



# Russia's War in Ukraine

Emerging Insights for UK  
and NATO Joint Doctrine

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# Preface

It has been a decade since Russia illegally annexed Crimea and seized portions of eastern Ukraine, and over two years since its full-scale military invasion in February 2022. The return of large-scale conventional warfare to Europe has prompted rapid innovation, keenly watched by other militaries and analysts.

Both sides have deployed uncrewed systems in vast numbers – with drones becoming an indispensable part of fighting on land, at sea and in the air. The combination of artificial intelligence (AI), smartphone apps, new types of sensors and commercial satellite imagery has brought unprecedented levels of transparency to the battlespace. This has sped up the targeting cycle and necessitated that forces on both sides disperse, hide, dig in or move to survive. Space-based broadband has helped military forces and civilians alike to stay connected. Cyber-attacks, electronic warfare and information operations have all helped shape the fighting.

Equally, the war has emphasised elements of continuity, often creating odd juxtapositions. Alongside more modern Western and Russian equipment and the latest experimental technologies, both sides are also deploying Soviet-era equipment in large numbers, or even weapons left over from the First or Second World Wars. The latest first-person view drones are used alongside massed artillery and gruelling trench warfare.

Against this complex backdrop of change and continuity, observers of the conflict have sought to derive insights – or, perhaps more

hubristically, to assert firm predictions and lessons – into the nature and character of warfare. This includes considering the war's implications for how other actors could or should expect to campaign and fight in future, be they the UK and its North Atlantic Treaty Organization (NATO) allies or potential adversaries such as Russia, China or Iran. The experience of the last two years has prompted defence and intelligence agencies to collect and share classified insights. It has also brought an outpouring of open-source analysis and commentary by think tanks, academics, industry and others.

To make sense of this large and growing body of public material, the Doctrine team within the Development, Concepts and Doctrine Centre (DCDC) of the UK Ministry of Defence (the Doctrine team has subsequently become part of the new Integrated Warfare Centre [IWC]) asked RAND Europe to conduct a review of relevant literature and to present implications for UK and NATO joint doctrine. RAND Europe is part of RAND, a not-for-profit research institute, and leads the Global Strategic Partnership (GSP). This is a consortium of organisations providing strategic analysis and academic support to the former DCDC, which on 1 July 2024 split to form Defence Futures and the IWC.

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## Summary

The ongoing war in Ukraine has provoked significant open-source research, analysis and commentary about the supposed insights and lessons for Ukraine, Russia, NATO and other military powers (e.g. China). Prominent themes emerging from the published literature include:

- Uncertainty about future direction and outcomes of the war, or relevance to future conflicts.
- Endurance of the old (e.g. trench warfare) alongside the new (e.g. use of drones in vast numbers), confounding simplistic ideas of military-technological revolution.
- Renewed debates over the salience of positional, attritional and manoeuvre warfare approaches.
- Renewed debates over the limits of jointery (cooperation between different branches of the military) and how to achieve visions of multi-domain operations (MDOs).
- Emphasis on continuous learning and adaptation to remain competitive given the pace of change in both tactics and technology, framing the conflict as one between competing innovation systems.
- Emphasis on sustainment of both the capacity and the will-to-fight and endure a long war, given the scale and rate of battlefield losses and the wider economic costs.
- Emphasis on a whole of society approach and the indispensable role of coordinating with allies/partners, partners across government (PAGs), industry, civil society etc.

Open-source analyses vary in their sophistication, rigour and evidence. This has led to a lack of consensus on the main insights to be gleaned from these assessments, fuelling major areas of debate, including:

- Whether, how and why NATO failed to deter the Russian invasion in February 2022.
- The reasons for Russian strategic, operational and tactical blunders and military underperformance that subsequent year.
- The extent to which positional and attritional fighting, or manoeuvre, will characterise future operations in a battlespace where concealment, movement and concentration of forces is increasingly difficult and costly.
- The extent to which new technologies (e.g. drones) or domains (e.g. cyber and electromagnetic (CyEM)) are having an evolutionary or revolutionary impact on operational and strategic outcomes.
- The extent to which legacy technologies (e.g. tanks, helicopters, surface ships) remain relevant.
- The likely trajectory and outcomes of Ukrainian and Russian operations in 2025 and beyond.

