is well known by the Russian leadership with Dmitry Medvedev, deputy chairman of Russia's Security Council, noting the urgent need for military drones given their effectiveness.[43] Despite statements by government officials, certain entrenched shortcomings exist in the Russian defense industry that are proving challenging to overcome. These issues existed well before the February 2022 invasion but have been brought to light and made critical by the Russia-Ukraine war.

Some insight into UAV production issues comes from the MOD itself. A recent admission by the MOD is that most of the drones produced in Russia currently do not meet MOD's tactical and technical requirements.[44] The main issue, according to the MOD, is a weak "element base"—the sum of quality, manufacturing capacity, and availability of microelectronics, sensors, and other key systems that enable drones to function well in a combat environment. As a result, the Russian military is forced to acquire simplified models and technologies.[45] While public self-criticisms are not unknown with the Russian military, this statement struck us as particularly revealing and is likely the result of significant Russian UAV losses in Ukraine, their perceived inability to provide enough capacity for the Russian military, and the public knowledge of these shortcomings.

In a November 21, 2022, interview, the director of a Russian non-state organization that delivers supplies to the Russian forces suggested that while the military-industrial complex knew of the advantages of smaller quadcopters, it either did not have adequate resources or direct government orders to mass produce small drones.[46] As a result, Russia was trying to produce heavier, more specialized military drones such as Orlan-10, Eleron, Zala Aero, or other products.

Russia currently has several major drone manufacturers, including Eniks, Special Technologies Center, Zala (part of Rosetc), Uzga, and Kronshtadt. These companies produce most of the

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[43] "Russia to Launch Mass Production of Effective Drones," Medvedev, Tass.com, Oct. 14, 2022, https://tass.com/defense/1523079.

[44] "The Russian Ministry of Defense Said That Most Domestic UAVs Do Not Meet Its Requirements" (В МО РФ заявили, что большинство отечественных БЛА не удовлетворяют требованиям ведомства), Tass.ru, Sept. 27, 2022, https://tass.ru/armiya-i-opk/15885129.

[45] "The Russian Ministry of Defense said that most domestic UAVs do not meet its requirements."

[46] Vladimir Orlov, "Veche: Second Wave Is Inevitable—Instead of Just Three Hundred Thousand, Two Million Are Needed" («Вече»: «Вторая волна мобилизации неизбежна – нужно не 300 тысяч, а 2 миллиона»), Veche-info.ru, Nov. 21, 2022, http://veche-info.ru/news/9453.

drones flown by the Russian military. All are affected by the sanctions in one way or another and, despite earlier government and MOD decrees calling for completely domestic production of key components, they still rely on non-Russian key parts to produce their UAVs.[47] It is also not clear to what extent these UAV manufacturers are cooperating with one another to close any technological or capacity gaps that may exist. According to Russia-based UAV experts, one of the main obstacles to additional, high-quality UAV products is the fragmented approaches of Russian developers to UAV production.[48] Other Russia-based automation and robotics experts lament the fact that while Russia's defense-industrial complex can in fact develop needed technology, it is then "shelved" because of the lack of further funding or perhaps even interest from the MOD.[49]

According to Yuri Molodykh, the director of the center for the development of competition systems at the National Technology Initiative (NTI), the biggest challenge for Russian developers is scaling up production—switching from UAV test samples to mass production. It requires the creation of large-scale drone production mechanisms that Russian industry is challenged to produce.[50]

In contrast to the MOD, Evgeny Prigozhin, owner of the Wagner private military corporation, and Dimitry Rogozin, former head of Roskosmos, have announced efforts to develop and deliver drones to Russian forces in Ukraine from small, private-sector companies that may already have the necessary products.[51] Prigozhin's Wagner, a private military corporation, is launching hackathons to come up with the best way to operate commercial drones like DJI in an electromagnetic spectrum (EMS)-challenged environment.[52] Although at nascent stages, these efforts may influence the MOD to explore new avenues of procurement and drone

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[47] James Byrne, Gary Somerville, Joe Byrne, Jack Watling, Nick Reynolds, and Jane Baker, *Silicon Lifeline*, RUSI, Aug. 2022, https://static.rusi.org/RUSI-Silicon-Lifeline-final-web.pdf.

[48] "By Single Regulation: Results of the Session on Robotics at Interpolitech" (Регулированием единым: Итоги сессии по робототехнике на "Интерполитехе"), Aeronext.aero, Oct. 24, 2022, https://aeronext.aero/press_room/news/212194.

[49] "Evgeny Dudorov: Russia's Robotics Needs a Revolution—There Is No Time for an Evolution" (Евгений Дудоров: робототехнике РФ нужна революция, на эволюцию времени нет), Ria.ru, Dec. 12, 2022, https://ria.ru/20221212/dudorov-1837506676.html.

[50] UAV Observer (Обозреватель БПЛА) Telegram Channel, January 3, 2023, https://t.me/dronesrussia/20940.

[51] "Rogozin Announces That Drones Will Be Developed for DNR and LNR" (Для войск ДНР и ЛНР планируется создать свои БПЛА, заявил Рогозин), RIA.ru, Nov. 12, 2022, https://ria.ru/20221112/rogozin-1831055022.html; "'PMC Wagner Center' from the Inside—Today Is the Opening of a High-Tech Complex" («ЧВК Вагнер Центр» изнутри — сегодня состоялось открытие высокотехнологичного комплекса), Nov. 4, 2022, https://www.youtube.com/watch?v=Q_QCOf3aT7k.

[52] UAV Observer Telegram channel, Dec. 11, 2022. https://t.me/dronesrussia/20803.

operation. With the recent admission by President Putin that Russia's war in Ukraine can be a "long-term process," a focus will certainly be on the country's domestic drone industry.[53]

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[53] "Putin Admits Ukraine War Could Be Lengthy," DW.com, Dec. 8, 2022, https://www.dw.com/en/putin-admits-ukraine-war-could-be-lengthy/video-64022908.

Acquisition, Integration, and Use of Commercial Drones

At the outset of the Russo-Ukrainian war, it quickly became clear that commercial drones were going to play an important role in the operations of both militaries. The Russian military and industrial complex, however, faced challenges in meeting this need because of a reluctance to accept the role of commercial drones and their difficulty in producing them once their value became evident. Cheap and easy drones, like the Chinese-made DJI Mavic, rapidly became some of the most sought-after and popular ISR platforms in the war.

The Russian military and industrial complex's lagging ability to supply numerous, smaller commercial drones prompted privately funded movements within Russia to send these systems to soldiers at the front. After months of Telegram-based reporting by volunteers on quadcopter use, official Russian state media followed suit in praising military use of commercial quadcopters. One publication referred to the use of commercially available drones as a "revolution from below and a very rare case for conservative military circles," likely referring to the Russian military community's usual skepticism of commercial technologies for military use.[54]

There is no lack of Russian commentors and military experts trying to understand the impact of commercial drones on current and future combat operations. In a November 21, 2022, interview, the director of a Russian non-state organization that delivers supplies to the Russian forces argued that today's modern armies were simply not ready for the "Mavic phenomenon, "[referring to the widespread use of the Mavic Chinese drones] and had not imagined that these quadcopters would be needed in such volumes.[55]

Acquisition of Commercial Drones to Address Gaps

The recent admission by Deputy Prime Minister Borisov that Russia was late to the drone game but is rapidly catching up in all UAV capabilities is doing little to improve the Russian military's

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[54] Dmitry Astrakhan, "Drone Amidst the Clear Sky: How Drones Change the Course of the Special Military Operation" (Дрон среди ясного неба: как беспилотники меняют ход СВО), Iz.ru, Oct. 24, 2022, https://iz.ru/1414691/dmitrii-astrakhan/dron-sredi-iasnogo-neba-kak-bespilotniki-meniaiut-khod-svo.

