Royal United Services Institute
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Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022

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Executive Summary

The full-scale invasion of Ukraine on 24 February 2022 has provided an invaluable opportunity to assess the capabilities of the Armed Forces of the Russian Federation (AFRF) and the implications of a range of capabilities for modern warfare. Many publicly made judgements on these issues have lacked supporting data or insight into Ukrainian operational planning and decision-making. To ensure that those drawing lessons from the conflict do so from a solid foundation, this report seeks to outline key lessons, based on the operational data accumulated by the Ukrainian General Staff, from the fighting between February and July 2022. As the underlying source material for much of this report cannot yet be made public, this should be understood as testimony rather than as an academic study. Given the requirements for operational security, it is necessarily incomplete.

Russia planned to invade Ukraine over a 10-day period and thereafter occupy the country to enable annexation by August 2022. The Russian plan presupposed that speed, and the use of deception to keep Ukrainian forces away from Kyiv, could enable the rapid seizure of the capital. The Russian deception plan largely succeeded, and the Russians achieved a 12:1 force ratio advantage north of Kyiv. The very operational security that enabled the successful deception, however, also led Russian forces to be unprepared at the tactical level to execute the plan effectively. The Russian plan's greatest deficiency was the lack of reversionary courses of action. As a result, when speed failed to produce the desired results, Russian forces found their positions steadily degraded as Ukraine mobilised. Despite these setbacks, Russia refocused on Donbas and, since Ukraine had largely expended its ammunition supply, proved successful in subsequent operations, slowed by the determination – rather than the capabilities – of Ukrainian troops. From April, the West became Ukraine's strategic depth, and the Ukrainian Armed Forces (UAF) only robbed Russia of the initiative once long-range fires brought Russian logistics under threat.

The tactical competence of the Russian military proved significantly inferior compared with the expectations of many observers based within and outside Ukraine and Russia. Nevertheless, Russian weapons systems proved largely effective, and those units with a higher level of experience demonstrated that the AFRF have considerable military potential, even if deficiencies in training and the context of how they were employed meant that the Russian military failed to meet that potential. Factoring in the idiosyncrasies of the Russian campaign, there are five key areas that should be monitored to judge whether the Russian military is making progress in resolving its structural and cultural deficiencies. These areas should be used to inform assessments of Russian combat power in the future.

1. The AFRF currently operate with a hierarchy of jointery in which the priorities of the land component are paramount, and the military as a whole is subordinate to the special services. This creates suboptimal employment of other branches.
2. The AFRF force-generation model is flawed. It proposes the creation of amalgamated combined arms formations in wartime but lacks the strength of junior leadership to knit these units together.
3. There is a culture of reinforcing failure unless orders are changed at higher levels. This appears less evident in the Russian Aerospace Forces than in the Ground Forces and Navy.
4. The AFRF are culturally vulnerable to deception because they lack the ability to rapidly fuse information, are culturally averse to providing those who are executing orders with the context to exercise judgement, and incentivise a dishonest reporting culture.
5. The AFRF's capabilities and formations are prone to fratricide. Electronic warfare (EW) systems and other capabilities rarely deconflict, while processes for identifying friend from foe and establishing control measures are inadequate. The result is that capabilities that should magnify one another's effects must be employed sequentially.

Beyond assessments of the Russian armed forces, there are significant lessons to be drawn from the conflict for the British and other NATO militaries. The foremost of these are:

- There is no sanctuary in modern warfare. The enemy can strike throughout operational depth. Survivability depends on dispersing ammunitions stocks, command and control (C2), maintenance areas and aircraft. Ukraine successfully evaded Russia's initial wave of strikes by dispersing its arsenals, aircraft and air defences. Conversely, the Russians succeeded in engaging 75% of static defence sites in the first 48 hours of the war. Nor is setting up a headquarters in a civilian building sufficient to make it survivable. The British Army must consider the vulnerability of higher-echelon enablement. The RAF must consider how many deployable spares kits it has to enable dispersion of its fleets.
- Warfighting demands large initial stockpiles and significant slack capacity. Despite the prominence of anti-tank guided weapons in the public narrative, Ukraine blunted Russia's attempt to seize Kyiv using massed fires from two artillery brigades. The difference in numbers between Russian and Ukrainian artillery was not as significant at the beginning of the conflict, with just over a 2:1 advantage: 2,433 barrel artillery systems against 1,176; and 3,547 multiple-launch rocket systems against 1,680. Ukraine maintained artillery parity for the first month and a half and then began to run low on munitions so that, by June, the AFRF had a 10:1 advantage in volume of fire. Evidently, no country in NATO, other than the US, has sufficient initial weapons stocks for warfighting or the industrial capacity to sustain largescale operations. This must be rectified if deterrence is to be credible and is equally a problem for the RAF and Royal Navy.
- Uncrewed aerial systems (UAS) and counter-UAS (CUAS) are essential across all branches and at all echelons. Although critical to competitiveness by providing situational awareness, 90% of UAS employed are lost. For the most part, UAS must be cheap and attritable. For land forces, they must be organic to units for the purposes of both situational awareness and target acquisition. The primary means of CUAS is EW. Another critical tactical requirement is to be alerted to the presence of UAS. For the Royal Navy,

CUAS is critical for protecting vessels operating beyond the protection of a task force. For the RAF, the provision of look-down sensing to locate UAS to contribute to air defence is critical. This allows defensive resources to be prioritised on the right axes.

- The force must fight for the right to precision. Precision is not only vastly more efficient in the effects it delivers but also allows the force to reduce its logistics tail and thereby makes it more survivable. Precision weapons, however, are scarce and can be defeated by EW. To enable kill chains to function at the speed of relevance, EW for attack, protection and direction finding is a critical element of modern combined arms operations. Sequencing fires to disrupt EW and create windows of opportunity for precision effects is critical and creates training requirements. In modern warfare, the electromagnetic spectrum is unlikely to be denied, but it is continually disrupted, and forces must endeavour to gain advantage within it.
- For land forces, the pervasive ISTAR on the modern battlefield and the layering of multiple sensors at the tactical level make concealment exceedingly difficult to sustain. Survivability is often afforded by being sufficiently dispersed to become an uneconomical target, by moving quickly enough to disrupt the enemy's kill chain and thereby evade engagement, or by entering hardened structures. Shell scrapes and hasty defences can increase immediate survivability but also risk the force becoming fixed by fire while precision fires and specialist munitions do not leave these positions survivable. Forces instead should prioritise concentrating effects while only concentrating mass under favourable conditions – with an ability to offer mutual support beyond line of sight – and should give precedence to mobility as a critical component of their survivability.

In due course, it will be possible to extend this study to cover the later phase of the war when Ukraine moved on to offensive operations. As the UAF expend significant ammunition, however, and now depend on their international partners for equipment, it is important that those partners draw the appropriate lessons from the war so far, not least so that they can prepare themselves to deter future threats and to best support Ukraine. Ukraine's victory is possible, but it requires significant heavy fighting. With appropriate support, Ukraine can prevail.

Introduction

RUSSIA'S FULL-SCALE INVASION of Ukraine on 24 February 2022 has seen the return of conventional warfighting to Europe. This has provided an unparalleled opportunity to assess Russia's military capabilities and the impacts of a range of modern weapons on the battlefield. Ensuring that the correct lessons are drawn from the conflict is vital in two key respects: for Ukraine, if it is to receive appropriate military support from its international partners; and for NATO members, if they are to ensure they are militarily capable of deterring aggression in the future.

Debates about the relative merits of armour, anti-armour weapons, electronic warfare (EW) and airpower have been fierce among external observers of the conflict. Most of these debates, however, have lacked any grounding in data. Much of the discourse surrounding the war has drawn on fragmentary online videos that show specific activities detached from a wider tactical or operational context. A great many definitive statements have been made about Russian capabilities based on the propaganda material produced by both sides. There are partial public datasets regarding Russian losses, but there is almost no detailed information on Ukrainian dispositions, actions, decision-making or setbacks. There is, therefore, a high risk that false lessons will be drawn from the war. Given that Ukraine now depends on its international partners for its strategic depth in training and materiel, a reasonable understanding of what transpired and the actual demands of modern combat in the Ukrainian theatre is necessary.

Prior to August 2022, when Ukraine was on the defensive against a large-scale and determined Russian offensive, operational security demanded that the Ukrainian government minimise the available information on its forces, dispositions and tactics. This is still the case with the preparation and conduct of offensive operations by the Ukrainian Armed Forces (UAF), their preparations to counter newly mobilised Russian units and the effects of Russia's renewed strike campaign against Ukraine's energy infrastructure. How Ukraine denied Russia its initial theory of victory and how the Armed Forces of the Russian Federation (AFRF) reprioritised to offensive operations in Donbas are now sufficiently historical to allow for a more open discussion of events. This report is an account of the pre-war plans of both Russia and Ukraine, the course of the initial phases of the war between February and July 2022, an overview of what has been learned about the AFRF, and an assessment of the implications for NATO and specifically the UK military.

This report is methodologically problematic. It draws on the operational data accumulated by the General Staff of the UAF during the conflict, which was made available to the authors. A significant proportion of this data cannot be made public but was used to inform the conclusions of this report. A good example is Ukrainian losses, which are factored into the conclusions reached as regards the relative effectiveness of tactics and capabilities but cannot be disclosed as they remain operationally sensitive. Other data that is cited was sometimes obtained

through methods and sources of collection that are sensitive. The authors have considered the data in the context of its method of collection and the corresponding confidence in its accuracy. However, these judgements cannot be discussed in the report because the nature of the underlying sources for this data remains classified. For this reason, this report should not be considered a work of academic scholarship and it does not use citations. Rather, it should be considered as testimony based on personal observations of the authors. This includes the direct participation in strategic and operational decision-making during the war by two of the authors: Lieutenant General Mykhaylo Zabrodskyi and Oleksandr V Danylyuk. It also includes extensive interactions and consultations with Ukrainian military and intelligence personnel at all levels and the observation of tactical activities by Jack Watling and Nick Reynolds, who worked in Ukraine in January, February, April, June, August and October 2022. Although this report is methodologically imperfect, the speed at which Ukraine's partners must make decisions on procurement, training and capability development to ensure their own preparedness means that it was felt to be more useful to publish an imperfect study than wait for the evidence to be publishable long after its relevance to decision-makers had passed.

It is also important to clarify what is and is not considered in this report. The work is intended to properly frame the international understanding of the conventional military aspects of the conflict. It therefore focuses on areas that deserve attention. It is too short to be a comprehensive study of what transpired throughout the conflict. The conclusions are limited to the consideration of conventional operations and do not seek to assess the extensive unconventional campaign waged by Russia against Ukraine. That said, unconventional operations are necessarily described insofar as they provide context for conventional force employment, but conclusions on the lessons to be learned regarding unconventional operations from the war are to be the subject of a separate and adjacent study. It is also important to reiterate that this report does not cover events after July 2022 when the UAF began undertaking offensive operations; these activities have produced additional lessons that are important for a broader appreciation of the challenges on the modern battlefield, even though they are regrettably inappropriate to publicly disclose at this time.

This report has five chapters. Chapter I outlines Russia's invasion plan as set out in captured copies of the orders issued to a range of Russian units. Given the criticality of unconventional operations in this plan, and the impact of these activities on the posture and tasks assigned to Russia's conventional forces, the chapter necessarily describes these in some detail. Since there was exhaustive discussion of the size and capabilities of Russia's conventional forces around Ukraine prior to the conflict, these details are only described in terms of the alignment of Russian forces to operational groups.

Chapter II sets out Ukraine's capabilities, assumptions and starting positions at the beginning of the war. One of the major problems with public analysis of the conflict has been the lack of awareness of the capabilities of the UAF. For example, the public obsession with anti-tank guided weapons (ATGWs) largely ignored the large number of main battle tanks fielded by the UAF at the beginning of the conflict. This chapter, therefore, seeks to partly explain what Ukraine could field at the start of the war, as well as how Ukraine planned to defend itself.

Chapter III covers the course of the first three phases of the invasion, from 24 February to the beginning of July 2022. It is largely narrative but focuses on the command decisions and key factors that shaped the success or failure of specific tasks undertaken by both Russian and Ukrainian forces. The chapter tries to also explain the concepts of operation employed by the AFRF.

Chapter IV details observations regarding the performance of the AFRF. Rather than describing Russia's strengths and shortcomings in context, this chapter endeavours to identify wider cultural and structural challenges for its military that can be tracked to judge whether Russian military performance is improving.

Chapter V provides a summary of relevant lessons for the British military seeking to refine its capabilities, training and organisation to be prepared for high-intensity warfare in the years to come.

The report concludes with recommendations for policymakers. First, consumption rates of munitions, materiel and systems during high-intensity warfighting will be high, and stockpiles are critical to conventional defence being credible; second, national policies, permissions and industrial processes must be adaptable enough to allow change at the speed of relevance; and third, getting the correct mix of and synergies between new and legacy systems is essential to effective modernisation.

I. Russia's Planning and Preparations

RUSSIA'S STRATEGIC OBJECTIVE in its invasion of Ukraine was the subjugation of the Ukrainian state. This plan was formulated first and foremost by Russia's special services and a core group within the presidential administration, supported by senior officials in the Ministry of Defence. As such, it is necessary to briefly outline the wider context from which the orders to Russia's conventional forces were derived.

Russia's military build-up against Ukraine began in March 2021 when large numbers of conventional troops were added to existing forces along Ukraine's borders. This build-up performed three functions. First, it put pressure on Western governments to re-engage in the Minsk II negotiations to encourage Kyiv to make concessions and thereby avert a conflict. Second, it pre-positioned military equipment around Ukraine that would allow for a more rapid build-up of forces when the time came for the invasion. Third, it provided an opportunity for Moscow to assess the reaction of Ukraine's international partners.

Ukraine's international partners dismissed the threat in spring 2021 because they did not observe the necessary enablers deployed with the Russian formations nor the necessary political shaping of the information environment in Russia to support an invasion. They were correct on both counts – the build-up turned out to be a mobilisation exercise. However, the lesson for the Kremlin was that the enablers could be brought to the formations faster than Ukraine's partners could bring military capabilities: if these were the indicators that would cause international partners to react, they would do so too late. The Kremlin's confidence that it could invade Ukraine without significant international interference was an important reason for undertaking the full-scale invasion.

In July 2021, the 9th Section of the 5th Service of Russia's Federal Security Service (FSB) was enlarged into a directorate and tasked with planning for the occupation of Ukraine. As part of this preparation, the FSB drew on extensive surveys carried out in Ukraine. These surveys painted a picture of a largely politically apathetic Ukrainian society that distrusted its leaders, was primarily concerned about the economy and thought an escalation of the war between Russia and Ukraine was unlikely. Moreover, Russian President Vladimir Putin had personally articulated in an essay in July 2021 his belief that the people of Ukraine viewed Russians favourably and believed they were part of a shared civilisation, cruelly divided by historical political mistakes. The barrier, in his view, to correcting these mistakes was the government in Kyiv, which he accused of being a puppet to external powers hostile to Russia. The Russian military leadership was also confident that it would defeat the UAF after more than a decade of modernisation. Assurances from General Valery Gerasimov on Russia's military capabilities played a key role in shaping the confidence of Russia's special services in their plan. As Gerasimov told international interlocutors on the outbreak of the war, 'I command the second most powerful Army in the

world'. Separately Gerasimov told British counterparts that Russia had achieved conventional military parity with the US.

The conception of the Russian invasion therefore was developed around several key assumptions:

- Speed was critical to success to render the response of the international community irrelevant.
- The removal of Ukraine's leaders would remove the barrier for pro-Russian Ukrainians to vocalise support for the occupation.
- Controlling heating, electricity and finance would be an effective means of controlling the apathetic majority of the Ukrainian population.
- The Russian military could defeat the Ukrainian military on the battlefield.

From these assumptions, the FSB, Defence Minister Sergei Shoigu, Gerasimov and elements within the presidential administration developed their plan to achieve Putin's strategic goal. The key military-strategic tasks for the Russian military and security forces were to:

- Degrade Ukraine's ability to defend itself by destroying its air, maritime and air-defence forces.
- Defeat Ukrainian Ground Forces by fixing them in Donbas.
- Diffuse Ukraine's will and capacity to resist by eliminating Ukraine's political and military leadership and occupying critical centres of political and economic power.
- Deceive the Ukrainian government as to the time, location, scope and scale of Russia's invasion.

There was a tension in this plan between the aim of diffusing Ukraine's political unity and deceiving Ukraine as to the intent. The former would have required a sustained shaping phase preceding the invasion. The latter demanded speed. It appears that Russian planners succumbed to optimism bias as to the dislocating effect that speed itself could achieve in diffusing Ukraine's will to resist and therefore opted to undertake a shock and awe campaign with little preliminary shaping.

Russia planned to commence the invasion with a massive missile and airstrike campaign against Ukraine's air defences, command and control (C2) infrastructure, airfields and ammunition storage depots. This campaign would not target critical infrastructure such as power stations and railways, because these were vital to Russia's plans for occupying the country. The elimination of Ukraine's political leadership would primarily be a task for Russia's special services. Another line of effort, allocated to Russia's special forces and air-assault troops, was to capture Ukraine's power stations, airfields, water supplies, central bank and parliament. The intelligence community of Ukraine believes that Russia also planned to use Belarusian airborne units to capture the Rivne and Khmelnytsky nuclear power plants.

To enable these operations, Russia's Ground Forces were to simultaneously advance under several groups of forces to clear and occupy administrative centres on the left (eastern) bank

Figure 1: Original Russian Axes of Advance

Source: Author generated.

of the Dnipro River, along with Kyiv, Kherson, Mykolaiv and Odesa. Russian groups of forces were built around the military district command posts, with the name of the group of forces corresponding to the military district commanding the direction. This can cause some confusion as the military district names correspond with their geographical position in Russia, but do not correspond with their relative position in Ukraine. The northern axis was the main effort, focused on the encirclement and capture of Kyiv. For this purpose, the Russians formed two groups of forces commanded from the Eastern Military District Command Post. One group was formed in the Gomel region of Belarus and used the tactical sign 'V' with orders to attack Kyiv along the right (western) bank of the Dnipro River. The second group was formed in the Bryansk region of Russia and used the tactical sign 'O' with orders to surround Kyiv from the left (eastern) bank. The Southern Military District Command Post commanded units with the tactical symbol 'Z in a square', ordered to attack from occupied Crimea to establish control over the North Crimean Water Canal, Energodar and the Zaporizhzhia Nuclear Power Plant, surround Mariupol, take control of the bridges over the Dnipro and advance along the right bank to Voznesensk with the aim of seizing the South Ukrainian Nuclear Power Plant. The Western Military District Command Post commanded groups of forces projected from Kursk, Belgorod and Voronezh using the

tactical symbol 'Z' and tasked with encircling the Ukrainian troops in Donbas along the Lozova–Gulyapole line or the Barvinkovo–Velika Novosilka line. Such an encirclement, combined with fixing operations along the line of control using conscripts from occupied Luhansk and Donetsk, was intended to cut off about 50% of the UAF (see Figure 1).

Ground forces were assigned sectors and tasks down to the level of the battalion tactical group. For mechanised forces, the intent was often to rapidly occupy and thereafter isolate and screen key objectives. On the axis from Gomel to Kyiv, for example, the force was divided into a screening force that was to establish positions facing west to cut off Kyiv from western Ukraine, and units responsible for pushing into the city. Very little consideration appears to have been given to Ukrainian reserves or the Territorial Defence Forces (TDF). The assertion in Russian planning that Ukraine could generate only 40,000 additional troops appears to be premised on the anticipated speed of the operation rather than an appreciation of Ukraine's capacity for mobilisation. This emphasis on speed led to units being ordered to advance in administrative column by road and to attempt to bypass any initial resistance. The assumption was that by D+10, Russian units would transition to stabilisation operations. The synchronisation matrix of the 1st Guards Tank Army (Western Military District), for example, captured near Kyiv in March 2022, stated that by D+10 the force would 'proceed to the blocking and destruction of individual scattered units of the Armed Forces and the remnants of nationalist resistance units'.

