

PISM REPORT

MILITARY-TECHNICAL ASSISTANCE TO UKRAINE AN ASSESSMENT OF ITS SHORT- AND MEDIUM-TERM NEEDS



DECEMBER 2022

MARCIN ANDRZEJ PIOTROWSKI

THE POLISH INSTITUTE OF INTERNATIONAL AFFAIRS

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LIST OF MOST FREQUENTLY USED TERMS

AMRAAM	Advanced Medium-Range Air-to-Air Missile
APC	Armoured Personnel Carrier
ATACMS	Army Tactical Missile System
ATGM	Anti-Tank Guided Missile
BM	Boyevaya Mashina
BMD	Boyevaya Mashina Desanta
BMP	Boyevaya Mashina Pekhoty
BTR	Bronetransporter
CAESAR	<i>Camion Équipé d'un Système d'Artillerie</i>
CAMM	<i>Common Anti-Air Modular Missile</i>
CFE	Conventional (Armed) Forces in Europe
COTS	Commercial off-the-shelf
C-UAS	Counter-Unmanned Aircraft System
DJI	Da-Jiang Innovations
DPRK	Democratic People's Republic of Korea
ERA	Explosive Reactive Armor
EU	European Union
GMLRS	Guided Multiple Launch Rocket System
GRU	Glavnoye Razvedyvatelnoye Upravlenie
HALE	High Altitude, Long Endurance
HARM	High-speed Anti-Radiation Missile
HCDS	Harpoon Coastal Defense System
HIMARS	High Mobility Artillery Rocket System
HMMWV	High Mobility Multipurpose Wheeled Vehicle
IFV	Infantry Fighting Vehicle
IISS	International Institute for Strategic Studies
Il	Ilyushin
INF	Intermediate (Range) Nuclear Forces
IRIS-T	Infra-Red Imaging System Tail
Ka	Kamov
LRHW	Long Range Hypersonic Weapon
M	Model/Modernizovani
MALE	Medium Altitude, Long Endurance
MANPADS	Man Portable Air Defence System
MARS	Mittleren Artillerie Raketen System
MBT	Main Battle Tank
Mi	Mil
MiG	Mikoyan and Gurevich
MLRS	Multiple Launch Rocket System
MRAP	Mine Resistant Ambush Protected
MRC	Medium-Range Capability

MTCR	Missile Technology Control Regime
MT-LB	Mnogotselovoy Tyagach Legkiy Bronirovanny
NASAMS	Norwegian/National Advanced Surface to Air Missile Systems
NATO	North Atlantic Treaty Organization
NSM	Naval Strike Missile
PAC	Patriot Advanced Capability
PISM	Polish Institute of International Affairs
PrSM	Precision Strike Missile
PT	Polish Tank
PzH	Panzerhaubitze
RAP	Rocket Assisted Projectile
RBS	Robotsystem
RPG	Ruchnoy Protivtankoviy Granatomet [Rocket Propelled Grenade]
RUSI	Royal United Services Institute
SHORAD	Short Range Air Defence
STANAG	Standardisation Agreement
Su	Sukhoi
T	Tank
Tu	Tupolev
UAV	Unmanned Aerial Vehicle
UDCG	Ukraine Defense Contact Group
UK	United Kingdom
USSR	Union of Soviet Socialist Republics
VMF	Voyenno-Morskoi Flot
VKS	<i>Vozdushno-kosmicheskiye sily</i>
Vz.	Vzor
ZSU	Zbrojne Syly Ukrainy

EXECUTIVE SUMMARY

- Western military aid has played a key role in Ukraine’s ability to preserve its independence, but it is still insufficient to break Russia’s offensive potential, to recapture Russian-held territory, or even to stop Russia’s next possible offensives—in short, to end the war. Ukraine cannot rely on its own defence industry, a great part of which has been destroyed. For these reasons, it is necessary to increase both the scale and scope of Western military support for Ukraine, which should include more NATO-standard weapons than before.
- Although the situation on the battlefield became more favourable for Ukraine in autumn 2022, Russia still has an advantage in terms of quantity and reserves of armament. Without breaking the Russian offensive potential, which would bring a conclusion to the war on terms favourable to Ukraine, there is no chance for changing Russia’s strategic ambitions and calculus. Russia will attempt to regain the military initiative, as confirmed by its “partial mobilisation” and placing industry on a war footing.
- To date, the course of the war has confirmed that the results at the strategic and tactical levels depend on the appropriate concentration and use of heavy conventional weapons. The six essential types of these capabilities are: heavy barrel and rocket artillery, armoured and motorised troops, longer-range missiles, air power, drones (UAVs) and loitering munitions, and air-defence systems. So far, Ukraine has serious gaps in each category, and this asymmetry persists despite Russia’s high losses.
- Most barriers to providing military assistance to Ukraine are, above all, political in nature. Ukraine’s partners differ in their strategic calculations, scope, scale, and determination to provide assistance. Objectively, obstacles to aid stem from limited reserves of armaments and ammunition and decades-long policies of reducing the production capacity of Western defence industries.
- In general, the first step for providing military aid to Ukraine is clarifying capability gaps, that is, the disparity with Russia. The next step is to analyse available options for supplying weapons and ammunition. One can consider **eastern options** (Soviet-made or compatible systems), **STANAG options** (NATO-standard weapons), and **asymmetric options** (systems that are not equal to a given capability but make it possible to counter it, for example, anti-tank guided missiles as a partial solution to the issue of Russian numerical superiority in tanks, at the same time substituting for the lack of Western tanks). A third step, especially for Ukraine’s neighbouring partners, could be to use the support of NATO forces and means, or accelerated individual modernisation efforts, to fill the gaps created by the transfer of their weapons to Ukraine.
- In most of the capability gaps analysed, there are severe limitations to further pursue the eastern options, due to the rapidly depleting reserves of Soviet systems or ammunition in NATO countries. At the same time, asymmetric options must be considered as interim or complementary solutions in the absence of a willingness by some of Ukraine’s partners to supply weapons analogous to Russia’s. Therefore, the most desirable and effective capabilities that can be offered to Ukraine are systems identified in this report as STANAG options, which are produced in NATO countries or by pro-Western Asian states.
- Within a few months of the war, Ukraine’s heavy artillery almost fully transitioned from Soviet-era systems to howitzers, HIMARS, MLRS launchers, and STANAG ammunition.

Moreover, Ukraine already relies almost entirely on Western drones and loitering munitions and on access to commercial drones. A similar transition will also be necessary in Ukraine's armoured and motorised forces, longer-range guided missiles, air force, and air defence systems.

- Ukraine's current artillery capabilities are based on several post-Soviet systems and at least 9-10 different NATO howitzer models. Weakness of such a "patchwork" of systems calls for a gradual rationalisation of assistance to Ukraine, for example the creation of simple and continuous logistics chains, the formation of units using the same standardised systems, and maintaining assistance from smaller groups of states that have supplied identical systems. Such rationalisation would be advisable in 2023-2024 for the majority of other STANAG options, which would also increase the interoperability of Ukrainian forces with NATO in the post-war perspective.
- Due to probable exhaustion of T-72 tank reserves in Europe in 2023, Ukraine may need to switch to NATO tank models, such as the American M-60 and M-1 Abrams or the German Leopard-1 and Leopard-2. Existing NATO and non-NATO reserves of M-113 armoured personnel carriers also make it possible to fully outfit Ukraine's land forces with them. Even with positive decisions on tank deliveries, Ukraine will still need a continuous supply of anti-tank missiles, especially of the Javelin or TOW type.
- Russia has an overwhelming advantage over Ukraine in ballistic and cruise missiles. Currently, Ukraine does not have the capability to strike Russian targets at more than 100-120 km, apart from the selective and improvised use of long-range drones. In 2023-2024, it is necessary to continue supplying Ukraine with HARM anti-radar and Harpoon anti-ship missiles. Urgent and binding arrangements between the U.S. and Ukraine are also needed for the possible delivery of ATACMS ballistic missiles with a range of 300 km.
- Ukraine faces the full degradation of its air force, which is based on MiG-29 and Su-27 multi-role aircraft, as early as in 2023. This requires its transition to a new fleet of aircraft, such as American F-16s or Swedish Gripens. Postponing this decision beyond 2024 will create a dangerous capability gap on the Ukrainian side. There are fewer problems with supplying Ukraine with post-Soviet transport and attack helicopters from Central Europe, so the full transition of this fleet to Western systems can be carried out at a later date.
- Ukraine's air defence is responsible for inflicting relatively high losses on Russia's air force, but in this area eastern options are running out, too. Therefore, in 2023 it will be necessary to build a new network of radars and air interceptor launchers for Ukraine, based on NASAMS, HAWK, and IRIS-T systems. Also during 2023 there is a need to finish studies on the new architecture of Ukraine's longer-range, integrated air and missile defence, preferably based on Patriot or SAMP-T systems.
- NATO's attention should focus on the capability gaps emerging in some Central European members due to their delivery of weapons to Ukraine. The cost and scale of their accelerated armed forces' modernisation to fill national gaps are now so high that they require support from Western Europeans and the U.S. NATO's forces and systems on the Eastern Flank must support credible deterrence and defence posture, which to now relies mainly on U.S. efforts. Only synchronised military aid to Ukraine and reinforcement of NATO's Eastern Flank countries will ensure the complete failure of Russia's plans in Europe.

PRELIMINARY REMARKS

The aim of this report is to identify the military capabilities needed by Ukraine to repel Russian forces, transition smoothly to NATO weapons standards, and enable its possible integration with the Alliance. The most important problem facing Ukraine's defence is, in the words of its foreign minister, "weapons, weapons, and weapons".¹ For Ukrainians, defence against Russia is an existential issue. Given the disparity between the two countries' capabilities, this requires maintaining adequate assistance from Ukraine's Western partners. This report is aimed at civilian decision-makers, officials, experts, and other research centres in countries interested in Ukraine's success. Addressing such an approach rules out the necessity for reviewing theoretical literature or methodology for planning the development of military capabilities, as these are already formulated within NATO.² Instead, it seeks to explain why the filling of specific gaps in Ukraine's military capabilities is a pre-condition for bringing about a military situation that favours this country and its partners. It skips comprehensive analyses that go beyond armaments, for example, to include organisational or doctrinal changes. One approach in NATO is to assess all forces and assets in a given domain, that is, land, sea, air, space, and cyberspace. The division into domains has advantages for some long-term planning studies. However, the "multi-domain" approach is still being discussed within NATO and is not very practical for Ukraine. It fails to take into account the unpredictable dynamics of successive stages in a conflict already underway.

The analysis contained in this report requires several clarifications. The text is based solely on publicly available information about the course of Russia's war against Ukraine. To standardise the data, estimates of Russia's, Ukraine's and its partners' military equipment prior to 24 February 2022 were used.³ The author views the statistics of Russian and Ukrainian equipment losses published by their respective governments with scepticism. However, these statistics are checked against photographic evidence of destroyed, damaged, or captured equipment provided by other analysts.⁴ While such verification does not provide a full picture of the war or the losses on both sides, it does reveal noticeable trends and facilitates the analysis of Ukraine's needs stemming from these losses. Also, the report does not deal with the issue of assistance to Ukraine in the sphere of intelligence, electronic warfare measures, or cyberspace operations. According to media reports, such assistance is being provided to Ukraine but, given the sensitivity of the subject, a more in-depth analysis should await after the cessation of hostilities. Given the scarcity of reliable data or the often contradictory reports about the cost of heavy weapons delivered to Ukraine, it was also necessary to forego estimating their value.

Some terminological issues also must be explained. First among them is the scope of the meaning of the terms "military capabilities" and "capability gap". Military capabilities will be understood primarily as heavy weapons systems or equipment allowing a country to attain

¹ See: "Ukraine Asks for 'Weapons, Weapons, Weapons,'" *BBC News*, 7 April 2022, www.bbc.com.

² The Alliance's so-called comprehensive assistance, including planning procedures, has been implemented since 2016 within the framework of NATO's partnership with Ukraine. See: "Comprehensive Assistance Package for Ukraine," *NATO Fact Sheet*, July 2016, www.nato.int.

³ Unless otherwise indicated, quantitative estimates for Russia, Ukraine, and NATO prior to February 2022 are from the International Institute for Strategic Studies (IISS), *The Military Balance 2022*, Routledge, London 2022. Unless otherwise indicated, technical specifications are from the updated profiles contained in the database for subscribers to IHS Markit's *Jane's*, <https://customer.janes.com>.

⁴ See the blog, deemed authoritative, of S. Mitzer and J. Oliemans, *Oryx*. Data from 2 October 2022, see: "Attack on Europe: Documenting Russian Equipment Losses during the 2022 Russian Invasion of Ukraine," *Oryx*, 24 February 2022 (first post), and "Attack on Europe: Documenting Ukrainian Equipment Losses during the 2022 Russian Invasion of Ukraine," *Oryx*, 24 February 2022, www.oryxspionenkop.com.

its goals on the battlefield. A deficiency in military capabilities means gaps that hinder or prevent further operations of the Armed Forces of Ukraine (ZSU). Assistance provided to them may also create capability gaps for Ukraine's partners. Second, in light of debates in several NATO countries, the terms "defensive" and "offensive" capabilities must be clarified.⁵ Indeed, Ukraine—and any country defending itself—needs to possess both types of armaments. Offensive-capable weapons can be defined as main battle tanks and other armoured vehicles, heavy artillery of a calibre larger than 100 mm, combat aircraft, and helicopters.⁶ Defensive capabilities, on the other hand, include air and missile defence systems. Such a division notwithstanding, there are many systems that, depending on the context, can provide defensive as well as offensive capabilities. Two general categories of such weapons in this "grey area" are guided missiles (especially longer-range) and armed unmanned aerial vehicles (UAVs, drones).

⁵ Against the backdrop of these differences, debates were held in Germany about what is a "tank," what capabilities it gives, and whether Marder and Gepard-type vehicles are tanks. See: H. von der Burchard, L. Gehrke, M. Karnitschnig, "Olaf Scholz's Ukrainian Tank Battle," *Politico*, 27 May 2022, EU Edition, www.politico.eu.

⁶ See the definitions of armaments subject to the arrangement [in:] "Treaty on Conventional Armed Forces in Europe," signed in Paris on 19 November 1990, www.osce.org/files/f/documents/4/9/14087.pdf.

OUTLINE OF THE POLITICAL PROBLEMS AND DETERMINANTS OF AID TO UKRAINE

CHANGES IN THE STRATEGIC CONTEXT OF RUSSIA'S WAR WITH UKRAINE

The context of Russia's war against Ukraine is subject to change, in terms of strategic calculations, the nature of both sides' military actions, and evolution in the type, scale, and formulas of military assistance provided to Ukraine. These factors will impact successive stages of the war and prospects for its end while, determining the chances of political and military success for either Ukraine or Russia.

Russia's Strategic Calculations. While Russia has claimed various goals for its "special military operation" since the war began, its primary strategic aim is to secure full control of Ukraine's domestic and foreign policy. Since 2014 and the annexation of Crimea, Vladimir Putin has shown a preference for military means over other tools of influence used until then. With varying intensity, for the past seven years Russia has conducted military operations in the east of Ukraine and, in the spring of 2021, had amassed enough forces for preparing a full-scale armed invasion. The fiasco of the Russian offensive launched from Belarus on 24 February 2022 and the failure to capture Kyiv led Russia in late March to redeploy its remaining forces and resources in the area to eastern Ukraine. The statements made by the head of Russia's Security Council suggest that, even with a limited geographical scope of the "special military operation", Russia would not give up its ambition to put an end to Ukraine's pro-West oriented foreign and security policies.⁷ For these reasons, even should bilateral negotiations be resumed, there would be no chance for building an area of common interests or compromise. The real purpose of Russia's talks with Ukraine would only concern the terms of a ceasefire, which Russia would treat as a temporary solution intended to "freeze the conflict", or guarantee total victory.

Russia has a military edge over Ukraine, especially after the "partial mobilisation" of its military reserves, so it may find it profitable to continue the war. As with the illegal annexation of Crimea, Russia is counting on creating a semblance of control over the captured territories, as indicated by the rigged "referendums" it held in September in the Donetsk, Luhansk, Kherson, and Zaporizhzhia oblasts of Ukraine. Such calculations may be furthered by the lack of any organised opposition to the war in Russia. Other factors the Russian government seems to be counting on are the divisions within NATO and the EU that existed before the war about Ukraine's place in Europe's security architecture. In other words, Russia seems to assume that the West's unprecedented political unity will weaken under the impact of inflation, high energy and food prices, and growing weariness among decision-makers and the general public with the war. In Russia's perception, from early 2023 on, the costs of the war for the West will lead to waning support for Ukraine.⁸

⁷ See: "Article by Vladimir Putin 'On the Historical Unity of Russians and Ukrainians,'" Moscow, 12 July 2021, and "Address by the President of the Russian Federation," Moscow, 21 July 2022, www.en.kremlin.ru. Despite opinions holding that Russia is moving away from its "regime change" plans in Ukraine, statements made by Putin and his advisors indicate that such a re-evaluation of goals has, in fact, not taken place. See, for example, "Russia not 'chasing deadlines' in Ukraine, says security hawk," *Reuters*, 24 May 2022, www.reuters.com.

⁸ See the assessments by U.S. intelligence in A. Alper, K. Freifield, J. Landay, "Putin Still Wants Most of Ukraine, War Outlook Grim—U.S. Intelligence Chief," *Reuters*, 29 June 2022.

Russia's Changing Military Tactics. The effect of high losses among Russia's invading forces restricted the aggressor's operational objectives to the Kharkiv, Kherson, and Donbas regions, forcing it to modify tactics. Without full and formal mobilisation, Russia is unable to resume operations in the Kyiv direction, while the experience of the siege of Mariupol, which was devastating also for Russian forces, discourages it from battles for Ukraine's larger cities. After the withdrawal of its forces from Snake Island, Russia is also unable to launch a combined amphibious and ground operation against Odesa. Thus, Russia has no way to take advantage of its naval blockade of Ukraine or its dominant position in the Black Sea. Instead, the Russian military command is counting on attrition to win the war. On that assumption, the Russians adapted the tactics of their land, air, and naval forces by focusing on strengthening their defensive positions, long-range missile strikes, and isolated attempts to breach local fronts.

Russia's military tactics in Ukraine from April to September were a continuation of familiar Soviet methods. Its most important effect was the gradual balance of losses on both sides. Ukraine's greater openness in such matters confirmed this trend. While initially Ukrainian authorities censored such information, in June they spoke openly about sustained and increasing daily losses. As fighting intensified in Donbas, the Ukrainian president reported 60-100 dead and 500 wounded per day, and later one of his advisors reported as many as 150 dead and 800 wounded daily.⁹ Toward the end of August, the ZSU Chief of Staff also publicly mentioned 9,000 fallen soldiers.¹⁰ With the successful ZSU counter-offensive in September-November, Russia continued its earlier long-range missile strikes on Kyiv, on Ukraine's military bases and airfields, as well as its critical infrastructure. Having lost the initiative, Russia is also forced to defend captured Ukrainian territory.

Changing Formulas for Aid to Ukraine. Since 2014, Ukraine's army has benefited from training, advisory, and equipment provided by NATO and bilaterally by individual members. This increased the preparedness of many ZSU units, the quality of their command structure, and brought their procedures and standards closer to those of NATO forces.¹¹ However, explaining Ukraine's successes by these programmes alone reduces the significance of combat experience against so-called "separatists" (*de facto* Russian forces) in eastern Ukraine and the general skill and determination of Ukrainian troops. The fact remains, though, that Ukraine would not have been able to cope with the aggressors without continued external assistance. There were gradual changes in the categories, types, and versions of weapon systems that the ZSU obtained since the beginning of 2022. They reflect the changing situation on the frontline, assessments made by Ukraine's partners, and their political interests. During the preparatory phase preceding the Russian invasion (December 2021-February 2022), assistance from some 20 countries consisted of helping Ukraine with small arms, and guided anti-tank and point defence missile units. This made the rapid expansion and rearmament of Ukraine's Territorial Defence Forces possible, which in turn reduced the burden on regular ZSU units. In the first quarter of 2022, the dominant assumption in Western countries was that Russia would capture Kyiv. The light weapons delivered at that time were therefore supposed to be useful both in defence and, later, in the resistance movement against the occupier.¹² During this period, 33 countries also supplied first aid and personal protection items, thus contributing to redu-

⁹ See: D. Sabbagh, "Ukraine Needs Many More Rocket Launchers from West, Says Adviser," *The Guardian*, 6 June 2022, and I. Koshiw, "We're Almost Out of Ammunition and Relying on Western Arms, Says Ukraine," *The Guardian*, 10 June 2022, www.theguardian.com.

¹⁰ "Almost 9,000 Military Killed in War With Russia," *Reuters*, 22 August 2022.

¹¹ For more about ZSU reforms until 2017, see: A. Wilk, "The best army Ukraine has ever had. Changes in Ukraine's armed forces since the Russian Aggression," *OSW Studies*, no. 66, July 2017.

¹² H. Cooper, "U.S. Considers Supporting an Insurgency if Russia Invades," *The New York Times*, 15 January 2022.

ced Ukrainian casualties. Then, from mid-March, Western assistance expanded to include non-NATO and non-EU countries and deliveries of ammunition, hand-held MANPADS and ATGM systems, and Soviet-type air-to-air missiles. In parallel, deliveries of heavy post-Soviet weapons and ammunition also began, especially from Czechia, Poland, and Slovakia.

Military assistance to Ukraine was initially bilateral and uncoordinated or unplanned among Ukraine's partners. The protracted nature of the war and Ukraine's growing needs led to the establishment of the Ukraine Defense Contact Group (UDCG) in April 2022. It now employs at least a hundred civilian and military liaison officers from interested countries and Ukraine, and is based at the U.S. Air Base at Ramstein, Germany. As part of the UDCG, three working groups operate around the clock in sharing intelligence and assessing Ukraine's current military needs. Their liaisons also coordinate logistical aspects of troop training and the delivery of military equipment to Ukraine.¹³ The UDCG meets monthly at the ministerial level. Its third meeting took place on 15 June in Brussels on the sidelines of the NATO defence ministers meeting (Ecuador, Georgia and Moldova joined 45 other countries). The group's fifth ministerial meeting was organised in early September, with 50 countries represented (without new members named), to discuss the long-term approach to military aid for Ukraine. A sixth meeting in mid-October focused on current needs in Ukrainian air defence.¹⁴

Future aid to Ukraine depends on continued U.S. leadership within a "coalition of the willing"—the UDCG. This leadership bridges the gap between those that are strongly committed to aiding Ukraine (the Nordic countries and the countries of NATO's Eastern Flank) and those worried about the potential risks of arming Ukraine (Germany and France). The bulk of U.S. assistance in equipment is now provided thanks to the adoption of the Lend-Lease Act by the Biden administration and Congress. This law ensures the financing of direct military assistance to Ukraine through 2022 and 2023, as well as the enhanced presence of American forces in Europe and other assistance to NATO's Eastern Flank. In addition to the \$33 billion already allocated, the approval by Congress of further tranches of U.S. aid for Ukraine and its partners in the 2023 defence budget is also expected (the further level of U.S. aid might depend on the political situation in Congress after the start of the next term in January).¹⁵

OBJECTIVE OBSTACLES TO MILITARY AID TO UKRAINE

In countries providing aid to Ukraine, political will remains crucial if military supplies to Ukraine are to continue. There are several objective barriers that affect the shape of this aid. Indeed, the scale and intensity of the war exceeds not only Ukraine's current capabilities but probably also those of the West's defence industry. Russia is also making efforts to counter the assistance to Ukraine.

Restrictions on the Transfer of Technologies to Ukraine. At least three factors hinder or slow down the transfer of advanced weaponry for Ukraine. The first is the security of such

¹³ See: I. Ali, "Conference Room in Germany Morphs into Nerve Center for Western Weapons Shipments to Ukraine," *Reuters*, 24 May 2022, and J. Detsch, "Inside a Major Nerve Center for Shipping Military Aid to Ukraine," *Foreign Policy*, 24 May 2022, www.foreignpolicy.com.

¹⁴ See: "Secretary of Defence Lloyd J. Austin III Delivers Opening Remarks at the Ukraine Defence Contact Group Meeting at NATO Headquarters, Brussels, Belgium," Department of Defense, 15 June 2022, and "Contact Group Aids Ukraine's Current Battle, Looks to Long-Term Assistance," *DoD News*, 8 September 2022, www.defense.gov; "Western Nations Rush Defensive Systems to Ukraine to Counter Russian Missiles," *The New York Times*, 12 October 2022.

¹⁵ For Pentagon budget proposals submitted to the House of Representatives, see: C. Edmondson, "House Passes \$840 Billion Military Bill to Counter Threats From Russia and China," *The New York Times*, 15 July 2022. For more about the divisions within the Republican Party, see: J. Bolger, "House Republicans divided over aid to Ukraine ahead of midterms," *The Guardian*, 18 October 2022, www.theguardian.com.

technologies, its associated legal restrictions, and concerns about them falling into Russian hands. These restrictions result in blocked deliveries of the latest weapons systems or in the delivery of simplified versions to Ukraine. A good example of this is the required modifications to Stinger MANPADS and artillery radars, which delayed their delivery to Ukraine prior to the outbreak of the war.¹⁶ Second, even older generations of NATO weapons require an adequate level of training, logistics, and servicing facilities. Challenges in this respect increase in proportion to the sophistication of the system. For example, deliveries of the highly effective Javelin ATGMs were initially not accompanied by the guaranteed and adequate maintenance to fix minor problems or malfunctions in field conditions.¹⁷ The Pentagon's current approaches seem to indicate that it is reluctant to deliver weapons without the appropriate training and assumed effectiveness on the battlefield. Third, Ukraine has gained post-1991 an image as a country with a black market in weapons, which for the U.S. administration requires assuring compliance with non-proliferation legislation and monitoring of end-users. Such barriers will be difficult to circumvent after the U.S. experience with the disintegration of the Iraqi army in 2014 and the Afghan army in 2021 when control of large quantities of small weapons for infantry and even heavy systems were lost.¹⁸

Reserves and Production Limits in the West. Even though the West's industrial base is greater than Russia's, this potential is not without limits. Two decades of fighting terrorism has increased NATO states' need for precision weapons that reduce civilian casualties to a minimum. Such costly ammunition, however, most often fails to be similarly effective when faced with the forces and means of a conventional aggressor like Russia. This can be clearly seen in the case of heavy artillery ammunition stocks in decline for many years now. Indeed, the withdrawal of most NATO forces from Afghanistan since 2014 has reduced orders for such ammunition. Their high cost and mistaken assumptions about Russia have worked against the build-up of greater strategic reserves. For example, the present cost of one Excalibur laser-guided shell for 155 mm howitzers is almost \$100,000.¹⁹ As an increasing number of statements made by policymakers indicates, greater production of weapons and ammunition for domestic and Ukrainian needs is beyond the current capabilities of West European industry. This is due to the peacetime mode of operation of private sector companies, previous limits on the volume of production, the negative effects of the COVID-19 pandemic on industry, as well as policies pursued by governments, which over the past 30 years have focused on consolidating the technological and industrial base rather than preparing it for wartime operations.²⁰ These problems can be seen even in the U.S., whose technology and production capacity is NATO's and the world's largest. For the past few months, the U.S. has been creating additional jobs and production lines, or looking for innovations in response to the growing needs of the Pentagon and Ukraine. The first consultations between the U.S. and British defence ministries and domestic manufacturers have already shown that, depending on the parameters of a given system, the quickest adaptations may require from one to six

¹⁶ See: M. R. Gordon, "How Removing a Handful of Screws Allowed Pentagon to Deliver Stingers to Ukraine," *The Wall Street Journal*, 9 March 2022; and S. Sprenger, "The Race to Arm Ukraine Highlights West's Worry of Losing Tech Secrets," *Defense News*, 8 June 2022, www.defensenews.com.

¹⁷ See: Th. Gibbons-Neff, N. Yermak, "Potent Weapons Reach Ukraine Faster than the Know-How to Use Them," *The New York Times*, 6 June 2022, and A. Horton, "For Ukrainian Troops, a Need Arises: Customer Service for Javelin Missiles," *The Washington Post*, 17 June 2022.

¹⁸ J. Hudson, "Flood of Weapons to Kyiv Prompts Fears of Smuggling," *The Washington Post*, 15 May 2022.

¹⁹ Price quoted from A. Świerkowski, "Kanada wysła na Ukrainę artylerię i amunicję dalekiego zasięgu," *Defence24*, 26 April 2022, <https://defence24.pl>.

²⁰ See: A. Vershinin, "The Return of Industrial Warfare," *RUSI Commentary*, 17 June 2022, <https://rusi.org>, and "Macron Calls for French Budget Boost in 'War Economy,'" *France24*, www.france24.com.

months of work.²¹ In turn, Central European armed forces have largely abandoned Soviet standards following their accession to NATO. This led them to shut down production lines of ammunition for small arms, tank guns, and heavy artillery in their countries. In this situation, the limited reserves of such ammunition and the cost of a possible resumption of production may also be a significant issue.