[55] Vladimir Orlov, "Veche: Second wave is inevitable."

situation on the ground.[56] There are examples of Russian soldiers expressing concern that they are lacking the tactical ability to view the battlespace even up to several kilometers from their positions. First voiced over Telegram channels by Russian bloggers on the ground in Ukraine, the concern over this gap has since migrated to the public domain, with Russian regional newspapers publishing accounts of Russian forces stating they are like "blind kittens" at the front because of a lack of tactical ISR assets.[57] In December 2022, the state-sponsored Tass national newspaper quoted a Russian soldier stating that more quadcopters are necessary at the front in order to locate Ukrainian forces, supporting the claim that the Russian military is lacking these key platforms.[58]

In late November 2022, multiple pro-Russian Telegram channels, run by volunteers who fundraised and delivered quadcopters to the troops, raised an alarm that the Chinese-made drones they are importing from China are being held up at the border by the Russian Customs office. The Russian bloggers publicly accused the government and the MOD of throwing up administrative barriers that prevented the delivery of drones to front-line forces.[59] Some volunteers even went so far as to say that "someone" in the Russian government was trying to establish a monopoly on drone imports and deliveries after the Russian president urged better and faster equipment for the Russian forces in Ukraine. The same volunteers went on to assert that the cumbersome MOD bureaucracy is incapable of quickly solving the problems with equipment the way volunteers can.[60] As evidence of the influence of these pro-Russian Telegram channels, the Russian Customs office made a public statement the following day on its steps to resolve this situation.[61]

Table 2.   Commercial drones used by Russian forces in Ukraine

Name	Type	Function	Country of Origin
DJI Mavic 3	Quadcopter	ISR	China
DJI Mavic 2 Pro/Zoom	Quadcopter	ISR and light combat	China
DJI Mavic 2 Enterprise Advanced	Quadcopter	ISR and light combat	China
DJI Air 2S	Quadcopter	ISR	China

[56] "Borisov Said That Russia Has Almost All Types of Drones" (Борисов заявил, что у России есть практически все типы беспилотников), Tass.ru, June 13, 2022, https://tass.ru/armiya-i-opk/14894783.

[57] Бюджет Бурятии потратят на прицелы и квадрокоптеры для «спецоперации», June 30, 2022, https://tayga.info/178163   Other similar complaints about lack of ISR: https://www.bbc.com/russian/features-61415343 ; https://www.golosameriki.com/a/6688347.html.

[58] "The Participant of the Special Operation Reported a Shortage of Quadcopters" (Участник спецоперации сообщил о нехватке квадрокоптеров), Tass.ru, Dec. 5, 2022.

[59] UAV Observer (Обозреватель БПЛА) Telegram channel, Nov. 26, 2022. https://t.me/dronesrussia/20663.

[60] UAV Observer (Обозреватель БПЛА) Telegram channel, Nov. 26, 2022.

[61] UAV Observer (Обозреватель БПЛА) Telegram channel, Nov. 27, 2022 https://t.me/dronesrussia/20667.

Name	Type	Function	Country of Origin
DJI Mini 2/3 Pro	Quadcopter	ISR	China
DJI Matrice 300 RTK	Quadcopter	ISR and light combat	China
DJI Matrice 30T	Quadcopter	ISR and light combat	China
Autel Evo variants	Quadcopter	ISR and light combat	China

Source: CNA.

A specific example of Russia's difficulty in producing commercial drones is the Dobrynya drone, Almaz-Antey's new commercial quadcopter that can be potentially converted to military use. With Almaz-Antey as one of the key Russian defense enterprises, its highly likely that this drone will eventually be delivered to the Russian armed forces now that the company claims it can mass-produce the Dobrynya.[62] But Dobrynya's unveiling in late November-early December 2022 generated sharp criticism from Telegram-based drone volunteers, enthusiasts, and experts, who saw in a Russian frame a Chinese-made Flight Nazgul5 Evoque F5 racing copter.[63]

The Center for Analysis of Strategies and Technologies (CAST), one of Russia's more prominent and authoritative military think tanks, noted that Russia is critically dependent on China as a whole and on Chinese manufacturing companies for the supply of both "Mavic-like" small UAVs and their components.[64] CAST noted that the quadcopter's basic equipment will naturally be Chinese-made for the near-future, but the choice of components itself also requires certain guarantees of quality, stability, and availability, and in large volume, so the choice of components for Russian manufacturers is already limited. Addressing the accusation of copying a Chinese drone, CAST argued that in many cases, copying the best and most developed foreign designs and concepts would be better than developing a similar model from scratch, which the Chines defense industry often does itself. CAST further argued that Almaz-Antey is required to mass-produce quadcopter drones in the thousands per month, without interruptions in supply and without significant and long-term external investment in production. Finally, CAST noted that any claims or complaints should be made not against Almaz-Antey but against the highest (government) authorities, who have not been able, since the spring, to carry out a genuine mobilization of state and private industry for truly mass development and production of small drones.[65]

Almaz-Antey did confirm that Dobrynya's case, fasteners, wires, frame, casing, lodgment, flight controller, and software are domestically made. The quadcopter's camera, video, and telemetry

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[62] https://ria.ru/20221201/bespilotniki-1835525848.html.

[63] https://t.me/dronesrussia/20684.

[64] https://t.me/bmpd_cast/14026.

[65] https://t.me/bmpd_cast/14027.

transmitters, an engine speed controller, and antennas are in fact imported (Chinese-made), while engines and batteries installed were both domestic and imported.[66] Addressing the accusation that its quadcopter looks like an exact copy of a Chinese drone, Almaz-Antey noted that the company focused on the specific drone type (in this case, sport first-person view (FPV) drones) to accelerate its own development, and admitted that because the enterprise is trying to catch up in the quadcopter market, "[I]t was impossible not to take advantage of the competitors' experience."[67] This public discourse, which took place over the span of 48 hours, offered a rare opportunity to observe how the Russian defense industry is trying to meet the military's needs in a specific technology niche. Still, even an apparently honest admission such as this was not enough for many influential Telegram-based war correspondents and commentators. Some argued that the Russian military does not just need many Dobrynya-like drones with a relatively high production cost, but two specific drone types: ultra-cheap, expendable, and simple quadcopters that can be mass-produced in the hundreds of thousands, and more advanced models produced in the tens of thousands for experienced drone operators throughout the Russian military.[68]

While the Russian military noted in 2019 and 2020 that it was starting to acquire large numbers of quadcopters for its forces, there was little evidence of their presence at the onset of the invasion of Ukraine. In fact, Russian volunteers have raised money through popular Russian Telegram channels to purchase drones for Russia's military forces.[69] One channel, WarGonzo, with more than 1.3 million followers, published a list of DJI Mavic drone series acquisitions, asking for donations and purchases of the most popular drones.[70] Given the official DJI moratorium on selling their products in Ukraine and Russia, these Telegram channels have urged volunteers to procure them wherever they can, including on online marketplaces in Eastern Europe, the former Soviet states, and east Asian countries. DJIs have become so widespread and useful because of their relatively low cost and simplicity that Russia's top military leaders have named them a "true symbol of modern warfare," noting they have elevated the importance of artillery to heights not seen since World War I.[71]

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[66] Конструктор рассказал об отечественных комплектующих в дроне "Добрыня," RIA.ru, Dec. 1, 2022, https://ria.ru/20221201/dron-1835529052.html.

[67] Дрон "Добрыня" построен на типовом решении, рассказал конструктор, Ria.ru, Dec. 1, 2022, https://ria.ru/20221201/dron-1835530821.html.

[68] https://t.me/dronesrussia/20709.

[69] Samuel Bendett and Jeffery Edmonds, "Russian Military Autonomy in Ukraine: Four Months In," CNA.org, July 6, 2022, https://www.cna.org/reports/2022/07/russian-military-autonomy-in-ukraine-four-months-in.

[70] The drones he listed included DJI Mavic 3, DJI Mavic 2 Pro, DJI Mavic 2 Zoom, DJI Mavic Pro, DJI Air 2S, DJI Mavic Air 2, DJI Mavic Air, DJI Phantom 4 Pro V2, DJI Matrice 300 RTK, DJI Mavic 2 Enterprise (Zoom), DJI Mavic 2 Enterprise Advanced, DJI Mavic 2 Enterprise Dual, DJI MATRICE 30T and the DJI Phantom (https://t.me/wargonzo/6887).

[71] "General Baluyevsky Spoke About the Revolution in Artillery" (Генерал Балуевский рассказал о революции в артиллерии), Ria.ru, Aug. 11, 2022, https://ria.ru/20220811/kvadrokoptery-1808761668.html.

Integration of Commercial Drones

Russian Telegram channels closely following the use of commercial drones by Russian forces in Ukraine note that drones in and of themselves are not a "panacea" and are effective only when there are established mechanisms for their integration into combat units and operations.[72] Some asserted that every third quadcopter sent to the Russian force since March 2022 was lost during the first or second mission because of a lack of operator skill. Telegram channels suggested that a well-established training system for both military and civilian drone pilots should exist to create a reserve and an instructor corps. In addition, commentators suggested that drones should be integrated into combat regulations and the organizational structure of the Russian Armed Forces. Finally, some individuals contended that secure and dedicated digital communications should exist for drone operations to ensure data integrity and facilitate information sharing.