A final grouping of Russian forces comprised the amphibious component and dispositions of the Black Sea Fleet. Two amphibious task groups were created with the intention of conducting landings ahead of advancing Russian ground forces on the Kherson–Mykolaiv–Odesa axis. These were to go in after the initial invasion, preceding the Ground Forces to seize key intersections and chokepoints to enable the rapid onwards movement of troops along the coast after Mykolaiv. In addition to this task, the Black Sea Fleet was to support the massive strike campaign by launching Kalibr cruise missiles throughout the depth of Ukraine, and isolate the theatre by blockading the Ukrainian coast.

After D+10, the role of Russia's conventional forces was to transition to a supporting function to Russia's special services, responsible for establishing occupation administrations on the territories. Since these activities were critical to the Russian theory of victory in the operation, it is important to outline these plans to appropriately contextualise the role of the conventional force. The assumption appears to have been that Ukrainian government officials would either flee or be captured as a result of the speed of the invasion. It was also anticipated that shock would prevent the immediate mobilisation of the population, and that protests and other civil resistance could be managed through the targeted disintegration of Ukrainian civil society. To manage these protests Russian forces would be supported by Rosgvardia (Russian National Guard) and riot control units. Meanwhile the FSB was tasked with capturing local officials. The Russian counterintelligence regime on the occupied territories had compiled lists that divided Ukrainians into four categories:

- Those to be physically liquidated.
- Those in need of suppression and intimidation.

- Those considered neutral who could be induced to collaborate.
- Those prepared to collaborate.

For those in the top category, the FSB had conducted wargames with detachments of the Russian Airborne Forces (VDV) to conduct kill-or-capture missions. In many cases, the purpose of capture was to put individuals involved in the 2014 Revolution of Dignity (often referred to as the Maidan Revolution) on trial to be executed. Although initial lists of persons in the second category existed, the approach was to be more methodical, with the registration of the population through door-to-door sweeps and the use of filtration camps to establish counterintelligence files on large portions of the population in the occupied territories. Filtration would be used to intimidate people, to determine whether they needed to be displaced into Russia, and to lay the groundwork for records to monitor and disrupt resistance networks. Over time, Russia would bring teachers and other officials from Russia itself to engage in the re-education of Ukrainians.

The intended method of political control had both a regional and national component. The regional component comprised the coerced cooperation of regional governors and local authorities. The national component involved the murder of Ukraine's executive branch and the capture of parliament. The pro-Russian faction within the parliament would be encouraged to form a Movement for Peace, which other parliamentarians would be encouraged and coerced to support. This Movement for Peace would ban resistance in the name of preserving peace. Regions that resisted could thereafter be cut off from electricity, water and finance from the central bank, following motions through this parliamentary body. Ukraine's nuclear power plants served three purposes therefore in the invasion plan: to function as reliable shelters for Russia's troops and military personnel, equipment, command posts and ammunition depots; to gain control over Ukraine's energy system, because nuclear power plants are responsible for generating more than 60% of Ukraine's electricity; and to provide the option to obtain leverage for blackmailing European countries with the risk of radiation pollution as a result of possible accidents at nuclear power plants if they attempted to intervene.

In addition, the seizure of nuclear power plants and scientific facilities engaged in nuclear energy research in Kharkiv and Kyiv was an important element of Russia's planned war propaganda. While justifying military aggression against Ukraine, Russian propaganda actively spread disinformation among its own population about the alleged threat Ukraine posed to Russia. Along with the narrative about the alleged presence of 'American Pentagon biolaboratories' in Ukraine, which were developing biological weapons, Russian propagandists and officials actively spread information about the alleged intention of Ukraine to restore nuclear weapons, which it gave up in 1994 in exchange for security assurances from Russia, the US and the UK as part of the Budapest Memorandum.

The goals of the Russian invasion were not only 'denazification', the destruction of national sovereignty and the banning of Ukrainian identity and 'demilitarisation', the destruction and banning of the UAF and the export to Russia of enterprises of the defence industrial complex of Ukraine, but also 'denuclearisation', the capture of nuclear power plants and their transfer to the direct management of Rosatom.

Russian forces massed on the Ukrainian border in autumn 2021 received orders to the effect that they would be away from their barracks for nine months. These orders, issued approximately three to four months before the invasion, demonstrate that the Russian government anticipated having Ukraine under complete control by summer 2022.

The Russian plans for the invasion of Ukraine were detailed and offered solutions to most of the practical problems that Russia would face in occupying Ukraine. If competently executed, these plans could have succeeded. As shall be seen later in this report, they came much closer to doing so than is widely appreciated. Although the assumption that there would be minimal resistance was incorrect, the occupation of southern Ukraine demonstrates that speed did offer a realistic path to asserting control over territory, even without popular support. Furthermore, despite the resistance of the Ukrainian armed forces, Russia had the combat power at the beginning of the war to overcome many Ukrainian formations. Beyond the shortcomings in the execution of the plan and the poor performance of Russian combat units, there are fundamental aspects of the plan that must be understood to appreciate the peculiarities of Russia's operations in Ukraine in the first phase of the war.

These plans were drawn up by a very small group of officials and the intent was directed by Putin. Many officials executing elements of the preparation were unaware of the wider intent. Russian military personnel – even up to deputy heads of branches within the Russian General Staff – were unaware of the intention to invade and occupy Ukraine until days before the invasion, and tactical military units did not receive orders until hours before they entered Ukraine. While this helped to achieve operational surprise – which was no doubt the intent – the tiny pool of personnel involved contributed to a range of false assumptions that appear never to have been challenged. That the Russians overstretched in terms of the number of axes embarked upon, the small size of the force employed for many tasks, and the failure to develop appropriate contingencies is indicative of many contributing technical judgements to the planning not having been fully briefed about the overall context. No independent red teaming appears to have taken place. Instead, the plan itself – while theoretically plausible – compounded optimism bias in each of its stages and, most tellingly, offered no reversionary courses of action, indicated no decision points to determine whether conventional forces should adjust their posture nor envisaged any outcome other than its own success. Neither did the plan account for the needs of those tasked with implementing it, nor afford any agency to Ukraine. The FSB's inaccurate assessment of the reaction of Ukrainian society is much less consequential in how the plan actually unfolded than the fact that there is no evidence in the Russian planning that anyone had asked what would occur if any of its key assumptions were wrong.

II. Ukraine's Planning and Preparations

TO PROPERLY UNDERSTAND what transpired in the opening phases of the conflict, the preparations made by the UAF since 2014 need to be appreciated. Many claims about the impact of Western military-technical assistance – for example – are problematic because they do not contextualise these systems alongside the existing capabilities of the UAF. Appreciating the scale of the conventional fight is important if the right lessons are to be drawn from the fighting. Once the structure and capabilities of the UAF are understood, the posture and dispositions of the force in February 2022 can be discussed in context.

Manoeuvre Brigades, Special Forces and Territorial Defence

The structure and condition of Ukraine's infantry and manoeuvre forces is worth considering, less in terms of their technical capabilities than in terms of their mindset, cohesion and C2. To begin, the Ukrainian Ground Forces had been in constant combat since 2014. Such combat may have been low intensity, but with more than 90 Ukrainian soldiers killed by Russian forces in 2021, it nevertheless required soldiers to take their tasks seriously and to prepare for escalation. For officers who rotated through the Joint Forces Operations (JFO) area, they had months to walk the ground, prepare positions and build an intimate understanding of the battlefield. The conversation throughout the UAF was what they would do in the event of a Russian escalation. Putting aside operational-level planning, even down to the level of platoon, the experience of junior officers and soldiers was to observe – for months – Russian positions that posed a threat to them and their comrades. These units had made extensive plans among themselves as to how they would defeat these positions in the event of war.

Furthermore, at the operational level, it was understood throughout the UAF that Russia may renew its assault on Ukraine. In 2014, the Russian military had tried to seize the country, only to pull back. Russia's Foreign Intelligence Service and other parts of the Russian government had urged a more deliberate aggression against Ukraine in 2015. The possibility, therefore, had been at the forefront of the minds of UAF officers. Wargames and exercises at formation level envisaged a defence against the full capabilities of the Russian military. Ukrainian units were confident that at the tactical level they would be better trained and better prepared than their adversaries. The persistent concern among commanders was the impact of artillery on their freedom to manoeuvre and, crucially, on their lines of supply. This problem was exacerbated by the shortage of personnel. With 10 brigades covering the entire line of contact in the JFO, a brigade frontage at the start of the war was around 20 km. This left a limited reserve and depended on a manoeuvre defence to counterattack against breaches in the line. Each brigade started the war with around 10 days of ammunition, but there was limited confidence – given the threat from artillery – that more would reach the lines if the Russians committed all their

Figure 2: The Line of Contact

Source: Adapted from information in Frederick W Kagan and Mason Clark, 'Russia-Ukraine Warning Update: Russian Military Operations in Southeastern Ukraine Imminent', Institute for the Study of War, 21 February 2022, <https://www.understandingwar.org/backgrounder/russia-ukraine-warning-update-russian-military-operations-southeastern-ukraine-imminent>, accessed 25 November 2022.

capabilities to this axis. Nevertheless, having observed the treatment of Ukrainians in the occupied territories after 2014, Ukrainian forces were also highly motivated in preventing more of the country falling into Russian hands and morale among the troops was therefore high.

Retaining a sufficient force was a challenge from 2014. The main problem was pay. Although pay had been increased, it did not keep pace with inflation, nor was it competitive with pay in the private sector. Combined with the use of short-term contracts, this contributed to a high turnover of personnel. Prior to 24 February 2022, this created serious problems for the UAF. It not only meant that many units had a shortage of specialists such as communicators, but also that the Ministry of Defence was having to expend disproportionate resources to train new specialists who would rarely be retained in the force. There was a benefit to this situation, however. Ukrainian reservists and wider society contained a very large number of people who had military experience and were trained to perform specialist tasks. One of the major errors

in Russian planning for the invasion was its assessment of the number of reservists Ukraine could mobilise.

There were also several brigades and units where retention was less problematic, and these constituted highly experienced formations. Among these units were the seven brigades of the Air Assault Forces, and the Special Operations Forces consisting of two regiments and two special operations centres. In addition, there were the Special Units of Ukraine's Special Services, including the 10th Special Unit of the Main Intelligence Directorate, Special Unit Alpha within the Security Service of Ukraine, the Special Forces of the National Guard, State Border Service and the Foreign Intelligence Service, responsible for operations deep behind enemy lines.

The creation of the TDF was an attempt to capitalise on the depth of Ukraine's reserves and the will of the population to create mass and therefore resilience. Established as a unified entity in January 2022, the TDF were conceptually promising, and over time have proven a valuable means of creating new combat units that can be trained to support the armed forces. However, even pre-existing Territorial Defence units were created far too close to the invasion to be well established and effective at the beginning of the war. It is important to understand that for the Ukrainian government, Russia's campaign against the country was continued for almost a decade and the cost of maintaining large territorial defence structures versus their immediate military utility made investment in such a structure a challenge for the UAF.

Because the TDF were only established in 2022, they lacked heavy weapons, or the C2 mechanisms to use them. They also had a limited command structure. While the value of the TDF has steadily increased – progressing from rear-area security to ground holding to contributing manoeuvre brigades to offensive operations – at the beginning of the conflict the lack of integrated C2 for these units made them an impediment in many cases. This is not the fault of the TDF personnel who mobilised to defend Ukraine, but simply reflects that trying to mobilise and coordinate such a large body of personnel with just over a month to establish chains of command and to distribute the necessary communications and training imposed a limit on how effectively they could be integrated into the armed forces. As of 24 February, therefore, the UAF had a limited body of experienced and professional manoeuvre brigades and had to make difficult decisions as to where to prioritise their deployment. They also had a large pool of tactically competent reserves, and a larger pool of willing civilian volunteers, but limited stocks of equipment to provision them. The critical question therefore was whether the professional body of the UAF could hold for long enough for a wider mobilisation to bolster Ukraine's defences in the event of war.

Artillery

In addition to its manoeuvre forces, Ukraine had systematically attempted to strengthen the combat support for its forces after 2014, recognising the significant fires capabilities of the AFRF. In the eight years of fighting before 2022, artillery had accounted for around 90% of casualties.

Prior to the Revolution of Dignity in 2014, President Viktor Yanukovych's pro-Russian government carried out a systematic reduction of missile and artillery troops. Thus, by the time of the Russian invasion of Crimea, the Ukrainian Ground Forces fielded one missile brigade armed with 9K79-1 'Tochka-U' tactical missile complexes, two artillery brigades equipped with 152-mm self-propelled and towed howitzers 'MSTA-S' and 'MSTA-B', 152-mm self-propelled and towed guns 'Hyacinth-S' and 'Hyacinth-B', and 203-mm self-propelled guns 'Pion'. They also fielded three artillery regiments, armed with 220-mm 'Uragan' and 300-mm 'Smerch' multiple launch rocket systems (MLRS). In addition, artillery units of mechanised and tank brigades used 152-mm and 122-mm artillery installations 'Akatsiya' and 'Gvozdika', as well as 122-mm MLRS 'Grad'. The units of the Airborne Assault Troops had neither their own artillery nor tanks.

Since March 2014, Ukraine has focused on recovering its artillery capabilities. As a result, five new artillery brigades and a separate artillery regiment of the Ground Forces were created, as well as one artillery brigade and a separate artillery regiment of the Navy. The 19th Separate Missile Brigade regenerated two additional battalions with tactical missile complex 'Tochka-U'. All new combined arms brigades in the Ground Forces, as well as all brigades of the marines, received their own brigade artillery groups. By 2019, the number of artillery battalions had doubled. As of February 2022, the Missile Forces and Artillery (RViA) of the UAF had 10 brigades and one regiment as part of the Ground Forces, as well as one brigade and one regiment as part of the Navy. The UAF had 1,176 barrel artillery systems, of which 742 were 152-mm calibre systems, 421 were 122-mm howitzers, and 13 units were 203-mm systems. The RViA also fielded 1,680 MLRS of all calibres, as well as about 40 tactical missile systems 'Tochka-U'. In terms of the number of artillery systems, Ukraine fielded the largest artillery force in Europe after Russia. The difference in numbers between Russian and Ukrainian artillery was not so significant at the beginning of the conflict: 2,433 barrel artillery systems against 1,176, and 3,547 MLRS against 1,680.

The UAF had ammunition to support these systems in high-intensity warfighting for just over six weeks. Ammunition had been depleted by regular explosions at Ukrainian arsenals as a result of Russian sabotage. From 2014 to 2018, there were six such explosions, which destroyed more than 210,000 tonnes of ammunition, a large part of which were 152-mm shells and rockets for MLRS. For comparison, during the five years of the war in Donbas, the UAF spent about 70,000 tons of ammunition in total.

The development of Ukrainian artillery was not limited to increasing the number of artillery systems and units. A lot of effort was also put into qualitative improvement. Since 2015, all battalions began to receive UAVs 'Furia', 'Leleka', PD-1 and others, which significantly increased their ISR capabilities. US radars AN/TPQ-36, designed to determine the coordinates of enemy artillery, were transferred to Ukraine as part of US military-technical assistance and strengthened the capabilities for conducting counter-battery fire. The use of the 'Kropyva' combat control system – Ukrainian intelligent mapping software – saw an 80% reduction in the deployment time for artillery units. Simultaneously, the amount of time to destroy an unplanned target was reduced by two-thirds, and the time to open counter-battery fire by 90%. Special attention was paid to personnel training. Every year, the armed forces conducted more than 35 field

brigade tactical exercises and more than 200 field battalion tactical exercises for artillery. Thus, Ukrainian defence plans aimed at using manoeuvre forces to fix and canalise attackers to enable their destruction by concentrated artillery fire.

Armour

The role and significance of armour in the conflict must be underpinned by an understanding of the tactical evolution of its employment over the past eight years and the scale at which armour is fielded by the UAF. Counting the two regular and four reserve tank brigades, tank units of mechanised and mountain brigades, as well as brigades of marines and air-assault troops, the UAF fielded about 30 tank battalions at the start of the conflict. A significant part of these tank units was formed between 2014 and 2018, for which 500 tanks were delivered to the UAF. The total number of Ukrainian main battle tanks at the time of the invasion was about 900. For comparison, the Russian armed forces had 2,800 combat-ready tanks in their invasion force, and Russian proxies in Donbas fielded about 400.

Traditional tank doctrine would see its employment in the direct fire zone. However, during the years of the war in Donbas, the tankers of the UAF changed traditional approaches and developed techniques for indirect fire. For this task, high-explosive fragmentation projectiles are usually used. This requires the use of special guidance devices – an azimuth pointer and a side level. The use of modern technologies, in the form of graphic and calculation complexes, developed in Ukraine with the function of automated transmission of information to other tanks participating in the combat mission, made it possible to achieve high accuracy at distances of up to 10 km and reduced the time for calculating fire corrections to a few seconds. This technique blurs the line between tanks and artillery. The value of this technique is that it allows tanks to concentrate fire over a wide area while they can manoeuvre without the protection and screening needed by artillery pieces. Ukraine therefore planned to use armour as mobile reserves supporting its formations, capable of offering blunting fire against enemy movements and to support counterattacks if conditions permitted.

Even though Ukraine produces BM 'Oplot' and T-84U, the lack of necessary funds forced the UAF to refrain from purchasing new tanks, and they instead chose to modernise their existing fleet. It was calculated that three or even four battalions of modernised tanks could be obtained for the funds required to purchase one battalion of new tanks. The 1st Tank Brigade was armed with T-64B and T-64BM 'Bulat' main battle tanks, which are modernised Soviet T-64 tanks. Modernised T-64s are equipped with digital radios, new internal communication and navigation systems, sighting systems with thermal imaging cameras, modified dynamic protection and other necessary options. The T-64BM 'Bulat' weapon system also includes the Ukrainian-made TAKO-621 tank missile system, enabling engagement of armoured vehicles, fortifications, helicopters and other targets at a distance of up to 5,000 m using Kombat guided missiles. In addition, the UAF have modernised T-72 and modernised gas turbine T-80BVs, which, due to their higher speed and manoeuvrability, are used by airborne assault troops and marines.

Although the UAF fielded a considerable tank fleet, this does not alter the fact that Russian tanks at the beginning of the war generally had better protection and sighting systems and were able to engage targets from a greater distance. For short-range engagements, these differences in protection and sensor performance were less relevant but offered significant technical advantages to Russia in mid-range engagements.

Anti-Tank Capabilities

The heavy emphasis in international commentary on anti-tank guided weapons (ATGWs) and especially those provided through military-technical assistance, means that it is vital to appreciate the volume of these capabilities and how they were distributed across the UAF to properly contextualise their impact on the fighting. At the beginning of February 2022, the armed forces received about 150 Javelin ATGW launchers with 1,000–1,200 missiles, 2,000 NLAW, as well as a large number of rocket-propelled anti-tank grenade launchers. Since Ukraine's partners at that time were persuaded that, in the most optimistic scenarios, hostilities would be centred on street battles in the largest cities, the anti-tank weapons transferred were intended for close combat.

Ukrainian anti-tank capabilities were not limited to Western-provided ATGWs, however. After 2014, the Ministry of Defence of Ukraine purchased at least 650 launchers for anti-tank missile systems 'Stugna-P' and 'Korsar' and about 7,000 missiles for them, 150 tower systems for armoured vehicles with dual anti-tank missiles and 900 missiles for them, and 1,600 guided missiles 'Cobra' and 'Kombat' for tank missile systems. Thus, the anti-tank capabilities of the UAF at the beginning of February 2022 amounted to around 950 ATGW launchers (Javelin, 'Stugna-P', 'Corsar', 'Barrier') and about 9,100 missiles. To this should be added short-ranged systems such as NLAW, Kobra/Kombat missiles, as well as more than a thousand Fagot and Metis ATGWs and several thousand missiles for them.