Russian Pressure and Sabotage Efforts. For several months now, Russia has been exerting diplomatic pressure on governments or companies that, in its view, are “illegally” supplying Ukraine with Soviet-made armaments. Russia is also trying to take advantage of Western concerns about the security of technology and the proliferation of weapons on black markets by spreading disinformation on the topic. With the delivery of increasingly advanced weapons to Ukraine, such disinformation is expected to increase.²² What’s more, Russian military intelligence (GRU) has been sabotaging ammunition depots in Ukraine for many years, and with known attacks in March and September 2017. The most spectacular cases, only confirmed following a lengthy investigation, were when it blew up an arms depot in the Czech town of Vrbetice as fighting was under way in eastern Ukraine (October and December 2014). The Prosecutor’s Office in Bulgaria is also pursuing Russian citizens allegedly involved in the attempted poisoning of local arms dealer Emilian Gubariev in April 2015. In addition, that same year in Kyiv, Russian intelligence allegedly thwarted Ukraine’s collaboration with India by kidnapping an official involved in the negotiations.²³ Since early 2022, the GRU may be conducting new operations against potential suppliers of arms and ammunition to Ukraine. The Gubariev arms depot was again the target of Russian sabotage at the end of July, and similar operations were likely planned for other Central European countries.²⁴ All of the cases uncovered so far are marked by Russian ruthlessness in the methods, as they seek to deter some suppliers and intermediaries, whether they operate on legal markets or in the “grey zone” of the arms trade.

GENERAL SCHEMES AND OPTIONS FOR MILITARY AID TO UKRAINE

The mechanisms of military aid to Ukraine on a bilateral basis can take different forms. After nine months of war, however, it is possible to outline a general pattern and common problems faced by the UDCG states, and to identify advantages and disadvantages of available options and the recommended steps to take in planning assistance to Ukraine.

Identifying Ukraine’s Capability Gaps. As a first step, it is advisable to identify the gaps in Ukraine’s military capabilities. Even a general assessment must begin with known differences in the quality of armaments and disparities in the potentials of the two countries at war. These are related to their initial resources and the reserves available to them. The current disparities are also influenced by the different levels of equipment losses on the battlefield (kill ratio). No less important is an assessment of the similarities or differences in the doctrine adopted and tactics pursued by both. Most of this data is available to the General Staff of the ZSU,

²¹ C. Albon, “Pentagon Reviewing Hundreds of Industry Proposals in Effort to Rapidly arm Ukraine,” *Defense News*, 6 May 2022, and A. Świerkowski, “Rusza brytyjski fundusz wspierający ukraińskie siły zbrojne,” *Defence24*, 6 May 2022.

²² H. Foy, S. Fleming, R. Olearchyk, “West Fears Arms Sent to Ukraine End up on Europe’s Black Market,” *Financial Times*, 13 July 2022 (the title was changed for printed version. The earlier online title was “NATO and EU Sound Alarm over Ukraine Weapons Smuggling”).

²³ See: B. Forrest, “The Ukraine Crisis: War Intensifies Global-Arms Competition,” *The Wall Street Journal*, 17 June 2022, and I. Khurshudyan, P. Sonne, “Russia Has Been Targeting Ukraine’s Ammunition for Years,” *The Washington Post*, 25 June 2022.

²⁴ D. Nicholls, “Britain Helps Ukraine’s Allies in the Hunt for Russian Spies Targeting Western-Supplied Weapons,” *The Telegraph*, 1 August 2022, www.telegraph.co.uk.

but it is not fully shared with all of Ukraine's partners.²⁵ An assessment of Ukraine's needs is not made easier by the changing pace and scope of military operations. It is also complicated by frequently incohesive calls by Ukrainian politicians, their advisors, media, and activists. Most of this is explained by a desire to exert stronger influence on public opinion and the governments of UDCG countries. Thus, since the beginning of the war, several Ukrainian "wish lists" or "shopping lists" have been published. Some of the gaps indicated in them reflect entirely legitimate Ukrainian demands that give background for confidential negotiations with a partner.²⁶ Some of the unofficial demands for specific weapon types, however, give rise to questions among non-governmental analysts about the realism of such expectations. An example of the latter case was the Ukrainian demand for supplying American Tomahawk cruise or Israeli LORA ballistic missiles.²⁷

Identifying Available Supply Options for Ukraine. The second step in planning assistance is to analyse available options for supplying armaments, ammunition, and other equipment to Ukraine. While identical or similar post-Soviet systems used by Russia and Ukraine allow for the use of many types and variants of equipment captured from the enemy, this is not a systemic solution, but only a means to supplement ZSU needs on a day-to-day basis. With the damage already done to Ukraine's defence-industrial base, most of the gaps cannot be filled quickly using domestic production facilities. In this context, it is advisable to assess the role of Ukraine's new capabilities, at least in the current perspective (to the end of 2022), as well as in the short (to the summer-autumn of 2023) and medium terms (by 2024-2025).

The attached **Diagram** based on the example of Ukraine's main battle tank capability gap illustrates the simplified and more or less available options. For most of Ukraine's capabilities, three main options can be identified: eastern, STANAG, and asymmetric. Each may require a different length of time for the ZSU personnel training programme, while for some others that won't be necessary. However, in many cases, the timing of deliveries to Ukraine will continue to be influenced by a given partner's current calculations, including risk assessments concerning various types of conflict escalation.²⁸ The available options can be summarised as follows:

- **The eastern option**, i.e., supplies of Soviet-standard spare parts or complete systems that are operated by Ukraine's partners. This is the easiest option in terms of operations and logistics. Unless they are further modified to NATO standards, additional training for ZSU operators is not required. One variant of this option is the supply of ammunition from factories or strategic reserves in Central Europe. Czechia, Bulgaria, Poland, Romania, and Slovakia in particular still have such capabilities. Concerns about Russian strikes or pre-emptive action may have limited their readiness to transfer some of the systems to Ukraine in the first months of the war. Even if the USSR and Russia have not conducted pre-emptive operations in the past, the governments in the region will continue to be guided

²⁵ Media suggest a similar lack of transparency in Ukraine's overall strategy. See: J. E. Barnes, "US Lacks a Clear Picture of Kyiv's Strategy in War, Officials Say," *The New York Times*, 9 June 2022.

²⁶ L. Brown, "Ukraine Can 'Break' Russians if West Supplies Enough Weapons," *The Times*, 6 April 2022, www.thetimes.co.uk, and J. P. Rathbone, R. Olearchyk, "Military Briefing: Which Weapons has Ukraine Received and How Many More Does it Need?" *Financial Times*, 14 June 2022, www.ft.com.

²⁷ See, for example, Ch. Maza, "Ukraine is Circulating a 'Wish List' of Western Weaponry. Here's What's in it," *National Journal Daily*, 2 June 2022, www.nationaljournal.com, and the list on the *Weapons List* website, "Save UA List," which has been supplemented irregularly since April and is intended for members of Congress, <https://saveualist.com>.

²⁸ Risk assessments change as the situation evolves, so some systems considered "escalatory" or "provocative" in March of this year may now be seen as less risky. See: T. Wetzel, B. Pavel, "What Are the Risks and Benefits of US/NATO Military Options in Ukraine?," *Atlantic Council*, 9 March 2022, www.atlanticcouncil.org.

by higher security requirements in assistance to Ukraine.²⁹ When analysing the availability of such options, one should also consider smaller Alliance countries with post-Yugoslav armaments (but Soviet-compatible), such as Croatia and Slovenia. Similar possibilities exist in connection with Greece and Finland, as both also have reserves of some Soviet heavy weapons and ammunition.

- **The STANAG option**, i.e., supplying Ukraine with NATO-compliant systems that are part of the operational arsenals or the reserves of Alliance countries.³⁰ This can provide Ukraine with comparable or even higher-quality capabilities than the *eastern option* and has the benefit of actually accelerating the ZSU's transition to NATO standards. Contrary to the first option, an additional advantage is that there exists a much larger pool of suppliers of systems, their parts, and ammunition. The short-term challenge with the *STANAG option* is the need to train operators outside Ukraine to use newer and latest-generation weapons. It also requires the simultaneous preparation of on-site logistics and ensuring a permanent supply chain for the future. In terms of availability, the largest reserves of STANAG systems are held by the U.S. In the first months of war, this option was limited by U.S. fears of delivering weapons to Ukraine that could give Russia a pretext to increase tensions or escalate in the nuclear sphere.³¹ As the war unfolded, however, the list of delivered equipment was expanded to include capabilities previously ruled out, like MLRS and HIMARS. The list of potential suppliers of STANAG systems can be expanded to include most NATO countries, Finland and Sweden, as well as countries that are outside the Alliance. The potential of this option has already been demonstrated by deliveries of M-113 personnel carriers from Australia and several NATO countries.
- **The asymmetric option**, i.e., the transfer of systems that are not equivalent to, but make it possible to counter a given capability, such as ATGMs, which would solve the problem of Russian superiority in tank numbers and, at the same time, to the West's unwillingness to provide such vehicles to Ukraine. This approach has shown its merits in the delivery of simple and light systems that do not require complex training. They include eagerly supplied "fire-and-forget" missiles (Javelin and Stinger) from January to March, and the lightly armed Bayraktar drones from Turkey. These types of capabilities do not entail risks of escalation for Ukraine's partners and have been provided by the largest group of NATO countries (see list in **Table 1**). This option's largest drawback is that it does not address the issue of Russia's superiority over Ukraine in certain types of capabilities, especially heavy ones (tanks, heavy artillery, and an arsenal of guided missiles with a range of more than 100 km). However, the *asymmetric option* in the case of Ukraine's proven light armaments needs to be continued. Partners must be aware though, that it is not a long-term alternative to Ukraine's needs, especially those of the *STANAG option*.³²

²⁹ See: M. Crowley, "Would Putin Strike NATO Supply Lines to Ukraine? History Suggests No," *The New York Times*, 28 March 2022.

³⁰ STANAG (Standardization Agreement) are standard procedures, requirements, and technical terms mutually agreed upon by NATO member states. The rationale for accepting more STANAG is to facilitate system interoperability and compatibility in the operations of Alliance forces and to reduce their unit, component and munitions costs.

³¹ See: A. Kacprzyk, "Changes in Russia's Nuclear Rhetoric," *PISM Spotlight*, no. 73, 30 March 2022, www.pism.pl.

³² For these reasons, one can be sceptical of repeated statements made in media that a given system provides Ukraine with capabilities that will determine the course of the war. Unfortunately, lobbying efforts by a specific arms manufacturer often stand behind publications about the appearance of a new "game-changer" or "silver bullet".

The Issue of the Capability Gaps of Ukraine's Neighbouring Partners. The third step is to identify possible capability gaps of Ukraine's partners. This problem may be acute for NATO's Eastern Flank states, which are adjacent to the conflict region and see the Russian threat as very real. The scale of their commitment to supplying post-Soviet equipment represents a heavy economic burden for them, but one that is secondary to their strategic interests. They deliver large quantities of heavy weapons and ammunition to Ukraine, and are their main suppliers in some categories. Two options are available to these countries to fill in their own gaps:

- **Strengthening the presence of NATO forces and capabilities.** Solutions of this type seem flexible and are currently easier to implement, as shown by the Alliance's decisions since the war broke out and by those taken at the Madrid summit. They include redeploying new units with heavy equipment to countries on NATO's Eastern Flank, strengthening deterrence and defence measures against Russia by expanding forward deployment.³³ One example is the rapid deployment of allied Patriot PAC-3 air and missile defence systems to Slovakia, which made its decision to deliver its own S-300s to Ukraine easier. Following this pattern and on the basis of bilateral arrangements, 14 British Challenger-2 tanks were also deployed to Poland, which decided to deliver more T-72 model tanks to Ukraine.³⁴ Reinforcements from NATO or individual allies can also do the job until the gaps are filled through new domestic capabilities.
- **Upgrading their own capabilities.** NATO's Eastern Flank is enacting multi-year programmes to acquire newer-generation capabilities. Their implementation in various countries is at different stages, and the war has accelerated its pace, shrinking previously assumed financing schedules. In Czechia, Poland, and Slovakia, the gaps left by the delivery of T-72 tanks led to an update in tank replacement programmes. This problem is illustrated by Poland's intention to purchase new tanks, with a target of 250 Abrams (in the latest M-1A2 SEPv3 version) and 180 K2 Black Panthers by 2025 (as many as 1,000 in the longer term). There is also the possibility of supplying used equipment or from strategic reserves. One such solution is the delivery of 116 additional vehicles of the older Abrams version (e.g., M-1A1SA), which Poland has negotiated with the U.S.³⁵ A similar solution could be the delivery of older versions of German Leopard-2 tanks to Czechia and Slovakia, with the possibility of upgrading them later to the latest standard.

In analysing the options available to Ukraine and its partners, it is also worth noting the countries that do not currently provide any military equipment. In NATO, this applies to Hungary, which has partially modernised its armed forces but, given the nature of its relations with Russia and Ukraine, does not extend military support to the latter. The *eastern option* for Hungary (such as its T-72 tanks) must be dismissed for the time being and will not be analysed here. Open sources are also unclear on the present extent of military assistance from Romania and Bulgaria. Given the relations between several Middle Eastern countries and Russia, it also does not seem realistic to expect that they could be direct arms suppliers to Ukraine in the coming months. On the other hand, it should not be ruled out that as the

³³ For a discussion about these decisions, see: A. Kacprzyk, "U.S. Increases Military Presence in Europe," *PISM Bulletin*, no. 95, 10 June 2022, and W. Lorenz, "2022 NATO Summit in Madrid—Collective Defense as a Priority," *PISM Spotlight*, no. 99, 30 June 2022.

³⁴ G. Allison, "Squadron of British tanks arrive in Poland to deter Russia," *UK Defence Journal*, 8 July 2022, <https://ukdefencejournal.org.uk>.

³⁵ See: IAR, "Polska kupi od USA 116 czołgów Abrams, SzeF MON: umowa została uzgodniona," *Polskie Radio 24*, 15 July 2022, <https://polskieradio24.pl>, and N. Fiorenza, "Poland Signs Execution Contracts for K2 MBTs and K9 SPHs from South Korea," *Jane's Defence Weekly*, 31 August 2022.

war continues, these countries and Israel, under U.S. influence, might agree to supply arms to Ukraine.³⁶ Israel's reassessment of its interests vis-à-vis Russia and the U.S. would also open up the possibility of it supplying Ukraine with more advanced weapons under the *STANAG option*. A possible bilateral arrangement with the U.S. could also open some of the vast reserves of Soviet-made equipment and ammunition that Egypt still possesses. Although on a smaller scale and in a different context, it was Egypt, also under U.S. influence, that played a key role in the supply of Soviet Igla MANPADS to the resistance movement in Afghanistan.³⁷ For these reasons, the U.S. administration and Congress should not entirely rule out smaller Middle Eastern countries or Pakistan as future arms supplies, possibly through an intermediary in the West.

³⁶ Israel was present at UDCG ministerial meetings, but publicly it has rejected Ukraine's demands. Israel's industry has been producing and exporting artillery rockets compatible with Soviet BM-21 Grad launchers for decades. See also an overview that includes Asia-Pacific countries in M. A. Piotrowski, "Gauging the Potential of Heavy Weapons Deliveries For Ukraine," *PISM Bulletin*, no. 155 (2574), 28 September 2022.

³⁷ P. Dimitrakis, *The Secret War in Afghanistan: The Soviet Union, China and Anglo-American Intelligence in the Afghan War*, I.B. Tauris & Co., London 2013, pp. 170-175.

DETAILED ANALYSIS OF GAPS IN SELECTED MILITARY CAPABILITIES

UKRAINE'S HEAVY ARTILLERY CAPABILITY GAP

Capability Characteristics. Before the war, Russia and Ukraine had heavy artillery systems that were either identical or very similar in performance. These were mainly howitzers and multi-barrel rocket launchers, most of which were manufactured in the USSR. Both sides could fire 122 or 152 mm self-propelled (Gvozdika, Akatsiya, and Giatsint-S) or towed howitzers (D-20, D-30, Giatsint-B, and Msta-B) with a standard ammunition range of up to 15 and 17 km, or up to 21 and 33 km with non-standard ammunition (RAP). In Russia's case, the last decade has seen the modernisation of the Msta-S self-propelled howitzers and the launch of a programme introducing the new Koalitsya-SV howitzer. Both armies also use BM-21 Grad, BM-27 Uragan, and BM-30 Smerch rocket launchers with maximum ranges of up to 20, 35 and 70 km, respectively. These launchers are manually loaded and their low levels of accuracy are made up for by salvos of highly destructive force. Russia is also putting more advanced Tornado model launchers and rockets into service in limited numbers.³⁸ The artillery rockets for the aforementioned systems carry fragmentation and demolition, anti-tank, cluster, and thermobaric warheads. In the USSR, all of these artillery systems were also platforms for chemical weapons.³⁹ Despite a number of changes, Ukraine has not succeeded in implementing modernisation programmes for its heavy artillery, such as the transition to STANAG ammunition, the production of the new Bogdana howitzer, or the Vilkh-M rocket launchers.

Both Sides' Potential. According to the IISS, Russia's Land Forces had 3,454 heavy artillery units in active service before the war. In addition, Russia had huge artillery reserves in both Europe and Asia—as many as 4,260 howitzers and 3,220 rocket launchers. Assuming that Russia deployed, along with the “local forces” of Luhansk and Donetsk, about 130-150 tactical battalion groups (with 12 systems each), this would come to 1,560-1,800 heavy artillery units. These estimates may have been inflated against the resources initially deployed against Ukraine. As regards Ukraine, after averaging pre-war estimates, it could have had about 800-1,100 howitzers and 350-400 rocket launchers.⁴⁰ As in the case of the aggressor, lower estimates of ZSU operationally available systems, closer to about 700 howitzers and 350 launchers, seem more realistic.

The gap between the Ukrainian and Russian artilleries can also be described by four other factors. First, it is made worse by the high consumption of ammunition and unguided rockets, which reached 20,000 shells on the Russian side and 5-6,000 shells on the Ukrainian side during the fighting for Donbas (June-July). This gave Russia a fourfold fire advantage.⁴¹ If Russia used ammunition on such scale, it can exploit its supplies for several months without having to increase industry production. Securing additional supplies in large quantities from

³⁸ See: IHS profile, “Russian Federation—Army,” *Jane's World Armies*, 13 July 2022, and “Ukraine—Army,” *Jane's World Armies*, 9 August 2022.

³⁹ See basic information and problems in M.A. Piotrowski, “The Potential Use of Chemical Weapons by Russia,” *PISM Spotlight*, no. 62, 16 March 2022.

⁴⁰ According to *Military Balance 2022*, this was 1,123 howitzers and 354 rocket launchers. The IHS profile has lower estimates for both types of ZSU artillery prior to the war: 872 howitzers and 398 or higher for rocket launchers. In Polish media, one could find assessments that the ZSU had up to 1,000 howitzers and heavy mortars and 400 rocket launchers. See: IHS, “Ukraine—Army,” *op. cit.*, and “Ukraiński bóg wojny—stan obecny i przyszłość artylerii SZ Ukrainy,” *Defence24*, 31 October 2021.

⁴¹ These estimates are those of a Ukrainian government analyst (in a private conversation with the author, Warsaw, 6 July 2022) and are consistent with those cited in I. Koshiw, *op. cit.*

Belarus, North Korea and/or China is also possible. Ukraine does not have such advantages. Second, with the intensity of the fighting comes the rapid degradation of artillery systems. For example, it is necessary to replace the barrel in each howitzer in the American M-777s after 2,500 rounds fired. Third, Russia's artillery losses to date have also been offset by reserves and the "cannibalisation" of spare parts from reserve equipment. According to *Oryx*, Russia lost 379 howitzers and 148 missile launchers in the period leading up to 31 October, while Ukraine lost 134 howitzers and 29 launchers. This is a kill ratio in Ukraine's favour of 1:2.8 and 1:5.1, respectively. Fourth, for many months, the lost Ukrainian artillery was not significantly replaced by captured or improvised systems. Ukraine captured a total of 25 howitzers and 41 rocket launchers from Russia before the offensive in the Kharkiv region—quantities that only partially made up for its artillery losses. Until August, Ukraine was also forced to improvise artillery rocket systems, which it built using tubes from destroyed Grads or mounting S-8 rockets (4 km range), originally intended for air platforms, on trucks.⁴² Such improvisations were useful to some ZSU units locally, but will not affect the situation along the entire front line.

Doctrine and Tactics on Both Sides. For Russia, heavy artillery is the primary tool of destroying enemy forces and equipment and supporting the operations of tank and motorised forces. Its doctrine calls for massive surface shelling of military or civilian targets. It is intended to spare Russian forces from a direct clash with the enemy or an attack on its defensive lines.⁴³ The Russian offensive on Kyiv, however, showed a gulf between the modernisation of Russian artillery and its deployment. Russian tactical groups attacking from Belarus lacked artillery support, which remained mostly behind the main forces. Here, Ukraine's artillery proved exceptionally effective, wreaking havoc on Russian armoured columns on the outskirts of Kyiv.⁴⁴

In contrast, Russia used its fire superiority effectively during operations in eastern and southern Ukraine. Russian artillery there may have been responsible for 75-80% of Ukraine's losses in military personnel, civilians, and infrastructure. The siege and shelling of Kharkiv (February-April) illustrated Russian tactics of terrorising the civilian population. Tactics calculated to break the ZSU's will to resist were also used during the exceptionally fierce fighting for Mariupol (ending 22 May). To a small extent, both sides then used their heaviest 2S7 Pion howitzers (203 mm, with a range of 37-47 km)—the Russians in the shelling of Kharkiv and the Ukrainians against selected targets in Donbas.⁴⁵ Ukrainian artillery had significant success with repeated shelling of a Russian helicopter airfield in Chornobaivka (Kherson region) and in the destruction of a full battalion of Russian troops as they attempted to cross a river in the Severodonetsk area (Luhansk region).⁴⁶ The role of Russia's artillery increased with the concentration of its forces in Donbas and in more static conditions. Its artillery was also crucial in driving ZSU forces out of parts of the Donbas region. As Russian ammunition stocks diminished, Ukraine conducted sparse and precise fire against the aggressor. Its artillery crews dispersed batteries and ammunition stocks to the maximum. Both sides first focused

⁴² See examples in "Ukraine Develops Local-Made Rocket Launchers While Waiting for US & UK artillery systems," *Army Recognition*, 23 June 2022, www.armyrecognition.com.

⁴³ On tactics, organisation, and armaments, see: L. W. Grau, Ch. K. Bartles, "The Russian Way of War. Force Structure, Tactics, and Modernization of the Russian Ground Forces," Foreign Military Studies Office, 2016, pp. 232-265.

⁴⁴ J. Watling, N. Reynolds, "Operation Z. The Death Throes of an Imperial Delusion," *RUSI Special Report*, 22 April 2022, pp. 3-4.

⁴⁵ D. Axe, "Russia and Ukraine Are Using the Same Giant Guns in Very Different Ways," *Forbes*, 22 March 2022, www.forbes.com.

⁴⁶ A. E. Kramer, "A Doomed River Crossing Shows the Perils of Entrapment in the War's East," *The New York Times*, 25 May 2022.

on artillery duels (counter-battery fire), with the goal of destroying detected or known enemy positions. It was during this phase that both sides employed large-scale reconnaissance and drone fire correction support (see section on drones below, pp. 45-51).⁴⁷ The arrival of the American M-142 HIMARS systems allowed Ukraine to employ new and more effective tactics. Thanks to them and to Tochka-U ballistic missiles, they were able to launch a campaign that destroyed Russian ammunition stockpiles along the front, mainly in the Kherson area (more than 50 stockpiles were destroyed in June-July) and, in doing so, distracted the Russians from Ukraine's preparations for the successful September counteroffensive in the Kharkiv area.⁴⁸

Eastern Options. In the spring of 2022, Ukraine's artillery capability gaps was partially mitigated with supplies from Central Europe. At first, this may have been deliveries of 122 and 152 mm barrel ammunition that perhaps began on a small scale before the war broke out. The first attempt to transfer post-Soviet systems to Ukraine was Estonia's December 2021 initiative to provide nine towed D-30 howitzers (122 mm).⁴⁹ After three months of the German government blocking the delivery within NATO structures, it finally went ahead in April. During the same period, assistance to Ukraine was prioritised by all the Baltic States, Poland, and Czechia. In March-April, deliveries of self-propelled howitzers of the 2S1 Gvozdika type (122 mm) from Poland and Czechia were able to provide Ukraine with some 20-40 howitzers. In April, Czechia also delivered to Ukraine at least 20 self-propelled ShKH Dana Vz. 77 howitzers (152 mm), and videos on social media confirm that they were used in combat in May 2022.⁵⁰

Deliveries of used Soviet-type howitzers arguably did not lead to serious capability gaps for NATO members given their artillery rearmament programs. And at this stage, more important than the launchers were deliveries of Grad-type rockets produced for the systems operated by Poland (WR-40 Langusta) and Czechia, Romania, and Slovakia (RM-70 Vampire). By May, Ukraine had received some 20-40 Grad launchers from Poland and Czechia, likely with a supply of rockets. In addition, in April Czechia brokered the delivery of an unknown number of D-20 towed howitzers (152 mm) bought back from Bulgaria's reserves. A similar arrangement was used in May-June when Czechia delivered Bulgarian Grad units to Ukraine, augmented in July by some 20 RM-70 launchers.⁵¹

STANAG Options. In analysing heavy artillery assistance to Ukraine, the supply of NATO systems should be considered as most prospective. They result in a qualitative improvement in artillery capabilities with an increased range of 155 mm howitzers to 24-30 km for most models used in the Alliance. The safer distance is crucial for conducting so-called counter-battery fire. This type of assistance was initiated by Canada with the decision to transfer six towed howitzers of the M-777 type. It was carried out as early as April along with a stockpile of 20,000 rounds of ammunition, and then supplemented by further deliveries and spare barrels.⁵² This transfer confirmed the sensibility of donating this and other 155mm howitzers to Ukraine. Australia donated four M-777 howitzers in May, later helping, along with New

⁴⁷ S. Cranny-Evans, "Ukraine Conflict: Examining the Counter-Battery Fight," *International Defence Review*, 9 June 2022.

⁴⁸ N. Zinets, "Ukraine Says It Has Destroyed 50 Russian Ammunition Depots Using HIMARS," *Reuters*, 25 July 2022.

⁴⁹ M. R. Gordon, "Germany Halts Ukraine Weapons Transfer," *The Wall Street Journal*, 22 January 2022.

⁵⁰ "Czech Republic, Poland Set New Rounds Of Military Aid To Ukraine," *Radio Free Europe/Radio Liberty*, 29 May 2022, www.rferl.org.

⁵¹ S. Mitzer, J. Oliemans, J. Janovsky, "Bohemian Brotherhood: List of Czech Weapons Deliveries to Ukraine," *Oryx*, 10 July 2022.

⁵² "Minister Anand Announces Further Military Aid for Ukraine," Canada Department of National Defense, 15 June 2022, www.canada.ca.

Zealand, to train ZSU artillery personnel.⁵³ In early May, the first photos of Ukrainians using these modern howitzers were released. The easy-to-use and lightweight M-777s (4.5 tonnes) have also become a major barrel-artillery system provided by the U.S. To date, Ukraine received a total of 142 M-777 howitzers from the U.S., and refit its artillery units or formed new ones.⁵⁴

Predictable delays accompanied deliveries of self-propelled STANAG-calibre howitzers, as the personnel needed 4-6 weeks of training. The advantages of this type over towed howitzers are their longer barrels, giving a standard range of 30 km, as well as high mobility in the field and better protection for crews. What sets the majority of these apart from the others is their rapid rate of fire stemming from the automatic loading systems. Although official statements on self-propelled howitzers appeared as early as April, most of the systems promised reached the front after the post-Soviet ones. In May, there were 22 M-109A3GN howitzers from Norway, and in June-July “over 20” British M-109A4BEs. By mid-August, six more M-109A5s from Latvia arrived in Ukraine.⁵⁵ At the end of May, the delivery of 12 French CAESAR wheeled and advanced howitzers with a standard range of 40 km (and up to 55 km with RAP-type ammunition) was also finalised. In June-July, Ukraine also deployed 18 AHS Krab howitzers donated by Poland (with a range of up to 40 km with RAP-type ammunition). This was the first batch of Polish Krab deliveries, to be followed by Ukraine’s purchase of 60 new systems in 2023.⁵⁶ Before October, 12 advanced and armoured German PzH-2000 howitzers (seven from Germany and five from the Netherlands) also arrived at the front, with their crews having been trained since early May at the Idar-Oberstein facility.⁵⁷ It is not clear whether Germany and the Netherlands transferred specialised ammunition with ranges that extend to 47 and 67 km along with the PzH-2000. In contrast, earlier reports of deliveries of self-propelled PzH-2000 howitzers from Italy had not been confirmed by early October. However, deliveries of FH-70 towed howitzers from Italy and Estonia (although in an unknown quantity) arrived in Ukraine. During the same period media speculated about the transfers of advanced Archer howitzers from Sweden; these deliveries cannot be excluded in 2023. In autumn, earlier social media reports about Slovakia’s transfer of several Zuzana-2 wheeled howitzers (a modification of the Dana from 152 to 155 mm calibre) was visually confirmed.