As of early December 2022, the Russian military ISR drone force appeared to be significantly depleted. For example, reports from Russian soldiers facing Ukraine's September counteroffensive in Kharkiv noted the lack of both drones and ammunition.[73] Although there is certainly more to the Russian military's failure to stop the Ukrainian counteroffensive in Kharkiv, the lack of tactical battlefield awareness likely played a significant role. As quadcopter use proliferated across the battlefield, units had to address their proper use and care, training levels of their operators, and the integration of this technology into ongoing operations.

One result of the perceived shortage of commercial drones was the creation of Russian volunteer groups seeking to assist Russian soldiers on the front lines. Some of these volunteers organized an inaugural meeting in Nizhny Novgorod in early September 2022, referring to themselves as "Dronnitsa." This meeting brought together approximately 300 civilian and military drone operators and drone enthusiasts for several days of training and education. Dronnitsa organizers recognized that there was a huge shortage of qualified UAV operators and an even greater shortage of good instructors.[74] The meeting was intended as a "train-the-trainers" event to scale up the use of these technologies as quickly as possible and establish an official instructor corps. This has become especially critical given that both sides are targeting drone operators as a "left-of-launch" solution to adversary drone use.[75] Other Dronnitsa goals included developing IT solutions such as "smart swarm" and computer vision as well as real-

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[72] Chadaev Telegram Channel, Dec. 21, 2022. https://t.me/chadayevru/1196.

[73] Mari Saito, Maris Tsvetkova, Anton Zverev, "Abandoned Russian Base Holds Secrets of Retreat in Ukraine," Reuters, Oct. 26, 2022, https://www.reuters.com/investigates/special-report/ukraine-crisis-russia-base/.

[74] Official "Dronnitsa" website, Sept. 5, 2022, https://dronnitsa.ru/news/17.

[75] Game of Drones Telegram channel, Aug. 6, 2022.

time geometric video analytics.[76] The organizers discussed creating a video archive and a data bank for pilot training and for potential artificial intelligence machine-learning libraries.

A key problem the group recognized was the place of small UAVs in the military's organizational structure and their integration into the broader battlespace.[77] The organizers called for establishing a unified "center of competence" at which quadrocopter operators could be trained to become capable of promptly responding to technical and organizational issues related to the use, assembly, and repair of quadcopters, along with a concept for the development and use of small quadcopters in combat.[78] Finally, Dronnitsa organizers vowed to hold this event several times a year across Russia to address these issues.[79] There is also evidence that Russian regional military centers are attempting to address the drone operator and trainer issues mentioned above, although it is not clear if all such efforts are coordinated.[80]

The Russian military is apparently beginning to embrace the utility of these cheap, expendable, and easy-to-operate drones. On September 28, 2022, the MOD announced that newly mobilized Russian soldiers can bring their own quadcopters to the front.[81] Several days later, on October 3, 2022, the MOD announced that Russian regions using their own funding to equip deploying soldiers can purchase drones and other equipment for the departing troops.[82] Today, official state media regularly reports on the military providing mobilized forces with training on quadcopters, although the extent and frequency of this training across the entire force is not clear.

Given that commercial quadcopters like DJI were made for ease of use, there is evidence that training to operate such drones takes about a week.[83] Numerous Russian Telegram channels report regularly on quadcopter training, for example, from inside buildings and from armored vehicles, on coordinating assaults on trenches using drone support.[84] According to some claims

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[76] Game of Drones Telegram channel, Aug. 6, 2022.

[77] Official "Dronnitsa" website, Sept. 5, 2022, https://dronnitsa.ru/news/17.

[78] Official "Dronnitsa" website, Sept. 5, 2022, https://dronnitsa.ru/news/17.

[79] For a more detailed account, see Faine Greenwood, "Dronnitsa, A Conference for Russian Battle Drone Pilots," Sept. 28, 2022, https://faineg.substack.com/p/dronnitsa-a-conference-for-russian.

[80] В Кузбассе начали готовить инструкторов и операторов квадрокоптеров, Ria.ru, Oct. 21, 2022, https://ria.ru/20221021/kuzbass-1825576969.html; В Приамурье мобилизованных начали обучать управлению квадрокоптерами, Iz.ru, Oct. 18, 2022, https://iz.ru/1411793/2022-10-18/v-priamure-mobilizovannykh-nachali-obuchat-upravleniiu-kvadrokompterami.

[81] Мобилизованные могут взять с собой квадрокоптер, Ria.ru, Sept. 28, 2022, https://ria.ru/20220927/kvadrokopter-1819744051.html.

[82] Кабмин разрешил регионам закупать по заявкам МО снаряжение и оборудование для военных, Tass.ru, Oct. 3, 2022, https://tass.ru/ekonomika/15944241.

[83] Dmitry Astrakhan, "Drone Amidst the Clear Sky: How Drones Change the Course of the Special Military Operation" (Дрон среди ясного неба: как беспилотники меняют ход СВО), Iz.ru, Oct. 24, 2022, https://iz.ru/1414691/dmitrii-astrakhan/dron-sredi-iasnogo-neba-kak-bespilotniki-meniaiut-khod-svo.

[84] UAV (Беспилотники) Telegram channels, Dec. 10, 2022, https://t.me/uav_tech/10471.

from Russian officials such as Ramzan Kadyrov, soldiers who complete such operations training are also able to fly larger UAVs in combat missions if necessary.[85]

Russia's Donbas allies in the Donetsk People's Republic (DNR) and Luhansk People's Republic (LNR) have used quadcopters on a large scale and opened a drone operator school to establish and train individuals on standard operating procedures.[86] The Russian military was slower to officially adopt commercial drones into practice, but as their importance grew for battlefield awareness, they became an organic and inseparable part of military operations in Ukraine.

Tactics, Techniques, and Procedures for Commercial Drone Operations

The central role of commercial quadcopters is necessitating new tactics, techniques, and procedures (TTPs),[87] including specific instructions on piloting them during operations. The following is a sample from Russian-language Telegram channels disseminated to drone operators at the front:[88]

- Do not launch the UAV from military checkpoints and or even near them—much will be visible from above in case the UAV is lost or the video/telemetry radio channel is intercepted.
- Before turning on the equipment, identify possible shelter locations in case of shelling —pits, ditches, capital buildings, etc.
- If possible, the drone landing site should be different from the launching one; do not stick out at the take-off site.
- Do not use the same site several times.
- Do not keep radio equipment turned on unnecessarily; turn off everything unnecessary before leaving.
- Specialized electronics equipment can take the bearing of even low-power sources from afar, such as a cell phone used to operate the drone.

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[85] "'Small but precious': Kadyrov Spoke about the Use of UAVs in the Special Military Operation" ("Мал золотник, да дорог". Кадыров рассказал о применении БПЛА в зоне СВО), radioSputnik,ria.ru, Dec. 9, 2022, https://radiosputnik.ria.ru/20221209/kadyrov-1837641350.html.
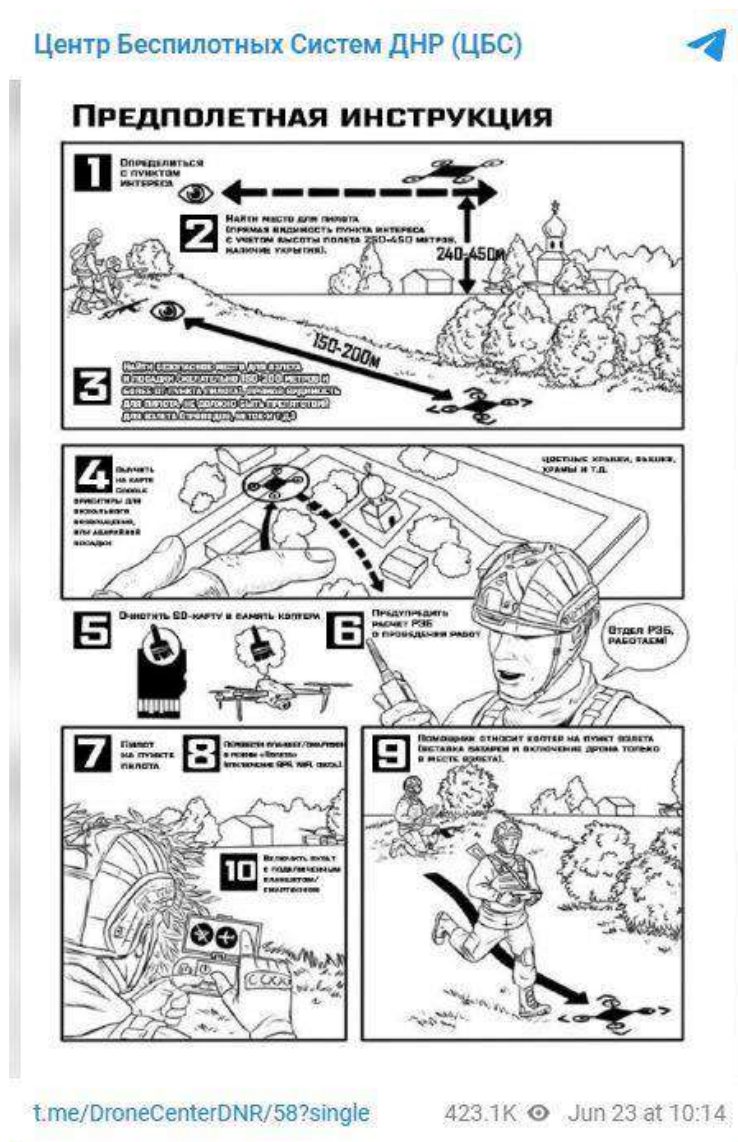
[86] Game of Drones, Telegram, Aug. 8, 2022, https://t.me/droneswar/2779.