It is also important to appreciate the characteristics of some of these systems, which determined how they were employed. 'Stugna-P', developed and manufactured at the Ukrainian state-owned enterprise KB 'Luch', is a more powerful equivalent of the Russian 'Kornet'. The range of both complexes is the same – about 5,100 m – but the armour penetration of 'Stugna-P' is better. In addition, among the advantages of 'Stugna-P' is a quasi-top attack, a thermal sight that can be used at night at a distance of up to 3,000 m, as well as the ability to remotely control the launcher with a cable several dozen metres long, which significantly increases the survivability of operators on the battlefield. This class of ATGW is highly valuable for defensive operations because it allows for armour to be engaged at the ranges within which Russian armour seeks to conduct ATGW launches against defensive positions. This prevents the enemy establishing a safe overwatch position to support infantry advances.

The distribution of these ATGWs was shaped by their relative training burden. Despite its effectiveness, Stugna-P and other wire-guided systems required considerable training time for operators to use the system effectively. This restricted these systems to being used by Ukraine's existing ground forces. After 2014, a lot of attention had been paid to the training of anti-

tank crews in the armed forces, and the School of Anti-Tank Artillery was created at the 184th Training Centre of the National Academy of Ground Forces. It took 30 days to prepare crews arriving from military units to properly employ Stugna-P.

Javelin, by contrast, was much easier to employ, requiring days to train crews, while personnel could be trained to use NLAW in hours. Because of the wide range of additional uses of the Javelin CLU – such as ISR – these systems were prioritised for Ukrainian special forces and other specialist troops. NLAW, by contrast, was distributed widely to ground-holding units. Although Western training on these systems was excellent, the rapid delivery of training to new units often overlooked maintenance of the weapons – especially for maintaining batteries – and, as a result, there was a widespread problem early in the conflict with Western-supplied ATGWs being unusable when distributed to units. Over time, the appropriate instructions were disseminated to address this problem. The tactical employment of ATGWs by the UAF prior to the conflict was largely aimed at fixing or blunting enemy armoured manoeuvre and for use in raiding by light forces because of the speed with which units with these systems could displace. There were too few missiles, however, for these to be the primary means of attriting enemy forces.

Air-Defence Capabilities

One of the most consequential causes of the international underestimation of Ukraine's military prospects prior to the conflict arose from a simultaneous overestimation of Russian Aerospace Forces (VKS) capabilities and a corresponding lack of familiarity with Ukrainian air-defence capabilities. It is therefore important to understand how Ukrainian air defences were organised and equipped at the beginning of the war.

Since the Russian aggression in 2014, developing the air-defence capabilities of Ukraine has been a constant priority of its government. The radio engineering troops, tasked with warning of an air attack, reorganised after 2014 to ensure they could detect targets at 300–400 km, and direct fighters and anti-aircraft missile troops against them. At the beginning of the full-scale invasion of Ukraine, the radio engineering forces of Ukraine consisted of four brigades, whose units maintained continuous radar coverage along the state border and ensured monitoring of the airspace of Ukraine. Their coverage over the Black Sea was less extensive. These units fielded 35D6M and 80K6 radars from KP 'NVC' 'Iskra', P-18 'Malakhit' from HC 'Ukrspetstechnika', 'Burshtyn-1800' from NPP 'Aerotechnika-MLT', and other equipment.

The modernised 3D radar station 35D6M, which is also used as a surveillance radar for the S-300 anti-aircraft missile complex, is much more powerful than the outdated Soviet 19Zh6. The 35D6M radar can detect up to 300 air targets simultaneously at 360 km, while the 19Zh6 detects only 32 targets at 150 km. In addition, the Ukrainian radar has a higher accuracy in determining the coordinates, improved trajectory processing parameters and a new cooling system that significantly increases the service life of the klystrons. 35D6M also requires significantly less time to fully deploy or collapse the station, which increases its survivability. These developments had not been fully appreciated by the VKS prior to the invasion, leading to tactical errors in the employment of radio-electronic attack.

The appearance in the UAF of the 80K6 'Phoenix' radar, as well as previous versions of this system, including the 79K6 'Pelikan', allowed the remote operation of the S-300PT(PS) anti-aircraft missile systems. This radar can be deployed in 15 minutes after going static, allowing for tactical redeployment. After 2014, the armed forces also received about 50 mobile 'Malachite' radars, which is a Ukrainian modification of the Soviet P-18MU 'Terek' radar. 'Malakhit' can detect targets moving at a speed of up to 1,000 m/s and tracking up to 256 targets at a distance of up to 400 km. In addition, this system can detect small and inconspicuous targets.

Even though the war in Donbas was mostly land based, many military-political centres and industrial and energy facilities demanded air defence, which could not be limited only to detecting threats. Five nuclear plants, six dams of the Dnipro Cascade Hydroelectric Power Plant and two dams of the Dniester Cascade, and more than 10 enterprises and facilities of the chemical industry required constant cover by the anti-aircraft missile forces of the UAF, limiting protection for its manoeuvre forces. Since 2015, Ukraine has focused on restoring and increasing its combat capabilities. As of 2016, the anti-aircraft missile forces consisted of five anti-aircraft missile brigades and seven anti-aircraft missile regiments comprising 60 air-defence divisions. A Ukrainian air-defence division holds the equipment of a Western battery along with organic C2 and sustainment capabilities, thereby performing a battlefield task closer to that of a battalion. Overall, the UAF held 35 S-300PS/PT divisions, nine S-125 divisions, three S-300B divisions and 15 divisions of the Buk-M1 air-defence system.

Another critical component of the air-defence capabilities of the UAF was the extensive employment of man-portable air-defence systems (MANPADS) across all units. The saturation of MANPADS in Ukrainian units, bolstered by those that were received as military-technical assistance before the Russian invasion, became an important element of countering Russian dominance in the air. MANPADS were complementary to the air-defence missile complexes because the latter forced enemy aviation to engage at low altitudes, where in turn they fell into the zone of impact of MANPADS. After 2014, Ukraine paid considerable attention to extending the lifespan and modernisation of its own MANPADS. The most common MANPADS in the UAF were the modernised 'Igla-1', which were distributed as organic elements to its units. Some were held in the Anti-Aircraft Missile Forces as mobile groups intended to provide protection for air-defence divisions as they displaced. A major problem with this distribution was the lack of access to the common air picture among those MANPADS teams not subordinated to the anti-aircraft missile forces at the beginning of the conflict.

Aircraft

Ukrainian fighter aircraft were also an important component of the national air-defence system. As of 24 February 2022, the Ukrainian Air Force had about 50 MiG-29 fighters in service with the 40th Tactical Aviation Brigade in Vasylkiv and the 114th Tactical Aviation Brigade in Ivano-Frankivsk, as well as about 32 Su-27 fighters operated by the 831st tactical aviation brigade in Myrhorod and the 39th in Ozerny. The air force also flew Su-24 and Su-25 aircraft. After 2014, significant efforts were put into repairing fighters and a large proportion of the fleet was modernised. Although this left the air force with a higher proportion of available fighters, from

a technical point of view it was overmatched by the combat aircraft of the VKS in almost every regard. Russian aircraft could generally see and shoot further while their countermeasures were effective against Ukrainian air-to-air munitions.

Despite the technical overmatch of the VKS, the training conducted by the air force prior to 24 February played a role in ensuring its survivability. An important element of the training was working out the survivability of units through the ability to disperse aircraft from the main airfields to operational ones. Special attention was also paid to the training of maintenance crews, their ability to carry out pre-flight preparation of aircraft in field conditions, and a full set of measures necessary for the performance of maintenance and routine repair of aircraft damaged during hostilities.

Because Ukrainian pilots understood the technical limitations of their aircraft, and the fearsome capabilities of Russian anti-aircraft systems, they had trained extensively for low-level flight over Ukrainian territory and were highly familiar with the exploitation of terrain to evade radar detection. Finally, as with other technical specialisms in the air force, Ukraine had struggled to retain pilots prior to 24 February, but consequently had a very large reserve of trained pilots. The critical limitation for the air force was airframes and their serviceability, not trained crews.

Maritime Defence Capabilities

The Ukrainian Navy was the least well equipped of the branches of service at the beginning of the war. Nevertheless, noting the economic impact of Russia's control of the Sea of Azov, the navy had pursued modernisation since 2014 and had made important progress in expanding its capabilities. The first phase of naval modernisation was intended to be completed by 2025 and provided for the establishment of control over the territorial waters of Ukraine, maintaining coverage out to 40 nautical miles from the coast. For this purpose, the navy had to acquire the capabilities necessary for timely detection, identification and defeat of the enemy in this zone. The first step was to restore and modernise the system of ISR of the surface situation, including through the integration of capabilities available in other government agencies. In this context, it is particularly important to note the purchase of the multifunctional radar complex 'Mineral-U', created by the Ukrainian State Scientific Research Institute of Radar Systems Quantum-Radiolocation. 'Mineral-U' is designed for detection in active and passive modes and classification of surface targets at up to 500–600 km. It is mounted on a truck platform, is highly mobile and adapted for close interaction with the anti-ship missile complex 'Neptune', which became widely known after the sinking of the Russian cruiser *Moskva* on 13 April 2022.

Developed by the Ukrainian design bureau 'Luch', the coastal mobile missile complex RK-360 'Neptune' was an important component of the navy's modernisation, along with the development of coastal artillery, the provision of mine-blocking actions and the conduct of radio-electronic warfare. With a range of up to 280 km, manoeuvrability and sea-skimming capabilities, the Neptune can be considered a critical element of the overall Ukrainian maritime defence strategy. The first battalion of Neptune complexes was to be received in April 2022. The Russian aggression forced the accelerated transfer of systems but did not allow the full use of

the capabilities of the complex in the first weeks of the invasion, as the crew still needed some time for final preparation. A serious challenge for the navy was also the lack of a sufficient number of missiles for the complexes. However, Ukraine's receipt of Harpoon anti-ship missile systems as part of Western military-technical assistance, which are very similar to the Neptune, solved this problem and provided confidence in the ability of the navy to deter Russia in the northwestern part of the Black Sea.

Assessments and Dispositions

Having given an overview of the capabilities of the UAF in some critical areas prior to the invasion, it becomes possible to properly outline the resources available and thus prioritisation decisions that underpinned their dispositions prior to 24 February. The General Staff of the UAF had conducted extensive exercises and wargames to assess how to orchestrate the defence of the country against a wide range of contingencies. Despite having identified methods for defending all relevant axes, however, the limited number of available units without full mobilisation meant that the weighting of units had to be driven by an assessment of enemy intent. It is also important to emphasise that the economic impact of full mobilisation made this very difficult for the Ukrainian government in the face of a sustained threat that could delay major attacks for a long time.

Until days before the full-scale Russian invasion, the intelligence community of Ukraine broadly assessed that the most dangerous enemy course of action was a high-intensity offensive against Donbas in late February 2022, with the Russians using the destruction of the Ukrainian forces in the JFO area as a means of destabilising the Ukrainian state. The most likely enemy course of action was assessed to be a prolonged period of political destabilisation to create favourable conditions for a military offensive in the early summer, with the main effort being against Donbas.

Several factors contributed to the assessment that Donbas would be the main effort, despite extensive warnings from Ukraine's international partners that Kyiv would be the enemy's main effort. First, an assessment of Russian forces north of Kyiv concluded that they lacked sufficient troops to effectively isolate and seize the city. The offensive was therefore viewed as a diversionary deployment, aimed at drawing and fixing Ukrainian forces away from Donbas. As the terrain north of Kyiv was highly unfavourable for a major attack, it was assessed that Russia's attempt to draw Ukraine to concentrate on this axis would make Kyiv disproportionately vulnerable from the east. Second, interception of communications and observation of the Russian units on the Gomel axis confirmed that the personnel did not believe they were going to war and were not prepared for major combat operations. The disconnect between strategic-level discussion that emphasised the threat to Kyiv – shared with Ukraine by Western partners – with this tactical picture, supported the belief that there was a strategic influence campaign that did not reflect the tactical preparations being made by Russian units. In this sense, it is worth emphasising that the Russian deception plan was largely successful through the information security measures taken, but that the impact on the combat effectiveness of Russian troops through a failure to brief them with sufficient time to prepare came at considerable cost.

The defence of Kyiv was seen as a necessary contingency for the UAF to plan against and, as the conflict came closer, the threat to this axis was perceived to have increased. Nevertheless, since Donbas was anticipated to be the main axis, over 10 combat brigades, constituting around half of the manoeuvre forces of the UAF, were kept in the JFO area.

In addition to Donbas, Ukraine held forces around Kharkiv, Dnipro, Sumy and Odesa, a manoeuvre brigade and two artillery brigades in Kyiv, and units in training areas. There were no major formations committed forwards on the Gomel axis. Nor were there any major units committed to defend the approach from Crimea, even though this was specified in the national defence plan. The reasons for this are currently subject to an investigation. TDF were nascent, only had light weapons and were not yet fully integrated into the military command. Ukraine's defence plans therefore aimed at a high-intensity defence in the direction of Donbas lasting six weeks, giving time for full-scale mobilisation of the reserves.

A major threat, identified before the conflict, relevant to the defence of Kyiv or Donbas, was Russia's long-range strike arsenal. As a result, beginning one week prior to the invasion and accelerated 72 hours before, munitions stockpiles were dispersed from the main arsenals. Aircraft and air-defence systems were also dispersed hours before the invasion. As it became apparent that the Gomel axis was the enemy's main effort and that another group of forces would strike through Chernihiv, a redeployment of Ukrainian forces was ordered approximately seven hours prior to the invasion. This took considerable time. The result was that many Ukrainian units were not at their assigned defensive positions when the invasion began and, especially on the northern axes, were not in prepared positions. Redeployments from the southern axis towards Kyiv also left fewer troops to hold the coast. Ukrainian units found themselves in a meeting engagement with the enemy. The critical point here is that the war started with the AFRF holding the initiative at the operational level but with their tactical units surprised by what they were being ordered to do. The UAF found themselves surprised at the operational level but with tactical units which had been psychologically and practically preparing for this fight for eight years. The interaction between these variables would be decisive in determining the outcome of the first 72 hours of fighting.

III. The Invasion

HAVING ASSESSED THE plans and dispositions of the opposing forces, this chapter outlines what occurred during the initial phases of the war.

Shock and Mutual Surprise: D+0–3

The invasion began with a massive fire-strike campaign across Ukraine. The strikes were preceded by the widespread application of electronic attack to disrupt and damage defensive radar and air-defence installations, along with the extensive use of aerial decoys to saturate the defences. This was followed by the employment of cruise and ballistic missiles launched from sea-, air-, and ground-based launch systems. In addition, Russian aircraft penetrated Ukrainian airspace to strike tactical targets. The Russian High Value Target list quite logically included industrial facilities, fuel and energy storage facilities, air-defence sites, C2 infrastructure, ammunition storage points and troop assembly areas, as consistent with Russian doctrine. It was noted that during the first two weeks, Ukrainian transport infrastructure was not targeted, except when it was required by a tactical situation.

There are some peculiarities to the order and effectiveness of this initial Russian fires campaign. For example, while the Russians had accurately mapped a large number of military sites, there were very few engagements against tactical groupings of forces, with the preponderance of strikes being at maximum depth and then working backwards towards Ukraine's tactical echelons. As the tactical elements were the most mobile, however, this sequencing maximised the time available for tactical elements to displace. Furthermore, the Russian lists appeared to be linear and unresponsive to updated information. Many strikes were struck that had not been military positions for years. Moreover, against moving targets, new detections would apparently be added to the target list, without removing the previous reported location, so that dynamic strikes were often delivered too late. Furthermore, the number of munitions assigned to each target appeared to bear little correlation to the size of the target, suggesting limited familiarity with the effects of these classes of munitions among Russian planners. The result was that within the first 48 hours, approximately 75% of stationary Ukrainian Air Defence sites were engaged. At the same time, the estimated percentage for mobile air-defence sites was only about 10%.

The effectiveness of the Russian strikes was greater than the number of platforms destroyed, however. Given the orders to redeploy Ukrainian forces, the damage and disruption to C2, the unexpected concentration on the Gomel axis, and the forced displacement of systems, many Ukrainian systems were alive, but uncoordinated for the initial 24 hours. A significant proportion of the air-defence infrastructure survived but was not in a position to conduct a coordinated defence. Instead, it largely delivered pop-up attacks against Russian forces. This suppression effect meant that for the first phase of the war, the success rate of interceptions of Russian cruise missiles, for example, was around 12–18%. Given that this rose to 40–60% in the

second phase of the conflict, the effect of both the scale of the Russian strikes and the impact of dislocation on the effectiveness of the defence can be seen.

Russian successes were disproportionately weighted to certain axes. The majority of available air-defence coverage for the southern coast around Kherson and Mykolaiv, for example, was destroyed or suppressed. Two air-defence sites responsible for screening the Dnipro River from the north were also destroyed, opening a gap in the defences which enabled the conduct of an air assault against Hostomel from Belarus. In addition to the dislocation caused by missile strikes, Russian aircraft flew sorties to strike specified targets along the axes of advance for their respective groups of forces. This further dislocated the positions of the air-defence forces.

An important element of the Russian plan to disorganise Ukraine's military C2 system was also to neutralise the top military leadership of the UAF. Thus, in the first days of the invasion, a large number of Ukrainian generals received personal messages from Russian military leaders urging them to surrender and assuring them that Russia did not intend to do any harm to Ukraine. Messages of similar content, but sent from anonymous numbers, were received by almost all colonels and other senior officers of the UAF. The strategic importance of this campaign is evidenced by the fact that on the second day of the invasion, Putin publicly appealed to the Ukrainian military to not resist the Russian invasion. This failed campaign also highlights the poor assessment of the psychology of the Ukrainian military by the Russian special services.

A critical weakness of the Russian strike campaign was battle damage assessment. First, the Russian military appears to have presumed that if an action had been ordered and carried out then it had succeeded, unless there was direct evidence to the contrary. Evidence of success appears to have disproportionately relied on three data points: confirmation from pilots that they hit their target; confirmation from Russian satellites that a site showed damage; and confirmation from signals intelligence (SIGINT) that Ukrainians reported a strike and damage to their equipment. Russian satellite reconnaissance proved very limited, even though Russian survey space reconnaissance of Ukraine has been conducted since at least 2012, and detailed reconnaissance, in the interests of invasion planning, since mid-2021. A probable reason for this may be the insufficient number of satellites in the orbital grouping of the VKS and the overestimation of their technical capabilities. Indirect confirmation of this explanation is provided by the fact that the AFRF began buying additional satellite images of the territory of Ukraine and individual military facilities on the world market in April 2022. One of the visible failures of satellite intelligence is the inability to detect on time a significant volume of strategic railway movements by the UAF, which, in March 2022 amounted to three–four echelons per day.

The poor Russian battle damage assessment process made the Russian military highly vulnerable to deception, which has been consistent throughout the conflict. Early strikes on Ukrainian airfields, for example, destroyed many hangars. By photographing this damage and printing the resulting pattern on to sheets, it became possible to clear the rubble and erect covers for aircraft to return to the site, sheltering in positions that the Russians would confirm as destroyed. This led – somewhat amusingly – to the Russians debating whether Ukrainian fighter aircraft were operating from subterranean shelters at several sites. Repeated strikes on dummy air-defence

positions also saw a considerable wastage of ammunition, while Ukrainian troops could confirm that sites were destroyed over the radio even when they were still functioning, causing Russian aircraft to ignore air-defence systems in their mission planning. The already-publicly reported use of dummy HIMARS (high mobility artillery rocket system) later in the war to lure Russian fires is indicative of the systematic use of deception to ensure survivability by the UAF, and it has proven widely effective.