In order to halt the Russian advance and support Ukraine’s counter-offensives, supplies of NATO rocket artillery systems would be the most effective means. The number of launchers and the type and range of such rockets to be delivered have been the subject of lengthy debates, first within the U.S. administration and then with Ukraine. The U.S. concerns leaked to the media revolve around the escalatory aspect of providing weapons that could reach targets in Russia. Moreover, Ukraine was refused deliveries of ATACMS tactical ballistic missiles with a range of 300 km, which also use HIMARS platform. Instead, Ukraine was supplied with M-31A1 GMLRS precision-guided rockets (in 227 mm) with a range of 70-80 km, a greater distance than the rockets fired from Uragan and Smerch units. The Biden administration also

⁵³ L. Benjamin, “Working Together for Ukraine,” *Australia Defence News*, 6 May 2022, <https://news.defence.gov.au>, and J. Weekes, “Russia-Ukraine War: NZ to Train Ukrainians to Use Howitzer, Sending 30 Defence Forces Personnel to Britain,” *New Zealand Herald*, 23 May 2022, www.nzherald.co.nz.

⁵⁴ *Fact Sheet on U.S. Security Assistance to Ukraine*, Department of Defense, 5 July 2022, www.defense.gov.

⁵⁵ “Norway Has Donated M109 to Ukraine,” *Norway Ministry of Defence*, 8 June 2022, www.regjeringen.no, D. Haynes, “Ukraine Receiving Enough Weapons to Win the War, Defense Secretary Says,” *Sky News*, 16 June 2022, <https://news.sky.com>, and “Latvia Donates Helicopters and Howitzers to Ukraine,” *Latvian Public Broadcasting*, 16 August 2022, <https://eng.lsm.lv>.

⁵⁶ See: J. Adamowski, “Ukraine to Buy Polish Howitzers as Long War Looms with Russia,” *Defense News*, 8 June 2022.

⁵⁷ N. Fiorenza, “Ukraine Conflict: Germany to Supply PzH 2000s to Kyiv,” *Jane’s Defence Weekly*, 11 May 2022; “Military support for Ukraine,” German Federal Government, 26 October 2022, www.bundesregierung.de.

did not address the calls of Ukrainian politicians for the delivery of 60, 100, or even 300 U.S. HIMARS systems.⁵⁸ The Pentagon's decision to supply HIMARS launchers with GMLRS rockets was made in May, and the first four units entered combat in late June. Four more of these launchers were delivered during the same month. The success of Ukrainian artillery in destroying Russian ammunition depots and command posts encouraged the U.S. to deliver four additional systems in July. That same month, there were also signals from the U.S. administration that the problem would not be the number of launchers, but the rate of their use and the reserves of GMLRS rockets.⁵⁹ A month later, the U.S. announced the transfer of four more launchers, bringing the total to 16 HIMARS. Ukraine's artillery was also reinforced at the end of July with the delivery of three British M-270 MLRS launchers, which can fire twice the salvo of the lighter HIMARS—12 rockets instead of six. In addition, Ukraine expected the delivery of three more British MLRS. As regards German deliveries of rocket launchers, in August, three of the 20 existing MARS-II systems (modifications of the M-270), which, according to the German government, required a change of software to support the GMLRS, entered combat. In October, the number of German MARS launchers deployed by ZSU increased to five systems.⁶⁰

Asymmetric Options. There is a lack of inexpensive yet effective alternatives or augmentations to Ukraine's heavy artillery. However, given the growing number of 155 mm howitzers and limited stocks of this ammunition, it may be desirable to supplement them with lighter systems. These could include the ultralight L118/L119 (105 mm) towed howitzer with a range of 12-14 km, of which the UK and Australia have reserves of about 100. In July, the British government announced the completion of training of ZSU personnel to operate 36 of these howitzers.⁶¹ Likely, the greater availability of 105 mm ammunition motivated the U.S. decision to transfer an additional 20 M-119 towed howitzers (the American version of the L-119).⁶² They can, along with heavy artillery, provide greater firepower at short ranges and selected segments of the front, reinforcing Ukraine's new units. Various types of mortars are also worthy of further consideration as an option for Ukraine. The effectiveness of capabilities already transferred to Ukraine would be enhanced by further deliveries of reconnaissance drones resistant to Russia's electronic warfare systems. The ZSU's economy of fire also increased quickly thanks to drone reconnaissance and the introduction of the *GIS Art for Artillery* targeting application.⁶³ An equally important means of support for Ukraine will be artillery radars, such as the 50 AN/TPQ-36 Firefinder already donated by the U.S. before July. Such radars or similar ones have been handed over to Ukraine by the Netherlands (eight) and the UK (one). The delivery of a COBRA radar system from Germany has also been announced.⁶⁴

Prospects. Filling gaps in the arsenal of heavy artillery for many months took precedence over Ukraine's other needs. Possessing heavy artillery is a pre-condition for any successful

⁵⁸ D. Sabbagh, "Ukraine Needs Many More Rocket Launchers From West, Says Adviser," *The Guardian*, 6 June 2022.

⁵⁹ A. Roque, "Ukraine Conflict: Four Additional HIMARS Headed to Kyiv, US Monitoring Ammunition Stockpile," *Jane's Defence Weekly*, 21 July 2022.

⁶⁰ "Deutschland hat Ukraine laut Verteidigungsministerin Mehrfachraketenwerfer geliefert," *Die Welt*, 26 July 2022, www.welt.de, and "UK to Give More Multiple Launch Rocket Systems and Guided Missiles to Ukraine," *UK Ministry of Defence*, 11 August 2022, www.gov.uk; "Military support for Ukraine," German Federal Government, 26 October 2022, www.bundesregierung.de.

⁶¹ J. Fitzgerald, "Ukraine War: UK Announces Latest Package of Weaponry," *BBC News*, 21 July 2022.

⁶² "Aid Package to Ukraine includes T-72B Tanks," Department of Defense, 4 November 2022, www.defense.gov.

⁶³ S. Cranny-Evans, *op. cit.*

⁶⁴ "Fact Sheet on U.S. Security Assistance to Ukraine," Department of Defense, 24 August 2022, www.defense.gov, and "Ukraine Conflict: Netherlands to Supply Weapon Locating Radars to Ukraine," *International Defence Review*, 3 March 2022.

ZSU counter-offensive. Also, in the event of a ceasefire or settlement of the war, Ukraine must have artillery for the long term. However, the operational utility of ZSU's post-Soviet howitzers may be diminished by early or spring 2023. Their usefulness can be extended only with ammunition supplies from Bulgaria, Czechia, Poland, and Romania. The depletion of 152 mm ammunition reserves for Ukraine's howitzers and the lack of Uragan and Smerch-type rockets in NATO countries may become a problem. In the event of higher losses in ZSU equipment in 2023, the supply of Grad launchers remaining in the reserves of Croatia and Poland, and RM-70s in the reserves of Slovakia and Greece, may also become necessary (see **Table 2**). Following its accession to NATO, Finland could also consider transferring to Ukraine dozens of Giatsint, Gvozdika and D-30 howitzers with ammunition, as well as rockets for Grad and RM-70 launchers from its reserves. Finland's decisions would probably be made easier if NATO forces continue to exercise on its territory. Deliveries of Grad rockets from outside Europe, especially from selected Middle Eastern countries, would also be possible and necessary.

At the end of 2022, Ukraine will have a significant arsenal of *STANAG option* barrel artillery. Its primary towed howitzer could by then be the M-777. Ukraine received 152 guns so far, and there should also be no problems in replacing those lost with new ones from U.S., Canadian, and Australian reserves. These might be augmented by at least 72 towed howitzers of the L-118/M-119 family from the UK and the U.S., an unknown number of FH-70s from Italy and Estonia, as well as up to 15 new TR-F1 Trajans from France.⁶⁵ That would mean at least 230-240 towed howitzers from the *STANAG option*. On the other hand, Ukraine will have a very diverse fleet of NATO self-propelled howitzers. The realization of the announcement made by Germany and the Netherlands to deliver six more PzH-2000s will increase the number of these howitzers to 18-20. In the second half of 2023, 16 Slovak Zuzana-2 howitzers, jointly funded by Denmark, Germany, and Norway, will also be produced and delivered to Ukraine.⁶⁶ Along with CAESAR, Krab, PzH-2000, M-109, and Zuzana-2 units, Ukraine's artillery will have at least 110-120 Western self-propelled howitzers next year. Further deliveries will depend on production levels and the replenishment of losses. Signed contracts between Poland's Stalowa Wola and Ukraine are expected to provide 60-70 new Krabs in 2023-2024. On the other hand, while the French company Nexter can produce additional CAESARs, it is already busy with domestic, Danish and Lithuanian orders, limiting further deliveries to Ukraine. Additional transfers of CAESARs might depend on customers delaying or cancelling contracts. This solution was chosen by Denmark, which agreed to waive its right to receive eight contracted howitzers in 2023 in favour of Ukraine going ahead of it.⁶⁷ A contract to supply 100 German PzH-2000s likely represents a greater challenge and may take several years to carry out.⁶⁸ With Ukraine's urgent needs and possible losses, these contracts may take too long to fully realise. Given NATO's available reserves, an easier solution may be to outfit Ukraine with the M-109 as its basic self-propelled howitzer. One model of the M-777 towed howitzer and at most two or three models of self-propelled howitzers, but in large numbers, would provide Ukraine with a rational structure of these capabilities and reduce maintenance costs.

⁶⁵ According to IHS *Jane's* and IISS, Italy may have 120-163 units of FH-70s in reserves. Estonia, between 2003 and 2004, received 24 of them from Germany. At the same time, TR-F1 towed howitzers are similar to the guns in the CAESARs, but so far these have not been ordered by the French Army, so Ukraine might be their first user.

⁶⁶ "Ukraina w 2023 roku otrzyma 16 haubic Zuzana 2," *Defence24*, 2 October 2022.

⁶⁷ A. Świerkowski, "Duńskie Caesary pojedą na Ukrainę?," *Defense24*, 3 October 2022.

⁶⁸ See: "Bund genehmigt Verkauf von 100 Panzerhaubitzen an die Ukraine," *Die Zeit Online*, 27 July 2022, www.zeit.de, and A. Świerkowski, "Ukraina: Polskie czołgi i holenderskie transportery razem," *Defence24*, 26 July 2022.

Projections concerning NATO rocket artillery for Ukraine are more difficult. In the fall of 2022, it may expect to receive up to 28-30 HIMARS and MLRS launchers. The Biden administration plans to deliver four HIMARS launchers from U.S. reserves by the end of 2022, followed by another 20-22 brand-new HIMARS launchers scheduled for delivery in 2023 or 2024.⁶⁹ Given the number of either systems in the U.S. alone (392 HIMARS and 225 MLRS), however, there should be no problem in replacing Ukraine's losses in 2023. Western Europe's MLRS potential is smaller, and after deliveries to Ukraine, may amount to at most a few or a dozen of the 120 or so remaining launchers. Already declared are transfers of a few of these from Italy and France. However, should the U.S. and other countries become interested, the two systems could potentially become the next pillars of Ukraine's rocket artillery after the Grads. The challenge in 2023 will be to ensure that it receives a steady supply of GMLRS or similar rockets from manufacturers in NATO countries. With adequate reconnaissance drone and artillery radar assistance, however, Ukraine could achieve fairly modern capabilities, while conforming to NATO standards in the longer and post-war term.

UKRAINE'S ARMoured CAPABILITY GAP

Capability Characteristics. Russia and Ukraine have similar—though not identical—capabilities in main battle tanks, infantry fighting vehicles, and armoured personnel carriers. They share tanks from the T-64, T-72, and T-80 families.⁷⁰ On Russia's side, this includes numerous upgrades of T-72s or the modern T-80s, and on the Ukrainian side, upgrades of T-64s. The proportion of tanks on both sides that have been upgraded is varied, but the number is in Russia's favour. The exceptions here are Ukraine's newer-generation T-84 Oplot tanks and, to a limited extent, Russia's T-90 tanks.⁷¹ All these models are equipped with 125 mm cannons (they also fire guided missiles), and have a similar weight and a three-man crew. The differences between them are in engine power, performance and armour or additional protection with explosive reactive armour (ERA). Russia and Ukraine also have similar infantry fighting vehicles and armoured personnel carriers. These include tracked IFVs of the BMP-1 (73 mm cannon) and BMP-2 (30 mm cannon) families, while some Russian units use the latest BMP-3 vehicles (100 mm cannon and 30 mm cannon). In the category of wheeled armoured personnel carriers, both sides rely on vehicles of the BTR-80 family or their newer and domestic modifications. In terms of personnel carriers, Russia uses mostly outdated and poorly armoured MT-LB tracked vehicles.

Both Sides' Potential. The similarities in technical parameters of Russian and Ukrainian armoured weapons are secondary in relation to the asymmetry of their numbers. Russia has the world's largest resources in terms of armoured units and reserves. It would be no exaggeration to state that even the Russian General Staff may have an incomplete and outdated picture of what Russia actually has at its disposal. Estimates are not made easier by the reference to former geographic limitations under the CFE treaty. Nevertheless, until 2007, NATO inspectors were able to verify the armoured arsenal in the European part of Russia. According to the IISS, Russia's Land Forces may have had 2,927 tanks, 5,180 infantry fighting vehicles and 6,050 armoured personnel carriers before the war. The same institute estimated that at the end of 2021 Russia could have huge reserves of as many as 10,200 tanks, 8,500 infantry fighting

⁶⁹ See: "\$625 Million in Security Assistance for Ukraine," *Department of Defense*, 4 October 2022; and "Amerykanie kupują wyrzutnie HIMARS dla Ukrainy," *Defence24*, 29 September 2022.

⁷⁰ For an excellent source of detailed information about Soviet equipment, see: M. B. Bariatinsky, *Vse tanki SSSR. Kollektionnoye izdaniye*, Eksmo-Yauza, Moscow 2013.

⁷¹ Russia has not brought the T-14 Armata tank, produced only in a test series, into combat.

vehicles, and 6,000 personnel carriers.⁷² These figures did not include equipment from units of the Airborne Forces, Coastal Defence and Interior Ministry. Assuming that Russia fielded 130-150 battalion tactical groups (each with 10 tanks, 20 BMPs and 20 BTR/MT-LBs), this would give the invading force 1,300-1,500 tanks and 5,200-6,000 vehicles and transporters. In contrast, Ukraine's potential before the war was much smaller. According to *Military Balance*, it had 858 tanks, 1,212 infantry fighting vehicles, and 622 armoured personnel carriers. Its tank reserves may have been 1,112 vehicles (a rather inflated estimate), with no data on reserves of infantry vehicles and transporters. A more realistic estimate for Ukraine's initial potential would be up to 700 T-64 family tanks, with 200-300 T-72 and T-80 tanks in reserve.⁷³

In keeping with the above estimates, Russia initially fielded on all fronts at least twice the number of tanks and almost three times the number of other vehicles. *Oryx* data at the end of October, however, suggests a ratio of losses that is favourable to Ukraine. Indeed, Russia may have lost at least 1,419 tanks and 2,552 other combat vehicles, while Ukraine lost 337 tanks and 704 vehicles (a kill ratio of 1:4.2 and 1:3.6, respectively). For comparison, the losses sustained by Soviet forces during their decade-long intervention in Afghanistan amounted to 147 tanks and 1,314 other combat vehicles while during one month of fighting for Grozny (in late 1994 to early 1995) Russia lost "only" 225 armoured vehicles of various types.⁷⁴ During the fierce fighting near Kyiv and Kharkiv, Ukraine may have captured some 450-500 abandoned Russian tanks. Depending on their actual condition, it is possible to use them to replace ZSU losses in armoured equipment or as a source of spare parts.

Doctrine and Tactics on Both Sides. Russia is relying on Soviet operational concepts. These call for overcoming enemy defences aggressively and rapidly ("deep operations") using tank and motorised units. In this approach, tanks are supposed to use surprise, speed, their armour, and fire superiority to destroy enemy forces. In the past decade, many of Russia's organisational changes (new tank divisions and armies) and modernisation programmes (T-14 tanks, T-15 BMPT vehicles) have suggested a return to these traditions, even if on a smaller scale than in the Red Army days.⁷⁵ However, the first phase of Russia's aggression deviated from its Land Forces doctrine and from scenarios observed during large-scale Russian exercises. Russia's lack of intelligence and reconnaissance and faulty planning ended in failure during the advance from Belarus on Kyiv, where Russian forces were to link up with the airborne units whose helicopter landing in Hostomel also ended in failure. As already noted, the columns attacking Kyiv lacked adequate artillery support. In contrast, and in accordance with Russia's doctrine and tactics, by early April its forces had scored a number of successes in southern and eastern Ukraine, inflicting high losses on the ZSU. Despite intensive artillery preparation, for a long time the Russians also made improper use of their armoured forces in attempts to seize major cities in the east of the country. In Mariupol and near Kharkiv, Russian tanks were often used without adequate infantry support, making it so Ukrainian

⁷² Polish experts give figures only for usable tanks in Russian field units and reserves, which, when rounded up, represent 6,000-6,200 vehicles, mainly T-72s and T-80s. Half of Russia's reserves of older T-62s and T-64s, which are difficult to estimate, may be fit only for "cannibalisation". See: J. Wolski, P. Przeździecki, "Pancerna potęga Rosji. T-14 Armata," *Wozy Bojowe Świata: Numer Specjalny*, no. 1, 2017, pp. 30-34; and M. Depczyński, "Radziecki i rosyjski potencjał pancerny – przegląd," *Nowa Technika Wojskowa*, no. 1, January 2022.

⁷³ Polish sources did not estimate the number of BMPs, BTRs, and MT-LBs, and with regard to tanks assumed 720-780 in ZSU units and reserves. In addition, they estimated that in the battles in 2014-2017, the ZSU lost about 120-200 tanks. See: M. Dąbrowski, "Czołgi, które bronią Ukrainy, Jak modernizowano T-64," *Defence24*, 16 April 2022, and J. Wolski, P. Przeździecki, "Czołgi na Ukrainie 2014-2015. Bułat," *Wozy Bojowe Świata: Numer Specjalny*, no. 4, 2017, pp. 12-25.

⁷⁴ See: L. W. Grau (ed.), *The Bear Went Over the Mountain. Soviet Combat Tactics in Afghanistan*, NDU Press, Washington DC 1996, p. xix; and *idem*, "Russian-Manufactured Armored Vehicle Vulnerability in Urban Combat: The Chechnya Experience," *Red Thrust Star*, no. 1, January 1997, p. 1, www.globalsecurity.org.

⁷⁵ L. W. Grau, Ch. K. Bartles, *op. cit.*, pp. 209-228.

troops could ambush them with ATGMs. Also noticeable on most sections of the front was poor coordination between tank and motorised forces and Russian combat aviation.⁷⁶ Russia changed tactics only during the fighting in Donbas and after its forces had been reinforced with additional units.

It is more difficult to clearly assess the overall tactics of the ZSU's tank and motorised forces. From 24 February to April, it was mostly engaged in defensive operations. Near Kyiv, Ukrainians were aided by melting snow, floods and deliberate flooding, as well as marshes that hindered Russian operations. At the same time, Ukraine's armoured forces were scattered and camouflaged to minimise losses. There are still no videos from this period that fully explain Ukraine's tactics, and there is no documentation of tank battles, unlike videos of artillery fire and ATGM strikes. For security and image purposes, the ZSU high command at the time published films that showed heroism and the ambushing of tanks by Ukraine's light infantry. Certainly, tanks were used extensively in delaying operations even then, from the fighting near Kyiv to the prolonged battles in Mariupol. Ukraine needs the capabilities offered by armoured equipment as it plans the continued defending its territory. It is this kind of equipment that provides firepower, a high operational tempo, and good protection for infantry. It allowed Ukraine to recapture small areas in the Luhansk and Donetsk regions in 2014. As early as the fourth month of the war, Ukrainian officials claimed that it would be necessary for ZSU counteroffensives to train, arm, and equip from scratch as many as four or five new motorised brigades.⁷⁷ The importance of such capabilities was confirmed by the significant progress of Ukraine's counter-offensives in the east and south of the country in September-October.

Eastern Options. Ukraine's armoured capability gap may remain a challenge for the foreseeable future. It will persist given the incapacitation of T-84 tank production and T-64 overhaul facilities in Kharkiv and the interruption of various vehicle overhaul facilities in Lviv. By comparison, in peacetime conditions, Russia's two tank factories can overhaul and upgrade 205-220 tanks to the T-72B3M version and 45-50 to the T-80BWM version each year.⁷⁸ In other words, even though Russia is struggling to make up for losses by having to overhaul equipment in such quantities, it still has reserves of T-72 and T-80, or very obsolete T-62M tanks.⁷⁹ Moreover, Russia continues to make rather limited frontline use of the brand new T-90 tanks.

Beginning in March, the gap in Ukraine's vehicle arsenal has been partially filled by Central European countries. The latter have different fleets and are at different stages of modernising their armoured systems. Initially, their deliveries to Ukraine may have included components for the T-72 and BMP-1, as well as ammunition for 125 mm tank guns, which were still present in armament, reserve, and production. As early as March, Czech media reported the delivery of the first small batches of BMP-1s and T-72Ms. Czechia was able to transfer 40 T-72 tanks by the end of April. There has been no confirmation of speculation about the Czech role in the delivery of Bulgarian T-72s to Ukraine, but this cannot be ruled out. What

⁷⁶ The Russians' poor flexibility at the operational and tactical levels calls for further analysis. The list of planning errors, coordination gaps, and lack of preparedness of logistics for urban combat is reminiscent of the numerous mistakes made during the 1994 and 1999 assaults on the Chechen capital. See: O. Olikier, "Russia's Chechen Wars 1994-2000. Lessons from Urban Combat," *RAND Arroyo Center*, Santa Monica CA, 2001.

⁷⁷ D. Sabbagh, *op. cit.*

⁷⁸ See: P. Luzin, "One-Way Ticket," *Riddle Russia*, 4 July 2022, <https://ridl.io/one-way-ticket/>, and M. Dąbrowski, *op. cit.*

⁷⁹ As noted, the modernised T-62Ms are arguably the worst-quality tanks in Russian reserves. Given their poor armour and smaller 115 mm cannon, they may be inferior to Ukraine's modernised T-64s and T-72s.

was confirmed at the end of April was the delivery from Poland of some 230-240 T-72M/M1R tanks.⁸⁰ Already then, these were probably all the operable vehicles of the T-72 family in Poland's reserves. Ukraine's heavy losses and need for tanks were illustrated by the handover in July of 30 or 31 very obsolete T-72As by North Macedonia, which on that occasion announced that it was liquidating its only tank battalion and accelerating the modernisation of its forces. Surprising, but also confirming the scale of the Ukrainian needs, was the transfer of 28 more obsolete T-55S tanks from Slovenia, finalised at the end of October.⁸¹

Also in April, Ukraine obtained at least 60 BMP-1s from Czech reserves or through the Czech intermediary role, as well as "almost a hundred" such vehicles from Poland. At the same time, the German government declared it was willing to provide Marder or Fuchs combat vehicles to Slovenia as compensation for its plan to donate M-84 tanks (the Yugoslav version of the T-72). In May, interest in donating reserve equipment to Ukraine in exchange for 50 Marder vehicles from Germany was declared by the government of Greece, which had 169 BMP-1s. This exchange scheme (*Ringtausch*) between Germany and Czechia, Poland, Slovakia, and Slovenia has not seen much progress so far. Nevertheless, by June, Slovenia had handed over to Ukraine up to 35 Yugoslav-era M-80A combat vehicles, and in July the first batch of the planned 30 M-84 tanks. Slovenia had previously been promised delivery of 15 Leopard-2A4 tanks by Germany.⁸² At the end of July, senior Polish and Ukrainian officials also confirmed that deliveries of the Polish-made and more extensively modernised version of the T-72, the PT-91 Twardy, had been launched. On that occasion, new information emerged that in the spring Poland asked Germany to supply 44 used Leopard-2A4 tanks but was offered only 20 vehicles, with delivery by the end of 2023 or early 2024.⁸³ This shows the still rather limited role of the *Ringtausch* as compared to the already completed direct deliveries to Ukraine and ongoing efforts made by Central European countries. Meanwhile, Ukraine's needs for infantry fighting vehicles were serious enough for it to accept an offer of 30-35 Yugoslav-era M-80A vehicles, which, given their original design and lack of spare parts, could complicate ZSU logistics.⁸⁴

STANAG options. Since the beginning of the war, opposition to supporting Ukraine and NATO's Eastern Flank with Western European armoured capabilities have persisted. During a visit to Kyiv, French President Emmanuel Macron even claimed that NATO had *de facto* adopted an "informal agreement" not to provide Ukraine with tanks.⁸⁵ His statement was likely an over-interpretation of discussions held within the Alliance, although it reflects existing divisions on the issue among NATO members. However, it is doubtful that the Alliance would treat this approach as a common and official position, as several allies were already pursuing *eastern options* at the time. It is also a fact that there exists a lack of readiness on the part of the larger NATO members to transfer newer generation tanks to Ukraine. In May, Ukraine's

⁸⁰ N. Fiorenza, "Ukraine Conflict: Germany Offers Gepards to Kyiv," *Jane's Defence Weekly*, 28 April 2022.

⁸¹ These tanks were sold by Ukraine in 2001. See: I. Bozinovski, N. Fiorenza, "Ukraine Conflict: North Macedonia Donating T-72s to Ukraine and Disbanding Tank Battalion," *Jane's Defence Weekly*, 29 July 2022. T-55S are essentially modernised with ERA and some other equipment (Soviet T-55 family tanks, i.e., a system introduced in the 1950s, for more see: "Slovenski tanki M-55S že v Ukrajini," *24UR*, 26 October 2022, www.24ur.com).

⁸² B. Knific, "Slovenija je Ukrajini predala serijo bojnih vozil pehote M-80A," *Revija Obramba*, 21 June 2022, and *idem*, "Slovenski tanki M-84 na proti v Ukrajino," *Revija Obramba*, 15 July 2022, www.obramba.com.

⁸³ See: J. Palowski, "Twarde na Ukrainie. Polskie czołgi idą do boju," *Defence24*, 25 July 2022, and M. Eichhorn, "Waffenlieferungen an Ukraine und Polen: Tauschgeschäft voller Missverständnisse," *Berliner Zeitung*, 25 July 2022, www.berliner-zeitung.de.

⁸⁴ See: A. Świerkowski, "Ukraińcy szkolą się na słoweńskich BWP," *Defence24*, 17 August 2022.

⁸⁵ "Western Countries Agree Not to Supply Aircraft and Tanks to Ukraine—Macron," *Ukrainian News*, 17 June 2022, <https://ukranews.com>.

unofficial expectations were as high as 300 M-1 Abrams tanks or their European alternatives.⁸⁶ Despite Ukraine's appeals, the Biden administration still does not seem ready to deliver U.S. tanks from reserves and depots in Europe.

Assistance to Ukraine in the form of older-generation NATO tanks of the Leopard-1 or M-60 type also turned out to be problematic. Already in April, the German government ignored the manufacturer's proposal to provide Ukraine 88 Leopard-1 tanks from Rheinmetall's inventory.⁸⁷ Tanks of this type are arguably still in better condition and have a higher combat value than Russia's T-62s but, at the same time, they are relatively poorly armed (they have a 105 mm cannon, not a 120 mm like the newer ones). Gaps in NATO members' armoured capabilities may be playing their part in limiting the scale of potential deliveries. Indeed, after decades of cuts in conventional forces, most Western European countries do not have surplus tanks. France, Germany, Italy, and the UK have no more than 200 operable tanks each, although they still have older ones reserves. Few NATO countries plan to modernise their tank forces as extensively as Poland. Most, like Norway, have needs that do not exceed a few dozen new vehicles.⁸⁸ The exceptions to this rule are Greece and Turkey, which have larger forces and reserves of M-60, Leopard-1, and Leopard-2.⁸⁹ But even if Greece has already delivered BMP-1 vehicles to Ukraine, it is not necessarily ready to deliver its older-generation tanks. The lack of motivation to do so is present in other NATO countries as well, especially since the U.S. has not taken any steps in this direction.