[87] From ADP 3-90: Offense and Defense—"Tactics always require judgment and adaptation to a situation's unique circumstances. Techniques and procedures are established patterns or processes that can be applied repeatedly with little judgment to various circumstances. Together, tactics, techniques, and procedures (TTPs) provide commanders and staffs with the fundamentals to develop solutions to tactical problems," United States Government, US Army, July 2019, https://armypubs.army.mil/epubs/DR_pubs/DR_a/ARN34828-ADP_3-90-000-WEB-1.pdf.

[88] https://t.me/droneswar/2975.

Figure 6.   Sample drone operations instructions

Source: https://ru.telegram-store.com/catalog/channels/dronecenterdnr.

One government-affiliated article noted the importance of these drones for intelligence and reconnaissance missions and highlighted a tandem tactic, where one ISR quadcopter gathers intelligence followed by a second combat version that drops bombs on identified targets.[89] The

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[89] Dmitry Astrakhan, "At This Point, Nothing Gets Down Without (Quad)Copters" («В данный момент без коптеров никуда»), Izvestia.ru, Nov. 28, 2022, https://iz.ru/1432143/dmitrii-astrakhan/v-dannyi-moment-bez-kopterov-nikuda.

soldiers interviewed noted that this tactic allows for continuous monitoring of a given area and fast targeting correction, suggesting attempts at dynamic targeting. The article also noted that many of the small bomb parts and devices needed to turn a quadcopter into a bomber are 3D printed by volunteers, with soldiers and civilians exchanging experiences to improve quadcopter operational performance.[90]

Offensive tactical operations often feature DJI Mavics because they are smaller and better for avoiding detection. These types of UAVs are often used over short distances to "look over a hill/onto the neighboring street/under a bridge" as the units move closer to the strike location and prepare for contact.[91] Artillery is directed from the information provided by attacking units, but also from the longer-ranged UAVs such as the Eleton-3 or Orlan-10 drone.[92] Another close-combat technique being used by the Russian military involves attaching "Cheryomuha" tear-gas grenades to their quadcopters to drive Ukrainian infantry out of their trenches and make them more vulnerable to follow-on attacks.[93]

With volunteer efforts playing such a significant part in socializing quadcopter use and practice throughout the services, there is evidence of more consistent drone tactics taking hold in the conflict. One observed technique includes assault groups using at least three quadcopters for ISR in urban combat: one monitors the possible enemy artillery and weapons locations, the second scans the streets for ambushes and fortifications, and the third accompanies the group by monitoring and controlling the situation from above.[94] Additionally, a Ukrainian report dated December 2022 concludes that Wagner Group is a unique threat in close combat, even if their units suffer huge losses. Wagner deploys its forces in mobile teams of about a dozen or fewer, using rocket-propelled grenades and real-time drone reconnaissance, which the report describes as a "key element."

One challenge that drone operators must contend with is that commercial quadcopters are vulnerable to EW—part of both sides' counter-UAV (C-UAV) tactics. Given a relatively short shelf-life of a DJI drone in this war—several days or several missions—quadcopter pilots try to avoid flying their UAVs in areas where adversary EW measures may be active.[95] During EW attacks, the quadcopter loses contact with the operator. Russian reports indicate one method for mitigating against EW is to fly small drones, such as the DJI mini, air2, or air3 UAVs, and observe their behavior at different altitudes to determine the extent of EW activity in the area.[96]

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[90] Dmitry Astrakhan, "At This Point, Nothing Gets Down Without (Quad)Copters."

[91] https://t.me/rusmildrones/38.

[92] https://t.me/rusmildrones/38.

[93] UAVs (Беспилотники (дроны, БПЛА, UAV)), February 17, 2023, https://t.me/uav_tech/12311.

[94] Dmitry Astrakhan, "Drone Amidst the Clear Sky."

[95] Dmitry Astrakhan, "Drone Amidst the Clear Sky."

[96] Two Majors (Два майора) Telegram Channel, January 7, 2023, https://t.me/dva_majors/7536.

Commercial drones are targetable by platforms such as DJI's Aeroscope system, which can detect most commercial drones and reveal critical information such as the drone's Home Point, making the operator vulnerable.[97] There is reporting that both sides are using equipment such as the Aeroscope.[98] To make their quadcopters more secure, Russian operators perform "reflashing" to change the drone's operating frequencies, allowing the UAV to fly farther and have a more stable control signal.[99]

Another emerging counter-UAV technique is the use of UAVs as platforms for downing UAVs. An operator finds an adversary UAV and then rams the UAV he is operating into the adversary UAV.[100] This underscores the disposable nature of many of the UAVs being used in Ukraine. UAVs are functioning much more frequently as slow but maneuverable munitions than enduring platforms.

Figure 7.   DJI's Aeroscope UAV tracking system

Source: DJI's Aeroscope diagram, DJI Enterprises, https://www.dji.com/aeroscope.

Both the use of and mitigation against commercial drones reveal that, for small drones, there is a heavier EW-drone square-off, whereas with medium drones, such as the Orlan-10, it is

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[97] AeroscopeAS-F1800 user Manual, DJI, Nov. 30, 2020, https://dl.djicdn.com/downloads/AEROSCOPE/20201130/Aeroscope_AS-F1800_User_Manual_EN_JP_v2.0.pdf.
[98] Dmitry Astrakhan, "Drone Amidst the Clear Sky."
[99] Dmitry Astrakhan, "Drone Amidst the Clear Sky."
[100] Game of Drones Telegram Channel, February 20, 2023, https://t.me/droneswar/5958.

more about man-portable air-defense systems (MANPADS) versus drones. This is problematic for the Ukrainians, given the relatively cheap price of an ORLAN-10 compared to a MANPAD. The war is underscoring the need for larger inventories of larger commercial drones that have more payload and employment possibilities.

Use of Iranian Drones to Augment Russian Capability Gaps

To address some of the platform and capability shortages, the Russian military has started to receive and use Iranian drones in Ukraine. Notably, Russian media outlets are claiming that the Russian military has used both Russian-made and Iranian-made drones in its attacks against Ukrainian targets, dividing target types among the different drone types.[101]

Choosing Iranian drones probably reflects Russia's own inability to produce the loitering munition drones in the same quantity and quality as Iran does.[102] In late August 2022, global news outlets reported the start of Iranian drone transfers to Russia, with Russian operators attending a training program in Iran.[103] Official US and Western media outlets identified the following three Iranian drones that Russia is operating: Shahed-129, Shahed-191, and Mohajer-6, along with a large number of Shahed-136 and 131 loitering munitions. All represent top-of-the line Iranian drones and address some of Russia's uncrewed systems shortages.

According to media citing foreign intelligence sources, Moscow and Tehran are moving ahead with plans to build a new factory in Russia's Yelabuga that could make at least 6,000 Iranian-designed drones. Although the timing and rate of production are unknown, this represents a

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[101] "What Kind of a Mass Attack Was Carried out by Russia's Geran-2 and Lancet UAVs?" (*Что за массированный удар нанесли российские БПЛА «Герань-2» и «Ланцет»?), Aif.ru, Sept. 29, 2022, https://aif.ru/society/army/chto_za_massirovannyy_udar_nanesli_rossiyskie_bpla_geran-2_i_lancet; "Russian Kamikaze Drones 'Geran' and 'Lancet' Are Successfully Used During a Special Operation" (Российские дроны-камикадзе "Герань" и "Ланцет" успешно решают задачи в ходе спецоперации), RG.ru, Sept. 28, 2022, https://rg.ru/2022/09/28/letiat-besshumno-atakuiut-roem.html; "On October 15, the Ukrainian Armed Forces Attempted a Large Offensive in the Kherson Direction, But Were Met by Dense Artillery Fire and Retreated. During the Retreat, Ukrainian Tanks Were Hit by Geran-2 and Lancet Drones" (Беспилотники "Герань-2" и "Ланцет" успешно применены при отражении атаки ВСУ под Херсоном), Involta.media, Oct. 16, 2022, https://involta.media/post/bespilotniki-geran-2-i-lancet-uspeshno-primeny-pri-otrazhenii-ataki-vsu-pod-hersonom.