The presumption of success caused the Russian military to take several unjustifiable risks in the disposition of its forces during the first 72 hours of the conflict. Aircraft did not fly with EW pods during the opening phase as they were not deemed necessary following the presumed success of the strike campaign. Similarly, Russian manoeuvre forces were not properly supported by air-defence units and Russian air-defence units were told to presume that aircraft were friendly. This enabled a significant number of ground-attack sorties by the Ukrainian Air Force, including using UAVs such as TB2, against Russian formations, even when they had attached air-defence units. Ukraine suffered aircraft losses in air-to-air engagements, however.

The penetration of Ukrainian territory by Russian air-assault units on the first day of the invasion deserves special consideration given its significance in the overall plan. Air-assault troops were landed at Hostomel in two waves, each comprising 10 helicopters. These followed the course of the Dnipro River from Belarus to remain below air-defence coverage and successfully reached their objective. In the first wave, two helicopters were shot down at Hostomel by MANPADS. This incident highlights the vulnerability of helicopters to MANPADS as, even under optimal conditions, there is little ability to prevent losses. The assault on Hostomel also highlights why air assault against positions – rather than axes – is extremely dangerous. Upon landing, the Russian VDV came under heavy artillery fire and were subsequently cleared from the airfield by a mechanised counterattack. Similar operations attempted in southern Ukraine and attempts to insert special forces in western Ukraine were unsuccessful for similar reasons.

The behaviour of Russian Ground Forces during the first three days of the war – which differed considerably from pre-war expectations, from their orders and from doctrine – require some explanation. For reasons of operational security, orders were not distributed until 24 hours before the invasion to most units. As a result, Russian troops lacked ammunition, fuel, food, maps, properly established communications and, most critically, a clear understanding at the tactical level of how their actions fitted into the overall plan. It is not so much the case that tactical Russian commanders are incapable of initiative or mission command, but rather that they lacked the detailed instructions of their commanders' intent or their role within the wider battle plan to make such decisions. Instead, by the time instructions reached battalion tactical groups (BTGs), what had begun as detailed operational planning descended into orders to reach specific locations within a specified timeframe. Confirming the notion that the conventional military component of the invasion was intended as a supporting demonstration of power rather than the main effort, Russian units were ordered to proceed in administrative column, and to bypass UAF units. Many Russian soldiers arrived in towns without their weapons loaded. They were – for the most part – not anticipating heavy fighting. Furthermore, old maps and a lack of

time to coordinate the activity of tactical units led many units to move along the same roads, rapidly becoming intermingled, choking up key junctions and slowing down the rate of advance.

Figure 3: Map of Ukraine on 27 February

Source: Based on information in Mason Clark, George Barros and Kateryna Stepanenko, 'Russia-Ukraine Warning Update: Russian Offensive Campaign Assessment, February 27', Institute for the Study of War, 27 February 2022, <https://understandingwar.org/backgrounder/russia-ukraine-warning-update-russian-offensive-campaign-assessment-february-27>, accessed 25 November 2022.

The speed and conception of the Russian advance posed grave dangers for the UAF. Russian Ground Forces made rapid progress towards Kyiv from Gomel where there were in any case very few Ukrainian troops. The axis past Chernihiv also posed major challenges as Ukrainian forces were caught between their positions, while the orders to bypass resistance left many Ukrainian units cut off, behind Russian lines. The UAF made three decisions at this stage that proved

important. First, a large portion of Ukraine's special forces and the special units of Ukraine's Special Services were committed on the Gomel axis. Second, Ukraine mobilised reserve units, which rapidly created new battalions near Kyiv. Third, the UAF mobilised its cadets and the teaching staff of its military academies to force-generate additional infantry battalions. In this way a new group of forces was formed within the opening week of the conflict, supported by the two brigades of artillery held in Kyiv and one mechanised brigade. Even with these efforts, the Russians achieved a 12:1 force ratio advantage on the Gomel axis. Similarly, around Chernihiv, the 1st Tank Brigade found itself encircled and lacking infantry support, necessarily drawing on territorial defence units and reservists to adopt a position of all-round defence.

In Donbas, the Russian operations to fix the bulk of the UAF proved almost entirely successful. Although the AFRF made little progress against the defensive positions along the line of contact, it proved impossible for Ukrainian troops to be redeployed from this theatre. To the south, the Russian breakout from Crimea proceeded in a manner consistent with the Russian invasion plan, with Melitopol and Kherson seized with minimal fighting and significant progress made in achieving the encirclement of Mariupol to bring the city under a state of siege. Russian progress towards Kharkiv proved entirely contrary to their plan and their forces were repulsed with heavy casualties. Initially Russian special forces entered the city in light vehicles, only to be isolated. When offered an opportunity to surrender, these personnel claimed that the Ukrainian defenders would soon be the ones surrendering once larger combat units arrived. The disparity in preparedness between these special forces' groups and their conventional supporting units, however, hindered their coordination and the advanced parties were subsequently destroyed, while Russian forces transitioned to a deliberate break-in against the city, supported by widespread artillery strikes.

From the above, it is important to recognise that the Russians achieved surprise and succeeded in bringing about highly favourable force ratios on their main axes. On the second day of the conflict, there was considerable anxiety in the UAF as to the ability to halt the advance from Gomel. In understanding why the Russians stalled, despite having the means and forces to push through the small Ukrainian units in front of them, it is necessary to consider the psychological state of the Russian troops. These troops were largely moving in administrative formations. They lacked a clear understanding of where they were. Whole towns did not exist when the maps they were using were made. They had not anticipated heavy fighting, nor did they have established communications to report the situation or to receive updated instructions. Ukrainian forces found themselves bypassed and often confronted with columns of unprepared Russian troops. Even without higher instructions, the immediate task was clear to these units, and, at the tactical level, Ukrainian forces therefore retained the tactical initiative. For the 1st Tank Brigade, for example, the first days of fighting saw numerous meeting engagements in forests at around 100–200-m range, where restricted movement limited the Russian ability to bring their mass to bear against a specific tactical situation. Better crew training combined with short-ranged engagements where their armament was competitive, and the faster autoloader on the T-64, allowed Ukrainian tank crews to achieve significant damage against surprised Russian units. Another example of the problem was that Russian units would arrive in towns and begin to try to engage with the civilian population to understand where they were. Their position

would be reported and the Russian unit would be engaged with artillery. This contrast between expectations and reality induced panic and caused the abandonment of equipment that was widely observed on social media.

The Battle for Kyiv: D+4–37

By D+3, it was apparent to Russian commanders that their plan had gone seriously wrong. It was evident that Ukraine's air defences were still operational, that the Russian Ground Forces had stalled, and that there was fierce resistance. Moreover, it was apparent that the activities of the special services in Kyiv aimed at neutralising Ukraine's political leadership – critical to Russia's theory of victory – were failing as the Security Service of Ukraine identified, isolated and destroyed their infiltrated groups. In fact, as Ukraine mobilised, repositioned its forces, and as its air defences recovered from their initial displacement and surprise, the defence was hardening. There was therefore a need to transition from attempting the *coup de main* to deliberate combat operations to defeat the UAF. This transition in the Russian posture began on D+3 with a progressive improvement in the enemy's cohesion over the following month. However, it took considerable time for Russian commanders to understand what was happening, to assert control over their units, or to adapt their tactics.

The fastest component of the Russian force to adapt was the VKS. From D+3, Russian aircraft began to change their tactics. Rather than flying single sorties to strike pre-designated targets, large strike packages of interceptors and aircraft armed with anti-radiation missiles would form up in an attempt to provoke Ukrainian air defences into illuminating. These would then be suppressed with anti-radiation missiles and hunted by Russian aircraft or helicopters at low level. The latter suffered heavy attrition to MANPADS employing these tactics and the depth of aviation operations gradually diminished.

The Russian transition to low-level hunting tactics coincided with the steady activation of air-defence complexes to protect Russian armed forces' manoeuvre formations. At this time, Ukrainian air defences deconflicted from the Ukrainian Air Force's interdiction missions by time, so that MiG-29s would conduct defensive counter-air sorties in pairs as the air defences displaced. This proved problematic because it was difficult to distribute awareness of these phases to deployed infantry with MANPADS. Both Russian and Ukrainian aircraft were threatened by friendly fire at this time. As a result, the deconfliction of air interdiction from Ukraine's air defences was changed to a spatial approach, with areas in depth assigned to defensive counter-air patrols and areas to the rear assigned to air-defence forces. For a time, Ukrainian pilots were able to engage their Russian adversaries in air-to-air engagements, although they often found themselves outnumbered 6:2. Nevertheless, Ukrainian aircraft did inflict some losses in these engagements, despite losing several aircraft, reflecting the comparatively low training of most Russian pilots. In the first weeks of the invasion, when Russian forces neglected the need to provide air cover, long Russian convoys were also subjected to air strikes by both Air Force and Army aircraft, including Su-24M/MR bombers, Su-25 attack aircraft, Mi-24 and Mi-8 helicopters, and Bayraktar TB2 UAVs.

By D+10, defensive counter-air missions became harder to mount. Russian A50-M orbits ensured that the VKS had ample early warning of Ukrainian air movements. As Russian EW complexes began to be deployed systematically, Ukrainian pilots found that they often had their air-to-ground and air-to-air communications jammed, their navigation equipment suppressed, and their radar knocked out. The use of jamming pods on Russian aircraft also increased. Combined with an intensifying threat from air-defence systems, the Ukrainian Air Force progressively lost access to parts of the occupied territories. Close air support and the use of strike UAS also became impossible over much of the battle space owing to dense EW and air-defence coverage.

This rapid improvement in the performance and organisation of the VKS is noteworthy because these units were flying from inside Russia's operational depth and did not therefore suffer from the confusion that was engulfing Russia's Ground Forces in Ukraine, slowing their adaptation to the circumstances on the ground. Another good indication that the intent of Russian commanders shifted fairly rapidly is the decision by the Russian command not to commit its maritime assault forces, which had been intended to conduct landings between Mykolaiv and Odesa. To conduct the amphibious landing, two amphibious detachments of three large amphibious ships were formed. For the landing in the first wave, units of the 810th Marines Brigade of the Black Sea Fleet and the 336th Marines Brigade of the Baltic Fleet were initially planned. With small breaks, the amphibious forces manoeuvred in the Black Sea until the beginning of April 2022. After the initial reconnaissance landing by Russian special forces in the first days of the invasion with flat-bottomed raiding craft destroyed and heavy casualties, the Russian command determined to refrain from launching this attack.

For those Russian ground units already in Ukraine, adaptation was slower. It is worth exploring why. The standard Russian approach to the formation of BTGs provided for the allocation of one or two BTGs from the composition of the full-time brigade or regiment. In forming, or more precisely, collecting, even one BTG from the brigade for a short-term military operation, the command tried to appoint the best personnel to its composition and distribute the best weapons and equipment for its mission. By itself, the BTG, in the understanding of the Russian command, was more like a 'reinforced battalion'. The main difference with such a reinforced battalion compared with a permanent combined arms formation is that approximately half of its personnel, and the unit commanders, largely saw each other up close for the first time in their lives on the amalgamation of the BTG. One can only assume how much the relevant commanders were informed about the level of training, experience and equipment of such a unit. At best, they had to rely on the reports of the commanders of regular units about the readiness of their distributed forces and their capacity to perform tasks.

In addition to BTGs being units that had not trained together and lacking staff who knew one another, they were also non-uniform in their composition. These deviations did not appear to derive from the tasks they were assigned but instead arose from the equipment available from the units that generated them. Yet, to commanders at higher echelons, the Russian battle management appeared to treat all BTGs as comparable units of action with no tailoring of tasks to their respective capabilities. When military advances are used as a mere demonstration of force this would not have been critical. But once the force tried to transition to fighting, units

Figure 4: Map of Ukraine on 2 April

Source: Based on information in Mason Clark, George Barros and Karolina Hird, 'Russian Offensive Campaign Assessment, April 2', Institute for the Study of War, 2 April 2022, <https://understandingwar.org/backgrounder/russian-offensive-campaign-assessment-april-2>, accessed 25 November 2022.

were now assigned tasks for which they were poorly equipped. As an example, consider the composition of two BTGs, which operated in almost the same area in the east of Ukraine at the end of April 2022. One of them was from the 228th Motor Rifle Regiment of the 90th Armoured Division of the Central Military District (Svatove district): 23 APCs; six tanks; a 122-mm self-propelled artillery battery; three MLRS BM-21 'Grad'; up to 40 vehicles; and about 400 personnel. Another was from the composition of the 57th Motor Rifle Brigade of the 5th Army of the Eastern Military District (Rubizhne district): more than 30 infantry fighting vehicles (IFVs); 14 tanks; a 122-mm self-propelled artillery battery; a 152-mm self-propelled artillery battery; a MLRS BM-21 'Grad' battery; up to 60 vehicles; and about 800 personnel.

Confusion as to the location and composition of units combined with significant deviation from their pre-assigned tasks led to paralysis in command decisions and no new statement of intent being provided to tactical commanders to rationalise their own decisions. A combination of a lack of time to exchange encryption keys on radios, the effects of Ukrainian EW, poor training

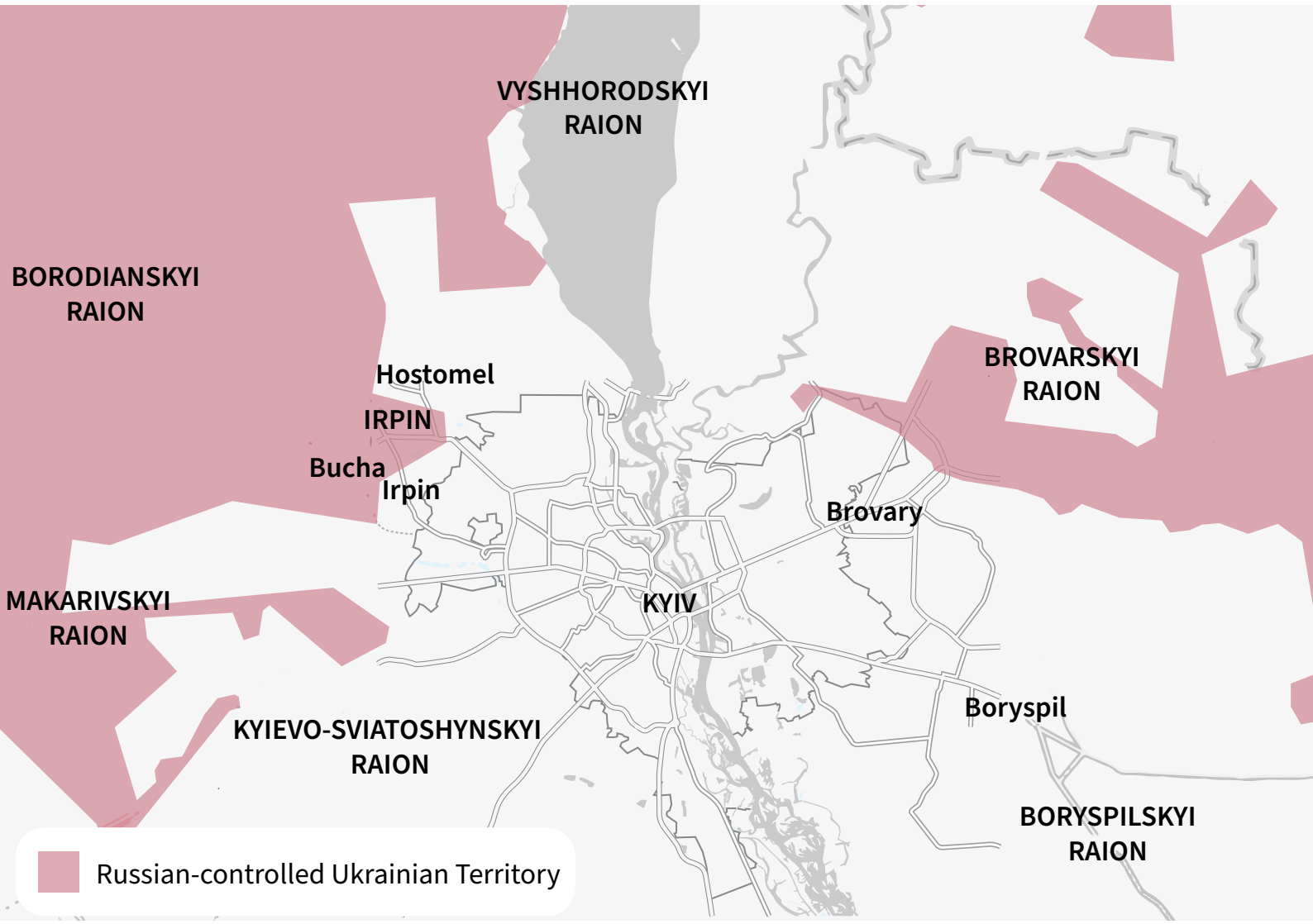
on communications equipment and the reversion to stealing cellular communications from local citizens allowed Ukrainian forces to monitor a significant quantity of Russian tactical communications. For the period of March, most of the radio exchanges of Russian troops at the brigade-BTG level consisted of information about the locations of units and individual elements, and only 10–20% related to combat management. Later, Friendly Force Information Requirements only partially considered the monitoring of the needs of class III and V supply which, in turn, created problems with ready supply and imposed loads on the control networks. This not only saw significant supply problems but also the nature of the traffic enabled Ukrainian forces to accurately target Russian positions.

The lack of understanding of Russian commanders as to the location or condition of their units and the lack of situational awareness of their tactical commanders near Kyiv and Kherson in March–April 2022 invariably led to the movement of newly arrived units along the same routes, repeated attempts to conduct already-exposed manoeuvres, the use of the same locations for temporary staging, and the overreliance on a small number of main supply routes. Even in the maritime theatre, this sticking to proven routes enabled a strike in early March using BM-21 Grad by the Ukrainian Marines on a Russian patrol boat at sea. Conversely, communication with 1st Tank Brigade was maintained along a small supply road running northwards on the left bank of the Dnipro that the Russians failed to sever, despite having an overwhelming force presence. This speaks to the poor situational awareness and lack of active patrolling by Russian units. The breakdown of communications also prevented units bringing up equipment to resolve a range of unforeseen tactical dilemmas. From an operational point of view, Russian intelligence obviously did not foresee the use of hydrotechnical structures for the improvement of existing natural barriers. An example of this is the slow response by Russian troops to the use of hydraulic structures on the Irpin River, which made it possible to raise the water level by 0.5–0.7 m and turn the small river into a significant obstacle for the Russian troops who were rushing to Kyiv.

This general confusion among Russia's Ground Forces gradually eased towards the end of March as senior officers came forward to establish situational awareness. In the meantime, however, on the axes approaching Kyiv, Ukrainian forces had effectively screened the flanks of the Russian force, which was in any case concentrated in too narrow an area for the number of troops pushed forwards. This unfavourable battlefield geometry made it impossible for the Russians to build up significant momentum, as they came under sustained and intense artillery fire throughout the month. By the time Colonel General Chaiko, commanding the Eastern Group of Forces, had re-established a clear picture of the battlespace, he faced a choice to break through Ukrainian lines and sever the roads to the west of Kyiv, or else withdraw. Initially the Russian forces attempted the former course of action. Unable to bring significant artillery or ammunition forward, however, they took massive casualties and, pressed from both flanks, were at risk of encirclement. When it became apparent that the Central Group of Forces was going to fail to invest Kyiv from the left bank, the decision was taken to withdraw from the Gomel axis and recover the troops.

The Central Group of Forces, attacking via Chernihiv towards Kyiv, and via Sumy, faced a different dilemma. Having bypassed large Ukrainian combat units, while attempting to traverse over

Figure 5: Map of Kyiv on 21 March



Source: Author generated from original map by lesniewski / Adobe Stock. Author assessment of control includes information in Mason Clark, George Barros and Kateryna Stepanenko, 'Russian Offensive Campaign Assessment, March 21', Institute for the Study of War, 21 March 2022, <https://understandingwar.org/backgrounder/russian-offensive-campaign-assessment-march-21>, accessed 25 November 2022.