The possibilities of supplying well-armed infantry fighting vehicles in the *STANAG options* look no better. This could change only under conditions of accelerated replacement of such vehicles by Western and Central European countries, something that is only taking place slowly and on a small scale.⁹⁰ Such constraints are not visible in the supply of NATO armoured personnel carriers to Ukraine. The will to make them available was evident from the beginning of the war, even though this led to a patchwork of vehicles of different generations and performance. Announcements of such deliveries were made by Australia and Alliance countries as early as March-April, but most of them did not enter combat until May-June. First up were 35 British FV103 Spartan tracked carriers and an unknown number of Dutch YPR-765s, a licensed version of the M-113.⁹¹ Favourable for Ukraine was the emergence of options related precisely to the U.S. M-113 family. By June-July, the U.S. had delivered as many as 200 such vehicles. Lithuania donated "more than 20" of them, and 28 up-armoured M-113AS4s were sent by Australia. Also planned for the July-August period were deliveries of 54 M-113G3DK vehicles from Denmark, 14 from Portugal, and 20 from Spain.⁹² In addition, in June, Canada announced it would transfer 39 new ACSV wheeled transporters to Ukraine, with a possibility for further deliveries. France also declared that it would transfer "a large

⁸⁶ "Weapons List," *Save UA List*, a printout of the 4 May 2022 version of that site, although this figure had already been removed from the site as of 26 August 2022, <https://saveualist.com>.

⁸⁷ N. Fiorenza, "Ukraine Conflict: Rheinmetall Prepared to Supply Leopard 1s to Kyiv," *Jane's Defence Weekly*, 14 April 2022.

⁸⁸ Norway plans to purchase 54 new tanks with supplies from 2025. See: N. Fiorenza, "Leopard 2A7 and K2 Black Panther compete to become Norway's next MBT," *Jane's Defence Weekly*, 2 February 2022.

⁸⁹ For an overview, see M. Cielma, "Potencjał pancerny NATO w Europie," *Nowa Technika Wojskowa*, no. 12, December 2021.

⁹⁰ See the summary of plans and problems in S. Cranny-Evans, "European AFVs: Countries invest anew in heavy or agile armour," *International Defence Review*, 29 November 2019, and G. Turnbull, "Soviet vehicle replacement falters in Eastern Europe," *Jane's Defence Weekly*, 19 June 2019.

⁹¹ H. Adams, "What Armoured Vehicles is the UK Sending to Ukraine?," *Forces Network*, 13 April 2022, www.forces.net, and A. Świerkowski, "Ukraina: Polskie czołgi i holenderskie transportery razem," *Defence24*, 7 June 2022.

⁹² See, respectively: "Amerykańskie i duńskie M113 dla Ukrainy," *Agencja Lotnicza Altair*, 4 May 2022, www.altair.com, "Australia Increases Support to Ukraine," *Australia Government-Defence*, 4 July 2022, www.minister.defence.gov.au, "Ucrânia: Portugal já enviou 315 toneladas de material militar, revela Ministra da Defesa," *MultiNews*, 20 June 2022, <https://multinews.sapo.pt>, and A. Świerkowski, "Hiszpańskie transportery w drodze na Ukrainę," *Defence24*, 7 August 2022.

number” of VAB wheeled transporters at an unspecified date and the first such vehicles were seen in Ukraine toward the end of July.⁹³

Asymmetric Options. Ukraine and its partners are reaching for alternatives such as anti-tank mines and ATGM-class missiles. In public perception, the latter have come to symbolise Ukraine’s resistance in the first phase of the war, but Ukraine’s production of its own systems should also be kept in mind. Before the war, the ZSU and National Guard possessed several hundred launchers and 5,000-7,000 Stugna-P and Korsar guided missiles with ranges of 2.5-5 km. Western assistance in January and February increased these resources by some 1,200 modern FM-148 Javelin guided missiles with a range of 2.5 km. This system was supplied to Ukraine primarily by the U.S. and UK, and on a small scale by the Baltic States and France. Ukraine was also able to fight Russia’s armoured units at short range (300-400 metres), thanks to supplies of 17,700 Western anti-tank weapons, including at least 2,000 British highly effective NLAW launchers.⁹⁴ Most of the grenade launchers, however, were American M-72 LAWs, Swedish-American AT-4s, and German Panzerfaust-3s. They were supplied by the U.S., Canada, and Western European countries, supplemented by other, older models of grenade launchers from Central Europe and Greece. In March-April, C-90R and Alcotan-100 grenade launchers were also introduced into service, with Spain donating 1,370. Until the end of July, the level of deliveries from the West remained high. Summing up the officially confirmed deliveries over six months of the war, Ukraine received as many as 6,500 Javelin missiles and 4,700 NLAW launchers.⁹⁵ In August, the number of Javelins supplied by the Pentagon had already reached 8,500. The delivery of 1,500 TOW-type heavy missiles (with a range of up to 3.7 km) was also announced. It should reach Ukraine by the end of the year. Substitutes for armoured personnel carriers may also play a part. These include a number of vehicles from Western Europe, but usually with minimal protection from shelling and shrapnel. In this regard, it’s important that the U.S. continued deliveries of “hundreds” of Humvees (HMMWVs), which began in 2015.⁹⁶ Unfortunately, of the several hundred off-road or transport vehicles donated so far, only a few are of the well-armoured MRAP-class, such as the 60 Bushmasters from Australia and 50 Kirpis from Turkey.⁹⁷

Prospects. At the end of 2022, Ukraine will have 300-310 T-72 family tanks from the *eastern option* as replacements for lost vehicles. The Pentagon plans to increase this in the coming months by an additional 45-90 T-72B tanks overhauled by Czechia.⁹⁸ However, there is no guarantee that in 2023 the ZSU will maintain an armoured capability similar to the one it had before the war. Should Ukrainian losses increase, further deliveries of PT-91s from Poland will be possible, but this will practically exhaust the reserves of T-72 family tanks in the region. Then, Central Europe will only be able to help Ukraine by overhauling T-72s and supplying ammunition for them. The same may be true of the BMP-1 vehicles, which Poland still has in reserve. About 350-370 vehicles of the BMP-2 family may still be available from Czechia, Finland, and Slovakia, and could be exchanged for Swedish CV-90s, if modernisation

⁹³ M. Brewster, “Trudeau Promises to Arm Ukraine with Modern Military Equipment,” *CBC News*, 30 June 2022; and “Guerre en Ukraine : la France annonce l’envoi de véhicules de transport blindés,” *RTL France*, 28 June 2022, www.rtl.fr.

⁹⁴ J. Wolski, “Ukraińska obrona przeciwpancerna—przykład do naśladowania,” *Nowa Technika Wojskowa*, no. 3, March 2022.

⁹⁵ On the basis of information from the Pentagon and the IHS compilation, “Ukraine Conflict: Military Assistance to Ukraine,” version from 6 July 2022.

⁹⁶ “Fact Sheet on U.S. Security Assistance to Ukraine,” Department of Defense, 24 August 2022.

⁹⁷ A. Galloway, K. Geraghty, ““Like a House on Wheels”: Australia’s Bushmasters Prove their Mettle on the Front Line,” *The Sydney Morning Herald*, 22 June 2022, www.smh.com.au, and B. Ege Bekdil, “Turkey Sends 50 Mine-Resistant Vehicles to Ukraine, with More Expected,” *Defense News*, 22 August 2022.

⁹⁸ “Aid Package to Ukraine Includes T-72B Tanks,” Department of Defense, 4 November 2022,

programmes are rapidly accelerated.⁹⁹ Should intense fighting continue until the summer of 2023, Ukraine's initial baseline level of capability in post-Soviet tanks and vehicles will be difficult to sustain. It could be augmented by T-72s and T-80s from non-NATO countries. A potential supplier of dozens of additional T-80 and BMP-3 vehicles is Cyprus, and media reports suggest preliminary talks were underway with the U.S. and Greece on the subject.¹⁰⁰

During the summer or autumn of 2023, there may be a need for the U.S. and Western Europe to change their stance on tanks and infantry fighting vehicles in the *STANAG options*. Europe's limited reserves, however, make it difficult to fill Ukraine's likely tank gap left by the T-64s and T-72s. Things may turn out better in terms of armoured personnel carriers, given the 350-360 M-113/M-557 family vehicles already delivered to Ukraine, and the Pentagon plans to deliver 240 M-1224 MaxxPro and 250 M-1117 Commando vehicles. Given their large numbers in NATO reserves, it is possible to adopt them as Ukraine's primary carriers. Europe's reserves, on the other hand, are not sufficient to fill the gaps being created in armoured capabilities on NATO's Eastern Flank. Plans to modernise Poland's tank fleet with new Abrams and K2 Black Panther tanks will be a quantitative and qualitative reinforcement, but it will be a drawn-out process. At the same time, Romania's plans to replace its obsolete vehicles are still uncertain, and the plan of reinforcing Slovakia with 15 used Leopard-2A4s may be of limited significance. Negotiations by Czechia for the purchase of 50 of the latest Leopard-2A7V+ were concluded in October, with agreement for the delivery of 14 used Leopard-2A4 tanks scheduled between December 2022 and December 2023.¹⁰¹ A greater presence of armoured units from the U.S. and Europe on the Eastern Flank may therefore be necessary, at least for the duration of Russia's war with Ukraine and the full replacement of Poland's tank fleet.

Also, in the case of positive decisions and further deliveries to Ukraine of tanks from the *STANAG option* it will be necessary to maintain weapon supplies from the *asymmetric option*. This is especially the case for ATGM-class weapons, but a precondition is increasing Javelin production in the U.S.¹⁰² Another option is to supply older-generation TOW missiles from the stocks of Alliance countries. To maintain mobility and a minimum of protection for the forces of Ukraine, it will also be necessary to increase the supply of MRAP-class vehicles and at least maintain the current level of supply of HMMWV-type vehicles. Only in the post-war perspective will it be possible to restore Ukraine's ability to produce and overhaul armoured equipment, although by then it may be interested in a full transition to NATO equipment.

UKRAINE'S LONG-RANGE MISSILE CAPABILITY GAP

Capability Characteristics. Guided missile weapons represent Ukraine's greatest capability gap vis-à-vis Russia. Long-range missile capabilities, understood here as ballistic and cruise missiles with a range of more than 100 km, launched from various land (mobile), sea (ships), and air (aircraft) platforms, are characterised by remote and advanced guidance and a safe distance for operators of the launch platform. According to Soviet terminology, guided missiles are classified according to range: tactical up to 500 km, operational up to 3,000 km, and

⁹⁹ N. Fiorenza, "Slovakia Expects to Start Receiving CV90 IFVs within Three Years," *Jane's Defence Weekly*, 5 July 2022.

¹⁰⁰ See: "Cyprijskie uzbrojenie dla Ukrainy?," *Altair Agencja Lotnicza*, 9 April 2022, www.altair.com.pl; L. Jakes, "The Hunt to Arm Ukraine Leads to Difficult Choices," *The New York Times*, 11 October 2022.

¹⁰¹ N. Fiorenza, "Ukraine Conflict: Germany to Backfill Slovakia with Leopard 2 MBTs," *Jane's Defence Weekly*, 25 August 2022; M. Mitków, "Leopardy dla Czechów zamówione," *Defence24*, 13 October 2022

¹⁰² In 2021, the manufacturer of these missiles assembled up to 2,100 units, but plans to increase production to 4,000 per year. See: J. Gould, "Lockheed, Aiming to Double Javelin production, Seeks Supply Chain 'Crank up,'" *Defense News*, 9 May 2022.

strategic up to 5,000 km.¹⁰³ In the last decade, Russia modernised its conventional missile arsenal. The most important aspect of this was the deployment of 3M-14/3M-54 Kalibr cruise missiles with a range of 1,500-2,000 km on ships. In turn, the OTR-21 Tochka ballistic missiles (with a range of 120 km) in use by the missile brigades of Russia's Land Forces were replaced by new Iskander launchers for missiles with a range of 500 km. These include the 9M723 ballistic and the 9M727 and 9M728 cruise missiles. Since 2018, the capabilities of Iskander launchers have been supplemented by the 9M729 cruise missile, a land-based version of the Kalibr. Russia has also been replacing its Kh-22 and Kh-55 air-launched cruise missiles with the new Kh-101 and Kh-555, and is developing hypersonic weapons—the naval 3M-22 Zirkon and the air-launched Kh-47 Kinzhal.¹⁰⁴ The modernisation of Russia's arsenal contrasted with the decline in Ukraine's capabilities over the past three decades. This process included the transfer to Russia of the USSR's strategic forces stationed in Ukraine, the scrapping of R-17 Elbrus (Scud) missiles, and the elimination of several OTR-23 Oka missiles with a range of 500 km (banned by the INF treaty).¹⁰⁵ Ukraine's industry has not kept pace with the growing threat since 2014. In recent years, Ukraine's funding for research and development has been insufficient for the production of new Hrim-2 type ballistic missiles (equivalent to Russia's 9M723) or RK-360 Neptune anti-ship cruise missiles.

Both Sides' Potential. While Russia's nuclear and strategic arsenals are limited by bilateral agreements with the U.S., there is no insight into its conventional missile arsenal. Thus, one can only estimate its missile platforms. Before the outbreak of the war, Russia had about 150-180 Iskander mobile launchers for several of the missiles mentioned. According to IISS, its coastal defences also had land-based anti-ship cruise missile systems: 40 Type 3K60 Bal launchers and 56 Type 3K55 Bastion-P with Oniks missiles with ranges of up to 260 and 600 km, respectively. Russia's long-range aviation had 137 Tu-22M3, Tu-95MS, and Tu-160M bombers armed with strategic cruise missiles. In addition, its air force had a limited number of MiG-31 aircraft with hypersonic Kinzhals. Russia's Navy had as many as several dozen ships with Kalibr missile launchers.¹⁰⁶ Compared to this superpower arsenal, Ukraine's platforms and missiles were negligible in number. The ZSU Land Forces were armed with up to 90 Tochka-U missile launchers, manufactured in the late 1980s. It is more likely, however, that the ZSU missile brigade operating them had 12-18 operational launchers, perhaps with a similar number in reserve. Neither IISS nor other sources specify the number of Neptune missile launchers (with a range of 280-300 km) equipping missile units of Ukraine's coastal defence.¹⁰⁷ Any analysis of Ukraine's missile capabilities should also keep in mind Russia's incomparably better reconnaissance, early warning, and missile guidance resources.

Between February and 26 June, the Pentagon counted 2,811 Russian conventional missiles used against Ukraine. This includes Russian missiles of all types detected over Russia, Belarus,

¹⁰³ A. Krupa (ed.), *Encyklopedia wojskowa. Dowódcy i ich armie, historia wojen i bitew, technika wojskowa*, vol. II, MON-PWN, Warsaw 2007, pp. 131-132.

¹⁰⁴ For details, see: M. Cielma (ed.), "Modernizacja Sił Zbrojnych Rosji," *Nowa Technika Wojskowa: Numer Specjalny*, no. 14, February 2018, and P. Butowski, *Russia's Air-launched Weapons: Russian-made Aircraft Ordnance Today*, Harpia Publishing, Houston, Texas, 2017, pp. 9-18.

¹⁰⁵ Incidentally, Russia broke this accord with the 9M729 missile (NATO designation SSC-8 Screwdriver), due to the similarities of the launcher, and with the 9M728 missile (SSC-7 Southpaw), also denied it after the U.S. denounced the accord. About the INF Treaty, see: A. Kacprzyk, Ł. Kulesa, M.A. Piotrowski, "NATO Deterrence and Arms Control Policy in a World Without the INF Treaty," *PISM Policy Paper*, no. 2 (177), March 2020.

¹⁰⁶ These are submarines of the Antey, Borey, Yasenya, Shchuka-B, Varshavianka/Paltus and Lada classes, frigates of the Admiral Gorshkov and Burevestnik classes, corvettes of the Steregushchiy class, and missile boats of the Buyan-M, Bykov, and Karakut classes.

¹⁰⁷ "Ukraiński bóg wojny..." *op. cit.*

and Ukraine with the help of satellites, radar, and telemetry, including anti-aircraft missiles.¹⁰⁸ In conjunction with incomplete information for August–November, it can be assumed that Russia has fired around 3,500–4,000 different missiles so far, including the officially retired Tochkas. By comparison, Russia fired dozens of Tochkas and Iskanders during the short-lived war with Georgia in 2008, and 44 Kalibr, 83 Kh-101, and Kh-555 missiles during the initial phase of the 2015 intervention in Syria.¹⁰⁹ This illustrates the scale of Russia’s capabilities, which are equal if not superior to the ones shown by the U.S. during some of its operations. For example, during the initial phase of the invasion of Iraq in 2003, the U.S. fired 456 ATACMS ballistic missiles and 725 Tomahawk cruise missiles; during the limited operations against Libya in 2011 it fired “only” 159 Tomahawks.¹¹⁰ The differences in the scale of the two superpowers’ attacks can be explained by poor Russian reconnaissance and the different number of targets, as well as the likely poor accuracy or production quality control of Russia’s systems, including the newer ones. Notwithstanding, the intensive attacks on Ukraine after 24 February, Russia could still have a significant reserve of missiles for a conventional war with NATO. Less promising for Russia, however, was the production capacity of its industry, estimated in peacetime at up to 225 missiles of all types per year.¹¹¹ In this context, one can often hear views about the exhaustion of resources produced as part of the modernisation programme and examples of the use of even less reliable Soviet-made missiles. In the long run and the post-war perspective, this trend may be beneficial for NATO countries within range of Russian systems. For the time being, however, the way it uses missiles remains the main threat to civilians and the infrastructure of Ukraine, which *de facto* does not have a missile defence system.

Doctrine and Tactics on Both Sides. Russia made heavy use of its missile arsenal until mid-April. On the first day of the war, it launched about 160 missiles against ZSU airfields and bases. With Russia’s poor target reconnaissance, this campaign did not bring the expected results. During this period, it used Iskander ballistic missiles from Belarus and Kh-101 and Kh-555 missiles from bombers in Russian or Belarusian airspace.¹¹² In addition, Tu-22M bombers with Kh-59 tactical missiles were used in attacks on Kharkiv and Mariupol. Since that period, the Russian missiles’ high failure rate and the inaccuracy of up to 40–60% its cruise missiles were reported.¹¹³ By the end of March, Russia had also used Kinzhal hypersonic missiles three times, although their effectiveness was questionable. It cannot be ruled out that by using them, Russia was intending to demonstrate its capabilities to NATO countries, which currently lack the means to counter hypersonic missiles. Equally demonstrative was Russia’s missile attack on the ZSU training centre in Yavorov, just 17 km from the Polish border.¹¹⁴ Throughout March, Russia also used Kalibr missiles from ships in the Black Sea, mainly against military targets, fuel depots, and railroad junctions in western Ukraine. Tochka missiles,

¹⁰⁸ See the DIA data compilation: “Russian Missile Attacks on Ukraine,” *CSIS Missile Defense*, 29 June 2022, https://twitter.com/Missile_Defense.

¹⁰⁹ See: R. N. McDermott, T. Bukkvol, “Russia in the Precision-Strike regime—military theory, procurement and operational impact, Norwegian Defence Research Establishment,” *FFI Rapport*, Oslo, August 2017, p. 23.

¹¹⁰ Data for the ATACMS come from the IHS Jane’s profile; for the Tomahawks from “BGM-109 Tomahawk – Operational Use,” *Global Security*, undated (2018?), www.globalsecurity.org.

¹¹¹ This could have been 55 Oniks, 50 M723 missiles, 20 Kh-59 tactical rounds, and up to 100 Kalibr, 9M729, Kh-101 and Kh-555 missiles. See: P. Luzin, *op. cit.* There is no confirmation of this data in available sources of information about purchases of the Russian defence ministry in 2021.

¹¹² T. Ripley, “Ukraine Conflict: Russian Iskander Ballistic Missiles Strike Ukraine from Belarus,” *Jane’s Defence Weekly*, 11 March 2022, and J. Smith, “Russia’s Missiles See Mixed Results in Ukraine War as World Watches,” *Reuters*, 28 July 2022.

¹¹³ DIA estimates quoted by W. M. Arkin, “Exclusive: Russia’s Air War in Ukraine is a Total Failure,” *Newsweek*, 25 May 2022, www.newsweek.com.

¹¹⁴ M. Gawęda, “Rosja atakuje Ukrainę ‘na dystans’. Broń dalekiego zasięgu kluczowa dla Moskwy,” *Defence24*, 21 March 2022.

which Russia brought out of its reserves beyond the Urals, were also used in attacks in the Kyiv and Kharkiv areas. During the same time frame, the ZSU made small-scale but effective use of the rocket arsenal they still possessed. As early as the second day of the war, several of their Tochkas struck the Russian airfield in the border town of Millerovo, destroying at least one Su-30SM fighter. Ukrainian Tochkas were also used on 24 March to hit the Russian-held port of Berdyansk where the loaded landing craft *Saratov* was sunk. However, Ukraine's greatest success was the 13 April sinking of the cruiser *Moskva*, the flagship of Russia's Black Sea Fleet, using Neptune missiles.¹¹⁵ The effect of this spectacular action was the suspension of Russia's plans for a landing in Odesa and the withdrawal of its other ships to safety, further away from the Ukrainian coast. Later, the lack of Russian air and missile defence and anti-missile cover also facilitated the recapture of Snake Island by Ukraine.

From the second half of April Russia continued its attacks, but usually at an already lower level of 15-20 missiles fired per day. Exceptions to this downward trend were attacks on 19 and 28 April, 1 May, and 9 and 27 June, when about 100 missiles were fired per day. Communiqués from the Russian Defence Ministry at the time claimed extensive damage to ZSU heavy equipment and concentration and command areas. In early May, several Kh-101 missiles were also used against railroad and supposed military facilities in the suburbs of Kyiv. In fact, however, Russia increasingly attacked residential areas and civilian infrastructure. This campaign was calculated to further destroy Ukraine's industry, but even more so to prevent any normalisation of life in the west of the country. Beginning in mid-June, Russia began using Bastion-P systems with Oniks anti-ship missiles to attack ground targets in the Odesa area. At the end of June, they also resumed striking western Ukraine with Iskander system and cruise missiles fired from Tu-22Ms. In the latter case, the Kh-22, a highly inaccurate and obsolete missile, but one carrying a heavy warhead, was used. The result was very high civilian casualties in several Ukrainian cities.¹¹⁶ During the fighting in Donbas, Ukraine in turn made sporadic use of Tochka missiles against Russia's frontline ammunition depots, most of which were eliminated using GMLRS rockets.¹¹⁷ Despite speculation about these systems used successfully against Russia's air base in Crimea on 9 August, it would appear that Ukraine carried it out with three or four of its own Hrim missiles.¹¹⁸ Russia's attacks on ground soft targets in Ukrainian cities using S-300 air defence missiles only served to illustrate Russia's terror tactics and dwindling arsenal.¹¹⁹ The use of such expensive missiles with their small fragmentation warheads did little damage to ZSU forces or equipment. Firing obsolete Tochkas, Kh-22, and, contrary to their intended purpose, Bastion and S-300 systems suggested that Russia has difficulties in attacking on the scale seen earlier.

Eastern Options. There is no way to replenish Ukraine's expended Tochka missiles. Several Central European countries that had launchers for their older version scrapped them in the 1990s. Currently, Tochka-U missiles are only stocked by Russia and Belarus, probably still numbering a few hundred missiles. A few dozen Tochkas of the older version can be found in the arsenals of countries that are unlikely to help Ukraine, including Armenia, Syria, and

¹¹⁵ See in chronological order: G. Jennings, "Ukraine Conflict: Ukraine Reportedly Strikes Russian Airbase," *Jane's Defence Weekly*, 26 February 2022; M. Szopa, "Ukraińskie Toczki znów uderzają," *Defence24*, 7 March 2022; and T. Grotnik, "Wojna morska o Ukrainę," *Wojsko i Technika*, no. 4, April 2022.

¹¹⁶ See: A. Cheng *et al.*, "Ukraine Accuses Russia of Launching Missile from Belarus," *The Washington Post*, 26 June 2022, and V. Daniel, "Russia's Explanations For Attacking Civilians Wither under Scrutiny," *The New York Times*, 3 July 2022.

¹¹⁷ M. Dąbrowski, "Radzieckie rakiety po obu stronach wojny. Toczka na Ukrainie," *Defence24*, 31 July 2022.

¹¹⁸ G. Jennings, "Ukraine Conflict: Russian Strike Aircraft Destroyed in Crimean Airbase Attack," *Jane's Defence Weekly*, 10 August 2022.

¹¹⁹ P. Andrusieczko, "Rosyjskie 'precyzyjne' rakiety zabijają coraz więcej ukraińskich cywilów i niszczą ich miasta," *Gazeta Wyborcza*, 15 July 2022, <https://wyborcza.pl>.

Yemen. What's more, Central European countries do not have any operational Soviet anti-ship missiles compatible with the launchers Ukraine still has.

STANAG Options. Since March, Ukraine has been voicing interest in NATO missile systems. Occasionally, it mentions specific ones like the Tomahawk, ATACMS, and LORA.¹²⁰ This was unrealistic, especially in the case of Israeli LORAs (430 km range, heavy warhead) and U.S. Tomahawks (whose newer versions have ranges of 1,125 or 1,610 km). Presumably, the restrictions associated with the 1987 MTCR agreement were of less importance to the U.S. administration, even though the issue did come up in media. Evidently, the U.S. was concerned about the consequences of delivery to Ukraine of ATACMS with a range of 300 km. It cannot be ruled out that MLRS and HIMARS systems' capability to launch them also slowed down negotiations and the delivery of GMLRS missiles. In June, Biden administration officials made several statements to the effect that the delivery of ATACMS missiles was still not being considered. However, several in Congress and some U.S. experts continued to lobby for this option.¹²¹

Ukraine's efforts to obtain missiles to replace its scarce Neptunes were more fruitful. Lobbying efforts reflected Ukraine's expectations for as many as 300 anti-ship missiles.¹²² Negotiations with several partners had probably been going on since early April and accelerated after the sinking of the cruiser *Moskva*. At the end of May, however, official information emerged about plans to deliver to Ukraine an undisclosed number of Harpoon-type missiles with a range of 124 km (RGM-84L version). Initially, they were to be supplied only by the U.S. and Denmark, but in July there were also reports of plans for deliveries from the Netherlands and the UK.¹²³ It cannot be ruled out that the rising number of suppliers had to do with Russia's naval blockade of Ukraine, preventing the free export of grain. Although Harpoon missiles are widespread on Western ships and aircraft, the U.S. confirmed the delivery of two land-based launchers. There was speculation that these may have been older mobile launchers withdrawn from service in Denmark, but it was also possible that launchers from the U.S. could be used as part of a new production line for HCDS-type systems ordered by Taiwan.¹²⁴ Two Harpoon missiles were used in mid-June to sink the *Sapsitiel Vasily Biech* tugboat, which was supplying the Russian garrison on Snake Island.¹²⁵ Given the time required to deliver and train HCDS operators, it can be assumed that Ukraine acquired them as early as May. It should be emphasised that, despite the Harpoons range of more than 100 km, no information has emerged about limitations being placed on Ukraine in its selection of sea and ground targets to use them. The supply of this new missile to the ZSU has in effect increased the risk to

¹²⁰ See: L. Brown, "Ukraine Can 'Break' Russians if West Supplies Enough Weapons," *The Times*, 6 April 2022. In the context of these Ukrainian suggestions, it is worth noting that there are currently no operational launchers for Tomahawk missiles other than offshore platforms. The MRC (Mid-Range Capability) Typhon land-based launcher for Tomahawks and SM-6 missiles is at the testing stage. In addition, Tomahawks have so far been exported only to the UK, and negotiations are still underway for possible deliveries to Australia, the Netherlands and Canada.

¹²¹ D. E. Sanger *et al.*, "The U.S. Is Sending Advanced Weapons to Kyiv. But Conditions Apply," *The New York Times*, 2 June 2022.

¹²² "Weapons List," *Save UA List*, a printout of the 4 May 2022 version of that site, although this figure had already been removed from the site as of 26 August 2022, see: <https://saveualist.com>.

¹²³ See: Sh. Gairola, "Ukraine Crisis: Denmark to Provide Harpoon Missile System to Ukraine," *Jane's Navy International*, 24 May 2022; "Netherlands to Give Ukraine Anti-Ship Rockets," *NL Times*, 16 June 2022, <https://nltimes.nl>; and A. Roque, "New Truck-Mounted Harpoon Launchers Headed to Ukraine," *Jane's Defence Weekly*, 16 June 2022.

¹²⁴ Taiwan ordered in late 2021, and obtained approval from the U.S. administration in March 2022, to supply 100 HCDS systems and 400 missiles. See: J. Grevatt, "Taiwan Bolsters Coastal Defence with New Harpoon Deal," *Jane's Defence Weekly*, 4 March 2022.

¹²⁵ "Ukraine Says It Hit Russian Tugboat with Two Harpoon missiles," *Reuters*, 17 June 2022.

Russian ships along Ukraine's coastline and made Russia more flexible in allowing movement of commercial grain-carrying vessels.