### Implications for doctrine

The GSP's review of open-source literature does not find compelling evidence to suggest that the war necessitates fundamental changes to key ideas and terms in UK or Allied joint operational-level doctrine, such as the

manoeuvrist approach, the comprehensive approach or mission command. The war certainly indicates there are some serious deficiencies for UK Defence to address as a matter of utmost urgency. But the literature suggests that these principally relate to other defence lines of development (DLODs). Examples include a lack of sufficient mass of personnel, equipment or stockpiles, especially munitions. Shortfalls are also reported in readiness, training, infrastructure, etc., and in levels of industrial mobilisation and societal resilience more widely.

Certainly, joint operational doctrine must continue to evolve. Tactics, techniques and procedures (TTPs) and tactical doctrine at the single-service level will also have to adapt to reflect the many detailed and practical insights to take from the war in Ukraine (e.g. how to operate in a drone-rich environment). But the published literature on Ukraine suggests that the most pressing question is not whether NATO and the UK's joint doctrine is appropriate, but rather whether sufficient resources are available to credibly implement those ideas and principles as envisaged, especially over the course of a long war. Relatedly, there is an urgent need to boost Defence's capacity for learning and adaptation, with the conflict emphasising the importance of accelerating innovation and adaptation in both technology and tactics. This includes having efficient lessons, warfare development and doctrine functions, and then the processes and culture to pull through those latest ideas and guidance into real behavioural change across Defence.

The literature suggests there could be benefit in further considering the following questions:

- Does doctrine need to change as the original force is attrited and less well-trained forces employed?
- How to achieve joint theatre entry, multi-domain operation (MDO) and manoeuvre in the face of anti-access/area denial (A2/AD) threats and possible trends in the offence–defence balance that could favour adversary attempts to impose more positional, attritional warfare?
- How to manage the dilemmas posed by the more 'transparent' battlespace with proliferation of sensors and fires, the shift to dispersed operations to maximise survivability, and the associated challenges with command and control (C2), signature management, concentration of forces and effects to achieve breakthroughs, or logistics in a contested environment?
- How to capture in doctrine the diversity of the impacts arising from the rollout of artificial intelligence, uncrewed vehicles (UxVs) and human-machine teaming (HMT) at all levels of the force at a greater pace and scale than the UK had likely anticipated before February 2022?
- Is it a matter for doctrine to reflect overlooked or under-resourced issues such as sustainability, industrial mobilisation, societal resilience and will to fight, or the protection of the UK homeland from proliferating standoff threats (e.g. air, missile or cyber-attacks against critical infrastructure)?
- How can doctrine be made more accessible and better understood by Partners across government (PAGs), the private sector and others, as civilian entities sit outside traditional military C2 structures?
- How to better improve awareness and use of doctrine and ensure that the resourcing and tempo of doctrine development are sufficient, given its importance?

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## Abbreviations and acronyms

A2/AD	Anti-access/area denial
AEW&C	Airborne early warning and control
AI	Artificial intelligence
C2	Command and control
C4ISR	Command, control, communications, computers, intelligence, surveillance and reconnaissance
C-RAM	Counter Rocket, Artillery and Mortar
CAS	Close air support
CASEVAC	Casualty evacuation
CyEM	Cyber and electromagnetic
DCA	Defensive counter-air
DCDC	Development, Concepts and Doctrine Centre
DEAD	Destruction of enemy air defences
DLOD	Defence line of development
ECM	Electromagnetic countermeasure
EM	Electromagnetic
EO	Electro-optical
EU	European Union
EW	Electromagnetic warfare
FPV	First-person view
GBAD	Ground-based air defence
GSP	Global Strategic Partnership
HIMARS	M142 High Mobility Artillery Rocket System
HMT	Human-machine teaming
IADS	Integrated air defence systems
IPoW	Initial period of war