200 km of densely wooded terrain, these forces had dissipated much of their combat power and were suffering heavily in ambushes and meeting engagements. Here the tactical initiative of Ukrainian tactical units and special forces inflicted heavy casualties. Given the use of Chernihiv as a strongpoint in all-round defence, the Central Group of Forces had the choice, once control had been re-established over its combat units, to either concentrate to reduce these positions to its rear, or else to screen these positions and continue towards the original objective, which was Kyiv.

The initial success of the Southern Group of Forces slowed considerably as the combat power of this grouping dissipated across multiple axes. The problems that arose in some of the tactical decision-making among this group of forces can be observed from the lack of intent in orders regarding reversionary courses of action. For example, the Southern Group of Forces only

encountered serious resistance on reaching Mykolaiv. As on other axes, the Russians achieved an advantageous force ratio and surprise. Available Ukrainian artillery in this sector was limited. Russian forces had also achieved air superiority. Nevertheless, adhering to the orders to bypass centres of resistance, the Russian units proceeded to try and encircle Mykolaiv to the north. In doing so, they dissipated their combat power, gave the Ukrainian Southern Command time to mobilise and organise more units, and left themselves with an exposed flank. As a result, this position became increasingly untenable, although it would take weeks of bitter fighting before Russian combat units stopped trying to push further west.

The Southern Group of Forces had much more success in closing off Mariupol. Despite many of the Russian tactical actions in this phase of the war, originating with precise and appropriate instructions from higher command, few of these commands could be properly executed. The advance on Mariupol represents an exception, where the higher operational intention to achieve encirclement was properly carried out. Here there was a skilful implementation of preparatory measures to block the communication routes from Mariupol to Volnovaha at D+8 during the encirclement of Mariupol. This set up conditions for the subsequent siege.

The destruction of Mariupol – where the Russians had anticipated fierce resistance and were not expecting a rapid surrender by the local authorities – demonstrates the difference that could have been made elsewhere if Russian forces were properly prepared for heavy fighting. Here the model was similar to that used against Grozny in the Second Chechen War: massive employment of fires combined with assault groups to break up defensive positions. The commitment of the 8th Combined Arms Army using BTGs with poor infantry–armour cooperation in the first phase saw significant attrition among Russian units. Nevertheless, Russian forces quickly adapted, forming storm groups of armour and infantry, and creating storm detachments of Chechen troops who proved relatively effective. There were shortcomings in the Ukrainian defence of Mariupol that have since been rectified. The main issue was the establishment of unit boundaries and the division of responsibility between naval, ground and territorial defence forces of the UAF. Russian assault units accurately identified the unit boundaries and were able to exploit these to fracture the defence into several isolated pockets. Given that Russian tactical commanders understood the intent was to seize the city, they were able to effectively implement tactical actions. The longevity of the defence of Mariupol reflects the extraordinary bravery of its defenders. Ukrainian forces not only exceeded the expectations of the Ukrainian General Staff, but also inflicted heavy losses on the Russian attackers. The battlefield geometry, however, of an encirclement deep behind Russian lines, the extensive air defences erected around the city, and the lack of friendly air defences enabled the use of heavy bombers, massive artillery and other means to steadily reduce the defence. Ukraine's Southern Command has subsequently worked to improve the coordination between Army, TDF and naval units.

Refocusing on Donbas: D+38–91

The Russian retreat from Kyiv saw a change in the objectives and strategy of the AFRF. Instead of seeking to seize the capital, Russian forces would endeavour to implement what the UAF had assessed to be their most dangerous course of action from the outset of the conflict: the

destruction of the UAF in Donbas; seizure and annexation of Luhansk and Donetsk; and, from this position, force Kyiv to negotiate on unfavourable terms. The focus of Russia's special services would also shift, from the destabilisation of the Ukrainian government to economic and political warfare against Europe to undermine international support for Ukraine.

Before describing the nature of the fighting, it is important to take stock of the relative condition of the forces, which were repositioned over the course of April. Russian forces had suffered from massive attrition around Kyiv and had lost a vast quantity of military equipment. Throughout April there was an ongoing debate in the Russian government as to the need for mobilisation. Eventually the decision was made against mobilisation. Alongside attrition, Russian forces were suffering from low morale given their lack of success on most axes. At this point, a peculiar bifurcation occurred in the Russian forces. On the one hand, the higher command was still convinced of the need to fight with the BTG as the preferred unit of action, even if this non-uniform and non-mission-specific grouping differed considerably in capability. Thus, when the offensive against Donbas was undertaken in earnest throughout May 2022, it is estimated that Russian forces were fielding a total of 146 BTGs located around Ukraine, of which 93 were active, 13 were being restored, and 40 were in first- and second-phase reserves. This included the 136 BTGs in the original invasion force and additional units formed from reserves and Luhansk People's Republic (LNR) and Donetsk People's Republic (DNR) conscripts.

At the same time, where the Russians had achieved success, they had formed mission-specific groupings, as in Mariupol. The need for non-uniform formations was also driven by several factors concerning human and material resources. Although the Russians were beginning to recruit new contract soldiers and commit Wagner mercenaries and other units, these groupings were largely organised into company-sized units. Heavy casualties among spetsnaz and air-assault units also led to these troops being fielded in company groups more often than battalions. Moreover, although the mobilisation of conscripts in Luhansk and Donetsk had produced around 35,000 troops, heavy casualties in these formations left them highly irregular. Equipment losses also led to the consolidation of capabilities, so that fewer BTGs fielded their assigned batteries of 152-mm howitzers, with these concentrated into artillery tactical groups instead. Over time, as the Russian military came under strain, its organisational principles were diverted into task-specific organisation, usually of brigade groups with several attached independent companies.

Materiel and personnel pressures were also shaping the disposition of the UAF between the assault on Kyiv and the offensive on Donbas. Ukrainian casualty figures remain classified and cannot be detailed in this report. Nevertheless, after months fighting outnumbered, the very high number of wounded – representing around 80% of casualties on the Ukrainian side, with around 40% of wounded personnel sustaining permanent injuries – left a number of key units heavily depleted. It was also noted at this time that the UAF did not have an established doctrine nor procedures for rotating units from contact. Units in Donbas, for example, had been under attack for more than a month with no reprieve, and it seemed probable that they would now face the full weight of a Russian offensive. Fatigue and concussion from artillery fire were serious issues best resolved through troop rotations. It became imperative to develop techniques to ensure the rapid circulation of troops. Despite these challenges, morale within

Ukrainian units remained high, first, because of the failure of the AFRF to place Kyiv under siege, and second, because while a fight in Donbas would be difficult, it was also something that Ukrainian troops had prepared for over several years, offering confidence in their ability to blunt the Russian offensive.

It is briefly worth flagging here a political factor that shaped, and in some ways constrained, Ukrainian military preparations for the defence of Donbas at this time. The discovery of war crimes perpetrated at scale by Russian forces in occupied territories on the axes approaching Kyiv created a political climate in which the surrender of territory, and especially settlements, became politically unacceptable. Given the disparity in forces, a manoeuvre defence would have been most effective from a purely military point of view, enabling the enemy to be shaped and then cut off through counterattack to maximise its losses. However, the human cost of these tactics on the population, whom the UAF were mobilised to defend, would have been unacceptable. Showing that the Army would hold ground for as long as practicable was therefore not only a political imperative, but also important in underpinning the moral component of the fighting force. This is not to argue that political decisions inappropriately had an impact on military decision-making. Instead, it is one of the ongoing strengths of the Ukrainian state that there remains a healthy civil–military discourse and an ability to balance these critical factors. Nevertheless, this led to tactical dispositions that, from a purely military perspective, may have appeared suboptimal.

The largest challenge at this stage in the conflict for the UAF was equipment losses and the expenditure of ammunition. Although Western support had been symbolically invaluable in the early stages of the war, the enemy was stopped principally through the employment of Ukrainian arms. Nevertheless, Ukraine had, by this point, exhausted most of its MLRS and heavier-calibre Soviet-era artillery ammunition. By the commencement of the Russian offensive against Donbas, NATO systems were becoming available. However, only small numbers had arrived, while training and support for first- and second-line maintenance was not yet available. For example, many of the M777 howitzers that were delivered became inoperable due to maintenance issues after being misused by crews. Furthermore, there was not yet a structured way for equipment to be provided. Whereas piecemeal deliveries of a wide range of systems was workable for rocket-propelled grenades and other light weapons, it was problematic for heavy weapons such as artillery. With little consolidation of support, Ukraine began to receive a wide variety of equipment types, all of which differed in their maintenance and logistical requirements. The early stages of the offensive on Donbas, therefore, saw the UAF at their most vulnerable from the point of view of equipment. The question was whether materiel support would accelerate sufficiently to meet the imminent threat. While Ukraine managed to maintain artillery parity in the first stage of the war, in the second stage, thanks to the absolute superiority in the volume of ammunition, Russia began to achieve fires dominance.

The Russian offensive on Donbas proceeded in accordance with the sound logic of operational encirclement through attacks to the north and south of the JFO. Although the overall operational concept was sound, it must be noted that no effort was made to disperse Ukrainian forces on to other axes or otherwise present the UAF with competing imperatives. Thus, while the UAF

had a shortage of armaments at this time, they also had a very limited and identifiable area where armaments needed to be concentrated. The protracted defence of the Azovstal steel works – long after the rest of Mariupol had fallen – proved important in slowing the release of forces to simultaneously pressure Donbas from the southern axis and thereby further limited the frontages that the UAF had to cover in the first weeks of the offensive. After initial attempts at an armoured breakthrough failed, the Russian military resorted to manoeuvre by fire. The efficiency of this approach was greatly hindered by the unwillingness of their infantry to make deliberate assaults without massive artillery preparation of the targets. It was not uncommon for a company position of the UAF – occupying a frontage of approximately 3 km – to be subjected to 6,000 rounds per day of fire. At this time, the Russians not only had vastly more ammunition than the UAF but also outranged most Ukrainian artillery and the concentration of EW limited the effectiveness of precision fires.

With the concentration of effort on Donbas, Russia set up EW complexes with up to 10 complexes per 20 km of frontage. Collectively, these complexes effectively disrupted navigation along the front, and conducted direction finding to direct artillery and electronic attack against Ukrainian aircraft and UAVs. The use of UAVs during this period deserves special consideration. As the war became dominated by artillery duelling, the importance of rapid target acquisition increased. The narrowing of the contested front and concentration of artillery also offered fewer opportunities for human reconnaissance. Both sides used UAVs extensively throughout the conflict. These ranged from commercial and adapted quadcopters at tactical echelons to fixed-wing reconnaissance UAVs such as the Ukrainian SKIF and Russian Orlan-10. The latter two were especially valuable because they could fly at medium altitude, were too cheap to be economical targets for air defences and provided extensive imagery to enable rapid and responsive fires. Both parties also used large medium-altitude long endurance UAVs such as Ukraine's TB2s and Russia's Orion for target acquisition, although these platforms were scarcer, more vulnerable, and therefore only committed under favourable conditions.

Despite the importance of UAVs to remaining competitive, their attrition rates were extremely high. Of all UAVs used by the UAF in the first three phases of the war covered by this study, around 90% were destroyed. The average life expectancy of a quadcopter remained around three flights. The average life expectancy of a fixed-wing UAV was around six flights. Skilled crews who properly pre-programmed the flight path of their UAVs to approach targets shielded by terrain and other features could extend the life of their platforms. However, even when UAVs survived, this did not mean that they were successful in carrying out their missions. UAVs could fail to achieve their missions because the requirements to get them in place – flying without transmitting data, with captured images to be downloaded on recovery, for example – prevented timely target acquisition before the enemy displaced. Furthermore, such a method, while improving survivability, also necessitated the right locations to be preselected for image capture. Many missions failed to find targets because there was no target at the specified location. Alternatively, and more common, was mission failure owing to disruption of a UAV under control through electronic warfare, the dazzling of its sensors or the denial of its navigational systems from determining the accurate location of a target. In other instances, the Russians successfully struck the ground control stations of the UAV. In aggregate, only around a third of

UAV missions can be said to have been successful. Here, the Orlan-10 should be singled out in terms of its utility because the cheap platform nevertheless had a high performance and proved difficult to counter, although its inertial navigation makes insufficient account of windage. Even the Russian military, however, found that it did not have enough of these platforms to sustain the loss rate during the battle in Donbas.

The defeat of precision was critical to unit survival. Defeating precision could be achieved by preventing a launcher from accurately determining its position, even with very small displacements, by preventing the enemy determining the precise location of the target or through direct interference with the mechanism for precision strike. The latter did not always require expensive methods. When Russian reconnaissance troops began to mark Ukrainian defensive positions with laser designators, for example, it was found that having laser warning indicators over strongpoints could alert personnel being targeted, who could then pop smoke grenades to disrupt the accuracy of the strike. This would also blind the defenders, making them vulnerable to assault. Thermal optics, or the targeting of the designating team from another position to relieve the suppression of the targeted post was critical. The experience of the UAF showed that precision artillery was not only disproportionately effective, but also limited the vulnerability of the force by reducing its logistical footprint. Nevertheless, in the early phases of the fighting in Donbas when the UAF had few precision systems, Russian EW reduced the effectiveness of these systems. This disproportionately affected the UAF because the Russians primarily relied on saturation fire from unguided shells.

Although Russian EW systems were highly effective, there were also noted weaknesses of these complexes. The Russians suffered extensively from these systems having an equally noticeable effect on its own troops. The AFRF have not yet managed to solve this problem, except in the case of some specific platforms such as the Su-34. Furthermore, there were often weaknesses in planning, partly exacerbated by the issue of fratricide. For example, when military communications were suppressed it was often possible to revert to cellular communications channels. Although the Russians have the means to target these communications, the Leer-3 payload carried by an Orlan-10 UAV is hard to synchronise with EW effects that make the use of UAVs exceedingly difficult. Furthermore, although navigational effects disrupted precision, direct jamming against precision systems was rarely effective. It is apparent that the Russians have refined, but done little to develop beyond, Soviet systems and some of their new systems such as the Repellent complex were largely ineffective.

During this period, the Russians had consolidated much of their artillery into artillery tactical groups and began directing fires from higher headquarters owing to a shortage of trained fire controllers. Russian artillery would tend to operate in batteries a third of their range behind the forward line of own troops (FLOT), with a spacing of 100–150 m between their guns. Missions were usually assigned to the battery, whereas the UAF mostly assign fire missions to guns. Russian units with their own UAVs could deliver highly responsive fires, bringing effect to bear within 3–5 minutes of target detection. For targets that ran through a fire-control headquarters, the Russians continued to add new detections to the bottom of the list and prosecute strikes in order, leading to fire missions taking 20–30 minutes at the tactical level, and around 48 hours at

the operational level. Russian artillery would conduct counter-battery fire, but never from the targeted battery. Instead, a targeted battery would immediately displace in the case of MLRS when under fire, or the crews would seek cover until fire lifted and then displace. Counter-battery fire would be assigned to a separate battery. The Russians rarely displaced after firing unless they received fire. This appears to have been because the volume of shells they needed to fire their missions could not be displaced or repositioned quickly, even if the guns could. Given their fires dominance, during this phase, their static approach was not overly costly until longer-range precision systems became available to the UAF, at which point the Russian fires system was severely disrupted. Owing to fire missions being coordinated at a high level, the AFRF at this time also exercised limited discipline in assigning weapons to fire missions but could instead draw on any available weapons system to complete a mission. Thus, Tochka-U were deployed for counter-battery effects. Overall, during the offensive against Donbas, Russian artillery were firing around 20,000 rounds per day, with their peak fire rate surpassing 32,000 rounds on some days. Ukrainian fires rarely exceeded 6,000 rounds a day, reflecting a shortage of both barrels and ammunition. For the offensive on Donbas, the Russians deployed over 1,100 tube artillery pieces with around 80–90 guns usually formed into a group to support the actions of brigade-sized groupings of three to four BTGs. The Russian advantage in artillery during May and June 2022 in Donbas was 12:1. Special attention should be paid to the use of Russian MLRS, including BM-21 Grad, 9K57 Uragan and 9K58 Smerch. Practically all these systems were used at their maximum range; 9K57 and 9K58, in particular, were used at 35–70 km. Despite their doctrinal role, MLRS were used not only on area targets, but also on point targets.

Despite this overwhelming firepower, the Russians made slow progress. The assault tactics employed by Russian operations evolved over time. Initially there were repeated attempts to make progress using armoured thrusts. A shortage of infantry, and, in particular, of motivated and skilled infantry, led to heavy equipment losses. Thereafter, the Russians resorted to the total saturation of defended areas to compel withdrawal. This created a dilemma for the UAF because if ground was ceded, the Russians would advance, but to prevent it being ceded it was necessary to maintain troops under massive bombardment, with inevitably high casualties. The threat became more acute as the Russians developed more effective means of attack. Rather than uniform BTG manoeuvres, they began to operate in waves. LNR and DNR conscripts would be pushed forwards to skirmish and assault a position, forcing UAF positions to reveal themselves. These would be identified by Russian reconnaissance troops and subjected to precision artillery fire. There would then be a massive artillery bombardment followed by a deliberate assault by more capable troops comprising airborne, spetsnaz or Wagner companies. Notably, spetsnaz during this phase were almost exclusively employed as capable light or sometimes mechanised infantry. Once the UAF withdrew, the Russians would occupy the position with LNR and DNR conscripts and withdraw their more capable forces. This cycle would take one or two days, with the Russians aiming to go firm in the evening to have the night to harden their positions against counterattack. Of course, this process could only ever advance a couple of kilometres per day, and often less, depending on the distance between defence lines. It also incurred heavy Russian casualties, although these were disproportionately concentrated among LNR and DNR conscripts. The Russians also changed their use of armour from thrusts by platoon-sized groups of tanks supported by armoured infantry to using tanks for indirect fire or long-range

Figure 6: Map of Kharkiv Region on 16 May

Source: Based on information in Kateryna Stepanenko, Karolina Hird and Frederick W Kagan, 'Russian Offensive Campaign Assessment, May 16', Institute for the Study of War, 16 May 2022, <https://understandingwar.org/backgrounder/russian-offensive-campaign-assessment-may-16>, accessed 25 November 2022.

engagements using barrel-launched ATGMs, copying the preferred approach of the UAF. A lack of training left Russian forces less accurate in applying these methods.

VKS operations during this time also shifted. Although heavy bombing was carried out in Mariupol, the penetration of Ukrainian airspace had declined after the withdrawal from Kyiv, other than with long-range precision fires. The VKS however recommenced the delivery of frontline effects as the offensive in Donbas got under way. This usually saw a fourship of Russian aircraft approach the Ukrainian air-defence zone at medium altitude, applying EW effects or launching anti-radiation missiles if Ukrainian radar illuminated. At the same time, a twoship of aircraft would approach the air-defence zone at very low level and usually conduct strikes with unguided munitions, including indirect rocket attacks after lofting. This technique – also applied by the Ukrainian Air Force and Army Aviation – could be effective in saturating an area target.

Other than close air support, the VKS's main effort was in releasing long-range precision fires from inside Russian airspace. Strategic aviation of the VKS comprising Tu-22M3 (Backfire) and Tu-95MS (Bear) long-range bomber aircraft operated as launch platforms for Kh-22/Kh-32 (AS-4 Kitchen) and Kh-55/Kh-555 (AS-15 Kent) from the first days of the war and proved to be effective. The first strikes with the use of air-launched missiles were noted on D+3 and continued throughout the conflict. For the period from February to the beginning of May 2022, approximately 180 Kh-22/32 and Kh-55/555 launches were recorded. Beyond air-launched effects, however, there was a marked difference in the pattern of long-range precision fires from the first phase of the war to the offensive on Donbas. The main portion of strategic, and sometimes operational, fire missions until the beginning of April 2022 was performed by the short-range ballistic missile systems 9M720 and 9M723 Iskander (SS-26 Stone). For the period from February to the beginning of May 2022, more than 200 missile strikes by this system were recorded. Missile strikes were conducted deep into the territory of Ukraine, up to the regions near the border with Poland. More than 160 civilian and military objects were hit. While Ukrainian Air Defences were effective at intercepting cruise missiles throughout the war, 9M720 proved exceedingly difficult to intercept, and 9M723 was almost impossible to manipulate via other means. The situation changed from D+14–16, when the number of SS-26 Stone employments significantly reduced, and at the beginning of April 2022, the Russians shifted from salvo to single strikes. The likely reason for this may be a shortage of missiles, the stocks of which were calculated for a short-term strategic operation. Russian industry has the capacity to manufacture six 9M723s per month.