Other equipment delivered to Ukraine by the U.S. included the AGM-88D HARM air-to-ground missile (with a range of 111 km), which appeared on the battlefield in early August. These weapons are capable of destroying radars and air-defence systems thanks to their advanced self-guidance system. Confirmation of the delivery of HARMs with photos of their remains coincided with the documented loss of several of Russia's Tor and Pantsir launchers. Pentagon officials confirmed the delivery, but media speculation at the time that the U.S. had supplied any of the aerial platforms, such as F-16 aircraft, were doubtful.¹²⁶ Adapting Ukrainian MiG-29 and Su-27 fighters for this purpose was probably complicated and time-consuming, but experts from the U.S. or some Central European countries could have helped. It seems almost as likely that Ukraine deployed some kind of new HARM ground launcher, similar in general design to the HCDS.¹²⁷ With HARM missiles, it gained the ability to launch a campaign to take out Russia's air defences in Donbas and Crimea. With sufficient numbers of HARMs and success in their use, this would give Ukrainian aircraft, helicopters, and drones greater freedom of action. It is worth noting in this context that U.S. missiles of this type have so far been delivered only to a small group of NATO and Asian allies.

Asymmetric Options. Ukraine's ability to hit distant targets cannot be ensured by its aviation. It can use alternatives to Neptune in the form of anti-tank missiles only at a very short range. In late March, the Azov regiment used ATGM Konkurs systems with a range of up to 3.5 km during the defence of Mariupol and sank one of Russia's modern cutters.¹²⁸ British Brimstone missiles with a range of up to 12 km, delivered in unknown quantities in May and fired from an improvised launcher mounted on a truck may also be used in this manner. Similar capabilities could be provided by RBS-17 missiles with a range of 8 km, whose delivery was announced by Sweden in June.¹²⁹ Both systems are variants of the U.S. AGM-114 Hellfire anti-tank missiles. They may be useful as an additional reinforcement to Ukraine's short-range coastal defence, but they do not offer the range or destructive power of the Neptune or Harpoon missile warheads.

Prospects. By the end of 2022, Ukraine's small stock of Tochka ballistic missiles will be depleted and the country most likely will be left without the ability to reach targets behind the frontline, occupied Crimea, or within the territory of Russia. The ZSU's spectacular success in sinking the *Moskva* and destroying the Saki airfield will therefore be difficult to repeat. Ukrainian strikes with improvised "flying bombs" (heavy drones) might be exceptions. The gap between Ukraine and Russia will endure and be a serious issue for the Ukrainians, making it difficult for them to conduct counteroffensives. Russia will keep some Iskander and Kalibr missiles in reserve in case of a conflict with NATO and it can fire on civilian targets with older systems. The missile threat from Russia will persist, even if on a smaller scale than at the start of the war. Also unclear is the scale of expected assistance to Russia from Iran, which may deliver even a few hundred short-range ballistic missiles of the Fateh-110 family

¹²⁶ O. Libermann, "Pentagon Acknowledges Sending Previously Undisclosed Anti-Radar Missiles to Ukraine," *CNN International*, 9 August 2022, <https://edition.cnn.com>.

¹²⁷ J. Travithick, "Ukrainian MiG-29s Are Firing AGM-88 Anti-Radiation Missiles," *The Drive*, 19 August 2022.

¹²⁸ M. Dura, "'Raptor'—ulubieniec Putina trafiony rakietą z brzegu," *Defence24*, 22 March 2022.

¹²⁹ A. Świerkowski, "Brimstone na Ukrainie," *Defence24*, 18 May 2022, and T. Ozberk, "How Can Swedish RBS-17 Anti-Ship Missiles Help Ukraine?," *Naval News*, 5 June 2022, www.navalnews.com.

(range of 300 km with a 500 kg warhead).¹³⁰ For Ukraine, acquiring Tochkas will be impossible and, with the continuation of the war, safe production of Hrim-2 missiles is unlikely.

In consequence, Ukraine will step up its efforts to obtain ATACMS missiles and the Biden administration will need to re-evaluate this option. Given Ukraine's dependence on U.S. aid, it seems unlikely that it would risk using them in violation of bilateral agreements about targets and geographical area. Deliveries of ATACMS, even in small numbers, would considerably strengthen Ukraine's capabilities on the battlefield, as well as future defence and deterrence strength vis-à-vis Russia. This type of missile (or the Israeli LORA or indigenous Hrim) would diminish possibilities of nuclear blackmail by Russia. Use of longer-range missiles by Ukraine would complicate current and future Russian plans, creating conventional risk for its territory and the threat of Ukrainian retaliation for any nuclear strike.¹³¹

The lack of ATACMS missiles constitutes also a gap in the capabilities of NATO's Eastern Flank. Among European allies, only Greece and Turkey currently have them in limited numbers and they may be delivered to Finland and Poland only in the indefinite future. From the point of view of the needs of Ukraine or the Alliance, however, there is no problem with a shortage of ATACMS. Despite the cessation of their production in 2011, large reserves (up to 3,000) are still held by the U.S. Army, including in Europe. In addition, in 2023, the U.S. will begin replacing them with new PrSM-type missiles for HIMARS and MLRS launchers, and with LRHW Dark Eagle hypersonic weapons and possibly MCR Typhon launchers—all with a range much greater than 300 km.¹³²

Ukraine requires further support with anti-ship missiles, even in peacetime as it will not be able to quickly rebuild an effective navy. Therefore it is important to continue supplying Ukraine with Harpoon missiles, of which NATO countries have large reserves. Given the scale of the Russian threat, however, Ukraine will need coastal defence missiles with a longer range, preferably assured through the resumed production of Neptune missiles after the war or transfer of Norwegian NSM-type systems (with a range of 200 km, they are currently used by Norway, Poland, and the U.S.). The *asymmetric options* already implemented by UDCG countries should be considered as a means of local defence reinforcement. It is also advisable to continue supplying U.S. HARM missiles, which can eliminate all of Russia's anti-aircraft systems at a range of 100 km. In the future, if Ukraine were to obtain aircraft as part of the *STANAG options*, it would also be necessary to consider supplying other air-to-ground missile systems for them. In addition, Ukraine will have to build entirely new capabilities to counter cruise and ballistic missiles (see the section on air defence capability gap, below pp. 51-58).

UKRAINE'S AIR FORCE CAPABILITY GAP

Capability Characteristics. The capabilities of the ZSU Air Force were already outdated in comparison to the qualitative modernisation of Russia's Air Force between 2011 and 2018. As part of subsequent reorganisations, the force was established in 2015 under a new name—the Air and Space Forces (VKS) of Russia. In this way, the Space Forces, previously subordinate

¹³⁰ See more: M.A. Piotrowski, "Iran Assist Russia with Weapons—the Military and Political Consequences," *PISM Bulletin*, no. 171 (2088), 4 November 2022, www.pism.pl.

¹³¹ For more on the credibility of such conventional deterrence and the possibilities to limit nuclear escalation by Russia, or just Russian verbal threats, see S. Dębski, "Jak zepchnąć Putina z drabiny eskalacyjnej?," *Polski Przegląd Dyplomatyczny*, no. 4 (91), 2022, pp. 7-12.

¹³² For the context and development of these programmes, see: A. Kacprzyk, M. A. Piotrowski, "State of U.S. Development of Ground-Launched Intermediate-Range Missiles," *PISM Bulletin*, no. 174 (2106), 20 August 2020.

to the Strategic Nuclear Forces, were merged, and the Air Defence and Army Aviation of the Land Forces were integrated with them. They then received some 500 aircraft and 700 helicopters, mostly upgrades of older airplanes, but also newly purchased ones. Among others, the VKS received new Su-30 and Su-35 multirole fighters, Su-34 tactical bombers, and Mi-28N and Ka-52 attack helicopters. New tactical air-to-ground (Kh-38, Kh-50 and Wikhr-1) and air-to-air (R-74M and R-77-1) missiles were introduced into the arsenal of these planes. The slowest progress was in R&D of the new-generation Su-57 fighter and Russia's strategic bomber. In parallel with the modernisation of the VKS, the number of hours flown by its pilots was increased and the intervention in Syria gave many of them hands-on experience.¹³³

For Ukraine, post-2014 aviation problems were exacerbated by the growing threat from Russia, the severed collaboration between the two countries' aviation industries, and outdated weapons. In the spring of 2020, the ambitious "Air Force Vision 2035" reconstruction and rearmament programme was adopted. Among other things, Ukraine planned to increase interoperability with NATO and acquire a modern multi-role aircraft to replace various models and types of post-Soviet ones. According to the document, operation of Su-27 and MiG-29 fighter jets and Su-24 tactical bombers would end by 2032, with speculation that they might be succeeded by the multi-role Gripen-NGs from Sweden or the U.S. F-16 Block 70/72 Viper and F-15EX Eagle-II.¹³⁴ In practice, however, Ukraine's ability to maintain industrial repair capacity and to seek new foreign partners, the most serious of which turned out to be Turkey, proved to be serious and urgent challenges.¹³⁵

Both Sides' Potential. The gap in Ukraine's aviation capabilities can be seen in the difference of its quantitative potential as compared with the VKS (nearly 1,200 aircraft), which is the third aviation power after the U.S. and China. According to *Military Balance*, before the war Russia could have had 185 MiG-29SMT, MiG-31BM, and Su-27 interceptor fighters, 427 Su-27, Su-30, Su-34, and Su-35 multirole aircraft, as well as 264 Su-25SM close support aircraft and Su-24 tactical bombers. Russia's helicopter potential was no less impressive, with 399 Ka-52A, Mi-24, and Mi-28 attack helicopters and 333 transport helicopters (mainly of the older Mi-8 family). For the operation against Ukraine, the VKS allocated up to 60% of this potential, mainly from forces in the Western and Southern Military Districts, Black Sea Fleet aviation, and additional units from other districts.¹³⁶ In all, this was some 400-450 relatively modern multirole aircraft, tactical bombers and support aircraft (Frontline Aviation) and up to 250-300 helicopters (Army Aviation). Russia's advantage was compounded by several A-50 early warning aircraft, which could track most of the airspace over Ukraine with their radars. In addition, the VKS directed an unknown number of its 137 strategic bombers of the Long Range Air Force into battle (see the earlier point on Russia's missile arsenal). These forces were supplemented by Army Transport Aviation with about 100 heavy Il-76 aircraft, which provided airlift and supplies to Russia's Airborne Assault Forces. In contrast, Ukraine's aviation potential before the war was three to four times smaller than the VKS forces deployed around its borders. According to IISS, Ukraine had 36 MiG-29 multirole fighters, 34 Su-27 family interceptors and multirole fighters, 14 Su-24 tactical bombers and 31 Su-25

¹³³ For encyclopaedic information on the organisation and weapons of the VKS and other Russian formations, see: P. Butowski, *Flashpoint Russia: Russia's Air Power: Capabilities and Structure*, Harpia Publishing, Houston Texas 2019; and *idem*, *Russia's Warplanes. Russian-Made Military Aircraft and Helicopters Today*, vols. I-II, Harpia Publishing, Houston, Texas, 2015. See also: A.M. Dwyer, "Assessment of the Russian Armed Forces' State Armament Programme in 2011-2020," *PISM Report*, June 2021, pp. 17-19, www.pism.pl.

¹³⁴ The Air Force Command of the Armed Forces of Ukraine, "Air Force Vision 2035," *Ministry of Defense of Ukraine*, Kyiv, May 2020, pp. 26-28.

¹³⁵ J. Fiszer, J. Gruszczyński, "Siły Powietrzne Ukrainy," *Lotnictwo – Aviation International*, no. 3, March 2022.

¹³⁶ P. Butowski, "Lotnictwo rosyjskie w wojnie przeciwko Ukrainie," *Lotnictwo – Aviation International*, no. 6, June 2022.

close support aircraft. Ukraine's Air Force and Ground Forces could also have 35 Mi-24 attack helicopters and 53 Mi-8 transport helicopters. Polish experts' estimates were slightly higher for Ukraine, but they did not alter the huge disproportion with respect to the aggressor's forces.¹³⁷

Ukraine's capability gap in aviation has persisted throughout the war, despite high air losses on both sides. At present, there is no confirmed information about how many were lost during air duels or due to the massive use of various ground-based anti-aircraft weapons. According to *Oryx*, by the end of October, Russia had lost 62 combat aircraft (mainly Su-25 and Su-34) and 55 helicopters of various types (half of these of Mi-8 and Ka-52 types). During the same period, Ukraine lost 50 combat aircraft (mainly MiG-29 and Su-25) and 22 helicopters (mainly Mi-8). This gives a slight difference in lost combat aircraft and a very unfavourable ratio for Russia in downed helicopters (with kill ratios of 1:1.2 and 1:2.5, respectively). In comparison, the USSR's aviation losses during the decade-long struggle against lightly armed guerrillas in Afghanistan amounted to 118 aircraft and 333 helicopters.¹³⁸ Aviation systems, unlike the armaments of ground troops, are practically impossible to replace with captured aircraft, hence the crucial importance of Russia's VKS reserves and the complete absence of reserves on the Ukrainian side. At the same time, some experts claim that Russia's aerospace industry is unable to produce new airplanes on a scale commensurate with its losses. Indeed, in 2021 it could produce only 30-35 new Sukhoi aircraft and 25-35 of both types of attack helicopter.¹³⁹ Such constraints on Russia's aerospace industry and the VKS are a very favourable development for NATO. However, this is of little comfort to Ukraine, which is currently unable to produce any aircraft. These issues are the main factors motivating Ukraine's continued efforts to replenish its lost aviation capabilities.

Doctrine and Tactics on Both Sides. There is a gulf between theory and practice in the way Russia uses its air superiority. The VKS's experience in Chechnya, Georgia, and Syria proved to be far removed from the concepts in place among NATO air forces. Moreover, pre-war analyses overestimated the VKS's levels of preparation, training, experience, and mastery of new equipment. Arguably, many of these issues will one day be fully explained. However, it is already clear that the Russians did not use the VKS as a capability acting independently and decisively. Its most effective use has been limited to strikes a few dozen kilometres beyond the front line instead of operations up to 400-500 kilometres away like in the days of the USSR and the Warsaw Pact. The VKS's support for land offensives has not led to the suppression of Ukraine's air defence or gaining air domination. Russian aviation failed to provide ground forces with adequate support in every aspect and at every level of the operation. Despite the use of additional bases in Belarus for air strikes against Kyiv, VKS planes operated without taking much risk, usually at a safe distance from their targets. In addition, after the helicopter airborne troops landed at Hostomel, Russia's paratroopers became easy targets for artillery and air strikes by Ukrainian Su-24s and Su-25s. In conjunction with Kyiv's effective air defence, this prevented Russia from landing additional forces by Il-76 transport planes. Ukrainian Su-25s were also seen attacking Russian columns heading for Kyiv. During this phase of the

¹³⁷ Before the war, there were supposed to be 10 Su-27P interceptor fighters, 27 Su-27S multirole fighters, 49 MiG-29 multirole fighters, 24 Su-24M tactical bombers, and 26 Su-25 support aircraft. In addition, in the ZSU as a whole there were supposed to be 35 Mi-24 attack helicopters, 50 Mi-8 transport helicopters, and 14 Mi-2 light helicopters. The same source also mentions 11 Mi-26 heavy transport helicopters not yet seen during the war. See: J. Fiszer, J. Gruszczyński, *op. cit.* The data cited in this section specifies only combat planes, without mentioning training versions.

¹³⁸ L. W. Grau (ed.), *op. cit.*, p. xix

¹³⁹ P. Luzin, *op. cit.*

war, effective tactical use of the VKS was observed only in eastern and southern Ukraine.¹⁴⁰ Russian successes in these directions could not hide the fact that Ukraine's own air defence and aviation were still in operation. Although visual documentation is lacking, it can be assumed that ZSU pilots used alternate airfields and resorted to landing on makeshift runways like highways. Ukrainian planes probably rotated between fixed bases and such runways, dispersing and hindering subsequent VKS strikes. Ukrainian pilots were also taking more risks, and able to land safely on their own territory even if their aircraft was shot down. In the information sphere, Russia was also losing out to the widespread media legend of a single MiG-29 ace pilot (the "Ghost of Kyiv") coping with successive waves of Russian aircraft and guided missiles.¹⁴¹ In addition, Ukrainian pilots have been repeatedly featured on various U.S. television programmes, publicising the help they need. During the most difficult period for Ukraine, its planes limited their operations to only five to 10 sorties a day, compared to up to two hundred daily flights by VKS aircraft.¹⁴²

In the second phase of the war, Russia was still unable to take control of Ukraine's airspace. From May on, the problems with the use of VKS and a drop in the number of operations became even more evident.¹⁴³ Russia's air force focused on easier tasks like terrorising civilians or giving local support to its own ground forces in Donbas. The already seldom-used guided missiles or bombs of the VKS were even less frequently seen over central or western Ukraine. Perhaps Russia's military command preferred to preserve such weapons in case of a conflict with NATO. The repeated and mostly successful raids by Ukrainian drones or helicopters behind Russian lines during their offensive in Donbas were also prominent military setbacks for Russia. In early April, Ukrainian Mi-24 attack helicopters launched a successful attack on fuel depots in the border town of Belgorod, thereby also demonstrating the vulnerability of Russian air defence. Despite the introduction by the Russians of additional air defence systems for their units besieging Mariupol, in March-April ZSU Mi-8 transport helicopters conducted daring and costly (three were lost) operations bringing supplies to besieged troops and evacuating the wounded.¹⁴⁴ A vivid illustration of the series of problems facing Russia's VKS was the conspicuous absence of the usual annual fly-over by combat aircraft over Red Square during Moscow's 9 May Victory Day parade. Rounding out Russia's string of failures was Ukraine's spectacular attack on the Saki airfield in occupied Crimea on 9 August, with most of the aircraft operating from that base and attached to the Black Sea Fleet destroyed or damaged (12 Su-30SMs and six Su-24M bombers were deployed there after 2014).¹⁴⁵ The tangible losses in material and standing from this attack are comparable to the failure of the Russian landing at Hostomel, the sinking of the cruiser *Moskva*, and Russia's evacuation from Snake Island. It can also be tentatively assumed that the attack on Saki—using still unconfirmed means—will significantly reduce the offensive capabilities of Russia's aviation at least over the Odesa and Kherson areas.

¹⁴⁰ See: M. Gajzler, "Lotnicze i morskie aspekty agresji na Ukrainę," *Nowa Technika Wojskowa*, no. 3, March 2022.

¹⁴¹ E. Bubola, "Ukraine Acknowledges That the 'Ghost of Kyiv' is a Myth," *The New York Times*, 1 May 2022.

¹⁴² These statistics from M. Vernikova, A. E. Kramer, "Ukraine Pilots Are Outgunned, But Russia Doesn't Rule Skies," *The New York Times*, 23 March 2022.

¹⁴³ Many observations about the VKS from the initial stage of the war have remained accurate up until the summer of 2022. See: J. Bonk, "The Mysterious Case of the Missing Russian Air Force," *RUSI Commentary*, 28 February 2022; S. Corbett, "Ukraine Conflict: Is the VKS Underperforming?," *Jane's Defence Weekly*, 3 March 2022; and J. Ismay, "Evidence Grows of Shortcomings of the Russian Air Force, U.S. Officials Say," *The New York Times*, 11 May 2022.

¹⁴⁴ See: R. Ponomarenko, "Bitwa o Mariupol," *Nowa Technika Wojskowa*, no. 6, June 2022.

¹⁴⁵ For the details about the deployment of the bases and the weapons of those forces, see: A. Charuk, "Rosyjskie lotnictwo wojskowe na Krymie. Lata 2012-2022," *Lotnictwo*, no. 6, June 2022.

Eastern Options. In practice, there is no source in Central Europe to provide the ZSU with Su-27 fighters and Su-24 bombers from Central Europe. Since the beginning of the war, Ukraine has been calling for ready to use or spare parts for the MiG-29 fighter jet family, and it was clear that within NATO they are only used by Bulgaria (11), Poland (22), and Slovakia (9). Both the Biden administration and the U.S. Congress had expressed expectations about the Polish MiGs in early March. Polish authorities stated publicly that they were ready to deliver their MiG-29s, but any transfer must have the political support of NATO as a whole and the jets should first go to the U.S. base in Ramstein. Such a proposal, however, met with an immediate reaction from the Pentagon, which considered the solution “too escalatory”. It appears that fears about Ukraine’s retaliatory air strikes against targets in Russia probably prevailed in the U.S. administration at the time. Poland, at least in the public sphere, ended any further discussions about its MiGs.¹⁴⁶ Bulgaria also ruled out the transfer of its MiG-29s. Unconfirmed reports later suggested that Ukraine may nevertheless have come into possession of 3-6 Azerbaijani MiGs, which had been flown to Lviv for an overhaul before the war began (Baku had 15 such planes in 2021).¹⁴⁷ This hypothesis is reinforced by statements made by Pentagon officials in April, according to which, Ukraine supposedly increased the number of its operable MiGs, thanks to spare parts from an undisclosed country.¹⁴⁸ Slovakia, in contrast, was quite open to supplying parts, or even aircraft. Its government was supposedly ready as early as March, but held additional consultations with Czechia and Poland about arranging patrols in its airspace by their air forces after the transfer of MiG-29s to Ukraine in August or September.¹⁴⁹ It can be assumed that during this period deliveries of R-27 air-to-air missiles with a range of 80 km, the primary weapon of the MiG-29, were made. Equally plausible is the assistance of Central Europe in maintaining the fleet of Ukrainian Su-25 support aircraft. First to be mentioned in this context was Bulgaria, which denied it, exhibiting three planes still in its possession. As of early July, there was speculation that the assistance more likely came from North Macedonia, which was about to dispose of all four of its Su-25s (bought 20 years earlier from Ukraine). This suggests that these planes and their components were transferred between May and July when their vacancy on the Petrovec airfield was noticed.¹⁵⁰ It is worth noting that, despite the Sukhoi’s tactical tasks, they may give Ukraine additional offensive capabilities, including to strike targets in Russia’s border regions.

Fewer political problems and more transparency characterised Ukraine’s efforts to obtain helicopters via the *eastern option*. The deliveries were facilitated by the fact that before the outbreak of the war, the U.S. announced the delivery of five Mi-17 transport helicopters (upgraded versions of the Mi-8). By July, the U.S. had delivered as many as 20 such helicopters, previously purchased from Russia for Afghanistan. In this context, speculation about the delivery of an additional five “Afghan” Mi-17s from Uzbekistan, where their crews took refuge after the collapse of the Kabul government, has yet to be confirmed.¹⁵¹ In mid-June, the delivery of four Mi-17 transport helicopters and two Mi-2 light helicopters was announced by Slovakia, which will replace them with U.S. UH-60M Blackhawks. The U.S. also did not object

¹⁴⁶ For a good summary of the positions and debates about the “Polish MiGs”, see: A. Mahshie, “Ukraine Wants F-16s, But USAF Officials Say That’s ‘Not A Recipe for Success,’” *Air Force Magazine*, 29 April 2022, www.airforcemag.com.

¹⁴⁷ A. Świerkowski, “Azerbejdżan przekazał myśliwce Ukrainie?,” *Defence24*, 7 August 2022.

¹⁴⁸ G. Jennings, “Ukraine Conflict: Kyiv Increases Available Aircraft Fleet,” *Jane’s Defence Weekly*, 21 April 2022.

¹⁴⁹ N. A. Youssef *et al.*, “The Ukraine Crisis: Allies Seek to Bolster Kyiv’s Air Defenses with Jets, Training,” *The Wall Street Journal*, 27 July 2022.

¹⁵⁰ E. Helfrich, “Ukraine Situation Report: Rumors Swirl Around Macedonian Su-25 Delivery,” *The Drive*, 5 August 2022, www.thedrive.com, and “Four ‘Schrödinger Airplanes’ For the Ukrainian Air Force,” *Defense Express*, 9 August 2022, <https://en.defence-ua.com>.

¹⁵¹ C. Putz, “Where Are the Afghan Air Force’s Aircraft Now?,” *The Diplomat*, 3 May 2022, <https://thediplomat.com>.

to Czechia's earlier announcements about the delivery of its attack helicopters to Ukraine, even expressing its thanks. Czechia had seven Mi-24Vs and 10 Mi-25s before the war, with a plan to replace them with AH-1Z Viper attack and UH-1Y Venom multi-role helicopters. The replacement plan accelerated in August, with the announcement of the transfer of eight used U.S. helicopters to Czechia free of charge, independently of the plan to purchase 10 newly produced helicopters each. In mid-August, Latvia confirmed the delivery of its two Mi-8s and two Mi-2s. Lithuania is also expected to transfer its Mi-8s. Both countries are awaiting delivery of several Blackhawks.¹⁵² In mid-October, Portugal also declared it planned to deliver six Ka-32A naval helicopters to Ukraine.¹⁵³ This created an additional pool of used helicopters capable of replacing Ukraine's lost units and should allow the ZSU to maintain the current pace of helicopter operations for their ground, air-mobile, and special forces.

STANAG Options. With MiG-29 options limited to three NATO countries, since April Ukraine has been asking for more modern Western aircraft. Pre-war ZSU documents called for the purchase of 78-102 such aircraft between 2023 and 2035.¹⁵⁴ After the war broke out, Ukraine's unofficial expectations were for 50 Western combat aircraft.¹⁵⁵ Calls for the delivery of used U.S. multirole F-15s, F-16s, and F-18s came just before the first UDCG ministerial meeting. One retired Ukrainian commander indicated that the top priority should be at least one fighter squadron, whose pilots could be trained within "two-three weeks". Such suggestions, however, were countered with the arguments of Pentagon that the delivery itself would not happen quickly, while the basic training of F-16 pilots lasts 9 months and is preceded by a long period of introduction on T-6 and T-38 training airplanes (six and seven months each, respectively).¹⁵⁶ The subject of Western fighter jets disappeared in media reports for the next three months, although talks behind closed doors may have continued. By the end of July, senior U.S. officials and military officers had already spoken in positive terms about supplies to Ukraine and there were expectations in Congress that a programme to train Ukrainian pilots would be initiated in 2023. The analysis of various options by the administration has been confirmed by the White House, while the Pentagon's aviation secretary hinted at the possibility of supplying Ukraine with A-10 Warthog close air support planes. These aircraft are easy to operate, have better survivability, range, payload, and more air-to-ground weapons systems than the post-Soviet Su-25s. The Pentagon still has 220 A-10s (85 in reserve) and all are scheduled to be retired from service. Interestingly, they have never been exported to U.S. allies or partners. An adviser to Ukraine's defence minister, however, questioned the wisdom of transferring the A-10, reiterating the requests for multirole jets. The Pentagon confirmed at the time that options for supplying U.S. or European airplanes such as the Gripen, Eurofighter, or Rafale would be examined. In August, the ZSU's social media accounts again hinted at interest in the F-16. In no statement by U.S. policymakers or military officials was there concern about the "escalation factor" associated with the supply of Western jets to Ukraine.¹⁵⁷ At least the option seemed to remain open for the Biden administration, while so far the Swedish

¹⁵² See, in chronological order, the following reports: G. Jennings, "Ukraine Conflict: Czech Republic Donates Attack Helicopters to Kyiv," *Jane's Defence Weekly*, 26 May 2022; *idem.*, "Ukraine Conflict: Slovakia Donates Mil Helicopters to Kyiv," *Jane's Defence Weekly*, 17 June 2022; and N. Fiorenza, "US to Gift H-1 Helicopters to Czech Republic," *Jane's Defence Weekly* 24 August 2022.

¹⁵³ V. Berreira, "Ukraine conflict: Portugal to donate Kamov helicopters to Kyiv," *Jane's Defence Weekly*, 14 October 2022.

¹⁵⁴ The Air Force Command of the Armed Forces of Ukraine, *op. cit.*, p. 27.

¹⁵⁵ "Weapons List," *Save UA List*, a printout of the 4 May 2022 version of that site, although this figure had already been removed from the site as of 26 August 2022, but it did mention that Ukraine needs fighter aircraft, close support and attack helicopters, <https://saveualist.com>.

¹⁵⁶ A. Mahshie, *op. cit.*

¹⁵⁷ See the summary in A. Mashshie, "Ukraine Says It Needs "Fast and Versatile" Aircraft, Not the A-10," *Air Force Magazine*, 22 July 2022.

government has not commented on the feasibility of Gripen deliveries. Media raised the issue of a lack of suitable ZSU airbases with destroyed and threatened runways that require significant investments, but are less challenging for the Swedish plane.¹⁵⁸

Asymmetric Options. There are two essential and proven solutions that can fill the gap in Ukraine's aviation capabilities. The first is strictly defensive, based on air defence systems. The second could involve the use of armed drones, which on a smaller scale and with weaker armaments would perform the tasks of Su-25 aircraft or helicopters of the Mi-24/35 family. Western assistance in both forms, however, does not eliminate the risk of further degradation of Ukraine's air capabilities. Both air defence and armed drones call for separate analyses (see next sections).

Prospects. Ukraine has more trained pilots than combat aircraft or helicopters on hand. Preparation and determination have allowed Ukraine's air force to survive six months of intense war, with surprisingly high resilience to Russian missile and air strikes. A number of mistakes on Russia's part were also to Ukraine's advantage. All of these factors may remain in place if the war continues in 2023.