ISR	Intelligence, surveillance and reconnaissance
IWC	Integrated Warfare Centre
MBT	Main battle tank
MDO	Multi-domain operation
MENA	Middle East and North Africa
MLRS	Multiple Launch Rocket System
MOD	Ministry of Defence
MRO	Maintenance, repair and operations
NATO	North Atlantic Treaty Organization
NCO	Non-commissioned officer
NGO	Non-governmental organisation
OCA	Offensive counter-air
OSINT	Open-source intelligence
PAGs	Partners across government
PGM	Precision-guided munition
PMC	Private military company
PNT	Positioning, navigation and timing
SAM	Surface-to-air missile
SATCOM	Satellite communication
SDA	Space domain awareness
SEAD	Suppression of enemy air defences
SLOCs	Sea lines of communication
SODCIT	Strategic Operation for the Destruction of Critically Important Targets
SOF	Special operations force
TTPs	Tactics, techniques and procedures
UAS	Uncrewed aerial system
UK	United Kingdom
US	United States
UxV	Uncrewed vehicle
VVS	Russian Air Force (Voenno-Vozdushnye Sily)

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# Chapter 1. Introduction

## 1.1. Context and purpose

### 1.1.1. The conflict in Ukraine has provoked a race to learn from the fighting, in pursuit of potential advantages in this or future conflicts

Following the full-scale Russian invasion of Ukraine in February 2022, a flurry of reports and articles has purported to gather observations, derive insights and present emerging lessons from the war. These commentaries vary significantly in their methodological rigour, use of primary or secondary data, and overall scope. Some seek to understand different potential trajectories for the conflict, or project how Ukraine and Russia might each evolve their military tactics, capabilities, force structures, concepts and doctrine in future. Others aim to identify transferrable learning that might apply to other actors (e.g. NATO or China) or possible flashpoints (e.g. the Middle East, Baltic States or Taiwan). And while some take in the broad scope of the war, others focus on specific operations, domains (i.e. land, air, maritime, cyber and electromagnetic [CyEM] or space) or technology areas (e.g. considering the role of drones and artificial intelligence [AI] or the future of naval or armoured warfare).

### 1.1.2. The implications of the war for joint operational-level doctrine – as opposed to lower-level tactics or military capabilities – are a potentially overlooked area of public discussion

Of this mass of published, unclassified work, comparatively little pertains directly to the question of military doctrine, especially at the operational and joint level. According to NATO and the UK Ministry of Defence (MOD), doctrine can be defined as ‘the fundamental principles by which military forces guide their actions in support of objectives. It is authoritative but requires judgement in application.’<sup>1</sup> This sets out official thinking and guidance on the best ways to operate, fight and win – building on both well-established concepts about the nature and changing character of warfare and the latest operational lessons.

As outlined in Joint Doctrine Publication 0-01, the UK Defence Doctrine, the UK aims to ensure interoperability with other NATO militaries by following Allied joint doctrine wherever it can. This serves to guide operational-level commanders and headquarters. Responsibility for developing and maintaining Allied and UK joint doctrine has moved to the newly established Integrated Warfare Centre (IWC) within UK Strategic Command. Until 1 July 2024, this was the Doctrine team of the Development, Concepts and Doctrine Centre (DCDC). Below this, at the tactical level, doctrine comprises a mix of Allied tactical publications as well as UK joint tactics, techniques and procedures (TTPs) produced by Strategic Command and domain-specific tactical doctrine generated by the single services (Army, Air Force and Navy).

### 1.1.3. This RAND Europe study seeks to gather evidence that might fill that gap in the debate

Against this backdrop, the Doctrine team in DCDC commissioned the Global Strategic Partnership (GSP), a research consortium led by RAND Europe, to conduct a review of academic, think tank and other publications since February 2022. The focus of this study was on identifying any reported insights for joint doctrine by:

1. Collating any existing open-source research, analysis and commentary on how Defence might best address the issues and challenges identified from the perspective of joint doctrine.
2. Mapping observations, as well as any reported insights and lessons identified, from the ongoing war in Ukraine, whether relevant to Ukraine, to Russia, or to NATO and the UK.