During the offensive on Donbas, although long-range precision fires continued, the Russians increasingly relied on obsolete systems. Target types that were struck with 9M720 earlier in the conflict were instead engaged, from April 2022, with the short-range ballistic missile system 9K79 (SS-21 Scarab A). A similar transition occurred with the employment of naval fires. For example, from D+60–65 there was a transition from target types that were previously engaged with Kalibr 3M-14K (SS-N-27 Sizzler), instead being engaged with 3K60 Bal (SSC-6 Sennight) and 3K55 Bastion (SSC-5 Stooge) coastal missile systems. The consequence of this inappropriate employment of munitions was reduced accuracy and, in many cases, the tragic striking of civilian structures. The main operational impact of these strikes on Ukrainian cities was to force Ukrainian air defences to be spread over a wide geographic area, limiting protection of the front.

The continued threat from strikes originating in the Black Sea further stretched Ukrainian air and missile defences. Although the sinking of the Russian warship *Moskva* on 13 April 2022 caused the Russian Black Sea Fleet, other than fast attack craft, to move its operations further from the Ukrainian coast, the Russian Navy could still functionally perform two of its defined tasks. It could no longer approach the coast and threaten landings. However, Russian ships and submarines continued to deliver long-range missile strikes against southern and western Ukraine, while the transition from a close to a distant blockade did not fundamentally alter the economic isolation of Ukraine's ports.

The volume of fires delivered on the front in Donbas led progressively to the total destruction of defensive positions until they were no longer viable. This led, in mid-June, to the decision to

withdraw from Severodonetsk. At this time, the Russian system of war was effectively inflicting casualties and taking ground from the UAF, but it also had several key dependencies and therefore vulnerabilities. The most prominent of these was its sustainment. The supply of fuel for the groupings of the AFRF in Ukraine was more a task of its delivery than a matter of availability. To solve this problem, a historically proven approach was mainly used: the exploitation of railways. The volume of transportation was large. For example, in just the period 1–19 April 2022, and only to the railway station of Rovenki (Luhansk region), 228 railway cisterns with fuel and lubricants (more than 13,600 tonnes) were moved.

For the supply of ammunition, the Russian command used the classic system provided for by doctrinal documents. Its essence is in a multi-level delivery and distribution from brigade to battalion to company/battery. However, during the strategic operation against Ukraine, the function of the 'brigade link' had to be performed by divisional- and army-level logistics units because of the volume of materiel moved. The Russians were forced to reorganise their logistics at D+7 upon realising that the conflict would protract significantly beyond their initial planning assumption. The ammunition supply system was based on two organisational solutions. The first was that the supply of ammunition relied on a network of deployed so-called 'field artillery depots'. Each of them turned out to be a complex of civilian industrial buildings adapted for the storage of ammunition. Such warehouses usually stored no more than two–three ammunition basic loads for an attached group of troops. One such warehouse could supply ammunition to units within a radius of 30–50 km. The second solution provided for the maximum accumulation of ammunition directly in units (company/battery-battalion/artillery battalion). This stimulated the dispersion of stocks and allowed for autonomy of actions in case of disruption of planned delivery. However, it also increased the probability of the destruction of stocks and reduced the tactical ability of artillery units to shoot-and-scoot, since they had large ammunitions stocks at their positions.

According to the requirements of Russian doctrine, which is essentially a carbon copy of the Soviet ones, the location of the main support elements and reserves of the divisional and army units is situated at a depth of up to 50 km from the line of contact. It is likely that such a requirement is justified for the conditions of dense operational order of battle with reliable cover of such elements by air defence. The practice of war in Ukraine showed something different – a decentralised operational structure and separate directions for advance. But the Russian command, for reasons not fully understood, continued to follow the doctrinal position unchanged, for more than 60 days. As a result, the specified objects regularly became targets for damage by the long-range MLRS BM-30 Smerch and Tochka-U – fired by the UAF. Only at the end of April 2022 was the concentration of a significant part of the personnel, equipment and materiel moved beyond the 50-km (later 100-km) security zone, based on the maximum range of weapons of the UAF.

From D+20–30 the Russians began to secure and exploit surviving rail infrastructure in the occupied territories for the transportation of troops and materiel. Understanding the importance of rail transportation, primarily from the point of view of efficiency, the Russian command managed to ensure the unloading of military echelons 30–50 km from the line of contact in

most directions. An understandable condition for this was its repair, restoration and protection with the involvement of military units of the Railway Troops of the Russian Armed Forces. For example, since May 2022, as part of the logistical support for the conduct of actions by Russian troops, the MLZH-VF-VT pontoon rail bridge was installed by the 29th Brigade of Railway Troops of the Western Military District near the destroyed rail bridge in Kupyansk (Kharkiv region), across the Oskil River. This was connected to the main railway by the Kupyansk-Vuzlovy–Vovchansk branch. To ensure adequate protection of rail communications, on the southern axes, Russian troops used such exotic means as armoured trains.

Although the Russian logistics system was chaotic in the first phase of the war, the structural efficiency of the approach ensured consistent supply throughout the offensive on Donbas. However, the dependence on fixed rail infrastructure, the viable distances from the known railheads to the field depots, and the lack of manoeuvrability of units because of their materiel-heavy concept of operations all exposed the force to systemic vulnerabilities. The mapping of depots and unit support areas, once Ukraine obtained long-range precision fires through military-technical assistance, allowed for the systematic targeting of this logistics infrastructure and through this means the denial of the Russian concept of operation. The introduction of HIMARS and M270 firing GMLRS into the UAF therefore can be seen as the point where the Russian offensive on Donbas ended and the war entered a new phase. The character of the summer fighting involves many elements that remain operationally relevant, and, to that end, it is inappropriate to discuss this phase of the war at this stage. In due course, it will be possible to discuss the Ukrainian preparation for offensive operations. Nevertheless, what has been discussed already provides a rich body of data from which lessons can be identified as to the structural strengths and weaknesses of the AFRF and wider lessons about modern combat for NATO forces. These are considered in the following chapters.

IV. Assessing Russian Military Performance in Ukraine

BEFORE 24 FEBRUARY 2022, Russia's potential adversaries, through professional respect, assumed that Russian forces would employ their capabilities with a basic level of competence. But the size of their forces, sustained investment, their available firepower and the proficiency with which the AFRF had conducted smaller-scale operations in preceding years led to an overestimation of Russia's actual military capabilities. There was also an overriding focus on the quantity of equipment, rather than the quality of personnel, their leadership, training and motivations. The general error was to take the best observed Russian performance and set this as the expected standard. This had a pernicious effect on policy by increasing fear of Russian forces among Ukraine's international partners, which Russia exploited to coerce its adversaries.

Since 24 February 2022, many observers who have not had direct experience of the conflict have overcorrected for their early analytical errors. There is a perception that the AFRF are systemically incompetent, irredeemably corrupt, that their weapons are ineffective and unreliable, and that the force is incapable of adapting. This narrative is dangerous, both because it is inaccurate, and also because it encourages complacency. Ukraine benefited significantly in its preparations by measuring its readiness against Russia's potential rather than its actual capabilities.

The operational data outlined above shows that the Russian military suffered from major errors of judgement made by the Russian leadership, special services and the presidential administration. The force also suffers from structural weaknesses in its force design and training system that created specific operational and tactical frictions. It was also a force designed for 'active defence' strategic military operations, not for a large-scale attack on another sovereign country without full wartime mobilisation. Nevertheless, the AFRF have already demonstrated that they are able to learn and adapt. They remain highly lethal, determined to achieve the mission set by their president, and employing highly capable weapons systems. In future assessments of Russian capabilities, careful attention should be paid to the extent that they have corrected some of the systemic weaknesses in their force, which they are unlikely to be able to resolve during the current period of aggression. If they can make progress in resolving these issues, the gap between Russian potential and its capabilities may narrow considerably. This chapter outlines these key identified weaknesses.

Russia Has a Hierarchy of Jointery

Viewed from the perspective of Russia's Ground Forces, its military likely appears to be a highly joint organisation. Against Ukraine, the Russian Navy and VKS were both integrated into the campaign plan, adapted as the Russian plan was forced to change, and each contributed to the

overall mission. Conversely, it is evident that Russian jointery functions as a hierarchy in which the Navy and VKS are subordinated to the Ground Force's needs. This was demonstrated in the C2 arrangements during the conflict and the prioritisations of their mission sets.

Even though the Russians had both airborne command posts in the form of Il-20 Coot aircraft and AWACS orbits provided by A-50M, the coordination of air operations was subordinated to the military district command posts of the Ground Forces rather than the VKS. Rather than running operations from a central combined air-operations centre, coordination of air tasking was managed by ground-based C2 and planned separately by air armies assigned to support each operational group of forces.

Another aspect of Russia's air campaign is that the initial targets were prioritised according to the extent that they enabled the Ground Force's seizure of critical infrastructure. After the Ground Forces began to struggle to make progress, Russian airpower shifted from targeting air-defence sites to win control of the air and instead attempted to provide increasing levels of close air support. The depth of penetration decreased and became tied to the Ground Forces' axes of advance. Thus, not only C2, but also the logic of prioritisation of air targets, was disproportionately shaped by the tactical challenges faced by the Ground Forces, arguably at the expense of the VKS planning to bring about control of the air.

For the Russian Navy, the task of blockade may be considered an application of sea power. Beyond this function, however, the Navy's core tasks were similarly in support of land operations, either to put troops ashore to seize key lines of communication in advance of Ground Forces movements, or to simply provide strike platforms in support of the wider strike campaign, and, in particular, servicing of targets of tactical importance to the Ground Forces moving along Ukraine's southern coast. The impact on the professionalism and identity of the service from being subordinated to the Ground Forces in this way is hard to measure but must necessarily contribute to the generally low level of seamanship demonstrated by the *Moskva*, whose radar was stowed when struck. A more effective employment of air and sea power would likely require a greater level of autonomy in planning for the separate branches with the prioritisation of tasks geared towards joint ends rather than subordinate to the logic of land operations.

Russian Force Generation is Not Aligned with its Concepts of Operation

The Soviet military was structured to fight in regiments, divisions and combined arms armies that also held independent brigades under command. The Russian armed forces have, for over a decade, pursued the concept of a BTG, constituting an all-arms formation with disproportionate enablement. After 2015, it was noted by the Russian General Staff that the BTG construct would not work without the divisional logistics structure sustaining it and, so, brigades and regiments would thereafter generate BTGs which would be supported by the divisional logistics effort and commanded by the associated combined arms army. The BTG would pool the experienced contract troops from the peacetime unit, thereby theoretically increasing the combat power of the forces generated. It would also allow mixed units of conscripts and contractors in peacetime,

which was consistent with a training model that saw the upskilling of soldiers conducted in their units.

Although Russia has attempted, for some time, to shift from a conscript-based force to a fully volunteer force, it has not been able to recruit enough contract soldiers to abandon conscription. Nor has the Russian military adopted a contract structure that retains experienced and educated personnel in positions of junior leadership. This is equivalent to the non-commissioned officer cadre in Western militaries. This makes the BTG construct highly problematic. The battalion staff is insufficient to manage all the enablers that are assigned. Moreover, because this is a composite formation drawing from multiple units and is only generated for operations, there is a lack of familiarity among the personnel in different arms of the BTG. The commander does not know their people. Thus, a small team of sufficiently trained personnel is unable to provide detailed instructions to each of its subordinate elements, but also does not know its subordinates well enough to be able to predict how they will handle brief and incomplete instructions.

A further problem with the BTG is its ability to absorb losses. An enabled company group – as a unit of action – either succeeds in its task or fails and can thereafter be rotated out if overly attrited. A BTG, however, because of the level of enablement, can become incapable of executing battalion tasks when key enablers are disproportionately attrited, even if many of its components are still useable. As an example, on 22 April 2022, as a result of engagements in the direction of Kurakhove, a BTG of the 136th Motor Rifle Brigade under the 58th Combined Arms Army of the Southern Military District was taken out of battle having lost 240 servicemen killed in action, 11 IFVs, four tanks, three self-propelled guns and three MLRS BM-21 'Grad'. Statistically, the BTG lost only up to 30% of its initial combat power, and many of its supporting elements were intact. However, as a unit, it was no longer capable of executing the tasks that it was being assigned.

The initial response to this challenge introduced even more confusion into Russian operations. The units less affected by attrition within a BTG would be removed and assigned to other BTGs so that a new amalgamated formation with the requisite combat power was created. The result was to further intermingle personnel from different units, once again changing the command team and ensuring that commanders had no familiarity with their subordinates. It also created logistical and communications problems as units were cut across from one chain of command to another, creating frictions with encryption keys and compatibility problems, and ensuring that the calibres and thus the sustainment demands within a given formation changed periodically. A further complication was that, because the BTG structure put the most experienced troops and commanders in the first echelon, attrition was disproportionately among those with the most experience and therefore best able to manage the uncertainty of composite and amalgamated formations.

These frictions may have been manageable with a higher proportion of junior leaders. Instead, the Russian military found that junior commanders were rapidly promoted to fill the critical staffing requirements at battalion and higher levels, denuding companies of effective leadership

and technical skills. As the conflict went on, the disparity between the precision and elegance of issued orders from headquarters and their execution widened considerably.

Although the weaknesses of the BTG were the most evident, similar issues have bedevilled other Russian branches, most notably the VKS. Ukrainian assessments concluded that given limited flight hours and the practice of training being delivered in units, the VKS entered the conflict with fewer than 100 fully trained and current pilots. Combined with a military culture that assigns the most dangerous missions to the most experienced crews, attrition in the VKS has fallen disproportionately on this cadre, reducing the overall effectiveness of the force and its ability to train new pilots. In negotiations over prisoner exchanges, the AFRF have been eager for the return of experienced pilots. The mobilisation of trainers from their flying schools to frontline formations has also hampered the ability to generate new pilots. The Ukrainian military has noted a rise in both very young and very old pilots in the VKS, with ageing pilots returned to frontline service. This has corresponded with a significant reduction in the scale and complexity of VKS air operations over Ukraine since the beginning of the conflict. It is also a problem that has affected ground crews, for example with the discovery of left-on covers on the sensors of Russian aviation operating over Ukraine, an easily avoided mistake which has a severe impact on effectiveness and should be considered negligence. This suggests challenges in discipline and junior leadership among maintenance crews in the VKS. Another demonstration of this poor discipline in the VKS is the routine stacking of munitions next to aircraft on Russian air bases.

It is harder to assess the limitations of the Russian Navy in terms of its force-generation model as there are fewer data points. Nevertheless, the alertness and damage-control capabilities on the *Moskva* suggest similar deficiencies in junior crew leadership may affect the Navy. The key point here is that Russia has built a force-employment concept that is beyond the capacity of its force-generation model to resource with the appropriate expertise. Key indicators for improvements in Russian military capability therefore will be whether it adjusts its force-generation model, or reconceptualises how it task organises for operations.

The Russian Military Has a Tendency to Reinforce Failure

During the first phase of the war, it was apparent that the course of events described in the orders issued to units diverged significantly from developments on the ground. Nevertheless, units continued to seek to execute their orders long after it had become apparent that assumptions in those orders were wrong. This behaviour has continued throughout the war. The continuous attempts to assault Bakhmut, for example, long after it ceased to be on Russia's main effort, demonstrate that until an order is countermanded commanders will continue to try to execute their last instruction. In the early phases, during offensive operations, this was best demonstrated around Mykolaiv and Chernihiv. In both cases, Russian units had been ordered to bypass resistance to reach their objectives. The orders made clear that resistance was expected to be light. When this assumption was demonstrated to be false, however, Russian commanders continued to seek to bypass strongpoints, even when it degraded their tactical position, exposed their flanks and diluted their combat power by spreading concentrated forces over a long frontage in contact with Ukrainian troops.

This should not be mistaken for a lack of flexibility or adaptability in implementing combat tasks. Russian units often rapidly adapt their methods in response to failure. They also demonstrate creativity within their assigned boundaries. In some contexts, the tendency to lean into a course of action poses dangers to the enemy. Much Western military literature discusses 'cognitive shaping' and the use of 'information manoeuvre' to divert or alter the enemy's course of action. These are unlikely to be effective against such a military culture. Similarly, if a force intending to divert an offensive into a killing area is insufficiently strong to blunt the enemy, the response to contact may be – and often is – to lean into the confrontation. If the blocking force is not sufficiently large or lacks firepower, it risks being destroyed, even if it inflicts high casualties, rather than stops the assault.

As a consequence of this tendency, it appears clear that anticipating the enemy's intent and setting dispositions to optimally respond is more important than trying to shape that intent. If an enemy accelerates through a killing area or recommits to an axis even if its intelligence assessment of resistance was unrealistic, anticipating its assigned axis is the best means of placing killing areas in the right location. Conversely, even if a more favourable or apparently advantageous route presents itself, it is unlikely that the unit will deviate from its axis. Cognitive shaping, therefore, must be aimed at operational commanders, with such decisions rarely being made lower than the combined arms army command post. In delivering such a capability, it is essential to understand the theory of victory and higher intent to which the commander is working.

A further aspect of Russian orders, which is a significant weakness, is the near absence of reversionary courses of action. If unsuccessful, or if the higher intent is no longer achievable, this leads to requests for clarification being referred upwards. Once decisions are made at higher echelons, the lower echelons can alter their actions quickly. The decision to withdraw from Kyiv, for example, saw a rapid break from contact – with varying levels of order – on both main axes. This was largely executed competently. However, in the interval when higher headquarters seek to formulate a plan, paralysis tends to grip lower echelons if their initial orders do not reflect the position on the ground.

This approach has probably had the greatest impact in creating a gap between potential and actual capability as regards Russian fires. All reported contacts are treated as true. All fire missions appear to be given equal priority and are prosecuted in the order in which they are received unless an order to prioritise a specific mission comes from higher authority. It seems that those directing fire missions either do not have access to contextual information or are indifferent to it. In any case, observations of Russian pre-planned fires shows that they will strike targets that have moved and subsequently engage the same target in its new position, suggesting a purely chronological prioritisation of activity.

In the case of the Russian Navy, a similar dynamic can be observed. The orders to initiate amphibious landings were conditions-based as they were in support of ground forces which never reached the point to justify the action. Thus, these were called off before the forces were committed. However, subsequently, when the sinking of the *Moskva* enabled the Ukrainian Air

Force to re-establish control of the air over Snake Island, it was notable that the Russian Navy continued to try to contest this outpost and the surrounding waters with fast attack boats. Lacking air defence, these were destroyed, mainly with TB2, while Snake Island became denied by Ukrainian long-range fires. Still, the Russian Navy sought to reinforce this failure even though control of the island had no functional impact on its ability to blockade Ukraine's southern coast. They only stopped reinforcing this failure when higher-level orders accepted abandoning the position. The tendency to reinforce failure was less evident in the VKS, which adapted rapidly to battlefield developments and emerging threats in terms of the employment of its capabilities. The VKS did suffer from the same tendency when it came to targeting, however.

The application of fires without prioritisation is a tendency that should be carefully monitored, except in instances where a battery is directly allocated to a unit, has organic capabilities for target acquisition or is operating under higher command. If the Russians can resolve the cultural tendency to treat all instructions as valid until directly countermanded, and all intelligence as accurate unless contradicted, their capability may rapidly improve, coming closer to what their systems suggest they should be able to execute.