[102] Matt Berg, "Iran Preparing to Send 'Several Hundred' Drones to Russia, Sullivan Says," Politico.com, July 11, 2022, https://www.politico.com/news/2022/07/11/iran-uav-drones-russia-00045195.

[103] Ellen Nakashima and Joby Warrick, "Iran Sends First Shipment of Drones to Russia for Use in Ukraine," *Washington Post,* Aug. 29, 2022, https://www.washingtonpost.com/national-security/2022/08/29/iran-drones-russia-ukraine-war/; Natasha Bertrand, "First on CNN: Russians Have Begun Training on Iranian Drones, US Believes," CNN.com, Aug. 9, 2022, https://www.cnn.com/2022/08/09/politics/russia-training-drones-iran/index.html.

significant expansion of bilateral drone cooperation that is likely to bolster Russia's capacity to continue using Iranian drones to strike Ukrainian energy and other key infrastructure.[104]

Since the 1980s, Iran has produced a proven lineup of military drones that were tested extensively against different types of targets by Iranian proxies and allies. Iranian drones such as the Shahed-136 are also relatively cheap—they reportedly cost approximately $20,000 per drone—and can be potentially mass-produced quickly.

The Russian military earlier capitalized on its experience with Israeli drones, reverse-engineering them into the Forpost-R and Zastava drones that are used in Ukraine.[105] This experience suggests that we may also see the Russian defense industry reverse-engineer some of the Iranian drones, and questions remain about whether doing so would address Russia's shortage in drone production required in Ukraine. In a recent statement, the US Intelligence Community indicated that Iran had agreed to supply up to 6,000 UAVs, mostly Shahed varieties, and has also agreed to supply designs as well as technical supervision for the planned Russian drone factory.[106] According to various sources, up to three-quarters of the initial batch of Shaheds ordered by Russia were shot down by Ukrainian defenders, with the Ukrainian military adapting to the ever-growing quantity of Shaheds in the skies over their country.[107]

[104] Dion Nissenbaum and Warren P. Strobel, "Moscow, Tehran Advance Plans for Iranian-Designed Drone Facility in Russia," WSJ.com, February 5, 2023, https://www.wsj.com/articles/moscow-tehran-advance-plans-for-iranian-designed-drone-facility-in-russia-11675609087?st=8zpf0nohm5fvi9f&fbclid=IwAR0yM1HUuBX8BzKEF0fG42DbqfGC12_YPU9UW54lBwskLp5xxIjuvea5XHk.

[105] Yaakov Katz and Amir Bohbot, "How Israel Sold Russia Drones to Stop Missiles from Reaching Iran," JPost.com, Feb. 3, 2017, https://www.jpost.com/magazine/books-israel-and-the-saleof-advanced-drones-to-russia-480326; "UAV Forpost to Change Israeli Payload for Russian Systems," Mil.today, Dec. 27, 2019, https://mil.today/2019/Science42/.

[106] Karen DeYoung and Joby Warrick, "Russia-Iran Military Partnership 'Unprecedented' and Growing, Officials Say," *Washington Post*, Dec. 9, 2022, https://www.washingtonpost.com/national-security/2022/12/09/russia-iran-drone-missile/.

[107] Valisu Venckunas, "Russia Resumes Shahed-136 Attacks after Ukraine Claims Supply Is Running Low," Aerotime.aero, Dec. 7, 2022, https://www.aerotime.aero/articles/32877-russia-resumes-shahed-attacks-ukraine-says-supply-low.

Figure 8.   Attack ranges of Lancet, KUB, Shahed-131, and Shahed-136 loitering munitions
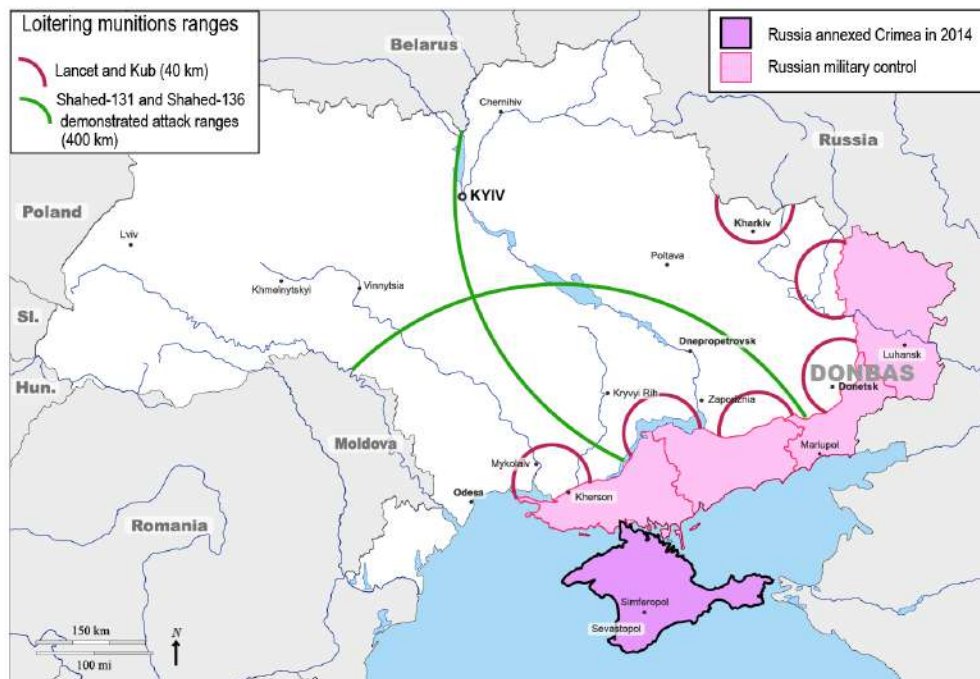
Source: CNA internal database.

Tehran's drone capability is almost entirely home-grown, which is likely attractive to Moscow, given the drone's resilience to Western sanctions. Recent evidence suggests the Iranian drone industry has successfully acquired and adapted imported civilian and dual-use technology for its drones, which is a key lesson Russia is possibly looking to emulate.[108] With Russia's domestic defense and high-tech industry under significant pressure from US and Western sanctions, a steady stream of Iranian drones would be beneficial to the Russian military.

With ranges in the hundreds of kilometers, antijamming systems, and the ability to fly low making them difficult to interdict, these systems could prove useful in targeting Ukrainian military capabilities more effectively than previous Russian military drone operations have.[109] The Ukrainian military has acknowledged that Shahed-136s effectively struck armor and artillery systems in the Kharkiv region. The drones apparently flew in pairs—one to target the

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[108] "Dissecting Iranian Drones Employed by Russia in Ukraine," Conflict Armament Research, Nov. 2022, https://storymaps.arcgis.com/stories/7a394153c87947d8a602c3927609f572.

[109] Yaroslav Trofimov and Dion Nissenbaum, "Russia's Use of Iranian Kamikaze Drones Creates New Dangers for Ukrainian Troops," WSJ.com, Sept. 17, 2022, https://www.wsj.com/articles/russias-use-of-iranian-kamikaze-drones-creates-new-dangers-for-ukrainian-troops-11663415140.

radar system and the other to strike artillery pieces.[110] In September and October 2022, additional evidence emerged of Shahed-136 loitering munitions use, with Russian sources claiming that many drones struck Ukrainian positions at once in Nikopol, Dnipropetrovsk Oblast.[111]

Of the three drones that are part of the transfer, the Shahed-129 and Mohajer-6 should be more familiar to Russian forces undergoing training in Iran. While Shahed-129 has a longer range than Russia's Orion drone, both have similar construction, potentially making it easier for Russian trainees to adapt to Shahed's operations. Mohajer-6 is similar in technical characteristics to the Turkish-made Bayraktar drone and to Russia's own Forpost-R.