To do so, the study team conducted a review of unclassified and open-source grey literature and academic sources published since 2014 and the illegal Russian annexation of Crimea, but with a focus on post-February 2022 sources. With support from RAND Knowledge Services, the study team identified a long list of 389 sources and reviewed them to produce a shortlist of 50 for initial review in detail using a structured data extraction matrix. This initial selection of sources was then supplemented with snowballing from bibliographies to ensure full coverage of the issues, resulting in the reference list attached to this report.

The following caveats should be considered:

- The literature review is based on unclassified information from open-source literature only, primarily from Western sources (using English).

- The war in Ukraine is still ongoing and things can change quickly. It is, therefore, difficult to know what the outcomes will be or to predict what lessons will be drawn from the conflict after its end.
- Given this uncertainty, speculating about the future of the war or of Ukrainian, Russian or NATO military thinking is likely to prove inaccurate. The same applies to doctrine, concepts, capability and force development trends. Even if the lessons of the current war could be predicted and learned, there is no guarantee that they will be relevant to a future conflict with its own unique conditions.
- Given the full-scale Russian invasion occurred only two and a half years ago (in February 2022), and given both classification issues and the time lag in publishing peer-reviewed academic research, much open-source information is still drawn from social media, news or grey literature.

## 1.2. Structure of this report

In addition to this introductory chapter, this report is structured as follows:

- Chapter 2 looks at overarching observations from the literature at the joint level.
- Chapter 3 considers domain-specific observations across land, maritime, air, CyEM and space.
- Chapter 4 considers actor-specific observations relating to Ukraine, Russia and NATO.
- Chapter 5 identifies implications for joint doctrine.

## Chapter 2. Overarching observations

This chapter presents overarching observations captured from the open-source literature review, focusing on the joint level. However, it must be remembered that many of the themes captured in the public debate do not reflect how NATO would fight a war, and so any purported conclusions must be put into context.

### Box 2.1 Overarching findings at the joint level

The war in Ukraine has demonstrated that understanding an adversary's strategic and military culture is critical. We have also seen that while the character of warfare evolves with technological progress, the fundamental nature of war remains unchanged. The fighting has employed a blend of traditional tactics like trench warfare with modern technologies like precision-guided munitions (PGMs) and drones. This is a mix that highlights the evolving and complex character of contemporary conflict, where old methods are used together with cutting-edge technology. The need for mass despite modern advances has reignited debates about the balance of quality versus quantity in force design and the credibility of conventional deterrence.

Open-source literature focused on strategic-level insights underscore the difficulty in aligning ends, ways and means, as well as the importance of using all levers of power, including diplomatic, informational, military and economic, to manage escalation and shape outcomes. Inconsistent application of existing Russian and Ukrainian doctrine, heavy equipment losses in the face of attrition, and barriers to interoperability have all emerged as key challenges in the fighting. Further, the war demonstrates the importance of a national effort to sustain prolonged conflict, necessitating robust civil-military relations and a mobilised and resilient industry, economy and society.

#### Over the first two years of the war in Ukraine the following key findings were identified:



Both the 2014 Crimean annexation and February 2022 invasion caught many analysts off-guard: a deeper understanding of adversaries' goals, perceptions, fears and decision-making calculus is needed.



The literature contains many bold assertions over the changing character of warfare and its drivers; the reality on the ground in Ukraine is more complex.



New technologies have had a significant impact on command, operational and tactical decision making, and the pursuit of information advantage.



Neither manoeuvre nor positional warfare have led to a decisive strategic outcome (yet), but claims in the literature of either approach's demise are premature.



Ensuring that doctrine is actually understood and applied consistently – and that it evolves at sufficient pace to stay relevant given operational lessons – remains a challenge.



The military effort – including the role of doctrine – cannot be divorced from wider cross-governmental, industrial and societal mobilisation in times of war.

## 2.1. Observations

The following sections explore each of these themes from Box 1 in more detail.