The real numbers of post-Soviet aircraft Ukraine can rely on are limited. *Eastern options* have played a key role in maintaining Ukraine's modest capabilities. Here, Central European countries have shown various degrees of readiness to part with their MiG-29 fighters. Czechia and Poland will take on the mission of patrolling Slovakia's airspace in the fall, and this is linked to Slovakia's transfer of its S-300 systems and MiGs to Ukraine. Slovakia also plans to take delivery of 12 combat F-16Vs in 2023, while Bulgaria will not receive the first eight of 16 planned aircraft until 2025.¹⁵⁹ Thus, it can be assumed that Slovakia and Poland will be able to supply Ukraine with "MiG-29s in parts" until their fleet of these jets is exhausted. It is more difficult to assess Bulgaria's actual readiness to transfer its MiGs. On the other hand, there is no way of assisting Ukraine in terms of Su-27 multi-role planes or Su-24 bombers. This leaves only the Su-25 support aircraft at Bulgaria's disposal, and its government may delay delivery as well if the transfer is not backed strongly by the U.S. Another solution could be to deliver obsolete Su-22M close air support planes from Poland. Its air force still has 12 of these aircraft and wants to replace them as early as mid-2023 with South Korean FA-50PLs.¹⁶⁰ This transfer would not necessarily create a gap in Poland's capabilities requiring additional NATO air presence.

Less complicated may be the issue of transferring post-Soviet Mil helicopters to Ukraine in the next year. These may be transferred in connection with the accelerated modernisation of helicopter fleets in Czechia, Poland, and Slovakia. Also worth considering are possible transfers of Mi-8/17 helicopters from Poland, which plans to replace their 21 with 32 new Leonardo AW149 helicopters in 2023-2029.¹⁶¹ Mi-8/17 helicopters continue to perform important tasks within Poland's special and airborne forces, and for the transport of VIPs. Potentially, the transfer of 28 Mi-24 attack and 25 Mi-2 light helicopters from Poland could also come into play. The decision to supply all these helicopters to Ukraine would probably be easier in the event of an increased rotation of U.S. ground and special operations forces helicopters in the

¹⁵⁸ "The Armed Forces of Ukraine Found Ways to Improve Airfields For the F-16: What Could Be the Problem," *Defense Express*, 28 July 2022. Contrary to some U.S. arguments and procedures, some NATO and Asian air forces are training on the use of highways in their F-16s.

¹⁵⁹ A. Mladenov, "Sofia Receives LOA for Eight More F-16 Block 70s," *Jane's Defence Weekly*, 25 July 2022.

¹⁶⁰ G. Jennings, J. Link-Lenczowski, "Update: Poland to Buy FA-50 Combat Aircraft from South Korea," *Jane's Defence Weekly*, 27 July 2022.

¹⁶¹ G. Jennings, "Poland Signs for AW149 Helicopters," *Jane's Defence Weekly*, 1 July 2022.

region. Bulgaria, Croatia, and non-NATO member Cyprus could be an additional source for a dozen or so used Mils.¹⁶²

The prospects of supplying Ukraine with NATO multirole planes are still very unclear. The jets from Europe suggested by the Pentagon would come in very limited numbers, as Sweden and Czechia are now in possession of some 100 Gripens. Both countries must maintain their capabilities given the situation in the region and the gaps in air defence of the Baltic States and Slovakia. In the case of Eurofighters and Rafales, only Germany and France may have reserves, limited to a dozen planes or so, but for both countries this would probably be too much of a risky move. It seems urgent for Ukraine and the U.S. to clarify the option of sending A-10s, which are available in larger numbers. Earlier comments from Ukraine may have been due to high losses of its Su-25s which are, however, a weaker plane than the A-10s and may also be necessary for counter-offensives. Given the scale of the threat to Ukraine, it makes no sense to postpone the delivery of multirole aircraft from the U.S. until after the war. As with other longer-range capabilities, this requires bilateral arrangements in terms of use, tasks, and weapon packages. There is urgency to complete the Biden administration's analysis as soon as possible and to launch a ZSU pilot-training programme in 2023. This is important in order to overcome a number of logistical challenges and the duration of training that would have to accompany the delivery of such planes. Certainly, the F-16C/Ds often cited by Ukraine exist in large numbers in the U.S. Air Force—550 in service and 335 in reserve.¹⁶³ Their introduction into Ukraine's fleet would facilitate the interoperability of its aviation with most NATO air forces and possible future military integration with the Alliance. Current users of the F-16 family along the Eastern Flank are Norway, Denmark, Poland, and Romania. A good interim solution is the delivery of used aircraft to Slovakia and Bulgaria. The transfer of "surplus" F-16s from the U.S. to Ukraine would not deplete NATO deterrence and defence capabilities, which are strengthened by the transition of many countries to the latest generation F-35 planes. In addition, the Alliance's capabilities will be enhanced by the addition of the Swedish and Finnish advanced forces.¹⁶⁴

UKRAINE'S DRONE AND LOITERING MUNITION CAPABILITY GAP

Capability Characteristics. Both sides have broad capabilities in the area of UAVs (drones) and loitering munitions. Variety and diversity of the systems makes it difficult to generalise about a gap, or rather several gaps. Drones are understood here as unmanned multi-role aerial craft of different classes (weight, size, and performance) and levels of technical advancement.¹⁶⁵ They are specially designed for different missions, mainly reconnaissance, electronic warfare, and kinetic support for other military capabilities. Loitering munitions include single-use designs, which, thanks to their small warhead, can strike selected targets, hence their popular nicknames: "suicide" or "kamikaze" drones. Both categories are broadened by improvised systems based on civilian drones, capable of reconnaissance tasks, as decoy

¹⁶² For details, see: J. Sabak, "Wymiana rosyjskich śmigłowców w europejskich armiach," *Defence24*, 19 July 2022.

¹⁶³ The remaining U.S. long-range multirole jets seem a less realistic option, but even there the number of F-15Es no longer in use in Europe amounts to 218 aircraft. In contrast, the U.S. Navy's F-18C/D fleet has 600 aircraft.

¹⁶⁴ The Finnish Air Force has a fleet of 62 multirole F-18s and an arsenal of AGM-158 JASSM air-to-ground missiles with a range of 370 km. The Polish F-16s are also a platform for JASSM missiles.

¹⁶⁵ Many criteria are used to classify drones, but according to NATO STANAG-4670, there are three classes: Class I (less than 150 kg) covering micro, mini and small drones; Class II (150-600 kg) covering tactical drones; and Class III (more than 600 kg) covering MALE (Medium Altitude Long Endurance), HALE (High Altitude Long Endurance) and heavy (armed) combat drones. See: T. Dmitruk, "Bezzałogowe statki powietrzne w Siłach Zbrojnych RP," *Nowa Technika Wojskowa*, no. 4, April 2022.

targets, or loitering munitions. After the collapse of the USSR, Russia, and Ukraine struggled to invest in unmanned planes. Russia began appreciating drones after the 2008 Georgian War, and Ukraine after the first battles in the Donetsk and Luhansk regions in 2014.¹⁶⁶ The intensity of fighting for Donbas in 2022 further increased the need for them. Russia's capability was weakened due to its rapid cut-off from Western technologies. On the Ukrainian side, capability improved due to an uninterrupted supply of military and civilian drones from the West. Both sides are also forced to use COTS-class systems, mainly from China. For both, the war began before many new drone programmes had time to be introduced. In Russia, this is the case with the armed and stealth S-70 Okhotnik heavy drone project, and in Ukraine for the RAM-II and ST-35 loitering munitions projects and PD-series drone production.

Both Sides' Potential. There is no data to assess the full capabilities of Russia and Ukraine in the area of drones and cruise munitions: such assessments are subject to even larger margins of error. *Military Balance* provides estimates only for larger MALE-class tactical and strike drones. It also does not give hard data for the Russian side, noting the unclear status of most of the Land Forces' and VKS systems. In the case of the former, these include Tu-243 and the lighter Pchela-1 reconnaissance drones and KUB-BLA loitering munitions, while its Air Force could include MALE Inokhodits-Orion and Forpost-R drones (a licensed version of the Israeli Searcher Mk. II). According to other sources, Russia may have had at least 46 Forposts, up to 30 Orions and an unknown number of Orlan-10 reconnaissance drones before the war. Russia also had a number of electronic warfare systems capable of jamming drone communications.¹⁶⁷ The IISS data on Ukraine also appears to be slightly outdated. In its estimate, Ukraine possessed only seven Turkish TB2 Bayraktar drones. Other sources assume that its ZSU Air Force and Navy may have had 12-16 TB2s, with 200 MAM laser-guided bombs. Ukraine's Land Forces possessed tactical reconnaissance drones—24, or as many as 72 U.S. RQ-11B Raven and an unknown number of the Polish FlyEye of the same class. In total, Ukraine may have had at least 300 of this class of drone before the war.¹⁶⁸ What is lacking, however, is any estimate of the number of loitering munitions and commercial micro/mini-drones equipping ground troops of both sides.

Analysis of the actual quantitative gap between Russia and Ukraine is complicated by the relative high losses of these systems since the outbreak of the war in February 2022. According to *Oryx*, Russia had lost 142 drones by 31 October, including six in the MALE class, and as many as 95 small Orlan-10s. In contrast, Ukraine's confirmed losses over the same period reached 47 systems, including 14 destroyed TB2s. This would give an overall kill ratio of 1:3 in favour of Ukraine, but in terms of MALE planes lost, it would be favourable for the Russians at 1:2.3. According to ZSU officers, small reconnaissance drones have a short lifespan on the battlefield—up to a week on average.¹⁶⁹ The destruction of Ukraine's industrial installations at the very beginning of the war made it impossible to replace losses with Ukrainian PD-2 reconnaissance drones under a production license for Warmate loitering munitions. Losses on Russia's side forced it to seek foreign replacements due to insufficient domestic production. U.S. authorities disclosed the fact that Russia was holding talks with China and Iran in

¹⁶⁶ See: R. Ciechanowski, "Rosyjskie bezałogowe statki powietrzne—stan obecny i perspektywy rozwoju," *Nowa Technika Wojskowa*, no. 6, June 2016.

¹⁶⁷ T. Ripley, S. O'Connor, "Russia Escalates Efforts to Catch up in the Global 'Drone Race,'" *Jane's Intelligence Review*, 26 February 2020, and J. B. Sunik, H. Williams, "Ukraine Conflict: Russian Battlefield EW Capabilities," *International Defence Review*, 1 March 2022.

¹⁶⁸ S. Roblin, "Russia's War in Ukraine," *Inside Unmanned Systems*, 30 June 2022, <https://insideunmannedsystems.com>, and W. Zabłockij, "Bayraktar TB2 w służbie Sił Zbrojnych Ukrainy," *Wojsko i Technika*, no. 1, January 2022.

¹⁶⁹ See: J. Watling, N. Reynolds, "Ukraine at War. Paving the Road from Survival to Victory," *RUSI Special Report*, 4 July 2022, p. 11.

March. Russia's negotiations with China likely involved speeding up earlier joint projects, as well as the need for electronic drone components.¹⁷⁰ According to U.S. intelligence, in the case of Iran, visits by military delegations from Russia concerned the delivery of "as many as 300 drones" within 1-2 months after the finalisation of talks. The Russians were interested in Iran's Shahed-129 and Shahed-191.¹⁷¹ Given Russia's relations with the two countries, options to replace its losses by deliveries of MALE drones modelled on the U.S. MQ-1A Predator and Israeli Hermes-450 (Shahed-129, CH-4, and Wing Loong-2) should be taken seriously. Iran was more willing than China to absorb additional U.S. sanctions. In mid-September, the use by Russia of the first batch of Iranian Shahed-136 kamikaze drones against ZSU forces near Kupyansk was confirmed. The smaller Shahed-131 was used en masse during strikes carried out in October against Odesa and Ukrainian critical infrastructure, especially in the Kyiv area.¹⁷² It was a different case with the supply of COTS drones manufactured by the Chinese company DJI Technologies. They have been used by both Russians and Ukrainians for years, and the demand for them grows as the war continues. At the same time, as early as the end of March, DJI Technologies announced that it would suspend sales of its drones to both countries.¹⁷³ In practice, this decision makes the supply of large numbers of Chinese commercial drones available in many markets to the two countries more difficult, but does not preclude it.

Doctrine and Tactics on Both Sides. The first phase of the war indicated a discrepancy between Russia's use of drones in practice and its theoretical concept of a "reconnaissance-strike complex". During the push for Kyiv, the landing at Hostomel and the artillery of the Land Forces made limited use of Orlan drones.¹⁷⁴ It cannot be ruled out that most artillery units from Russia's Asian military districts did not have any such drones at that time. Russia's drones had to contend with strong air defences, the coordination of ZSU and National Guard units, and already proven electronic warfare systems.¹⁷⁵ Russia also attempted to use its KUB-BLA loitering munitions in Kyiv in March. Several of these were damaged in flight and then recovered by Ukrainian forces, showing evidence of poor workmanship and faulty targeting.¹⁷⁶ During this phase, the Russian command apparently disregarded the TB2 drones, which effectively attacked lengthy columns and supply lines. They became one of the symbols of the Ukrainian resistance, and the ZSU command skilfully used videos of Bayraktars in action to boost even more the already high Ukrainian morale (it even became the subject of a hit song). They helped as decoys for defence systems during the strike on the cruiser *Moskva* and inflicted high losses on Russia during its attempts to resupply troops on Snake Island. In April-May, the Bayraktars used glide bombs to destroy, among other targets, four Raptor-class

¹⁷⁰ K. Hille, "Russia Asks China for Weapons in Reversal of Roles: Arms Supplies," *Financial Times*, 31 March 2022, and E. Wong, J. E. Barnes, "Russia Asked China for Combat Aid, U.S. Officials Say," *The New York Times*, 14 March 2022.

¹⁷¹ See: J. Warrick, A. B. Wang, "Iran Will Send Hundreds of Drones to Russia for Use in War, U.S. Says," *The Washington Post*, 12 July 2022; and E. Schmitt *et al.*, "As Russia Runs Low on Drones, Iran Plans to Step In, U.S. Officials Say," *The New York Times*, 17 July 2022.

¹⁷² The *Intelligence Update* post on the account of the British Defence Ministry of 14 September 2022: <https://twitter.com/DefenceHQ>. For more details, see: M.A. Piotrowski, "Iran Assists Russia with Weapons – the Military and Political Consequences," *PISM Bulletin*, no. 171 (2590), 4 November 2022.

¹⁷³ Ch. Shepherd, "Chinese Drone-Maker Suspends Operations in Russia and Ukraine," *The Washington Post*, 28 April 2022.

¹⁷⁴ See: L. W. Grau, Ch. K. Bartles, *op. cit.*, pp. 372-374.

¹⁷⁵ See the interview with the commander of the Ukrainian National Guard drone unit, J. Palowski, "Jak drony bronia Ukrainy?," *Defence24*, 22 June 2022.

¹⁷⁶ G. De Wynck, P. Verma, "Exploding 'Kamikaze' Drones Usher In Autonomous Era of Modern Warfare," *The Washington Post*, 26 March 2022.

boats on the island or near it, the landing ship *Sarna*, a Mi-8 helicopter, and several air defence systems.¹⁷⁷

During the fighting for Donbas, Russia used reconnaissance and combat drones more effectively. Both sides published drone videos as part of their information campaigns. By July, however, the number of videos illustrating effective TB2 strikes had diminished, probably as a result of the high number lost. Nevertheless, Bayraktars systematically harassed Russian forces on Snake Island. Surprising to the Russians was also an explosive-filled drone attack carried out in June against an oil refinery in Novoshakhtinsk in the Rostov district of Russia (150 km from the front).¹⁷⁸ On the other hand, Russia used Orlan drones extensively to direct the fire of its artillery in the Donbas region. They reduced the time from target detection to destruction to under a few minutes. On the same front and in a similar fashion, Ukraine used Polish FlyEye drones integrated with Krab howitzers as target guidance.¹⁷⁹ The ZSU also made extensive use of civilian drones or new reconnaissance drones from NATO countries. Even more important was the *Aerorazvidka* volunteer unit, which worked with Ukraine's intelligence and Special Forces during the defence of Kyiv. In Donbas, it conducted strikes using COTS drones armed with grenades and mortar shells, harassing the positions of Russian soldiers and eliminating their more lightly armoured vehicles.¹⁸⁰ During this phase of the fighting, Ukraine began making more extensive use of U.S. loitering munitions. Photos of their use were apparently subject to an information embargo, and it is difficult to confirm the models visible on a single video released in July. Perhaps the same reasons prevented documenting the strikes with Polish Warmates, although they were publicly praised by Ukraine's defence minister.¹⁸¹ June also saw the first Russian media reports about the use of new Lancet-3 loitering munitions. However, Russian means of electronic warfare remained a problem for Ukraine's drone and loitering munitions. At this stage, both sides were also using point defence systems, as well as counter-drone units.

Eastern Options. Due to the technological backwardness of Soviet drones, it makes no sense for Ukraine to use them. The rational use of Tu-141 Strizh and Tu-143 Reys drones is limited to confusing Russia's air defence during Ukraine's missile or air strikes, or as an improvised "flying bomb" with an explosive load. As the incident with the crashed Tu-141 near Zagreb showed, their continued use is a risk for Ukraine and for NATO partners.¹⁸²

STANAG Options. Despite the West's industrial potential, supplies to Ukraine so far have been limited to drones and loitering munitions from a few NATO countries. Earlier cooperation between Ukraine and Turkey, the U.S. and Poland continued, expanding to include more countries as the war unfolded. Against the backdrop of the losses and the ambiguous attitude of the Turkish authorities, the TB2 drone manufacturer honoured its earlier commitments to Ukraine. In March, an unknown number of tactical Mini-Bayraktar reconnaissance drones

¹⁷⁷ For more about the cooperation between the Ukrainian Air Force's TB2s with the Ukrainian military intelligence, see: M. Tucker, "The Ukrainian Drone Pilots Out to Halt Putin's War Machine," *The Times*, 6 July 2022.

¹⁷⁸ D. Hambling, "Ukrainian Kamikaze Drone Strike Sets Russian Oil Facility Ablaze (Updated – Attack Drone May Have Been Made In China)," *Forbes*, 22 June 2022.

¹⁷⁹ Besides Ukrainian artillery, FlyEye drones were also used by Ukraine's Security Services. "'Stealth Aircraft' Helps the Ukrainian Armed Forces Destroy Enemy's 'Tor' Air Defense Systems and Other Equipment," *Defense Express*, 26 June 2022.

¹⁸⁰ About the establishment of the unit, see: J. Borger, "The Drone Operators Who Halted Russian Convoy Headed for Kyiv," *The Guardian*, 28 March 2022.

¹⁸¹ A. Kielar, "Ukraiński minister obrony Oleksij Reznikow chwali polskie systemy Piorun oraz Warmate," *Polska Times*, 16 May 2022, <https://polskatimes.pl>.

¹⁸² For details of the incident, see: G. Jennings, "Ukraine Conflict: UAV Crosses NATO Airspace Before Crashing in Croatia," *Jane's Defence Weekly*, 11 March 2022.

supposedly arrived in Ukraine. Most likely, another batch of Bayraktar TB2s was delivered to the ZSU before the outbreak of war, and by August a total of about 20 of these systems had been delivered. Turkish authorities stuck to a policy of not commenting on the number of TB2s delivered, but their manufacturer agreed to supply 4-5 drones from funding organised by Ukrainian, Lithuanian, and Polish NGOs. In August, Turkey and Ukraine confirmed at the same time that work had begun on building a factory to produce TB2s under license at an undisclosed location in Ukraine.¹⁸³ In light of this, it was important to maintain the supply of electronics for TB2s from Canada and the U.S., paid for by their governments. Polish sources, on the other hand, confirmed continued deliveries of FlyEye drones and Warmate loitering munitions systems, without indicating the number of such systems transferred to Ukraine. In April-May it also received 25 small Heidrun reconnaissance drones (with a range of up to 30 km) purchased by the Danish authorities, allowing for reconnaissance of targets and digital mapping of combat areas. In August, the Norwegian and UK governments announced the delivery of as many as 850 Black Hornet reconnaissance nano-drones, which are very useful for Special Operations Forces and in urban terrain settings (they weigh 33 grams).¹⁸⁴ In addition, drone deliveries have been pledged by Australia, Germany, and the UK without, however, specifying the types or planned delivery dates.

Supply of U.S. reconnaissance drone systems primarily from the AeroVironment Corporation continued. The Pentagon purchased more small drones from the company for Ukraine's artillery and Special Operations Forces—the RQ-11, which they were already familiar with, and the newer RQ-20 Puma. It is also known that about 100 new Quantix Recon drones are to be delivered, although this was an initiative by the manufacturer, not Pentagon-funded.¹⁸⁵ Despite leaks about Ukraine's talks with the U.S., the option to purchase armed MALE drones has not been confirmed. They supposedly focused on the MQ-1C Gray Eagle systems or the even better-armed and longer-range MQ-9 Reaper. Both offer Ukraine better strike capabilities than the TB2. Bayraktar carries only 55 kg of underslung ordnance, the MQ-1C carries as much as 1.45 tons with several armament options (four Hellfire missiles/GBU-44 Viper Strike glide bombs or eight Stinger missiles, or combinations of both). However, this would entail many times higher costs (a Bayraktar costs \$2 million, a Reaper \$32 million), as well as lengthy training for operators (about a year). It seems the Biden administration considered both options escalatory at this stage. The decision to deliver Grey Eagles may have been hindered by concerns about losing the latest technology amid Russia's strong air defence.¹⁸⁶ In addition, it should be noted that previous U.S. administrations have been very cautious with MALE transfers to their allies, guided by limits on exports of cruise missiles and drones with a range of more than 300 km and a payload capacity of up to 500 kg (of warhead or external ordnance). Even the lightest Gray Eagle can be counted as Category I equipment under the MTCR regime, which also includes drones and guided missiles, although it was intended to control mainly missile technology. The U.S. allows transfers of missiles and drones in this

¹⁸³ See: G. Jennings, "Ukraine Conflict: Turkey Airlifts Additional TB2 UCAVs to Ukraine," *Jane's Defence Weekly*, 2 March 2022; *idem*, "Ukraine Conflict: Baykar to Donate Further TB2 UCAVs to Kyiv," *Jane's Defence Weekly*, 28 June 2022; and "Bayraktar Drone Factory to be Built in Ukraine," *Kyiv Post*, 9 August 2022, www.kyivpost.com.

¹⁸⁴ M. L. Heiberg, "Regeringen har købt 25 droner i Nordjylland til brug i Ukraine," *TV2 Nord*, 7 April 2022, www.tv2nord.dk, and A. Chuter, "New British Aid package for Ukraine Includes Micro-Drones," *Defense News*, 24 August 2022.

¹⁸⁵ G. Jennings, "Ukraine Conflict: AeroVironment to Donate UASs to Ukraine," *Jane's Defence Weekly*, 20 April 2022.

¹⁸⁶ See: M. Peck, "Ukraine May Get U.S. MQ-9 Reaper Strike Drones," *Forbes*, 13 April 2022; G. Jennings, "Ukraine Conflict: US to Provide Grey Eagle UAVs to Kyiv," *Jane's Defence Weekly*, 6 June 2022; and V. Insinna, "US-Made Jets, Air Defense on Ukrainian Fighter Pilots' Wishlist, But Not Grey Eagle," *Breaking Defense*, 22 June 2022, <https://breakingdefense.com>.

category to NATO allies, but has refused to supply Predator and Reaper drones to Saudi Arabia, Iraq, Pakistan, and the United Arab Emirates.¹⁸⁷

The U.S. launched significant deliveries of loitering munitions for Ukraine, which reached 800-820 systems by August. In April-June there were about 600 light Switchblade-300 systems (hand grenade explosive power, range 10 km), supplemented in August by about 100 heavier Switchblade-600 systems with the Javelin ATGM warhead (range up to 40 km). In April, the U.S. announced the delivery of 121 systems, and in August a total of “about 700” of the short-range, secretly developed Phoenix Ghost loitering munition.¹⁸⁸ During the initial deliveries from the U.S., however, there were suggestions in social media about problems with the operation of the Switchblade-300 by ZSU personnel, a system otherwise tested by the Americans in Afghanistan and Syria. It is impossible to verify these opinions and resolve whether the problems stemmed from inadequate training of operators or by Russian electronic and counter-drone means. Electronic warfare systems from the U.S. and UK were also helpful to Ukraine in the fighting in Donbas, but details about them remain unavailable.

Asymmetric Options. Ukraine uses COTS systems, with a clear preference for DJI drones like the Mavic Mini and Phantom. Their advantages are low cost, simple operation, and cameras that provide situational awareness. Disadvantages include a lack of secure communications and vulnerability to enemy fire. Their market availability and the low cost encourage the organisation of numerous fundraisers or individual purchases. As of May, at least 2,500 DJI drones were donated to the ZSU thanks to fundraisers in Finland, the Netherlands, and Ukraine.¹⁸⁹ However, these are still only substitutes for military reconnaissance drones. The COTS class is also the basis for numerous modifications by *Aerorazvidka* experts, yielding simple “bombing systems” or kamikaze drones. Systems improvised in this way are equipped with anti-tank grenades, grenade launcher and mortar shells.¹⁹⁰ The announced Revolver 860 drones from Taiwan with a few mortar shells on board, are similarly intended to harass the Russians with a few mortar shells on board. Commercial or improvised drones will probably continue to be used by ZSU soldiers, but one should be aware of their disadvantages compared to military systems. This is because *Aerorazvidka*’s designs and the Switchblade-300 systems provide too little explosive power that pales in comparison to light artillery. Their high accuracy may guarantee destruction of selected targets, but they will not affect the frontline situation. What’s far more needed is funding for counter-drone equipment, such as money collected by a Lithuanian journalist for 110 Sky Wiper jamming systems.¹⁹¹ This capability should be provided to Ukraine in the form of proven military systems guaranteed by the governments of its partners.

Prospects. Russia’s war with Ukraine has seen intensive use of reconnaissance and combat drones, as well as commercial and improvised systems. These complement or support Ukraine’s other capabilities. The electronic warfare, air defence, and counter-UAV systems used on both sides have taken high losses, requiring constant replacement. As it seems, Ukraine can offset

¹⁸⁷ All the countries mentioned received MALE drones from China.

¹⁸⁸ See: “Phoenix Ghost Drone Will Have Similarities With AeroVironment’s Switchblade,” *Air Force Technology*, 12 May 2022, www.airforce-technology.com; A. Roque, “Ukraine Conflict: Pentagon Sending New ‘Suicide’ Drone, Additional Artillery to Ukraine,” *Jane’s Defence Weekly*, 22 April 2022; and “Fact Sheet on U.S. Security Assistance to Ukraine,” Department of Defense, 24 August 2022.

¹⁸⁹ S. Roblin, *op. cit.*

¹⁹⁰ See: “How Ukraine Uses Obsolete Soviet Grenades To Destroy Russian Tanks From Above,” *Radio Free Europe/Radio Liberty*, 5 May 2022; Ch. Parker, “Specialist Ukrainian Drone Unit Picks off Invading Russian Forces as they Sleep,” *The Times*, 18 March 2022, and M. Tucker, *op. cit.*

¹⁹¹ The collection happened on the initiative of Andrius Tapinas, www.facebook.com/andrius.tapinas.

Russia's quantitative advantage with access to military and COTS systems from the West. However, Ukraine will need to expand assistance to include air defence and counter-drone systems, especially in the event of Iranian and Chinese drone deliveries to Russia. In that case, the West's response should also be technological sanctions against China and Iran.

The relatively positive trends for Ukraine cannot be sustained by non-government sourcing so more support from NATO countries will be needed. In terms of MALE drones, the gap between Ukraine and Russia can be bridged, if supplies of the combat proven TB2 from Turkey are maintained. However, it will be difficult to meet Ukraine's expectations and allocate all of its production to it. The Baykar corporation has already delivered up to 40-50 such drones to Ukraine in less than two years. It would be necessary to increase the level of TB2 production or arrange for its licensed production in Ukraine. This solution is also needed because of Turkey's signed contracts with Poland (24 systems by the end of 2024) and several non-European countries.¹⁹² Further analysis and lobbying by Ukraine shows that it also requires combat drone options with higher performance. In this regard, no alternatives to U.S. drones are in sight. Currently, only the U.S. has a sufficiently large fleet of HALE-class—about 200 MQ-1Cs and more than 200 MQ-9s.¹⁹³ If the security of the technology and equipment of both types of drones is at stake, it would be advisable to tap into the still-existing U.S. reserve of some 200 MQ-1A Predators, which are older and already out of service. According to their producer, they require only 4-5 weeks of basic training for operators.¹⁹⁴

A potential gap in Ukraine's capabilities may be the lack among its current NATO partners of specialised loitering munitions like Israel's Harop and Harpy systems, capable of eliminating Russia's radar and electronic warfare equipment (although the Phoenix Ghost may be capable of this).¹⁹⁵ Ukraine will need to maintain a continuous and uninterrupted supply of tactical reconnaissance drones in *STANAG options*. Continued deliveries of RQ-11, RQ-20, ScanEagle, and FlyEye drones produced in large quantities for NATO countries may also be feasible. In the event of a prolonged conflict, it also may be necessary to relocate Ukraine's drone production lines to other countries. Increased production of heavier loitering munitions like the Switchblade-600 may also be needed. The current surge in Poland and Romania of NATO reconnaissance aircraft and MQ-9 drones also fills a gap in such capabilities of the Allies. Moreover, many of their needs are met by U.S. satellite intelligence.