In late September, Russian forces used another Iranian loitering munition, the Shahed-131 (flying under the Russian name Geran-1), striking civilian targets in Ukraine. Slightly smaller than the Shahed-136, it has a lighter carrying capacity and a shorter range at 900 km, still giving it considerable operational range in Ukraine.[112] A defining feature is that it contains many electronic components made in the US as well as a civilian GPS system that appears to be somewhat hardened against some electronic countermeasures. At the same time, open-source data point to Shahed-131 flying off course when entering an area where GPS signals were suppressed. This course deviation can be around 5 percent, with the drone correcting its flight once it reacquires a GPS signal.[113] Currently, the Russian military is using Shahed drones to strike Ukrainian civilian energy infrastructure, crippling the supply of electricity, heat, and water to the population, attempting to undermine political support for the Ukrainian government.[114]

A growing number of these drones may be utilized in combined loitering munition strikes composed of Geran-2 and Russia's own Lancet. One such attack was documented in September 2022, when roughly 20 loitering drones struck targets in Ochakov, Nikolayev, region and carried out an attack on the operational command HQ in the port of Odessa. According to Russian sources, Geran-2 hit Ukraine's 66th artillery battalion of the 406th brigade, while the

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[110] Trofimov and Nissenbaum, "Russia's Use of Iranian Kamikaze Drones Creates New Dangers for Ukrainian Troops."

[111] Ukraine weapons tracker Twitter post, accessed Sept. 16, 2022, https://twitter.com/UAWeapons/status/1570438897926029312 and game of drones Russian Telegram Channel, Accessed Sept. 16, 2022. https://t.me/droneswar/3588.

[112] "Not Only Shahed-136: A Detailed Study of Another Iranian Shahed-131 Kamikaze Drone Used by Russia," Sept. 24, 2022, https://en.defence-ua.com/weapon_and_tech/not_only_shahed_136_a_detailed_study_of_another_iranian_shahed_131_kamikaze_drone_used_by_russia-4320.html.

[113] "Not Only Shahed-136."

[114] "How We Know Russia Is Using Iranian Drones in Ukraine," WSJ.com, Nov. 11, 2022, https://www.wsj.com/video/series/news-explainers/how-we-know-russia-is-using-iranian-drones-in-ukraine/1FD1F986-AC63-4B21-B421-DEE9E8071F38.

Lancet hit the air defense point, company headquarters, and fuel storage facilities.[115] There was at least one other combined Iranian and Russian loitering munition attack that took place on October 15, 2022, in the Kherson region, when Ukrainian tanks were hit by Geran-2 and Lancet drones.[116] While there has been no more public admission of follow-on attacks, additional copy-cat strike should not be ruled out in the future.

The addition of Iranian drones to Russia's military operations in Ukraine helps to address Russian challenges in effectively using uncrewed systems in Ukraine. Should Russia manage to reverse-engineer and start mass-producing them, these drones could offer advantages to include greater numbers, lower production and acquisition costs, some antijamming capabilities, extended ranges, and increased strike capabilities. These are all areas where Russian forces have been challenged in the fighting in Ukraine.

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[115] "What Kind of a Mass Attack Was Carried out by Russia's Geran-2 and Lancet UAVs?" (*Что за массированный удар нанесли российские БПЛА «Герань-2» и «Ланцет»?), Aif.ru, Sept. 29, 2022, https://aif.ru/society/army/chto_za_massirovannyy_udar_nanesli_rossiyskie_bpla_geran-2_i_lancet.

[116] "When Repulsing the Attack by the Ukrainian Armed Forces near Kherson, the Russian Military Successfully Used 'Geran-2' and 'Lancet'" (При отражении атаки ВСУ под Херсоном ВС РФ успешно применили «Герань-2» и «Ланцет»), Novostivl.ru, Oct. 15, 2022, https://novostivl.ru/post/1280974/.

Russian Ground and Maritime Uncrewed Systems in the War

It is not clear at this point whether the Russian military will be fielding any of its combat UGVs against Ukrainian forces. The Russian MOD claims it will begin to acquire the Uran-9 combat UGVs in 2022, after their redesign following testing in Syria in 2018, but we have not seen this yet. On February 2, 2023, Russia's Dmitry Rogozin—a former Roskosmos (space agency) director—announced on his Telegram channel that several Marker UGVs have arrived in the Donbas, promising to start operations using its target images and combat algorithms. He indicated that the platform will also carry antitank weapons to confront Western-provided Abrams and Leopard tanks.[117] Rogozin promised to conduct two Marker tests—one as an ISR platform with a tethered drone for better situational awareness, and the other as a combat version with anti-tank weapons.[118] The veracity of Rogozin's statements should be questioned until we see further evidence of the presence and operations in Ukraine.

One of the reasons for this gap was recently offered by Evgeny Dudorov, director of "Android Technologies," a company that builds robotics for civilian and military applications. Dudorov indicated that while Ukraine's Western allies are ready to try new technologies in ongoing combat, Russia's approach "was and for the most part remains different: we do not use in this war what we have not tested before at our training grounds, although the question today is how to change this system to meet the current challenges."[119] This suggests that Russian combat UGVs are perhaps not as far along as had been suggested prior to the conflict.

In what appear to be carefully orchestrated videos, the Russian military has used the Uran-6 demining UGVs sparingly in the conflict so far, mostly in the Donbas.[120] The Uran-6 UGV was used by the Russian military in Syria to clear mines and unexploded ordnance and saw limited use in Nagorno-Karabakh by Russian peacekeepers.[121] There is also some evidence of Russian forces using Prohod demining UGVs in Ukraine to protect Russian military personnel conducting demining operations.

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[117] Dmitry Rogozin's Telegram channel, February 2, 2023, t.me/rogozin_do/3690.

[118] "Dmitry Rogozin: Marker Combat Robot Will Arrive in Ukraine in February" (Дмитрий Рогозин: боевой робот "Маркер" прибудет в зону СВО в феврале), RIA.ru, January 24, 2023, https://ria.ru/20230124/rogozin-1846873502.html.

[119] "Evgeny Dudorov: Russia's Robotics Needs a Revolution."

[120] See https://t.me/milinfolive/80873.

[121] "Russian Peacekeepers Use Uran-6 Mine-Clearing Robot in Nagorno-Karabakh," Tass.com, Dec. 11, 2020, https://tass.com/defense/1233857?utm_source=google.com&utm_medium=organic&utm_campaign=google.com&utm_referrer=google.com.

There are also several smaller ISR-purposed UGVs in use by Russian sappers and engineering battalions in the conflict. In August 2022, Russian sappers used the Scarab small-sized UGV to inspect buildings for explosives.[122] While Russian forces will likely show additional examples of Uran-6 and other UGVs in their promotional videos, it is likely that most demining is actually done by human sappers.[123] For its part, Ukraine is acquiring a small TALON explosive disposal robot from the US.[124]

The war is driving both sides to innovate with uncrewed systems on the battlefield. In August 2022, Russia's Rostec claimed that it had developed the technology to transform manned combat vehicles into uncrewed platforms controlled manually or even operated autonomously.[125] The intent of this upgrade is to allow the vehicle to operate in dangerous environments, such as urban areas or at the front of an advancing column of troops and vehicles. As applicable as this development is to the war in Ukraine, such a concept is probably years from being implemented, considering the lack of evidence of Russia's use of other combat UGVs, such as Soratnik, Nerehta, or Platforma, in the conflict.[126]

In February 2023, Russian forces may have used an unmanned surface vessel (USV) to attack a bridge between Ukraine and Moldova, according to numerous social media reports that included a video of an alleged attack. If true, this may be the first known case of a Russian USV use in this war.[127] It is unclear at this point if this USV was a Russian domestic development, a vehicle procured elsewhere, or a joint project with the Iranian military, as advertised in 2020.[128] It is also possible that this USV was a reverse-engineered version of the Ukrainian USV that attacked the Russian Black Sea port of Sevastopol in October 2022.[129]

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Conclusion

The extensive use of uncrewed technology and its impact on the war in Ukraine is not a new development for the Russian military and its defense establishment. Russian armed forces learned and paid attention to lessons from the 2020 Nagorno-Karabakh war, which highlighted the importance of combat and loitering drones—including C-UAVs—for any future combat. That the Russian military's performance earlier in the Ukraine war did not correspond to this assessment is a central topic of detailed analysis in this report. However, at this point in the conflict, Russia is increasingly utilizing relatively inexpensive defense and commercial technology against Ukraine. Therefore, two significant developments will affect how this war progresses and how future wars may be conducted. First, the proliferation and availability of combat drones for longer-range, more sophisticated operations are central to tactical operations and operations throughout the depth of the battlefield. Second, the availability of cheap tactical UAVs for close-support operations is something all militaries must consider.

The relatively cheap cost of drones in each class is appealing to countries seeking to gain aerial ISR and combat capacity and may be cheaper than acquiring similar technology from other countries known for arms exports. With Russia possibly manufacturing Iranian Shahed drones domestically in large numbers, Moscow could further accelerate strikes against Ukrainian civilian infrastructure, which may increase their hopes of putting significant pressure on the Ukrainian government and Kyiv's North Atlantic Treaty Organizaion (NATO) allies to undermine continued will for this war.