### 2.1.1. The 2022 invasion caught many analysts off-guard: a deeper understanding of adversaries' goals, perceptions and decision making calculus is needed

Understanding an adversary's strategic and military culture is crucial to hopes of influencing it and creating a deterrent effect. The conflict has sparked debates comparing Russian and Western military approaches, highlighting issues such as the widely observed demoralisation within Russian ranks compared with the strong morale observed in Ukrainian forces and society. Observations from the literature include:

- **The importance of intelligence and understanding:** Russia's failure to achieve its objectives in the initial period of war (IPoW) reflected the impact of poor strategic intelligence.<sup>2</sup> New technology is enabling a proliferation of data that can provide advantages in the engagement space if properly understood and interpreted in an environment that allows for critical thinking, multidisciplinary expertise and constructive challenge.<sup>3</sup> This means going from sensing to sense-making.
- **The influence of strategic and military culture on decision making:** The failure to deter Russia – or Russia's own failure

to achieve the aims of its 'special military operation' in February 2022 – speak to the enduring importance of strategic intelligence and of understanding an adversary's 'strategic culture' so as to be able to influence their decision-making processes.<sup>4</sup> A state's approach to threat perception and use of force is influenced by its strategic culture – its cultural and historical experiences rooted in geography, religion, language and national identity. Therefore, understanding (in this case) Russia's strategic culture and, by extension, how its leadership understand their reality can help make sense of their behaviour.<sup>5</sup> Related to this is military culture; here, the conflict has elicited significant debate in the open-source literature over the relative merits of Russian versus Western approaches to leadership, culture, warfighting and mission command.<sup>6</sup> Reports of demoralisation within Russian military ranks have, for example, contrasted with the 'spirit of resistance' and resolve observed both within the Ukrainian armed forces and civil society – though the Ukrainians are increasingly facing challenges recruiting fresh troops to replace battlefield losses.<sup>7</sup>

- **The importance of a clear strategy and theory of victory:** Further, at the strategic level, the war has reiterated the importance, and difficulty of, aligning ends, ways and means, and devising a militarily successful strategy based on robust and realistic net assessments of the adversary's

2 Dalsjö et al. (2022).

3 Dalsjö et al. (2022); Walt (2023).

4 Atlantic Council (2022); Baev (2022).

5 Yurchenko (2024).

6 Farida et al. (2022); Halem (2023); Pomper & Tuganov (2023).

7 Dickinson (2023).

strengths and weaknesses. This extends to developing a strategy that creates the conditions for an eventual political resolution and de-escalation into a state of competition on acceptable terms.<sup>8</sup> The war also suggests that both the fighting parties (Ukraine, Russia) and other third parties (the West) must consider how to use all diplomatic, information, military and economic levers to manage escalation risk, both to shape conflict outcomes and to establish a more stable post-war security architecture in Europe (including addressing questions such as NATO and European Union [EU] membership for Ukraine as well as security guarantees).<sup>9</sup> There has been an especially prominent economic dimension to the conflict, with the use of force to exercise economic statecraft in particular raising questions about escalation dynamics. The conflict has been accompanied by Western sanctions, Russian maritime and port blockades, and direct attacks on Ukrainian industrial facilities and supply chains in attempts to frustrate the war effort.<sup>10</sup> These have had widespread cascading effects on the global economy, affecting energy, food and fertiliser prices, and threatening the supply of basic foodstuffs to the Middle East and Africa in particular.



### 2.1.2. The literature contains many bold assertions over the changing character of warfare and its drivers; the reality on the ground in Ukraine is more complex

The ongoing war in Ukraine, which does not possess the full capabilities of the NATO Alliance, illustrates that while the character of warfare evolves with technological advancements, the fundamental nature of war remains unchanged. Observations from the literature include:

- **The contested role of technology in influencing the changing character of warfare:** The conflict in Ukraine has reiterated the fact that while the character of warfare is changing, the nature of war remains constant – notwithstanding some techno-determinist sources within the literature which argue that the nature of war has fundamentally changed as result of new technologies, e.g. drones and AI tools integrated into command and control (C2) software.<sup>11</sup> While the conduct and character of warfare continues to change from technological progress, the nature of war is subordinated to an enduring logic as ‘the continuation of political activity by other means’.<sup>12</sup> Despite constant innovations at the tactical and operational levels of warfare, there are thus continuities at the strategic level.<sup>13</sup> Technological trends towards automation, process optimisation and a more transparent, networked and data-rich battlespace aside, the war has for example reiterated the enduring impact