The Russian Military is Culturally Vulnerable to Deception

A combination of too few experienced tactical commanders and a culture that leans into courses of action without distributing sufficient situational awareness for contextual judgement leads to a force that is systemically vulnerable to deception measures. It is vulnerable to deception for three reasons. First, the tendency to treat information received as true unless there is contradictory information leads to systemic confirmation bias. Second, the force does not encourage honest reporting of failures, while there is a shortage of capabilities for battle damage assessment. Third, Russian systems are largely designed around single missions. Even within an EW or air-defence system, each operator will control a different sensor or function. Operators are trained to examine the specific picture for which they are responsible. Neither in their systems' design, nor in their culture, is there an effective fusion process. In consequence, although the force often has the information to spot inconsistencies in its sensor picture, it is rarely able to compare its datasets to identify these inconsistencies within an operationally relevant timeframe.

Deception has succeeded against Russian forces at all echelons and across all three service branches. At the tactical level, the UAF have systematically employed false signals traffic and decoys of prestige systems to misdirect Russian fires. This has almost always succeeded, leading to a vast expenditure of munitions against non-existent targets and a corresponding vulnerability for Russian fires in revealing their positions. Tracking how the Russians were conducting battle damage assessment and thereby assuring the Russian military that all strikes were successful repeatedly led to the loss of Russian aircraft and other capabilities because they proceeded on the assumption that the threat had been eliminated. At the operational level, too, Russian forces have been predictable in allocating resources against telegraphed movements and failing to detect or prepare for concealed movements. This has even taken place when some Russian

reporting streams have detected concentrations but have been unable to present a sufficiently convincing case to commanders to win resources.

The vulnerability of the Russian forces to deception is also a risk for its adversaries. Especially prior to a conflict, the primary aim of a force is often deterrence or shaping. In much NATO discussion of these issues subtle changes in force posture, weapons fits on aircraft, patterns of behaviour and so on are used to try to message varying levels of readiness, preparedness and will. Many of these actions are premised on the assumption that they will be observed by the adversary. From a technical point of view, it is certainly true that the Russians can see these kinds of activities. However, when Ukrainian forces struck the cruiser *Moskva* in the Black Sea with Neptune anti-ship cruise missiles on 13 April 2022 there was no indication that its radar was operating. This was supposed to be the central ISTAR node for the air defence of the Black Sea Fleet, yet despite being in an active warzone, the ship's primary sensors were not on. Nor was this an isolated incident. Russian aviation, shot down over Ukraine, has been found on more than one occasion to have its radar in the stowed position, with safety covers over primary sensors. These incidents speak to complacency, poor ground crew training and a lack of mission focus. When considering the issues of process and lack of fusion described above, however, the visibility of these subtle adjustments for Russian operational commanders is at best inconsistent and at worst non-existent. From a deterrence point of view – or for the purposes of shaping decision-making – this is concerning because it suggests that most of the nuance in messaging may be lost. Therefore, while the Russian forces may be vulnerable to deception, the message must be clearly telegraphed. In the context of deterrence, one of the biggest challenges may be preventing the Russians from deceiving themselves.

In assessing whether the Russians are closing the gap between their potential and actual capabilities, it is important to pay close attention to their discipline in the employment of sensors, the level of fusion achieved between sensors and whether the situational awareness that is needed to provide officers context for information is properly disseminated. If these issues are addressed, there could be a rapid improvement in the performance of the Russian armed forces. Left unaddressed, the Russians, having the potential capabilities but not the necessary awareness, may fight by lashing out at sounds and in response to blows. One can readily trick such an adversary into striking in the wrong direction. But that does not stop it from being a dangerous adversary.

Russian Forces Are Prone to Fratricide

Fratricide has been a widespread problem for the Russian forces during their invasion of Ukraine. This has been across all systems. Russian air defences have regularly engaged friendly aircraft. When Russian troops deviate from their assigned axes or the timing of their actions becomes desynchronised, they are often bracketed by their own artillery. Russian units in complex terrain have also become embroiled in exchanges of fire between one another's positions. This speaks to a lack of C2 and control measures during operations. It likely reflects Russian troops largely conducting scripted exercises rather than free-play force-on-force activity where they are used to dealing with the ambiguities that arise on the battlefield. Some Russian units are much better

at this. Among line units, however, map-reading and other basic soldiering skills are not well understood, leading to disorientation and therefore a propensity to misidentify sources of fire. Artillery strikes on friendlies have arisen either because units have been detected retreating or redeploying by UAV and presumed hostile based on their direction of travel, or because pre-planned strikes have caught units that have moved slower or faster than dictated by planning. Here, a lack of IFF (identification, friend or foe) procedures is notable.

Beyond the sub-tactical errors described above, fratricide is a systemic issue between Russian systems. For example, the Khibiny EW pod, mounted to a number of Russian aircraft, automatically detects radars and disrupts them. Unfortunately for the Russians, it tends to also do this to other Russian aircraft. Pairs of Russian strike aircraft mounting this system have therefore had to choose between having a functional radar or EW protection. They have often been ordered to prioritise their radar. This wider issue of confliction between systems, or lack of compatibility between communications equipment, could be managed if units had good situational awareness and a high level of training and reversionary planning in the deconfliction by time or space of their different EW effects. In practice, it leads to a great deal of confusion and mutual disruption. It also offers innumerable – albeit regularly shifting – seams through which effects can breach Russian defences.

A further fratricidal issue is the culture of reporting within the Russian military. Those who fail are usually replaced or threatened with punishment. Alternatively, for senior officers, failure can lead to a different organisation being given leadership for a specified task. Far from incentivising success, this often leads to dishonest reporting in which the blame for failure is transferred onto others. This scapegoating of colleagues – endemic in the Russian special services but also in the military – obscures the actual operational problems that must be solved. These only become apparent when they can no longer be concealed, slowing the learning of lessons, but also leading to predictable and predicted vulnerabilities not being addressed.

The issue of fratricide therefore may be studied in three respects as a measure of progress in the development of the Russian Armed Forces. First, there must be an assessment as to the level of effort in future Russian systems to deconflict their effects. Second, there is the question of free-play exercises and testing deconfliction in a dynamic environment to build the necessary skills to avoid fratricide. Third, there is the cultural issue of an honest reporting culture. Without incentives to resolve these issues, it is likely that the Russian military will continue to employ effects that cause its troops harm.

A final point on fratricide is the attitude of the Russian military generally, and of its officer corps in particular, to people – its own and civilians. The widespread war crimes by Russian troops throughout the conflict have been widely documented. But it should also be noted that many Russian officers do not invest time in looking after their personnel or caring for their welfare. The culture of hazing in the Russian military arguably creates strong disincentives for junior officers to become involved in the everyday lives of their subordinates. This stems from a general cultural approach that does not place a great deal of value on human life. For senior Russian officers who spent their time as junior officers in the Soviet Union there is still a mindset

of seeing people as an inexhaustible resource to be expended. But that is not Russia today. Russia has a finite number of available military personnel. This culture of not valuing individuals is a form of institutional fratricide. Although it leads Russian troops to take a great deal of punishment without surrendering on the battlefield – there is an expectation and acceptance of suffering – it also leads to low morale, poor unit cohesion and troops who lack the team spirit to effectively conduct sub-tactical manoeuvre. Given Russia's ageing population and its limited base for recruits, progress in its approach to its human capital is another important metric for assessing whether the Russian armed forces can improve their capabilities after this conflict.

V. Lessons Identified for the British Military

THE UKRAINIAN MILITARY – as outlined in the second chapter of this report – differed considerably in its size, capabilities, structure and culture compared with NATO forces. There are some threats that proved exceedingly difficult for the UAF that would not pose a threat to NATO armies. For example, NATO would not face the same technological disadvantages in the air against Russian aircraft or be unable to contest Russia's distant blockade. Conversely, there are areas where the UAF are considerably more capable than the forces of many NATO states. Another feature of identifying lessons for future conflict is that some of the weaknesses identified in the previous chapter as regards Russia's armed forces may be resolved following this conflict. This chapter, therefore, focuses on those aspects that are considered likely constants and applicable to a range of adversaries. This chapter is also specifically aimed at identifying relevant lessons for the British military in relation to how it is currently projected to develop until 2030, although many of the observations have application across NATO members. For other armies, slightly different lessons may apply.

There Is No Sanctuary

The first clear lesson from the war in Ukraine is that the enemy can conduct strikes on targets throughout its adversary's operational depth with long-range precision fires. Moreover, in target states, the Russians have proven able to retain networks of agents in place to observe key targets and to update their command on the movement of troops and stores. The integration of human intelligence (HUMINT) into Russian long-range precision-fires kill chains is critical. Given that Ukraine has also retained this capability, despite the exigencies of the counterintelligence regime on the occupied territories, it seems unlikely that states can plan on the assumption that they can conceal key sites, or the movement of materiel, from the enemy. The Russians have missed targets because of self-imposed frictions in their kill chains, usually striking too late rather than not at all. Their misses have not been for want of intelligence. The effect of these munitions on targets when they strike them is sufficient to destroy most military objects other than deep subterranean or heavily hardened structures. Non-hardened structures are also targetable by loitering munitions, whose accuracy and affordability make them a persistent and pervasive threat.

For the UAF, it was found that the ability to conduct dispersed operations was critical to survivability. Without this capability – to disperse and maintain aircraft in the field for a limited period, while periodically returning to main bases when repairs allowed – it is likely that the Ukrainian Air Force would not have survived the opening days of the conflict. Furthermore, dependence on single critical pieces of infrastructure for C2 is not only risky if they are struck, but also risks encouraging escalatory behaviour by the adversary. For the RAF it appears that

a critical question for its survivability is the number of deployable maintenance kits available for its aircraft and the capacity to use secondary and tertiary airfields to disrupt enemy planning. This challenge is especially important in future concepts as aircraft become more dependent on software.

The Ukrainian Ground Forces similarly found that long-range precision strikes were used against their stockpiles, against training establishments and against maintenance facilities when these were identified. Maintenance facilities had to be situated a long way from the front and dispersed, not because distance assured protection, but because increasing the space over which the enemy had to search for them improved survivability. Ukrainian war stocks survived because they could be rapidly displaced and dispersed. Russian materiel has remained highly vulnerable to long-range fires. The reduction in the logistical tail and therefore reduced vulnerability of precision systems is perhaps as important as their effect in terms of their superiority to non-precision fires. The historical approach of the Allied Rapid Reaction Corps and 3 UK Division of erecting tented cities – command posts with a large physical footprint – is non-viable in wartime on the modern battlefield. These sites will be identified and struck. Moreover, as the Russians have found to their detriment, concentrated command posts inside requisitioned civilian buildings are similarly vulnerable to long-range precision fires unless all staff retain rigid communications discipline. Even here, the HUMINT threat means that locations should be moved frequently and key components of a staff dispersed. The capacity to access staff work remotely means that it is not strictly necessary to concentrate all headquarters components in close physical proximity to one another.

The implications of pervasive strike capabilities are different for the Royal Navy because naval operations are in continual motion and therefore do not suffer from the same vulnerabilities. Nevertheless, the war in Ukraine has seen a vast expenditure of anti-ship munitions fired from the air, sea and land. These have mainly been fired against ground targets and in this role have had reduced accuracy. Technical examination of these munitions – and how and why they struck the wrong ground targets – demonstrates that they would be highly effective at sea, however. The volume of long-range anti-ship missiles the Russians can bring to bear means the fleet must not set patterns and work strenuously to break the targeting kill chain. Conceptually, the true problem for the Royal Navy lies in multi-domain concepts. In a constrained sea, in close proximity to the shore, or in sea space canalised by mines, the vulnerability to such fires increases exponentially. While sea power can deliver significant if non-decisive effects on an adversary from afar, if it is to affect the fight in other domains it must come closer. Much UK Commando Force thinking about ship-to-shore manoeuvre for raiding currently emphasises the exploitation of clutter in the littoral environment and the noise of civilian shipping. Ukraine demonstrates that once mines are in play during a major conflict, this clutter rapidly evaporates. Arguably a major conceptual gap has emerged in UK military thinking between the Royal Navy, with blue-water capabilities, and the rest of the force, with its emphasis on multi-domain integration. The conflict in Ukraine demonstrates that this is a conceptual gap to which the UK joint force needs an answer.

For the most part, the Russian missile systems are reliable and accurate. Cruise missiles can be intercepted, but the Russians routinely adapted flight routes for every mission and such missiles were observed to make up to 80 changes of course on their way to a target. It is not economical for any state to maintain coverage across the requisite frontage to be able to defend all targets with a sufficient density of air defences to guarantee defence against these systems. Russian ballistic missiles meanwhile – notably Iskander 9M723 – fly in a quasi-ballistic trajectory, launch six decoys that significantly alter their radar cross section and targetability, and retain a directional link to satellite-based navigation during the terminal phase, in addition to multiple redundant layers of navigation, that mean it is highly uneconomical to deploy interceptors to defeat these threats against all possible targets.

There has been a lot of attention given to Russia's depleted stocks as regards these capabilities, given the rate of expenditure in Ukraine. This is an issue. Moreover, Russia cannot rapidly produce these missiles. It is estimated that it can fabricate around 100 Kalibr missiles per year, for example, and this may come at the expense of other munitions because many Russian munitions have common key modules that act as bottlenecks in the production of multiple systems. For Iskander 9M723, the Russians have been able to maintain a production line of six per month during the war in Ukraine.

Nevertheless, given that this arsenal has proven effective during the war, it can be assumed that its replenishment will be a priority for the Russian military. With China and Iran both relying heavily on similar complexes, and the proliferation of knowledge on how to achieve precision with these weapons, it must also be assumed that a convergence in systems design between these states will create economies of scale. Ironically the loss of military equipment may also encourage the Russian military to consolidate around fewer platforms, further increasing the capacity to prioritise resources. This lesson from the conflict regarding the threat that British forces must prepare for is pertinent to both the future as regards Russia and adversaries in other theatres.

Warfighting Demands Significant Slack Capacity

The professionalism of the British military and the competence of units is high. Ukrainian troops have found British training invaluable. British weapons have also proven highly effective on the battlefield. High morale, skilled soldiering and significant corporate experience are of limited value in high-intensity warfare without ammunition, however. It is abundantly clear that the British military is woefully deficient in its stockpiles across domains. At the height of the fighting in Donbas, Russia was using more ammunition in two days than the entire British military has in stock. At Ukrainian rates of consumption, British stockpiles would potentially last a week. Of course, given that the UAF fielded more than 10 times as many operational artillery pieces as the British Army at the beginning of the conflict, it might take more than a week for the British Army to expend all its available ammunition. All this demonstrates, however, is that the British Army lacks the firepower to deliver the kind of blunting effect that the UAF achieved north of Kyiv. The oft-cited refrain of the UK Ministry of Defence that these deficiencies are not a problem because the UK fights alongside NATO allies would be more credible if the situation

were much better among any of the UK's European allies. It is not, except in Finland. Nor – as Ukrainian troops discovered to their surprise – are ammunition, charge bags and other essential consumables consistent between NATO artillery systems; there is an inadequate capacity to draw on one another's stocks.

The deficiencies are not limited to tube artillery. Air defence – whether air- or sea-launched, or ground-based – is similarly entirely inadequate. Ukraine has practical experience using British MANPADS. They are highly effective. Although Ukraine lacks experience with Sky Sabre, Sea Viper, Meteor or Aster missiles, the effectiveness of these systems has been widely demonstrated. Nevertheless, a cursory study of procurement data and, for the land environment, an examination of the units available for air defence, shows that there is insufficient depth of munitions for any of these systems to be credible in high-intensity conflict. The survivability of Ukrainian units has demanded organic MANPADS to be available at all echelons and across all arms. Even with 60 dedicated Air Defence divisions, Ukraine has struggled to provide air defence to its manoeuvre forces, its critical national infrastructure and population centres. It has had to prioritise between them. It is worth briefly noting that there is a point at which munitions become overly complex, expensive and slow to produce so that the value of their increased performance comes with diminishing returns.

Ukraine's survival initially depended on its own large stockpiles of Soviet-calibre munitions. Now, Ukraine is almost entirely dependent on NATO supplies. It is evident, however, that manufacturing capacity in many NATO states cannot meet the needs of its members in the event of a major conflict. Establishing production lines and assuring access to key materials such as explosive energetics takes time. Beyond merely holding sufficient stockpiles and spares, therefore, it is also abundantly clear that NATO countries – including the UK – must work out a value-for-money proposition that allows defence industry to maintain slack capacity to be ramped up in the event of conflict.

One area where the British Army at present appears particularly strong is in its maintaining large training establishments disproportionate to the size of the force. The British Army maintains dedicated training schools for many of its military specialisms, which all require permanent staff and instructors. As demonstrated by the large-scale training to Ukrainian troops – carried out in parallel to the ongoing training of British forces – there is considerable slack capacity in this system. While this is a disproportionate cost on a small army in peacetime, its importance during any major conflict should not be underappreciated. Even assuming that British forces remain highly survivable, the rate of injury combined with the very small overall size of the British armed forces must see troop levels in frontline units decline in any major war.

The UK must therefore be able to train a second echelon. Ukraine mobilised its instructors from training establishments early in the conflict and this has contributed to difficulties in training additional forces. Russia has suffered even more from this problem because it delivers a significant proportion of training in-unit, which is not possible for units that are deployed. The British Army, therefore, must not squander its resilience in training capacity for the sake of efficiencies in the short term. Given that the RAF and Royal Navy have pushed their training

establishments towards externally contracted solutions, the scalability and adaptability of these structures in wartime should be critically examined. The air war over Ukraine has demonstrated a rapid action–reaction cycle between offence and defence that has required significant adaptation of tactics and methods. For the Royal Navy and the RAF it is vital that simulators and externally contracted training solutions enable rapid adaptation of tactics and parameters in conflict, lest trainees become forced to learn obsolete tactics as a result of the training tools available rather than operational requirements.

Another area where slack capacity is invaluable is logistics and maintenance. As explained earlier, the UAF suffered from a high rate of turnover of key specialists during peacetime. This, however, proved invaluable in war. The British military currently lacks logistical capacity for its existing forces, let alone in a situation where more forces would need to be mobilised, or where the UK was seeking to sustain a multinational formation over which it had command. The critical point is less whether logistics units can be retained in the force, but rather whether better recruitment of logistics personnel in which they receive training that certifies them for civilian work can create a depth of reserves with associated liability to underpin the sustainment of both the existing force and additional mobilised units in wartime.

It is also important to appropriately establish which platforms, whether because of their ubiquitous utility, or the inherent vulnerability of their tasks, demand mass. Some, such as pontoon bridging, mortars and UAS must be available at scale. A large number of troops are required to know how to use these tools. While there are minimum characteristics of such devices for them to perform their assigned task, the rate of consumption of these capabilities demands that they are ruthlessly simplified and rationalised so that they can be produced at scale and cheaply. Identifying where such consumables demand complexity and striving for standardisation of complex components, even if other elements of a system may have variations, is vital for achieving sufficient economies of scale. Again, there is a challenge for industry because this demands a great deal of work up front on design, but a very narrow margin of return on each manufactured object. Developing an appropriate value-for-money framework to have industrial capacity in such areas is similarly critical.

UAS and CUAS Must Be Available Across All Branches and Echelons

A key lesson from the war is that UAS and CUAS must be available at all branches of the force. It is also evident that the UK and other NATO members have made mistakes in how they categorise UAS, generate the capability in the force and have governance for their employment.

Because NATO forces were early adopters of UAS, they have inherited the legacy of earlier generations of system. Early UAS were expensive, complex and often difficult to fly. Thus, specific units were established to be trained to use UAS and considerable investment was put into making the platforms better. Furthermore, because NATO forces have used UAS in an environment where even small numbers of casualties were politically significant, the emphasis has been skewed towards force protection. Since UAS were flying objects, they should be managed as

such. In the UK this places permission for launching UAS under the responsibility of the Military Aviation Authority. On NATO exercises careful attention is paid to airspace deconfliction, so that helicopters and UAS, for example, do not find themselves in the same airspace and at risk of collision.