The use of cheap commercial drones in Ukraine for ISR, combat, artillery spotting, and information and psychological operations also drives home the point that real capacity need not come from expensive bureaucratic defense acquisition pipelines. The use of thousands of such drones, mostly Chinese-made DJIs, have enabled persistent observation of adversary positions, movements, and maneuvers, with both sides admitting that these quadcopters were everywhere, necessitating a change in ground combat tactics, maneuvering, and camouflage.

With Russian forces launching quadcopter pilot training initiatives to enable mass application of this technology and providing official quadcopter training to mobilized forces, NATO should expect to see small Russian UAVs as a constant on the battlefield, with smaller units at the platoon and company levels increasingly able to conduct reconnaissance and combat missions.

The Russian defense industry is slowly beginning to manufacture different quadcopter types, which will likely provide them with increased drone capacity over the winter. The issue up for debate is whether the Russian military formations can institute the flexibility and independence in using and operating drones that is now prevalent across the Ukrainian forces,

qualities that have contributed to Ukraine's improved ability to successfully operate at close ranges against Russian units.

All these factors point to persistent use of UAVs to provide coverage of the modern battlefield, challenging any military's ability to maintain the operational security of its units. The US military is already noting that with so many UAVs in Ukraine at any given time, future combat will belong to smaller units that can quickly maneuver prior to and after military operations/missions.[130] Future units should have their own UAV capacity, such as small quadcopters, as well as more operational longer-ranged drones. Such constant aerial surveillance will also necessitate better masking of not just physical but also electronic signatures such as unit and formation communications.

Russia's invasion of Ukraine and both sides' subsequent mass-scale use of different uncrewed aerial technologies are also spurring a debate about the future of drone warfare. Some Russian commentators think this particular conflict is the last where commercial drones can be used at such a scale, as they are vulnerable and susceptible to air defenses.[131] According to one popular Russian Telegram channel, the future belongs to compact and nimble short-range FPV drones used at the platoon level for reconnaissance and pinpoint strikes; loitering munitions for mid- to long-range strikes; high-altitude reconnaissance and guidance drones, along with aircraft-class strike drones; and transport, delivery, and escort drones.[132] The blueprint for this future is unfolding daily in Ukraine, with all participants seeking an edge in how drone technology is used now and in the near future.

Finally, all the factors discussed above are necessitating C-UAV efforts at the tactical and operational levels, with systems and technologies that can jam, disable, and ultimately bring down adversary drones. This need is especially prevalent at the tactical level, with Ukrainian and Russian soldiers constantly forced to mitigate against small quadcopters and maintain round-the-clock monitoring of the skies to protect their positions. Combined with EW, such C-UAS tactics will grow in importance over the winter, as both sides attempt to exploit opportunities and gaps to pressure the adversary.

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[131] Game of Drones Telegram channel, Dec. 3, 2022. https://t.me/droneswar/5135.

[132] Game of Drones Telegram channel, Dec. 3, 2022. https://t.me/droneswar/5135.

Appendix A: Matrix of Expected versus Seen Systems

The CNA team conducted research into Russian industry and military claims about its state of development in the field of uncrewed systems prior to the conflict, attempting to forecast what systems we would likely see in the conflict. We find, in general, few surprises in the types of platforms being used. Table 2 separates those systems we have seen in action from those systems we investigated earlier. The list does not include all of the platforms mentioned in Russian media; it is limited to those that we assessed were under development.

Table 3.   Matrix of seen and unseen uncrewed platforms in Ukraine

Type	Name	Manufacturer	Present in Ukraine?
UAV	Eleron-3	Eniks Design Bureau	Yes
UAV	Orlan-10	Special Technology Center (STC)	Yes
UAV	Orlan-30	Special Technology Center (STC)	Yes
UAV	Korsar	"Luch" Design Bureau	Yes
UAV	Takhion	Izhmash	Yes
UAV	Zastava	UZGA	Yes
UAV	ZALA	Kalashnikov (Rostec)	Yes
UAV	Granat	Kalashnikov (Rostec)	Yes
UAV	Lastochka	"Luch" Design Bureau	Yes
UAV	Kartograf	Special Technology Center (STC)—Orlan variant	Yes
UAV	Forpost	UZGA	Yes
UAV	Orion	Kronstadt Design Bureau	Yes
UAV	Lancet-1/3	Kalashnikov (Rostec)	Yes
UAV	KUB	Kalashnikov (Rostec)	Yes
UGV	Scarab	CET-1	Yes
UGV	Uran-6	Rostec	Yes
UGV	Prohod-1	High Precision Weapons JSC	Yes
UCAV	Okhtonik (Охотник)	Sukhoi (Rostec)	No
UCAV	Altius (Альтиус)	UZGA	No
UAV	Volk-18 (Волк-18)	Almaz-Antey	No
UAV	Unknown	Kalashnikov (Rostec)	No
UAV	Unknown	N/A	No

Type	Name	Manufacturer	Present in Ukraine?
UAV (helicopter)	R-2200 (Р-2200)	Rus Design Bureau	No
Uncrewed naval vessel	Kadet-M (Кадет-М)	*Center for the Development of Innovation Activity SPbPU*	No
UUV	Poseidon (Посейдон)	Rubin and Malahit design bureaus	No
UUV	Galtel (Гальтель)	Institute for Problems of Marine Technologies RAS	No
UUV	Vityaz (Витязь)	ARF and Rubin Design Bureau	No
UGV	Udar (Удар)	Rostec	No
UGV	Marker (Маркер)	ARF	No
Swarm technology	Unknown	Southern Federal University	No
Humanoid android	Fedor (Федор)	ARF and Android Technologies	No

Source: CNA internal database of Russian uncrewed vehicles.

Appendix B: Russian Commercial Drone Operating Instructions

Current widespread quadcopter utilization in this war created a need for better instruction on their use in the war. At this point, Russian forces and their allies can lean on two quadcopter training manuals that have been disseminated via Telegram. One, produced by volunteers, called "Theory and Practice in Using Uncrewed Aerial Vehicles," describes in detail what UAVs generally are and how to operate them. Another detailed manual, called "Conducting Combat Missions with a Quadcopter," appears to originate from military-affiliated sources. Both manuals were disseminated widely on Russian-language Telegram channels covering the war in Ukraine.

For easier acquisition of familiarity with flying a quadcopter, there are also simple leaflet instructions, translated in the following pages, that were developed by volunteers to inform quadcopter users of the best practices for such UAV operations.

Figure 9. Russian instructions for using DJI drones in combat (preflight)
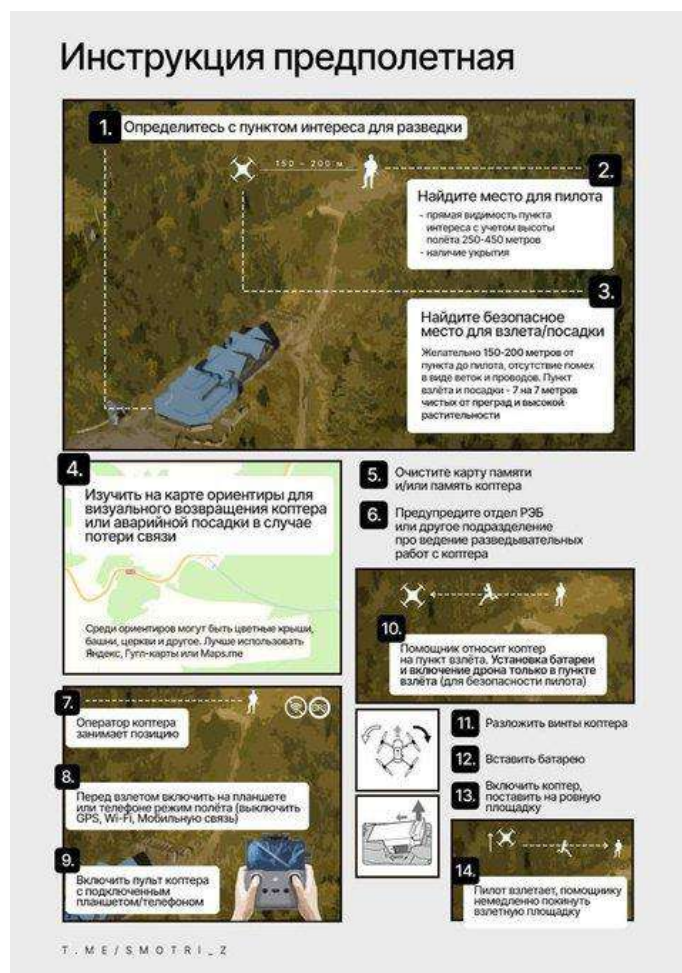
Source: Novorossia Aid Coordinating Center (Координационный центр помощи Новороссии) https://kcpn.info/articles/mavic/.