8 Davydiuk & Zubok (2023); Gady (2023a); Walt (2023).

9 Atlantic Council (2022); Cherniavska et al. (2023); Kepe & Demus (2023); Kostyuk & Brantly (2022).

10 Atlantic Council (2022); Colom-Piella (2022).

11 Baev (2022); Biddle (2023); Favaro & Williams (2023); Johnson (2022); Lonergan et al. (2023); Šlebir (2022).

12 Von Clausewitz (1976).

13 Hughes (2006).



of uncertainty and friction in complicating operations. In this context, redundancy, reversionary modes and TTPs remain essential to ensure resilience.<sup>14</sup>

- **The complex interplay of old and new, in both tactics and technology:** The war on the ground has witnessed a unique blend of old and new military tactics and technologies. Traditional tactics including trench-style warfare and heavy use of artillery have been employed in high-intensity fighting. These conventional methods are employed alongside modern and advanced systems including PGMs, drones and cyber capabilities. What you have in Ukraine is thus the brutality of early 1900s trench warfare on the one end of the spectrum, and a modern embrace of technology and digitalisation of the battlespace on the other.<sup>15</sup> Employing innovative new technology at the tactical level (including uncrewed vehicles or UxVs) alongside Soviet-era systems and platforms in trench warfare presents a complex reality on the ground.<sup>16</sup>
- **A continued need for critical mass:** While the efficiency afforded by new technology can offset the need for mass in certain situations, it cannot replace the general

need for mass. We have not yet observed any game-changing technology or tactic that negates the need for critical mass in personnel, infrastructure, materiel and stockpiles. This observation has reignited debates about the relative balance of quantity versus quality, or that of mass versus precision, especially in Western military doctrine and force design, although it must be remembered that this war is being fought without the full employment of air power. Further, such discussions have also encouraged debate about whether NATO countries' military forces constitute a credible conventional deterrence at their current size and how quickly they could be scaled up or reconstituted in a lengthy conflict.<sup>17</sup>

- **The persistence of a continuum of conflict:** The war has also emphasised that competition and conflict exist on a continuum, with relations between actors existing at multiple points across that continuum at any given time. This means that it is, for example, possible to be engaged in open conflict while simultaneously cooperating in other fora as actors seek to test, blur and exploit the blurred thresholds between war and peace.<sup>18</sup>

14 Lonergan et al. (2023); Walt (2022).

15 Bfbs Forces News (2023).

16 Joshi (2022); Kunertova (2023).

17 Biddle (2023); Pomper & Tuganov (2023).

18 Rushing & Hunter (2023); Šlebir (2022).





### 2.1.3. New technologies have had a significant impact on command, decision making and the pursuit of information advantage

New technologies have enabled significant innovations in decision making and information advantage. Key observations include:

- **The pursuit of decision and information advantage:** The war in Ukraine has seen significant innovation in pursuit of decision and information advantage (e.g. through the use of novel sensors and AI tools, such as those being used with Ukraine's Delta software system, in order to support situational awareness, C2 and targeting). This reflects a wider emphasis on behalf of Ukraine and the West on a 'manoeuvrist approach' in attempts to impose dilemmas on Russia.<sup>19</sup> The last two years of fighting have emphasised the central importance of the continuous competition for (often only temporary windows of) advantage between command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) and corresponding counter-C4ISR systems. Both sides of the conflict continue to innovate in their efforts to build more effective 'reconnaissance-strike complexes' and more efficient 'kill chains', so that they can find, fix and engage targets at increasing speeds.<sup>20</sup>
- **The importance of battlefield tempo:** The war has prompted thinking about how to best manage this accelerating speed of decision and execution at the tactical level alongside the more deliberate tempo needed at the strategic level. This includes how to

balance and manage roles, responsibilities and authorities across different levels, including the role of politicians or partners in strategic decisions; how to navigate various domains, horizontal and vertical escalation dynamics; and how to handle the blurred distinction between 'home' and 'away' given threats to the homeland.<sup>21</sup>