While the evolution of the system of governance for UAS has proceeded logically and the structures around their use made sense when they were formulated, they have produced forces poorly suited for the operating environment, as observed in Ukraine and elsewhere. For pilots and other elements of the force, the expectation that UAS can be excluded from airspace is not viable. There will be many enemy UAS in the airspace. Training to manage this flight risk, therefore, is critical; training in an airspace without this hazard simply transfers risk from training to operations. In any case, given the need for troops to manage their electromagnetic signature and the impact of jamming, tactical echelons cannot guarantee getting information about their flight plans back to higher headquarters. Nevertheless, they will need eyes in the sky to retain situational awareness and to remain competitive. Requiring higher-echelon approval will make the employment of UAS uncompetitively slow. Requiring units to follow the procedures for aircraft in launching UAS also means that it is inordinately expensive to train UAS operators and this too becomes a constraint on their employment that means tactical units will not have enough pilots to keep up the required number of orbits to be competitive. For the UK, the implication is that UAS need to be classified as munitions rather than aircraft. At present, there are fewer administrative restrictions for the Royal Artillery to fire live 155-mm howitzer munitions over civilian roads than for them to fly a UAS over the same airspace to monitor what they are hitting. This must be changed, and it requires changes to policy, rather than simply expecting units to make the administrative burden of employing UAS manageable.

UAS should be split into three broad categories for land forces. The first are rotary-type UAS able to manoeuvre close to the ground and in complex terrain, fielded across all manoeuvre formations for the purposes of route proving, reconnaissance, situational awareness, target acquisition, fire correction, and a wide range of other tasks. The second are fixed-wing UAS able to fly at medium altitude into operational depth and perform a single task, whether that be target acquisition or direct effects. Where multiple effects are required, this can be achieved by flying complexes of multiple UAS of this type. These should be used by units able to affect what they find, either reconnaissance units or artillery. Both the first and second category of UAS must be cheap and available in quantity. The third category comprises platforms carrying higher-echelon sensors. In Ukraine, this includes the TB-2, which was most useful as a maritime patrol platform. Platforms such as Watchkeeper and Protector fall into this category, best employed behind the FLOT and tasked with standoff sensing. It must be understood that employing these scarce assets depends on shaping, or else they will be rapidly attrited.

UAS were also found to be highly useful for air and naval forces in Ukraine. The ability to put sensors aloft for a protracted period without the need for a wrap to recover pilots or the burden of life support on the platform greatly extended the range at which maritime patrolling could be conducted and the risks that could be taken to gain situational awareness. The lack of loitering munitions able to target air-defence radars has been noted as a critical deficiency in the UAF that

would have enabled much more aggressive air operations. Flying at around 50–100 ft and using terrain, Ukrainian pilots have been able to get within around 15–30 km of targets. Although Western aircraft are much more capable, Russian surface-to-air missile (SAM) complexes remain highly lethal and would likely drive aircraft low. The Ukrainian Air Force found that the suppressive effect of HARMs (high-speed anti-radiation missiles) launched against Russian radar was short. Loitering munitions, by contrast, can remain in place and thereby create multiple dilemmas for SAM operators that could significantly increase the window within which aircraft could penetrate the Russian missile-engagement zone.

Countering UAS has proven no less important across all domains. For land forces, tactical sub-units must first have a means of detecting the presence of hostile UAS. Frontages must be covered by the means of defeating enemy UAS. Defeating UAS does not mean kinetically destroying them. It simply means denying the UAS the ability to achieve its mission. This could be done through the dazzling of sensors, or denial of navigation or control. The most efficient protection against UAS is EW and ensuring that electronic attack and electronic protection is available at all echelons.

Again, the British Army has under-resourced this capability. Having two EW signal regiments and assigning their capability to operational tasks leaves most of the force unprotected. It is also important to note that electromagnetic spectrum (EMS) fratricide and C2 are both major challenges of widespread EW employment. The UAF have suffered from battalion staffs who are not sufficiently familiar with EW capabilities to synchronise and manage these tools. The Russian military has suffered even more from this problem. The availability of these troops on exercise and an understanding across units as to how to work with their EW support is vital, especially to avoid EW personnel knocking down friendly UAS, or UAS being launched when the EMS has not been shaped to enable their employment.

There is, nevertheless, a need for kinetic defeat of some kinds of UAS, especially those penetrating operational depth to conduct target acquisition or loitering munitions. It is highly inefficient to have dedicated CUAS batteries in addition to air-defence batteries. Nevertheless, the munitions that air and missile defence batteries employ do not make CUAS missions economical. The answer must be the provision of intermediate munitions that can draw on the common air picture and guidance available to air-defence units but without the cost associated with munitions that must catch and defeat more complex targets. Point defence for critical sites is also an enduring requirement given the ability for long-range UAS to fly below the radar horizon on complex pre-programmed routes and thereby reach static targets in operational depth.

For the RAF, the issue of CUAS is foremost one of integration. Given that loitering munitions targeting airfields, critical national infrastructure and other targets are exceedingly small and low flying, elevated sensors such as the AESA radar of the F-35 are ideal for detecting these targets. At the same time, the allocation of F-35s against such targets would be an entirely inappropriate use of the platform. The RAF therefore should either ensure that it has an economical means of supplying wide-area surveillance for tracking these threats or that it can offboard track data from combat air patrols to ground CUAS systems. Given that CUAS systems are often short

ranged, these would not usually be priority recipients of such data, but ensuring access to that data will be important if the RAF wishes to avoid having assets drawn to suboptimal taskings.

The Royal Navy also faces a CUAS challenge. UAS can be used on maritime patrolling to locate and monitor task forces in a more efficient manner than aircraft, while they are also less economical to engage. Conceptually this is not a novel threat. Of much greater concern is that as the Royal Navy seeks to project power into littoral environments, targets such as ship-to-shore connectors, fast attack boats and other vessels lacking air defence become highly vulnerable to armed UAVs. If the threat from anti-ship cruise missiles drives the main task force out to sea, the ability to operate in the littoral demands that fast attack craft have a means of detecting and countering UAS. The UAF have had considerable success against Russian fast attack craft with TB2. As countries such as Iran increase their investment in strike-capable UAVs, the ability for fast craft to operate within this threat is important beyond contests with Russia.

Fighting for the Right to Precision

As indicated in the discussion of UAS above, the experience in Ukraine clarifies some of the critical effects of a contested EMS. Military discourse has – for several years – focused on the problem of EMS denial. Its denial was a major challenge for the UAF in 2014 and 2015. Measures were taken to make the force more resilient. The 2022 invasion therefore provides a better canvas to assess the impact of EW on militaries with appropriately resilient systems, and tactics, techniques and procedures. The effect is not EMS denial. Limitations of power, the tactical necessity to manage signatures and the consequences of EMS fratricide all mean that even forces with large EW capabilities cannot achieve blanket denial across large geographic areas for a sustained period. Denial can be achieved for a short period, or across a limited geographic area. Targeted denial can be delivered for a sustained period over a wide area. However, any kind of targeted denial of bands of the EMS can be evaded through altering frequencies or bearers. The result is that EMS interference and disruption is continual, but denial is limited.

This does not mean that contesting the EMS is less of a priority. Left uncontested, EW slows kill chains, increases confusion and, perhaps most importantly, degrades precision. The inability to determine accurate locations, let alone transmit timely data on target locations, or for munitions to achieve precise impacts against targets, all risk a force losing competitiveness against an opponent. Precision munitions not only inflict disproportionately more damage to the enemy but significantly reduce friendly vulnerabilities in the rear by shrinking the logistics footprint. Precision depends on a functioning kill chain, however. To assure that kill chain and to ensure that the munitions function properly, it is essential to actively contest the EMS. The layering of EW and kinetic attacks is vital to ensure that limited stocks of high-end weapons deliver the effects required. For example, an attempt to deliver precision effects against a target can be disrupted through interference with navigation frequencies so that precise target acquisition is denied. Here, the use of an EW baseline to identify the location of the source of this interference can enable non-precision fires to force the EW platform to displace, thereby opening a window in which the coordinates for an accurate precision strike can be obtained.

Initially, Ukraine distributed EW capabilities across its groups of forces to provide organic support on key axes. It was rapidly discovered that there was insufficient training in units to properly employ these troops. For that reason, the UAF have formed a Cyber and Electromagnetic Activities Command, enabling end-to-end management of capability development, electronic-payload preparation and delivery, as well as force protection and direction finding. Although a more centralised approach to the allocation of EW assets has been adopted, it remains necessary to have these capabilities available on all active fronts. The three basic tasks of EW troops are reconnaissance (direction finding), protection and electronic attack. It is necessary for EW troops to understand the fires plan and scheme of manoeuvre, and to have access to the synchronisation matrix of other arms in a force so that they can distribute capabilities to optimally support the other branches.

Another aspect of contesting the EMS is pattern recognition in enemy cyber and electromagnetic activities, and the provision of advice on where there are seams in the enemy system that can be exploited. For example, wide-area jamming of navigational systems likely means that the enemy is not postured to conduct accurate fire missions. The lifting of this may indicate that UAS are about to be launched or that a fire mission is about to commence from a sector. However, this also means that friendly UAS committed to that sector can – for a time – accurately determine the location of the targets such as batteries that are fixed by virtue of their preparing to fire. Similarly, if enemy EW protection is strong, targeting the sources of emission will cause EW platforms to displace, revealing gaps in protection that can be exploited to deliver effects. All these effects, however, are limited in duration and require the necessary capabilities to all be available so that the window of opportunity can be exploited once it is identified. Understanding that EW may drive, as well as be a tool applied by, planning is key.

For the British military EW is primarily available from the air and at sea, with limited numbers of specialists available for ground forces. Although Russian capabilities are quite effective in dividing air and ground components, with their air defences also drawing air forces into mission sets that will struggle to complement ground force activity, it is reasonable to assume that the British military could plan on using air assets for electronic attack. Naval EW support is harder to envisage because of the distance at which navies must operate from the land to remain survivable. Air-based electronic attack does not offer electronic protection, however. It is evident that there is a need for EW defence to be widely available for all manoeuvre elements. This includes deception. The British Army has had success in exercises through the emplacement of false command posts and other EW decoys. Russian and Ukrainian forces have also successfully employed these techniques. While units might be able to organically use such measures to improve their survivability, deception in the EMS also offers a valuable means of drawing out and then striking enemy prestige systems, especially those capable of delivering precision fires. Lining up the assets to take advantage of such a lure necessitates drawing on kinetic capabilities and their synchronisation of availability with EW capabilities. There is thus a need for planners – often at quite a junior level – to understand this game of cat and mouse and to be able to assign personnel to enable it. Attriting enemy precision capabilities or EW assets is critical in fighting for the right to precision. Whichever side can secure better access to the EMS is likely to retain significant tactical advantages that accumulate over time.

Activity contesting the EMS requires regular emissions. Operations also create significant EMS signatures even among disciplined forces. A force that sees the EMS as something to be feared, with its sole aim being the limitation of its signature, is likely to introduce so much friction into its operations that it cedes initiative and advantage to the enemy through self-imposed constraints. Avoiding this means that a force exposes itself to greater risk of targeting. Mitigating that risk requires an understanding of the force's own signature across the force – not just among the specialist EW community – and comfort on planning actions that prevent the enemy's detections creating timely and reliable information for targeting. Understanding the EMS is also important because in an active contest, EW troops cannot guarantee sustained protection. The enemy may successfully bring about windows of opportunity where it has an advantage in the EMS and can therefore bring precision effects to bear. Understanding the indicators for these conditions among manoeuvre force commanders is important if they are to take the appropriate countermeasures to ensure the survivability of their forces.

Although the importance of EW to air and maritime operations is significant, the war in Ukraine offers limited lessons for the RAF and Royal Navy in this context because Ukraine's air and naval capabilities are too technologically inferior to Russia's to provide a comparable problem set.

Disperse, Dig Deep or Move Fast

The concept of dispersion has been at the forefront of British Army discussion since 2015. In general, the importance of dispersion was vindicated by the data from the Russian invasion of Ukraine. Ukrainian infantry companies tend to disperse across a 3-km frontage. Greater concentration often decreases the survivability of units because it begins to make the use of precision munitions and the allocation of ISTAR assets economical in terms of the effect delivered per munition. One important consequence of dispersion is that it increases the tactical commander's span of control. When combined with the multiple enablers necessary for a formation to be competitive, it is evident that a battalion commander in this conflict is often dealing with a comparable frontage to that traditionally occupied by a brigade, with similar effects in terms of their ability to maintain a physical presence among their troops. Since battalion staffs are not staffed like brigades – and would not be survivable if they were – there is considerable strain placed on company and battalion commanders. The British Army, which tends to put senior personnel within their rank into command positions, is in a reasonable position to handle this challenge. Nevertheless, developing C2 tools to allow beyond-line-of-sight C2 in sub-units is critical. Another challenge for dispersed forces, especially if they must echelon through one another, is identifying friend from foe. Ukrainian troops have tended to sacrifice camouflage for clear identification (using coloured bands) for their manoeuvre forces, relying on speed rather than concealment for survivability.

Although dispersion has proven critical to survivability against indirect fire, it also risks individual positions becoming isolated against enemy forces if they choose to concentrate. In concentrating, the enemy likely accepts higher rates of attrition, but that does not necessarily prevent ground from being taken. On both the attack and defence, the UAF have found that localised actions using reserves are critical to the reinforcement of sectors under pressure and

thus to ground holding or building momentum. This ability for dispersed elements to echelon through one another to rapidly flank and defeat enemy concentrations has also been important in offensive operations. To do this, however, requires that the force concentrates, as survivability is afforded principally by mobility. If the period of concentration is sufficiently short and the target sufficiently mobile, it is difficult for the enemy to bring effective fires to bear on the right location. If these actions coincide with EW and other effects that extend the enemy's kill chain, the window of opportunity for concentration at the appropriate point can be extended. Troops must remain mobile if under observation or they will come under highly effective fire. Even Ukrainian Special Operations Forces found that if they went static having penetrated the enemy, they risked being detected by UAS traversing the battlespace to the front and engaged with indirect fire.

The importance of speed as the best means of protection is also evident in the employment of air-assault operations. Russia successfully penetrated deep inside Ukraine's air defences precisely because it was able to open a window of opportunity in which the speed of insertion was critical. Ultimately Russia inserted too few personnel too deep for them to be reinforced. Ukraine has also employed aviation assault to cut ground lines of communication ahead of an advance. This too had to be done rapidly, exploiting gaps in enemy air defences. The prospect of pattern setting through second waves or resupply to these troops, however, is bleak, risking ambush for aviation en route or being caught on the ground by artillery. The feasible depth for such operations therefore is very limited. If under observation from UAS, troops ultimately have two options: having defeated the UAS they must either displace or move into hardened cover.

The need for hardened cover has been demonstrated throughout this conflict. Shell scrapes and other hasty procedures may improve the survivability of a unit against the opening salvo, but this salvo also risks fixing the unit in cover that is insufficiently protected. Once fixed, the enemy can transition to airburst or thermobaric munitions and thereby kill the target in place. In essence, troops should avoid making administrative stops in the indirect fire zone. If these are essential, shell scrapes may be justified. Mobility is the preferred means of improving survivability in this context. However, if troops are to remain in a position for any length of time, positions must be hardened and have overhead protection. Urban settlements, which often have cellars and other subterranean infrastructure, are optimal defensive points because these positions can be reinforced but begin as a sound basis for shelters. In the open, defensive positions should be dug underground. Both thermal sheeting and overhead cover are very important. Trenches in open ground are too easily targeted so they should be dug along treelines and other areas where there is overhead cover, thereby obscuring where in a trench there are entrances to hardened positions. Hardening positions – including entrances to trench structures – also requires the establishment of UAS detection and laser detection with countermeasures, such as smoke grenades. For any force required to hold vital ground, which is therefore restricted in its ability to displace and manoeuvre, excavation equipment should be available to rapidly emplace hardened defences.

Conclusion

THE WAR IN Ukraine is far from over. Although the Russian military is now on the defensive and withdrawing in multiple directions, there is not yet an indication that its hostile intent against Ukraine nor its efforts to undermine the West economically and politically have subsided. Although the massive sacrifices of the UAF have inflicted serious and widespread damage to the Russian capacity for offensive operations, Ukraine's international partners need to fully appreciate the scale of the conflict, the adversary's capabilities and the cause of their deficiencies to assess whether the Russians are effectively adapting when they try to recover from their recent setbacks.

This report has aimed to properly frame events in Ukraine by outlining Ukrainian decision-making, capabilities and intent, to clarify the scale of operations, and to distinguish between the consequences of Russia's deficient planning and mistaken decisions compared with the structural and systemic weaknesses of its forces. The shortcomings of this report are that it does not deal in detail with Ukrainian losses nor does it assess the relative effectiveness of Ukraine's tactics and performance. It also does not cover the second part of the conflict. For reasons of operational security, these issues will need to be discussed at a suitable point in the future. However, the authors have ensured that what is set out in this report's conclusions is not contradicted by non-public data. It is hoped that this report has therefore provided a sound basis from which to identify critical lessons from the fighting.

Rather than offer a summary of the many detailed and specific observations made in this report, it is worth instead summarising three critical points that policymakers should draw from the conflict if they are to ensure that their national security is built on sound foundations.

First, the war in Ukraine has demonstrated that consumption rates in high-intensity warfighting remain extraordinarily high and that resilience demands a capacity to build new units, produce spare parts and ammunition, and have sufficient stockpiles to remain competitive in the opening phases of fighting. At present, it is evident that NATO members other than the US are not in a strong position on these fronts.

Second, the UAF were competitive against their adversaries not because of superior equipment in the early phases of the war but because they were adaptable – especially at the tactical level – and rapidly innovated new capabilities and concepts of employment to address specific areas of vulnerability where the Russians had achieved overmatch. For NATO countries, the critical question therefore is not whether a specific weapons system gives advantage, desirable though this is, but whether a country's policies, permissions and industrial processes enable the rapid development, experimentation, refinement, acquisition at scale and employment of new systems and tactics. Do personnel at all levels have the permissions to contribute their expertise? Do tactical formations have the capability to procure and test equipment properly? Or is defence

procurement a glacial process that is detached from the development of tactics, techniques and procedures? A state in the latter position is unlikely to adapt at the speed of relevance.

Third, there has been abundant debate over whether the war proves the utility or obsolescence of various military systems: loitering munitions versus artillery, or ATGWs versus tanks. These debates are largely nugatory. Legacy systems, from T-64 tanks to BM-21 Grad MLRS have proven instrumental in Ukraine's survival. That does not mean, however, that historical concepts of employment for these systems remain advisable. The key priority is to understand how new capabilities not only offer opportunity in and of themselves, but also enable and magnify the effects deliverable by legacy systems. Perhaps most important is to appreciate how the correct employment of exquisite capabilities can magnify the impact of cheap and crude equipment. It is evident that to exploit these opportunities, changes to orders of battle, C2 and novel employment may be necessary. The grouping of armour as a reserve, to be committed under propitious circumstances, for example, may make more sense than its distribution into the leading edge of offensive manoeuvre forces. It is also entirely plausible that the synergies between old and new capabilities shift the balance of requirements for the next generation of armoured platforms. But the enduring utility of these tools is not diminished by these changes. In modernising, therefore, forces need to examine how old and new form novel combinations of fighting systems, rather than treating modernisation as a process of deciding what should be procured and what should be discarded.

And finally, for all the new capabilities on the battlefield, the war in Ukraine has been marked by the usual miscalculations, uncertainties and human failings. For Ukraine, victory is essential but can only be achieved with the ongoing support of its international partners.

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