UKRAINE'S AIR DEFENCE CAPABILITY GAP

Capability Characteristics. Ukraine inherited an extensive ground-based air defence network from the USSR, but after three decades of independence it is obsolete. The deployment of the ZSU's early warning and guidance radars was not reflecting Russian threats. This became evident with the redeployment of additional VKS and Black Sea Fleet forces to Crimea after 2014. The threat to Ukraine was also growing from the direction of Belarus with the increasing redeployment of VKS forces to its airfields and repeated Iskander exercises on its territory. A new aspect of Ukraine's defence has been Russia's use of drones in Donetsk and Lugansk in recent years. Elements of both sides have air defences are similarly organized. Its

¹⁹² L. Saribahimoglu, "Ukraine Conflict: Baykar to Commit Entire Bayraktar Production to Ukraine," *Jane's Defence Weekly*, 30 June 2022.

¹⁹³ According to *Military Balance 2022*, the following European NATO countries have MQ-9 drones: Greece has 3, the Netherlands 4, France 8, Italy 6 (it also has 4 RQ-1B Predator drones), and the UK 10.

¹⁹⁴ L. Seligman, P. McLeary, "Armed Drones for Ukraine? Not so Fast," *Politico*, 14 June 2022, US edition, www.politico.com.

¹⁹⁵ In November, the Pentagon announced a plan to purchase from industry and transfer to Ukraine an additional 1,100 Phoenix Ghost systems, which seems to be realistic for the first half of 2023.

strategic and operational levels report to the air force, which still has an interceptor fighter fleet. In both countries, the tactical level of defence is subordinated to their ground troops. In Russia, the last decade has seen a deeper modernisation of air defence capabilities at all levels, while in Ukraine, it has been a gradual degradation. Russia's VKS has upgraded its S-300PS/PM systems with missiles with a range of 250 km and introduced the new S-400 Triumf system with a range of up to 400 km (with an altitude to 25,000 and 30,000 m, respectively). Russia's army has been outfitted with new Pantsir-S1 point defence systems, also receiving newer versions of the Osa, Tor, and Buk families of systems (with ranges of up to 10, 14, and 25-32 km, respectively, and an altitude to 20,000 m). With these, Russia has a multi-layered air defence, enhanced by missile defence capabilities of upgraded S-300V4 systems and specialised missiles for S-300PS/PM launchers. Development work on a newer generation of air defence in Russia was also being completed. Already during the war, the VKS had put into service 3-5 S-350 Vitazh tactical systems (with a range of 120 km and an altitude to 25,000 m), and from 2025, planned deliveries of the strategic S-500 Promethei (with a range of 500 km and an altitude to 35,000 m).¹⁹⁶ Ukraine could not afford such a costly generational leap, relying on the S-300PS/PT and S-300V systems, as well as the obsolete S-125, which returned to service. Ukraine's relatively new systems were actually limited to the 9K37 Buk. The ZSU Land Forces also had mobile 9K331 Tor systems for defence of selected units, and various variants of Osa, Strela, and Igla point defences (with ranges of 3.5-8 km and altitude to 4,000-6,000 m). Ukraine planned to withdraw and replace most of the post-Soviet systems in 2025-2035 by purchasing replacements in the West, such as 36-40 NASAMS systems and 9-12 SAMP-T or Patriot PAC systems.¹⁹⁷ Of course, those plans have not gone beyond the study phase.

Both Sides' Potential. The majority (up to 60%) of the VKS's air defence forces are concentrated in western Russia, i.e., in Ukraine's neighbourhood. According to *Military Balance*, Russia had more than 2,000 air defence systems before the war. There were 584 S-300PM/PS and S-400 Triumf family systems in VKS units, additionally covered by 50 Pantsir-S and 80 Buk-1M systems. Russia's Land Forces had as many as 1,520 anti-aircraft systems, including 370 tactical Buk and Tor-M, an unknown number of S-300V/V4 anti-missile systems, and more than 1,000 mobile or handheld launchers for point defence (Tunguska, Osa, Strela, and Igla). Assuming that Russia's Land Forces assembled 130-150 battalion tactical groups, they could have had as many as 700-800 Pantsir, Osa, or Strela-10M mobile air defence systems, with the quantity of support from ZSU-23 Shilka cannons or MANPADS hard to estimate. Russia could benefit from enhanced defences against Ukrainian aircraft and drones, with additional support from S-400 long-range systems in Russia, Crimea, and Belarus. In contrast, Ukraine's pre-war air defence was based on some 250 S-300 systems, 72 Buk-M1 systems, and an unknown number of S-125s.¹⁹⁸ The IISS estimated that the ZSU ground forces had "several" S-300V systems, six Tor-M systems, and more than 75 different point defence systems (Osa-AKM, Tunguska, and Strela-10M). Slightly higher estimates were presented by Polish experts (without data for the S-300), according to which the Ukrainian army had six Tor-M systems, 75 Tunguska systems, about 100 Osa-AKM and more than 150 mobile Strela-10M, supplemented by an unknown number of Igla and Stinger MANPADS.¹⁹⁹ *Jane's* estimated

¹⁹⁶ For a good introduction to the modernisation and air-defence capabilities of the VKS, see J. Bonk, "Modern Russian and Chinese Integrated Air Defence Systems. The Nature of the Threat, Growth Trajectory and Western Options," *RUSI Occasional Paper*, January 2020; and the IHS profile "Russian Federation—Air Forces," *Jane's World Air Forces*, 20 June 2022.

¹⁹⁷ Air Force Command of the Armed Forces of Ukraine, *op. cit.*, pp. 28-29.

¹⁹⁸ IISS estimates for the number of Ukrainian S-300P family launchers could have been inflated and included those in reserve.

¹⁹⁹ J. Fiszer, J. Gruszczyński, *op. cit.*

that Ukraine's military received at least 1,200 Igla/Strela-family point defence systems since 1991.²⁰⁰ The latter, however, along with Western Stinger MANPADS, will play an important role in defence, perhaps even comparable to longer-range systems.

Comparisons between Ukraine's and Russia's air defence losses can be misleading. While the latter primarily lost point defence systems, Ukraine mainly lost S-300 systems—equipment of strategic importance. According to *Oryx*, on the Russian side it was 78 different air defence systems and 16 radars; on the Ukrainian side, it was 54 systems and 31 radars. Overall, this gave a kill ratio in air defence systems favouring Ukraine (1:1.4), but in radars it favours Russia (1:1.9). More meaningful for analysis would be data on the number of lost airplanes shot down by ground-based air defence systems and air-to-air missiles. However, it is impossible to verify these proportions based on residual information. Likewise, the proportion of aircraft shot down on both sides by their own defences is unknown and such cases were not incidental. Only speculatively can one estimate the available reserves of anti-aircraft missiles (interceptors). Despite their cost, Russia regularly uses them to attack ground targets, which suggests that it still has large reserves. Analogous resources are not available to the ZSU, which is why videos have appeared about bringing back into service S-125 missiles previously meant to be decommissioned.

Doctrine and Tactics on Both Sides. In the military theory of the Soviet Union, extensive ground-based air defences were meant to offset the enemy's expected air superiority.²⁰¹ These assumptions are still present in Russian and Ukrainian military thinking. The beginning of the war was undoubtedly the most difficult time for Ukraine's air defence. The deployment of its systems around strategic centres and to counter expected directions of VKS air strikes, combined with a high level of readiness, made survival possible and gave it a significant share of Russian losses. It was during this period, however, that Ukraine may have lost most of its air defence radars and S-300 and Buk systems. Despite this, it forced VKS pilots to operate at low altitude for fear of being shot down by both systems. In turn, such tactics by Russian planes and helicopters exposed them to the effective point defence systems of the Ukrainians. In addition to the failure of the helicopter assault at Kyiv's Hostomel airport, Russia conducted several more costly airborne and helicopter assault attempts. On 26 February, ZSU defences shot down two Russian Il-76 transport aircraft during an attempted landing at Vasilkovo airfield, arguably derailing a much larger operation. In early March, VKS losses were also compounded by at least two attempted helicopter assaults in the Nikolaev area, foiled by Ukrainian air defence units. On both sides, Su-25 aircraft used for close support remained the most frequent victims of MANPADS systems, while losses in attack helicopters also steadily increased on the Russian side.²⁰² As for Russia's armoured columns near Kyiv, they lacked sufficient cover from mobile air defence systems, probably due to the assumption that Ukraine's aviation would be rapidly eliminated during the first wave of Russian strikes. Russia's mobile air defence units were observed more frequently only from mid-April, mainly in Donbas. Defence against enemy drones also increased on both sides from April on. Also from April, Russian air defence began inflicting heavy losses on Ukrainian TB2 drones. With the growing threat of MANPADS systems, Russian and Ukrainian helicopters adopted a new tactic of firing unguided rockets at ground targets from a greater distance.²⁰³

²⁰⁰ IHS, "Ukraine—Army," *Jane's World Armies*, 9 August 2022.

²⁰¹ See: L. W. Grau, Ch. K. Bartles, *op. cit.*, pp. 266-271.

²⁰² See the previous sections on missile, aviation and drone capabilities, and M. Strembski, "Wojna powietrzna nad Ukrainą 24 lutego—23 marca 2022," *Lotnictwo*, no. 3, March 2022.

²⁰³ J. Cieślak, "Armia rosyjska—armia agresora: Obrona przeciwlotnicza wojsk lądowych [raport]," *Defence24*, 15 July 2022.

Gaps in missile defences on both sides were also observed from April to May. An illustration of Russia's problems was the loss of its cruiser *Moskva*, which was equipped with S-300 naval equivalents. In turn, Ukraine's defences quite often reported interceptions of Russia's low-speed cruise missiles by ground-based systems or fighter aircraft. Ukraine had a limited capability to intercept Iskander or Tochka ballistic missiles. It could succeed only in cases of less intense Russian salvos and the use of the few S-300V missile defence systems it still had. In May, Ukraine lost another dozen S-300 and Osa-AKM launchers. The Ukrainians were also helpless in the face of Russian missile strikes on longer-range targets in the west of the country.²⁰⁴ Despite several successful helicopter and drone raids in the Belgorod region, however, Russia's air defence deterred Ukraine from retaliatory raids. Russia continued its rocket fire and bombardment of Kharkiv, where Ukraine's air defence systems were in short supply. In addition, ZSU aircraft in this area risked finding themselves within range of Russian S-400s. More frequent reports of successful cruise missile interceptions can be found in the Odesa area, where Ukraine's reinforced defences still operated²⁰⁵ Both sides struggled with the lack of defence of their troops against heavy artillery rockets. The result was high losses of Ukrainian forces from Uragan and Grad rockets, and very high Russian losses after GMLRS rockets were used in battle. Russian S-300V4 ballistic missile defence units have been seen in Donbas on several occasions, but it is difficult to confirm their effectiveness against Ukrainian GMLRS or Tochkas. The scale of Russia's August tactical bomber losses in Saki Air Base brought the rapid deployment of the few S-350 systems to protect the remaining airfields in southern Russia and occupied Crimea.²⁰⁶ As with previous raids, the kamikaze drone strike on the headquarters of the Black Sea Fleet in Sevastopol (20 August) raised questions about the effectiveness of Russia's extensive air defence.

Eastern Options. Ukraine's air defence capabilities gap has been a priority for its partners since the beginning of the war.²⁰⁷ Given the long range of the S-300 systems, opportunities were sought to replace its destroyed launchers and missiles. The options were limited to a single S-300PMU system in the U.S. (bought from Belarus in 1994), one battery of "several" launchers from Slovakia, and eight possessed by Bulgaria. The only country with more was Cyprus with 12 such systems, but this option was unrealistic. In mid-March, declarations about the delivery of S-300s were made by Slovakia, which handed them over to Ukraine a month later after having first deployed NATO Patriot systems.²⁰⁸ Slovakia's transfer was not met with any reaction from Russia, and the S-300s were seen as a defensive system among UDCG countries and a good alternative to the idea of a "no-fly zone" over Ukraine. By April, post-Soviet shorter-range systems, or at least missiles for them, were also possibly delivered to Ukraine. Missile deliveries of older Osa, Kub, and Tor units could still have been considered, although there is no confirmation from countries that have some, like Greece, Bulgaria, Poland, Romania, and Slovakia.²⁰⁹

²⁰⁴ M. Strembski, "Wojna powietrzna nad Ukrainą 24 maja—23 czerwca 2022," *Lotnictwo*, no. 6, June 2022.

²⁰⁵ For example, see the post by Sergey Bratchuk of the Odesa local government on the *Telegram* channel, 21 August 2022, https://t.me/Bratchuk_Sergey/17394.

²⁰⁶ A. Świerkowski, "Rosja: nowa generacja obrony przeciwlotniczej," *Defence24*, 18 August 2022.

²⁰⁷ J. E. Barnes, J. Ismay, "Bolstering Ukraine With Arms That Are Easy to Carry and Simple to Use," *The New York Times*, 17 March 2022.

²⁰⁸ A. Higgins, "Hiding in Plain Sight, a Soviet-Era Air Defense System Arrives in Ukraine," *The New York Times*, 14 April 2022.

²⁰⁹ See: N. A. Youssef, M. R. Gordon, "U.S. Sends Soviet Air Defense to Ukraine," *The Wall Street Journal*, 22 March 2022, and A. Higgins, "Soviet-Era Missiles Now Guard Ukraine's Skies," *The New York Times*, 15 April 2022.

Also since March, deliveries to Ukraine of Soviet-made point defence systems have been confirmed. Czechia, in March or April at the latest, handed over six of its Strela-10M mobile units.²¹⁰ This was important because of the availability of missiles for this system, used in several NATO countries as portable systems. In the latter case, there was still considerable availability of post-Soviet MANPADS systems. Confirmed deliveries of even up to 2,700 units of various versions of Strela missiles were made in April-May by Germany.²¹¹ According to social media, however, some of the German Strelas may not have been usable. Both models of the Strela may also have been supplied on a small scale by Balkan countries, such as Bosnia and Herzegovina, Croatia and North Macedonia. It is reasonable to speculate that Soviet MANPADS, or Egyptian and Chinese copies, may have been easily transferred to Ukraine from arms smuggling thwarted by the U.S. or from the reserves of its Middle Eastern allies.²¹² These systems, along with Western MANPADS, had a positive impact on Ukraine's defence and inflicted high losses on Russia despite their very short range. Providing ammunition for Ukraine's ZSU-23-2 or ZSU-23-4 Shylka cannons, manufactured or stockpiled in Central Europe, also may not have been problematic.

STANAG Options. Ukraine's partners launched significant deliveries of MANPADS systems just before the war. Ukraine received the first FIM-92 Stinger systems—simple to use and tested in several conflicts. The U.S. missiles have a range of up to 4.5 km and an altitude to 3,800 m. Lithuania, Latvia, and Italy transferred their units of this type before the invasion. In addition to the U.S., Stinger deliveries have been made by Denmark, the Netherlands (200), and Germany (500). In total, by May the ZSU could have had at least 2,100-2,300 Stinger missiles.²¹³ 100 French Mistral missiles, equipment of the same class, were supplied by Norway.²¹⁴ Mistrals were also supplied by France, although confirmed information on their quantity is lacking. Ukraine then also obtained British Starstreak missiles, first in the MANPADS version and later in the Stormer vehicle-mounted version. This missile has a range of up to 5.5 km, an altitude to 7,000 m, and is resistant to Russia's jamming measures. The first use of Starstreak by Ukraine took place in early April.²¹⁵ Poland was also an important source of MANPADS, producing Piorun missiles that are more advanced than the Soviet ones with a range of 6 km and an altitude to 4,000 m. Although there is already abundant documentation of the use of the Pioruns, the Polish authorities adhered to the principle of non-disclosure of their quantity with this system. The result of Western MANPADS deliveries was point defence equipment extensive used by Ukraine's forces to counter the Russian VKS.²¹⁶

Plans to supply Ukraine with NATO advanced medium-range air defence systems were more challenging. In May, Ukraine's unofficial expectations were as high as 50 NASAMS launchers.²¹⁷ During this time, Ukraine's calls for supplies of a Patriot-type air and missile defence system were ignored. Barriers to this option were issues of integration with Ukraine's command and radar network, as well as the long training period for operators. The lack of a positive decision

²¹⁰ J. Lopatka, "Czech Ship Tanks, Rocket Launchers, Artillery to Ukraine," *Reuters*, 8 April 2022.

²¹¹ "Military support for Ukraine," German Federal Government, Berlin, 26 October 2022, www.bundesregierung.de.

²¹² N. A. Youssef, M. R. Gordon, *op. cit.*

²¹³ On the basis of IHS *Jane's* compilation, "Ukraine Conflict: Military Assistance to Ukraine," 6 July 2022 version.

²¹⁴ "Norway Provides an Air defense system to Ukraine," Norwegian Ministry of Defence, 20 April 2022, www.regjeringen.no.

²¹⁵ See: N. Fiorenza, "Ukraine Conflict: UK Considers Supplying Starstreak to Ukraine," *Jane's Defence Weekly*, 10 March 2022, and Ch. Parker, L. Brown, "UK Missile Shoots Down First," *The Times*, 1 April 2022.

²¹⁶ P. Felstead, "MANPADS Threat Blunts Effectiveness of Russian Helicopter Attacks," *Jane's Defence Weekly*, 18 March 2022.

²¹⁷ "Weapons List," *Save UA List*, a printout of the 4 May 2022 version of that site, although this figure had already been removed from the site as of 26 August 2022, <https://saveualist.com>.

by the U.S. on Patriots and by France and Italy on SAMP-T systems creates the risk of a lack of air and missile defence for Ukraine once the missiles for the Soviet S-300 launchers are exhausted. The U.S. and Norway have agreed to supply jointly-produced NASAMS, although not in the quantities Ukraine suggested. The system has the ability to intercept aircraft and cruise missiles at distances of up to 18 km and an altitude to 20,000 m. Norway declared its readiness to transfer two NASAMS batteries to Ukraine in April, but the Pentagon confirmed delivery of the AIM-120 AMRAAM missiles needed for them in early August. Once the crews have been trained, their first two units were integrated with Ukraine's defence at the end of the year.²¹⁸ In the case of this system, its ability to defend a larger area and the broad availability of the AIM-120 missiles used in it are important. At the end of August, the Biden administration announced a plan to deliver six more, and brand new NASAMS with an unspecified number of missiles.²¹⁹ The IRIS-T system, the delivery of which Germany announced in early June, will be a comparable to NASAMS reinforcement of Ukraine's defences. The mobile IRIS-T has a range of up to 25 km and an altitude to 20,000 m. However, delivery of a second IRIS-T after the training of operators is not expected earlier than in December 2022. In addition, Germany will hand over three more IRIS-T launchers, still a smaller number than the 10 requested by Ukraine.²²⁰ Spain's announcement that it would deliver the first Aspide short-range system was also confirmed in August. It is based on AIM-7E Sparrow missiles with a range of 15 km and an altitude to 6,000 m. Given that Aspide has been withdrawn from service, this increases the chances of transferring all 10-13 from Spain.²²¹

In the same month, Germany delivered to Ukraine the first batch of 15 self-propelled 35 mm Flakpanzer Gepard anti-aircraft guns and then announced in April that it would send a total of 30 systems: the system is highly effective at ranges of up to 3.5 km and an altitude of 3,500 m. The barrier to a quick handover to Ukraine was unlikely to be operator training, as the system is highly automated and has a radar with a range of up to 15 km. However, the realisation of the Gepard delivery was slowed down by the Bundeswehr's small stockpile of 35 mm ammunition and the Swiss manufacturer's refusal to supply more.²²²

Asymmetric Options. There is a lack of good alternatives or substitutes for the gaps in Ukraine's air defence. However, UDCG countries can significantly strengthen Ukraine's existing air defence network with supplies of electronic and counter-drone warfare systems. In addition, it will be important to augment Ukraine's anti-radar capabilities with HARM missiles or specialised loitering munitions, which would in turn neutralise Russian air defence against Ukrainian drones.

Prospects. As with many of Ukraine's other capabilities, the resistance and effectiveness of its air defence exceeded the expectations of all experts. It suffered heavy losses to its S-300 systems and radar network. Ukraine's ability to rebuild its multi-layered long- and medium-range defences through the *eastern options* is limited. If the intensity of air strikes against Ukraine

²¹⁸ T. Beruca, "New U.S. Weapons Package for Ukraine Includes Norwegian NASAMS," *Inside the Pentagon*, 11 July 2022, and A. Roque, "Ukraine Conflict: Washington Pledges Additional USD1 Billion in Munitions and Other Military Support," *Jane's Defence Weekly*, 9 August 2022.

²¹⁹ "Fact Sheet on U.S. Security Assistance to Ukraine," Department of Defense, 4 October 2022, T. Semenova, "Ukraine war latest: NASAMS, Aspide air defense systems arrive in Ukraine," *The Kyiv Independent*, 8 November 2022, www.kyivindependent.com.

²²⁰ See: D. Axe, "Ukraine Could Get German Air-Defenses. They Might Prevent Devastating Bombing Raids By Russian Planes," *Forbes*, 1 June 2022, and *Military support for Ukraine*, German Federal Government, Berlin, 5 October 2022.

²²¹ J. Sabak, "Hiszpania wysła Ukrainie system przeciwlotniczy," *Defence24*, 7 June 2022.

²²² N. Fiorenza, "Ukraine Conflict: Germany Offers Gepards to Kyiv," *Jane's Defence Weekly*, 28 April 2022; and "Ukrainian Military Tell What German 'Gepard' Anti-Aircraft Guns Will Be Used For," *Defense Express*, 6 August 2022.

does not drop further, there will be a problem with a shortage of missiles for Ukraine's S-300Ps. Their supply from Slovakia was a temporary solution, and larger quantities could only be provided by Bulgaria. Another source for S-300 launchers and missiles could be Cyprus, but its interest in supporting Ukraine is still in question. A preliminary condition for a transfer from Cyprus would have to be U.S. agreements with Greece and an accelerated modernisation of Cyprus' air defence (to be outfitted with Israel's short-range Iron Dome).²²³ At the same time, there is no possibility of providing Ukraine with S-300 missiles from the Middle East and Asia, as they are exclusively in the possession of Russia's traditional partners or allies. Such a situation will increase Ukraine's needs, forcing it to pressure the U.S. government for Patriot or France and Italy for SAMP-T units.

Ukraine may also face a shortage of medium- and short-range systems to defend its major cities and airfields in 2023. These are essential to counter Russia's aircraft and cruise missile strikes. In this case, consistent implementation of the already initiated *STANAG option* will be very important. U.S. and Norwegian efforts to supply NASAMS are a good starting point for rebuilding Ukraine's air defences. The eight expected NASAMS units will still be disproportionate to the scale of the Russian threat. However, it is a temporary solution to the full depletion of post-Soviet short-range systems stocks. Another solution initiated by Spain is to deliver in 2023 four HAWK systems (range of 32 km, altitude 13,700 m) and an unknown number of declared French Crotale NG systems (range of 12 km, altitude 6,000 m). In the context of the still available stocks of HAWK launchers and missiles in dozens of countries, it is possible to preserve Ukraine's air defence capabilities, however, in the shape of an unprecedented "patchwork" of different systems and radars.²²⁴ The issue of integrating German IRIS-Ts into Ukraine's air defence network also calls for clarification. This is because a single launcher will only enable Ukraine to defend a small area. It would, therefore, be necessary to increase German production or look elsewhere for similar systems, such as the planned transfer of Spanish Aspide launchers.

In terms of point defence with MANPADS, it will be necessary to maintain missile supplies for launchers delivered to Ukraine. Despite their limited range, the Stinger or Piorun missiles have proven their worth by partially neutralising Russia's advantage in attack helicopters. It should also be assumed that Ukraine's demand for drone systems is high, so it would be advisable to provide it with at least 50 Gepards or analogous systems. A transfer from the U.S. of M-1097 Avenger systems, which are based on HMMWVs and Stinger missiles familiar to Ukrainians, would also be another good option.²²⁵

Thus far, the assistance provided to Ukraine's air defence has not led to the significant capability gaps on NATO's Eastern Flank. The Alliance has a modern and very potent air force and air defence capability, and has excellent situational awareness with its E-3A AWACS aircraft.²²⁶ Russia's aggression accelerated Central Europe's modernisation programmes in this regard as well. The gap left by the transfer of Slovak S-300s was filled with Dutch and German Patriot PAC-3 units, deployed as part of a NATO multinational battle group in Slovakia. The same

²²³ A classified agreement was signed by Cyprus and Israel in August for the delivery of these systems, but media leaks are silent on the quantity and timing of deliveries. See: E. Fabian, "Cyprus Set to Buy Iron Dome from Israel—Report," *The Times of Israel*, 21 August 2022, www.timesofisrael.com.

²²⁴ M. Stone, "Exclusive: U.S. considers HAWK air defense equipment for Ukraine," *Reuters*, 25 October 2022, J. Irish, M. Rose, "France to deliver anti-air systems to Ukraine in coming weeks," *Reuters*, 12 October 2022. The HAWK system is no longer produced by the U.S., but is still operated by many NATO and Asian countries, with stockpiles of more than 30,000 missiles for it. Crotale NG is used only by Finland, Greece, and Georgia.

²²⁵ According to *Military Balance 2022*, U.S. Army currently possess 453 Avenger systems.

²²⁶ H. Foy, "Military Briefing: NATO's 'Eyes in the Sky' Keep Watch as Ukraine War Rages," *Financial Times*, 6 April 2022.

air and missile defence systems have been deployed by the U.S. in Poland to protect Rzeszów airport. Regardless of the assistance already provided to Ukraine, however, a rotating presence in the region of allied Patriots or longer-range U.S. THAADs is needed. In addition, Poland will have its first Patriot-Vistula units and new Narew short-range defence systems with CAMM missiles in 2023. Romania's short-range defence programme has been similarly accelerated and will rely on NASAMS, IRIS-T, Mistral-ATLAS or Israeli Spyder systems. Czechia will also begin using its Spyder systems and MMR radar network in 2023.²²⁷ After the outbreak of the war, the Allies also redeployed short-range and point defence systems for the forces reinforcing the Eastern Flank—these included a British Sky Sabre battery from CAMM in Poland and a Spanish NASAMS battery in Latvia.²²⁸

²²⁷ See: M. Cazalet, "Romania Considers Options for SHORAD and VSHORAD," *Jane's Defence Weekly*, 30 May 2022; N. Fiorenza, "PGZ and MBDA Agree Delivery Schedule for Narew SHORAD Components," *Jane's Defence Weekly*, 26 April 2022; and Y. Lapin, "Update: Czech Republic, Israel Sign SPYDER Air Defence Agreement," *Jane's Defence Weekly*, 12 October 2021.

²²⁸ N. Fiorenza, "Ukraine Conflict: Spain to Deploy NASAMS Battery to Latvia," *Jane's Defence Weekly*, 1 July 2022, and T. Ripley, "Update: UK Sky Sabre operational in Poland," *Jane's Defence Weekly*, 26 May 2022.

SUMMARY OF MILITARY TRENDS AND ISSUES

Nine months after the start of Russia's intensive war against Ukraine, there is no sign of change in the aggressor's strategic calculations. Russia is counting on Ukraine's political, social, and economic exhaustion, and hoping to exploit its advantage in military capabilities and reserves. The ZSU have so far demonstrated unprecedented determination and creativity in the face of a superior opponent. However, Ukraine would not have been able to cope with this threat without military assistance from the West. Nevertheless, a number of political, administrative, and technical factors continue to significantly slow down assistance to the country. Contrary to Russia's expectations, Ukraine's resistance is receiving high level of public support in the West, including in the U.S., which is key to maintaining military assistance.²²⁹ The scale and pace of deliveries of Western aid, coordinated through the UDCG format, still fails to meet Ukraine's enormous needs. Another factor affecting the dynamics of the conflict is the expected impact of Western sanctions on Russia, most of which will not bring severe consequences for Russia until 2023.