- **The application of 'systems thinking' on both sides:** At different times during the war, both sides have emphasised and adopted a 'systems thinking approach' in an effort to go after their adversary's centre of gravity, seeking to destroy key nodes and linkages within the adversary's C4ISR and logistical systems to provoke cascading effects that disrupt or paralyse the wider force. This includes prioritising finite stockpiles of precision-munitions and using non-kinetic effectors like offensive cyber for attacks against high-value targets and key nodes in C2 networks, or to force low-volume assets such as air defence radars and missile launchers to expose their position. Such activity is linked to evolving Western ideas of multi-domain operation (MDO) and to Russian military concepts such as reflexive control or disruption.<sup>22</sup>



### 2.1.4. Without airpower, neither manoeuvre nor positional warfare have led to a decisive strategic outcome, but claims in the literature about the demise of such approaches are premature

The war has demonstrated that there are different approaches to manoeuvre and attrition warfare, with no decisive breakthroughs from

19 Davydiuk & Zubok (2023); Halem (2023).

20 Colom-Piella (2022).

21 Favaro & Williams (2023).

22 Colom-Piella (2022); Gilliam & Van Wie (2022); Pomper & Tuganov (2023).

either side, given the lack of air power. However, both sides have used attrition and disruption tactics, highlighting the lethality of sustained warfighting at scale. Observations include:

- Precision versus saturation:** Both sides have where possible sought to disrupt, confuse or paralyse their adversary's decision making, rather than to defeat and destroy adversary forces in place.<sup>23</sup> However, this more subtle approach is often not possible. At times attrition has, therefore, been the primary focus, with Russia willing to employ human wave attacks, often with contracted private military companies (PMCs) or convict forces, or saturation attacks with artillery and drones.<sup>24</sup>
- The primacy of land operations without air power:** Unsurprisingly, given Russian war aims, there has been an inescapable need to take and hold territory. Russian attempts at a swift and surgical decapitation of the Ukrainian military and political leadership in the IPoW were unsuccessful; since then, Russia has varied its approach to its air and missile campaigns against Ukraine at different stages of the war, including more traditional 'Strategic Operation for the Destruction of Critically Important Targets' (SODCIT) using PGMs and suicide drones without any serious attempts for control of the air. These aerial bombing campaigns have not yet had a decisive strategic effect or negated the primary focus of this conflict on the land domain (if with an important maritime component).<sup>25</sup>
- The increased debate over Ukraine's manoeuvrist approach:** The contrasting outcomes of Ukrainian counteroffensives in 2022 and 2023 elicited a narrow debate about the manoeuvrist approach and how to succeed in more positional warfare, perhaps ignoring the wider advantage of 'cognitive' not just physical manoeuvre. However, what we have seen is the differing utility and success of various approaches in diverse situations, rather than any definitive evidence that the future of conflict will be mobile or static. The failure by either side to achieve decisive breakthroughs has, however, certainly emphasised the lethality of sustained warfighting at scale in the land domain when operating without sufficient control of the air, and the associated losses both sides can expect to incur. This re-emphasises the need for defence establishments to be ready to endure attrition and reconstitute depleted forces over time during major combat operations, including through industrial and societal mobilisation.<sup>26</sup>
- Debates on the use of decision support tools and techniques:** The war has prompted controversy and debate about the relative benefits and deficiencies of wargaming, modelling and simulation as helpful techniques to operational planning or mission rehearsal. This was particularly seen to be the case on the Ukrainian side following leaks on supposed disputes between US, UK and Ukrainian officials engaged in wargames ahead of the counteroffensive of 2023.<sup>27</sup> More generally, the last two years have

23 Colom-Piella (2022); Pomper & Tuganov (2023).

24 Atlantic Council (2022); Bauer & Mueller (2023); Katz et al. (2020).

25 Baev (2022); Bielieskov (2022); Dalsjö et al. (2022); Pomper & Tuganov (2023); Walt (2023).

26 Gady (2023a); Joshi (2022); Konaev & Brathwaite (2022).

27 Washington Post (2023a).

highlighted a need for support to help train and prepare Ukrainian joint planners for the complexities of designing and executing complex operations at scale – especially in the context of resource constraints and capability gaps that mean the Ukrainians cannot simply replicate a NATO approach to warfighting at scale.<sup>28</sup> On the Russian side, the failure of the so-called ‘special military operation’ to achieve its objectives in the IPoW have been linked back to a lack of mission rehearsal, wargaming, modelling or Red Teaming in the run up to the invasion.