Preflight instructions

1. Determine a point of interest for intelligence forces.

2. Find a spot for the pilot: direct target visibility from a flight of 250–450 meters; should have cover.

3. Find a safe place for take-off/landing: preferably 150–200 meters to the pilot, absence of obstacles like branches or electric wires. Takeoff pad is 7 x 7 meters, cleared of any obstacles or tall growth.

4. Learn key markers on a map for copter's visual return or emergency landing due to loss of comms. Your markers could be colored roofs, towers, churches and others. Better sue Yandex, GoogleMaps or http://maps.me.

5. Clear out memory map/or copter's memory.

6. Warn [coordinate with] EW units or other units about your intel work involving a copter.

7. Copter operator takes a position.

8. Before flight, turn on the flight coordination on the pad or a cell phone (turn off GPS, wi-fi, mobile connection).

9. Turn on copter control console with a pad or cell phone connected to it.

10. Assistant delivers the copter to the launch position. Install the battery or turn on the drone only on the launch pad, for operator safety.

11. Unfold copter propellers.

12. Install battery.

13. Turn the copter on, put it on the even ground.

14. Pilot launches the drone, assistant must immediately vacate the launch pad.

Figure 10. Russian instructions for using DJI drones in combat (inflight)
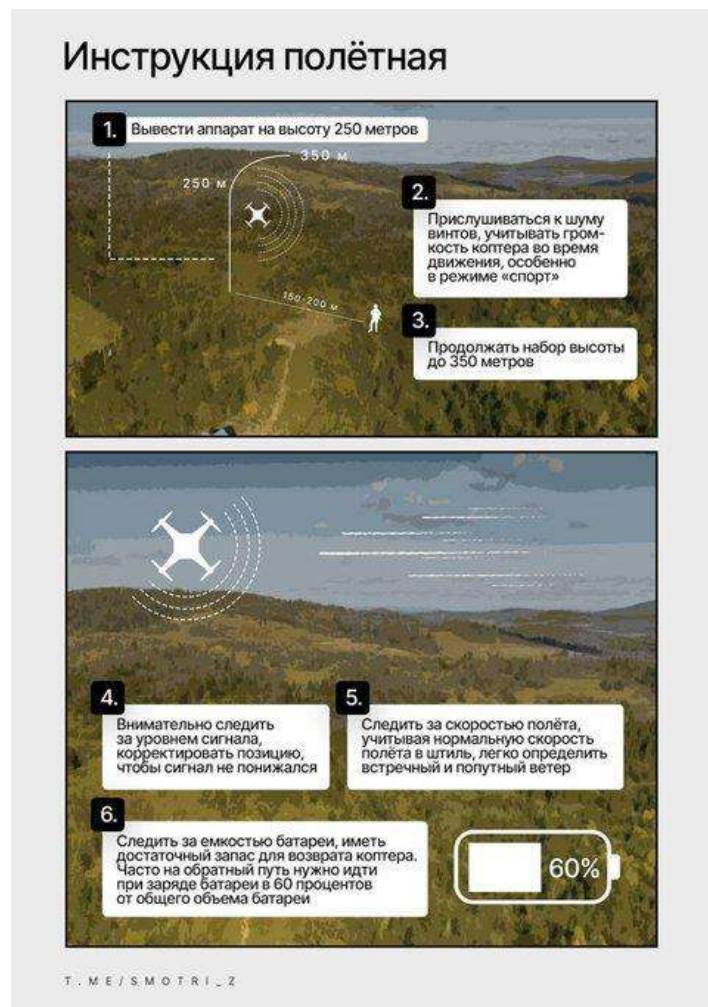
Source: Novorossia Aid Coordinating Center (Координационный центр помощи Новороссии), https://kcpn.info/articles/mavic/.

Inflight instructions

1. Take the copter up to 250 meters.

2. Listen to the propeller noise, especially considering copter movement, especially in "sports" mode.

3. Continue climbing to 350 meters.

4. Monitor the signal level, make sure the signal does not diminish.

5. Monitor copter speed, especially in still weather and considering head-on and tail winds.

6. Monitor battery power, make sure there is enough juice for the copter's return flight. Often, you need 60 percent battery power for the copter's return flight.

Figure 11.   Russian instructions for using DJI drones in combat (return flight)
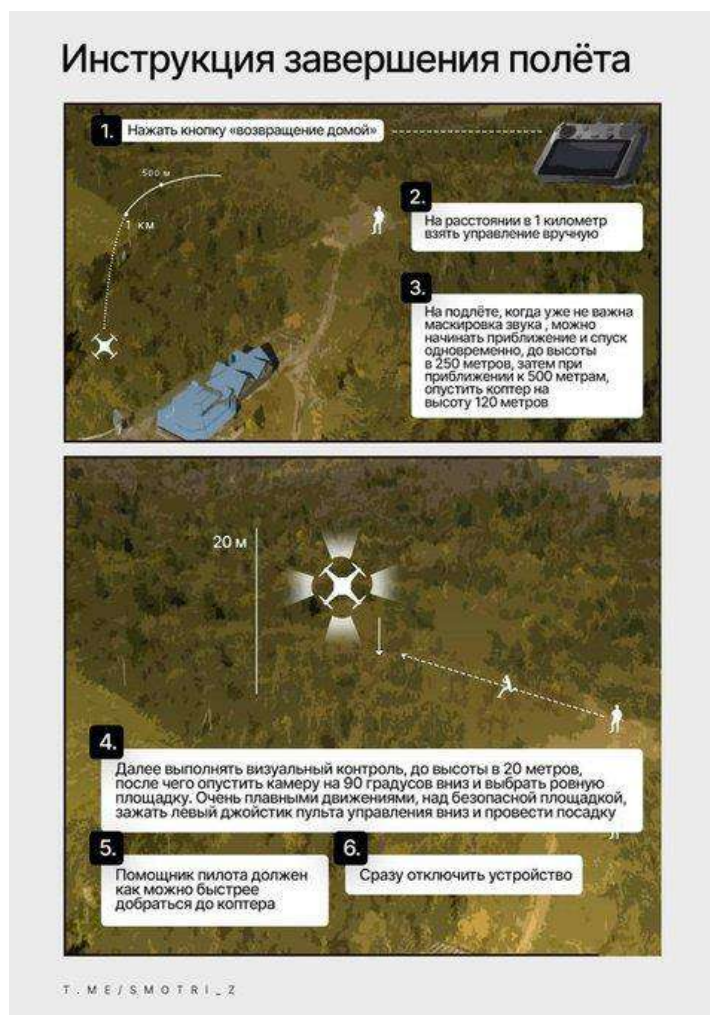
Source: Novorossia Aid Coordinating Center (Координационный центр помощи Новороссии),
https://kcpn.info/articles/mavic/.

Return flight instructions

1. Push "return home" button.

2. Switch to manual when the copter is 1 km away.

3. Near the return point, you do not have to be concerned with the copter noise, start to
   descend the copter to 250 meters, at 500 meters form "home" lower the copter to the
   height of 120 meters.

4. Perform visual check till the copter is 20 meters form the ground, then lower the camera at 90 degrees angle and chose an even ground. Using a very smooth movement, use the left joystick and slowly lower the copter to the ground.

5. Assistant must retrieve the copter as quickly as possible.

6. Immediately switch off the copter.

Figures

Abbreviations

CAST	Center for Analysis of Strategies and Technologies
C2	command and control
C-UAV	counter-uncrewed aerial vehicle
DNR	Donetsk People's Republic
EW	electronic warfare
FPV	first-person view
ISR	intelligence, surveillance, and reconnaissance
LNR	Luhansk People's Republic
MANPADS	man-portable air-defense system
MLRS	Multiple Launch Rocket System
NATO	North Atlantic Treaty Organization
MOD	Russian Ministry of Defence
SOCDIT	Strategic operation for the destruction of critically important targets
TTPs	tactics, techniques, and procedures
UAS	uncrewed aerial system
UAV	uncrewed aerial vehicle
UCAV	uncrewed combat aerial vehicle
UGV	uncrewed ground vehicle
USV	uncrewed surface vehicle
UUV	uncrewed underwater vehicle

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SP3 provides strategic and political-military analysis informed by regional expertise to support operational and policy-level decision-makers across the Department of the Navy, the Office of the Secretary of Defense, the unified combatant commands, the intelligence community, and domestic agencies. The division leverages social science research methods, field research, regional expertise, primary language skills, Track 1.5 partnerships, and policy and operational experience to support senior decision-makers.