The military outcomes will be influenced by several key categories of Russian and Ukrainian weapons. Some of their capabilities are offensive by nature—these include heavy artillery, armoured, and air force equipment. Some are purely defensive, like air and missile defence. The purpose of longer-range missile weapons and drones depends on who uses them and how. From the point of view of Ukraine's partners, however, all these capabilities should be seen in terms of strengthening its defence and ensuring its existence, which is why these issues are no longer controversial in most UDCG countries. Even based on publicly available sources, it is possible to determine gaps in Ukraine's capabilities vis-à-vis Russia, the initial military potentials, its role in the conflict, and the overall proportions of equipment lost by both sides. This makes it possible to identify available options for arms deliveries needed by Ukraine, which boils down to the already discussed *eastern options* (systems mainly manufactured in the USSR), *STANAG options* (NATO standard systems) and *asymmetric options* (other and non-equivalent means). The analysis of these options makes it possible to plan UDCG assistance to Ukraine. In terms of post-Soviet capabilities, however, it may involve the creation of short- or medium-term gaps in NATO Eastern Flank countries. If that is the case, the next step is to clarify the possibilities of accelerated modernisation of NATO Eastern Flank states' armed forces. As an alternative to such programmes, there are options for the temporary or permanent reinforcement of the Eastern Flank with forces and capabilities from other Alliance countries.

Nine months of Russia's full-scale war with Ukraine point to the following trends and problems in its military capabilities, which require attention in the following time frames: current (end of 2022), short-term (end of summer 2023), and medium-term (2024-2025):

- **Heavy artillery:** Russia has at least a two-fold advantage on the front over Ukraine's howitzers and artillery rocket launchers. Despite a kill ratio that is generally favourable to Ukraine, it does not have the artillery and ammunition reserves that Russia does. So far, all of Russia's offensives have been repelled precisely because of Ukraine's heavy artillery. Capabilities in this area are a prerequisite for stopping the Russians and planning Ukraine's next counteroffensives. There is a risk that by early 2023 Ukraine's capabilities resting on

²²⁹ One in-depth opinion poll found that as many as 72% of Americans surveyed favour U.S. arms shipments to Ukraine (their support for ongoing economic aid is equally high. See: "Few Signs of 'Ukraine Fatigue' Among American Public," Chicago Council on Global Affairs, August 2022, www.thechicagocouncil.org).

its post-Soviet howitzers will be exhausted, and their usefulness will be prolonged only by supplies of 122 mm ammunition from Central Europe. A better outlook for the next year is the possibility of providing Ukraine with Grad family artillery rockets, produced in the region by friendly countries. The beginning of deliveries of NATO-standard 155 mm howitzers—more than 300 guns to date—has been an important form of support for Ukraine. Reserves of such towed and self-propelled howitzers exist, but maintaining a high level of deliveries along with ammunition of this type throughout 2023 will be a challenge. It is also necessary to simplify the logistics for Ukraine's artillery as it already relies on five different models of NATO self-propelled howitzers. Last but not least, it will be necessary to continue supplies of precision GMLRS rockets with a range of 70 km for the excellent Western systems used by Ukraine (by the end of the year, there will be 28-30 HIMARS or MLRS launchers). Moreover, regardless of the situation at the front and when the war will end, Ukraine will be transitioning to more advanced and precise NATO artillery systems, of which it will need just as much in the long term.

- **Armoured vehicles:** Russia and Ukraine have post-Soviet capabilities in main battle tanks, infantry fighting vehicles, and armoured personnel carriers. Russia had a two-fold advantage over Ukraine on the front but lost as many as half of its tanks to Ukrainian artillery and anti-tank weapons. However, it still has reserves of older-generation vehicles that allow it to keep fighting. Ukraine has replaced its lost capabilities with deliveries of T-72 family tanks and BMP vehicles from Central European reserves (over 300 tanks) and with Russian equipment captured in the Kharkiv area. But the reserves in Central Europe are dwindling and will dry up by the summer of 2023 unless replacements from Cyprus arrive. This will mean that Ukraine will need to switch to a NATO tank. In practice, the only long-term options are the American M-60 or M-1 and the German Leopard-2. In light of the limited reserves of Western European tanks, this is an issue that should already be taken into account by the planners and decision-makers of UDCG countries, so that Ukraine can prepare for their introduction into its arsenal in 2023-2024. The prospects for Ukraine's transition to NATO-standard armoured personnel carriers are more promising, as they can be guaranteed for many years by existing reserves of older vehicles of the M-113 family. In the short and medium term, Ukraine's partners may be required to maintain the supply of ATGM-class systems (such as Javelin and TOW) and increased deliveries of also MRAP-class vehicles. In the long run, Ukraine will be able to rebuild its industry and produce MRAPs or indigenous carriers, presumably to NATO-like standards.
- **Long-range strike missiles:** While the previous two gaps are relative, Russia still has an absolute advantage over Ukraine in terms of longer-range missiles. Russia may have exhausted its stockpile of missiles produced in the past decade (Kalibr, Iskander, and Kh-101) during the war, but it has reserves of various missiles produced by the USSR. This arsenal could still be used to terrorise Ukraine's civilian population and critical infrastructure for a long time to come. The Ukrainians do not have the ability to continue replacing their spent Tochka missiles or to strike at Russian targets located more than 100 km away. Despite Ukraine's spectacular successes in sinking the cruiser *Moskva*, recapturing Snake Island, and destroying the Saki airfield, it faces shortages of these capabilities in 2023. Ukraine's coastal defence and the situation in the Black Sea will be managed by Harpoon systems with a limited range of 124 km. Further deliveries of HARM anti-radar missiles with a 100 km-plus range in 2023-2024 could also be an important means of support for Ukraine. In the same two-three year time frame, Ukraine needs to be able to safely produce its Grim and Neptune systems, or receive U.S. ATACMS missiles with a range of 300 km. So far, the U.S. has been reluctant to pursue the latter option, but the issue should be a priority in

bilateral negotiations and arrangements that make their delivery conditional (used solely on Russian targets located on Ukrainian territory). In the long term, rebuilding Ukraine's arsenal of missiles with a range of 100-300 km will be crucial for deterring Russia and defeating future threats.

- **Aviation:** Russia's failures so far in the war against Ukraine stem from its inability to take advantage of its superior air force and control Ukraine's airspace. Despite a kill ratio favourable to Ukraine (especially in helicopters), Russia still has the world's third-largest air force and reserves for a long war. Despite deliveries of spare parts and armaments for MiG-29s, Ukraine is facing a degradation of its military aviation in 2023. In 2023-2024, the delivery of post-Soviet transport and attack helicopters, facilitated by their accelerated replacement in Central Europe, might be less problematic. Ukraine's issues will not be solved through the *asymmetric options*, such as lightly armed drones and point air defences. There is virtually no possibility of providing its air force with post-Soviet aircraft after 2023, so any rearmament would have to be based on U.S. F-16s or Swedish Gripens. Ukraine should also carefully examine the advantages and disadvantages of rearming with A-10 close support aircraft, which, if it decides to do so, could enter service as early as mid-2023. However, by 2024-2025 at the latest, it will need F-16 or Gripen multirole aircraft, so the U.S. administration and Congress (and possibly the Swedish government) should begin the lengthy process of training Ukrainian pilots as soon as possible. Advance analysis and planning by the U.S. or a few other UDCG countries would make it easier to solve the numerous logistical challenges involved. These decisions can be postponed in the current perspective, but given the multitude of issues, it is preferable to resolve them in the first half of 2023 at the latest.
- **Drones and loitering munitions:** UAVs and loitering munitions complement Ukraine's heavy weaponry. Their impact on the war is clear when used for reconnaissance and information warfare. Less clear so far is the impact of MALE-class combat drones, although Turkey's Bayraktar has become a symbol of this war. Both sides are suffering extremely high losses in terms of reconnaissance drones and the less numerous MALE drones. Russia does not have large reserves of combat drones, so it will try to bring Iranian (and perhaps Chinese) ones into the fight quickly. Ukraine is in a better position, as it has permanent access to drones from NATO countries and the commercially available COTS-class. So far, talks about U.S. MALE drones have not led to any deliveries. In this regard, Ukraine can only hope for more Bayraktars in 2023 and the possibility of licensing their production in the longer term. However, the Biden administration could consider the delivery of some or most of its reserve of 200 RQ-1 Predator drones by the end of spring 2023. The U.S. and Poland have so far led the way in supplying Ukraine with kamikaze drones, but these inflict limited damage on Russian troops, especially compared to its heavy artillery. Loitering munitions can still play an important role in resistance activities or for Ukraine's Special Operations Forces, so it makes sense to maintain the current scale of supplies in 2023-2024. In addition, the reconnaissance and strike capabilities provided to Ukraine by different classes of military drones will certainly not be assured by private fundraising or improvised constructions. The supply of various types of counter-drone systems to Ukraine will be no less important in the current, short, or long term.
- **Air defence:** Ukraine's ground-based air defence systems are responsible for high Russian air losses and continue to deter Russia from conducting air operations deep behind enemy lines. So far, Western assistance with post-Soviet MANPADS has helped Ukraine. However, Ukraine will need a full replacement of its air defence systems. In particular, it is necessary

to build new battle management with a network of radar and air and missile defence systems from the beginning of 2023, especially based on NASAMS (eight have been promised so far, but even twice as many are needed), older but widely available HAWK (initiated by the Spain and the U.S.) and German IRIS-T (four units have been promised, with at least 8-10 needed). These systems will defend Ukraine against both Russian aviation and cruise missiles. A very serious problem for Ukraine will be the gap in the damaged radar network and the lack of options other than Cyprus for supplying S-300 longer-range interceptors. The end of 2022 to spring 2023 should be the period for concluding studies on Ukraine's medium- and long-term air defence architecture. In the meantime, assistance for MANPADS should be continued while keeping in mind their limitations and the possibility of Russia changing its air tactics. The problem to be solved in the long term (2024-2025) will be Ukraine's lack of defence against Russia's ballistic missiles. This could only be provided by U.S. Patriot PAC-3 or European SAMP-T systems.

A separate long-term issue will be rebuilding Ukraine's navy. The ongoing war will be settled on land, thanks to the heavy systems of Ukraine and Russia. Currently, Ukraine *de facto* lacks surface and submarine vessels allowing it to operate in the Black Sea and fight against Russia's fleet. At the beginning of the occupation of Crimea in 2014, Russia managed to seize 75% of Ukraine's naval vessels and facilities. In this respect, all of Ukraine's ambitious naval armament programmes had no chance of being realised in 2014-2022. Ukraine's capabilities were limited to coastal defence, naval infantry, emergency services, and border guards.²³⁰ With the outbreak of war, Ukraine also lost the last of its frigates (the *Hetman Sakhaydachnyy*) and the cutters and patrol boats it still has can at most perform support tasks for land and special forces, such as harassing the Russians in Crimea.²³¹ After the end of the war, Ukraine will need to rebuild its maritime capabilities and will not be able to cope with this challenge without help from the West. As noted, important contributions from UDCG countries have been the delivery of Harpoon missiles, while mine-removal capabilities are needed immediately. In the long term, it will be necessary to coordinate and significantly expand the various assistance programmes by the U.S., British Royal Navy, and Turkey in order to rebuild Ukraine's ability to operate in the Black Sea (and possibly in the Sea of Azov) and defend itself against Russia.

²³⁰ For details, see: M. Gajzler, "Niedokończona modernizacja ukraińskiej marynarki wojennej," *Nowa Technika Wojskowa*, no. 8, August 2022.

²³¹ On 29 October 2022, Ukraine attacked the Black Sea Fleet headquarters and base in Sevastopol with naval drones, seriously damaging the frigate *Admiral Grygoryevich*; for more details, see: Sh. Gairola, A. Pape, "Ukraine conflict: Ukrainian kamikaze USVs target Russian naval base," *Jane's Navy International*, 31 October 2022.

CONCLUSION

Military assistance to Ukraine has undoubtedly played a major role in maintaining its independence in the face of Russian aggression. However, to date it is insufficient to repel subsequent Russian offensives after its “partial mobilization” and retake all territories it occupied. Although many of the trends on the battlefield are favourable—or even very favourable—to Ukraine, Russia still assumes that it can exploit its quantitative advantage in its military potential. Thus, without a decisive armed settlement in Ukraine’s favour, there is no chance of a profound change in Russia’s ambitions and strategic calculations. In the face of its full-scale aggression against Ukraine, the West has shown unity that has taken the Russians aback. This is due to the determination of Ukraine and many of its Western neighbours as well as U.S. leadership within NATO and the UDCG.

Most barriers to further military aid to Ukraine are political in nature, with bureaucratic ones being a derivative. These can be overcome with explicit political will of the governments concerned or from pressure on them by allies. At the same time, there is a favourable public attitude in most NATO countries for military and economic assistance to Ukraine, which is seen as preferable to direct confrontation between the Alliance and Russia. The general schemes for aid to Ukraine are fairly simple, with potential problems arising from technological barriers, limited weapons and ammunition reserves, and the peacetime mode of their production in NATO countries.

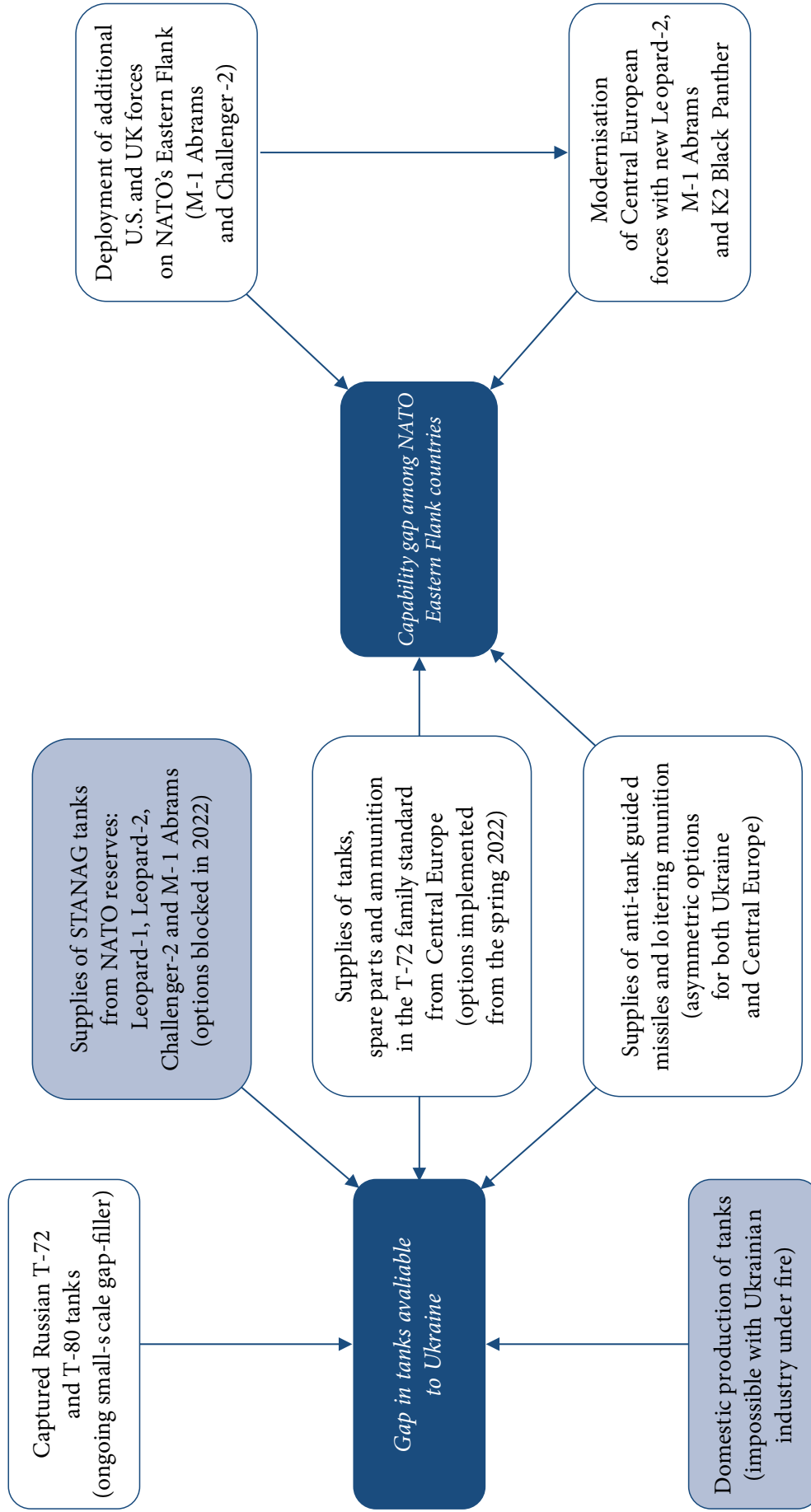
There are serious limitations to Ukraine counting on the availability of Soviet-type weapons. This is especially true for main battle tanks, multi-role aircraft, and air defence. There is a serious risk of growing gaps on Ukraine’s side, implying high-level decisions in 2023 to supply it with NATO-standard artillery ammunition, tanks, longer-range missiles, and aircraft (see summary in **Table 3**). These are not only logical but necessary, and postponing them will only increase Ukraine’s losses and prolong the war without affecting Russia’s calculus and strategy. Against the backdrop of Ukraine’s systems analysed here, only its naval capabilities are currently unaffected by the course of the war, so plans to rebuild them can be pushed back to a later period (after 2024).

With the continuation of the war in 2023 likely, it will be necessary to maintain at least the current level of Western assistance to Ukraine in the spheres of air defence, military kamikaze drones and counter-drone systems. The priority of the UDCG, in military and civilian protection terms, should be the creation of Ukraine’s new air defence architecture, followed by its missile defence. For logistical and economic reasons, it is also advisable to rationalise Ukraine’s assistance in those categories of armaments that currently form a veritable “patchwork” of NATO systems beginning in 2023: especially include self-propelled howitzers and ammunition for them, armoured personnel carriers, and MRAP-class vehicles. Also, there is a need to maintain constant assistance to Ukrainians in categories not mentioned in this report, such as small arms and ammunition, personal protection and medical equipment, and fuel supplies.

In addition, the consequences of the assistance provided to Ukraine by Central European countries require greater attention from decision-makers in other NATO countries. Indeed, due to its scale, there is a risk of temporary gaps in the capabilities of armoured forces, aviation (mainly helicopters), and air defence on NATO’s Eastern Flank. The costs of accelerated modernisation programmes are so high that they require much greater effort on the part of Western Europe—led by Germany—in developing and deploying new military capabilities.

NATO forces and resources directed at the Eastern Flank must be factors of credible deterrence and defence, but they still rely mostly on U.S. capabilities and forces. This situation is far removed from the desired and declared “burden sharing” in Europe’s transatlantic relations with the U.S. It will therefore also be necessary to take a look at the resulting gaps in planning the short- and medium-term presence of Alliance forces on the Eastern Flank. Parallel direct military assistance to Ukraine, together with the strengthening of defence capabilities on the Eastern Flank will ensure the complete failure of Russia’s plans in Europe. Moreover, the effect of Ukraine’s accelerated transition to Western weapons systems will be increased interoperability with NATO forces, inspiring intense discussions about its membership in the Alliance.

DIAGRAM. REPLENISHMENT OF GAPS IN UKRAINE'S CAPABILITIES USING THE EXAMPLE OF BASIC TANKS



Prepared by the author.

TABLE 1: ASSISTANCE IN SMALL ARMS AND EQUIPMENT FOR UKRAINE UNTIL JUNE 2022

Category	Confirmed examples (quantity)	Confirmed suppliers
Individual equipment and medical assistance	Uniforms, helmets and bulletproof vests, gas masks and NBCR suits. Individual medical first-aid packages and full or partial field hospital equipment.	Australia, Austria, Azerbaijan, Belgium, Bulgaria, Croatia, Montenegro, Denmark, Estonia, EU, Finland, France, Georgia, Germany, Ireland, Italy, Japan, South Korea, Latvia, Lithuania, Luxembourg, Netherlands, Norway, New Zealand, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Taiwan, UK, U.S., Uzbekistan
Hand grenades	DM41A1 (100000), L109A1 (50000),	Czechy, Hiszpania, Kanada, Niemcy, Portugalia, Wielka Brytania
M-67 (7500)	Czechia, Spain, Canada, Germany, Portugal, UK	Chorwacja, Czechy, Estonia, Kanada, USA
Pistols and submachine guns	Beretta M-9 (1000), Cz. 82 (30150), Makarov PM (2400), Samopal Vz. 48, Skorpion Vz. 61 (2085)	Croatia, Czechia, Estonia, Canada, USA
Assault rifles	Adams P-1 (2500), AK-47 (20000), Bren Cz. 805/6, Colt M-4 (5000), FNC (3000), FN SCAR-L, H&K G-3, MSBS Grot, Norinco Type 56 (2500), PA Md. 86, PM Md. 63, Samopal Vz. 58 (5000), Zastava M70 (20000) and M77	Belgium, Croatia, Czechia, Finland, Greece, Canada, Poland, Portugal, Romania, Slovenia, U.S.
Machine guns	Beretta MG-42/59, Browning M-2, FN Minimi (3000), Rheinmetall MG-3 (100), M-240 (600), Vz. 59 (3200)	Belgium, Croatia, Czechia, Spain, Canada, Germany, Slovakia, Slovenia, Italy, U.S.
Sniper rifles	Accuracy AWM and AX308 (100), Barrett Mod. 98B, Sako TRG-22, Tikka T3	Czechia, Finland, Netherlands, Canada, U.S.
Large-calibre sniper rifles	AG-90C, Barrett M-82, M-99 and M-107, BA50, PGW, TAC-50, ZVI Falcon	Czechia, Canada, Sweden, U.S.
Light and automatic grenade launchers	M-203 (200), M-320, Mk. 19 (100), RPG-40, RPG-76 Komar	Poland, U.S.
Anti-tank grenade launchers	AT-4/Carl Gustaf M2 (16000), GIAT APILAS (60), Dinamit MATADOR (2650), Instalaza Alcotan-100 and C90-CR (1370), M-72 LAW (14200), M-141 BDM, Panzerfaust-3 (3400), PSRL-1, RPG-18 Mucha (815), Saab-Bofors NLAW (5900), Zeveta RPG-75	Australia, Belgium, Czechia, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Canada, Norway, Spain, Sweden, U.S.
ATGMs	FGM-148 Javelin (6700), MBDA Milan-2 (50), Thales Martlet	Estonia, France, Netherlands, Luxembourg, Sweden, Italy, UK, U.S.
Point air defence systems	FIM-92 Stinger (2200/2500), MBDA Mistral (100), Piorun, Striela-2 (2860), Striela-10M, Thales LML Starstreak	Czechia, Denmark, Lithuania, Latvia, Germany, Norway, Poland, Italy, UK, U.S.
Mortars	LMP-2017 (100), M-224 LWCMS, Soltan K-6	Czechia, Denmark, Canada, Poland, Slovakia, U.S.
Mines and sapper equipment	AT-2, Bozena-5, mine detectors, DM-31, M-18 Claymore, PARM-2	Netherlands, Lithuania, Germany, Slovakia, Italy, UK, U.S.
MRAP-class vehicles, off-road and trucks	Dzik-2, Humvee, Jeep Wrangler, Land Rover Snatch, Mamba, Mastif, MXT-MV, Nissan Navarra, Senator, Toyota Land Cruiser, Unimog, Vamtac	Australia, Estonia, Spain, Canada, Lithuania, Luxembourg, Poland, Portugal, UK, U.S.

Prepared by the author on the basis of publications in the trade press and IHS, *Ukraine Conflict: Military Assistance to Ukraine*, version dated 6 July 2022. Note: during the course of the war, and especially from May-June 2022, the transparency of supplies of light weapons to Ukraine has decreased.

TABLE 2: SOVIET-MADE AND COMPATIBLE ARMAMENT IN NATO COUNTRIES

Category	Country and type (estimated quantity)	Total
Towed howitzers	Bulgaria D-20 (24), Croatia D-30 (20), Czechia M-77 Dana (96), Estonia D-30 (36), Poland M-77 Dana (111), Romania M-30 (96) and M-1981/1985 (351), Slovakia M-77 Dana (3) and Zuzana-1/2 (24)	751
Self-propelled howitzers	Bulgaria 2S1 Gvozdika (48), Croatia 2S1 Gvozdika (8), Poland 2S1 Gvozdika (227), Romania 2S1 Gvozdika (40)	323
Rocket artillery	Bulgaria BM-21 Grad (24), Croatia BM-21 Grad (21) and M91 Vulkan (6), Czechia (no data), Greece RM-70 (109), Poland BM-21 Grad (75) and RM-70 (29), Romania APR-40 (134) and LAROM (36), Slovakia RM-70 (30)	464
MBTs	Bulgaria T-72M1/M2 (90), Croatia T-72/M-84 (75), Czechia T-72M4Cz (30) and T-72M1 (89), Poland T-72M1 (318) and PT-91 Twardy (232), Slovakia T-72M (30), Slovenia M-84 (14)	878
IFVs	Bulgaria BMP-1 (90) and BMP-23 (70), Croatia BTR-50 (15) and BOV-VP (6), Czechia BMP-1 (98) and BMP-2 (120), Greece BMP-1 (169), Poland BMP-1 (1252), Slovakia BMP-1 (148) and BMP-2 (91)	2059
APCs	Bulgaria MT-LB (100) and BTR-60 (20)	120
Medium-range anti-aircraft systems	Bulgaria S-200 (12) and S-300PMU (8), Poland S-200 and S-125 (n/a), Slovakia S-300PMU (n/a)	20
Transport helicopters	Bulgaria Mi-17 (5), Czechia Mi-8 (4), Mi-17 (5) and Mi-17Sz (16), Poland Mi-8 (9) and Mi-17 (8), Slovakia Mi-17 (13)	60
Attack helicopters	Bulgaria Mi-24W (6), Czechia Mi-24 (7) and Mi-35 (10), Poland Mi-24D/W (28), Slovakia Mi-24D/V (5+10)	66
Close Air Support aircraft	Bulgaria Su-25 (3), Poland Su-22M (12)	15
Multi-role jet aircraft	Bulgaria MiG-29 (11), Poland MiG-29 (22), Slovakia MiG-29 (9)	42

Prepared by the author on the basis of data from IISS, Military Balance 2022, Routledge, London 2022 (Chapter 4). Hungary was omitted from this compilation.

TABLE 3: SUMMARY OF EXPECTED GAPS IN UKRAINE'S CAPABILITIES AND GAP-FILLERS (2022-2025)

Ukraine's Capabilities	2022–2023	2023–2024	2024–2025
Heavy Artillery	Deliveries of ammunition for Soviet-era howitzers until exhaustion Deliveries of Grad and GMLRS rockets Deliveries of mortar munitions, both in Soviet and STANAG standards	Continuous delivery of 105 and 155 mm STANAG artillery ammunition Continuous delivery of Grad and GMLRS rockets	Further deliveries or GMLRS rockets Full transition to or licensing of production of STANAG howitzer ammunition
Armoured Vehicles	Deliveries of T-72, BMP-1, and BMP-2 family vehicles until exhaustion Repairs of Soviet-era vehicles in Central European countries Deliveries of HMMWV, MRAP, and ATGM STANAG systems	Gradual transition to STANAG Armoured Personnel Carriers (M-113) Eventual deliveries of STANAG vehicles and main battle tanks Further deliveries of HMMWV, MRAP, and ATGM STANAG systems	Full transition to combat vehicles in STANAG Full transition or indigenous production of MRAP-class vehicles Further deliveries or indigenous production of ATGM systems
Longer-Range Strike Missiles	Deliveries of Harpoon and HARM missiles	Further deliveries of Harpoon and HARM missiles	Odbudowa możliwości produkcji własnych pocisków Hrim i Neptun Ew. prace nad rodzimymi pociskami dalszego zasięgu
Aviation	Exhaustion of possibilities to deliver further MiG-29 jets and spare parts Lack of spare parts for Su-27 and Su-24 Deliveries of available Mil helicopters	Eventual deliveries of Su-22 and A-10 attack airplanes Decision on training for multi-role STANAG airplanes (F-16 or Gripen) Deliveries of spare parts for Mil helicopters	Reconstitution of services for Mi-8/17 and Mi-24/35 helicopters Full transition to multi-role STANAG jet airplanes
UAVs and Loitering Munitions	Deliveries of recon drones Deliveries of COTS drones Deliveries of TB2 MALE drones Deliveries of "kamikaze" drones	Further deliveries of all classes of drones initiated in 2022-2023 Eventual deliveries of MALE drones from the U.S.	Licensed production of TB2 drones Reconstitution of indigenous/ licensed recon and "kamikaze" drone production
Air and Missile Defence	Exhaustion of reserves of interceptors for S-300V and S-300P systems Deliveries of STANAG SHORAD systems Deliveries of MANPADS in both standards	Wider use of STANAG SHORAD systems Strengthening of air defence with NASAMS, IRIS-T, and HAWK systems Eventual decision on delivery of PAC or SAMP-T missile defence systems Further deliveries of STANAG MANPADS	New and fully integrated air and missile defence networks Cooperation with the U.S. and Western Europe in licensed production of interceptors for air defence

Prepared by the author; see main body of the report text for more details and comparisons.



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