### 2.1.5. Ensuring that doctrine is actually understood and applied – and evolves at sufficient pace at the tactical level to stay relevant – is a challenge

Inconsistent application of doctrine and TTPs at the tactical level, equipment losses and difficulties in resupply and mass sustainment have emerged as significant challenges. The conflict has underscored the importance of integration and interoperability to come to terms with these. Observations in the literature include:

- **The challenge of shortcomings in doctrine application:** Like many prior conflicts, the war has seen both sides, and suggestively Russia in particular, apply doctrine and TTPs inconsistently at best.<sup>29</sup> This reflects the Russian leadership’s political choice to invade in 2022 in a manner inconsistent with the Russian armed forces’ own concepts and doctrine for warfighting, due to the mistaken assumption that Ukrainian resistance would be limited and short-lived. This points to systemic issues in

civil-military relations, military intelligence and education, and groupthink or lack of challenge on the Russian side. At a more tactical level, the inconsistent application of doctrine by units in the field could be the result of training limitations, different levels of professionalism and varying levels of experience of non-commissioned officers (NCOs) and junior commanders. All of these issues are only exacerbated as heavy losses have forced both Russia and Ukraine to deploy new forces hastily without sufficient time for training. These shortcomings and inconsistencies have limited the capacity of either side to carry out manoeuvres at scale, resulting in many engagements undertaken at smaller unit sizes on limited front areas.<sup>30</sup>

- **High levels of equipment losses and casualties:** The rate and scale at which both sides have lost both troops and materiel, and the difficulties ramping up both industrial production and training capacity in the West, have underscored challenges of resupply, reconstituting losses and sustaining mass mobilisation. Thus there needs to be a discussion as to whether and how doctrine should evolve at operational and tactical levels to reflect inevitable force changes and reconstitution over the course of a conflict (including the changing level of experience, training and balance of professional versus conscript forces).<sup>31</sup>
- **Barriers to integration and interoperability:** The war has also reiterated the challenge of barriers to integration and interoperability. This has particularly been the case for Ukraine, which has operated

28 Atlantic Council (2022); Gady (2023c); Washington Post (2023a).

29 Farida et al. (2022); Pomper & Tuganov (2023).

30 Dalsjö et al. (2022); Zabrodskyi et al. (2022).

31 Atlantic Council (2022); Colom-Piella (2022); Detsch (2022d).

a wide variety of Western and Soviet-era equipment, sometimes in the same unit. But such issues have also affected Russia, which post-Prigozhin moved from using an ad hoc mix of regular, volunteer, mobilised and mercenary forces towards more integrated ground forces.<sup>32</sup>



### 2.1.6. The military effort – including the role of doctrine – cannot be divorced from wider cross-governmental, industrial and societal mobilisation in times of war

The war has highlighted the importance of well-functioning civil-military relations, collaboration, robust societal resilience, and a mobilisation of industry and wider society. Observations in the literature include:

- **The importance of civil-military relations:** The war has demonstrated the importance of carefully navigating civil-military relations and the need for strong political leadership to mobilise the nation. The failed three-day 'special military operation' that turned into a long and ongoing war has emphasised the importance of societal resilience and most importantly having robust mechanisms in place to mobilise industry and the wider society onto a war footing. This includes the implementation of civil defence measures, conscription and increased defence production.<sup>33</sup>
- **The need to develop an integrated and comprehensive approach:** The conflict
- **The importance of narratives and will to fight:** The war has re-emphasised the importance of a narrative and audience-centric approaches. This includes the crucial but often overlooked role of a national will to fight<sup>36</sup> – a topic extensively analysed at RAND but often overlooked, especially in Western defence establishments.<sup>37</sup> Recent research has explored the ways in which Ukraine has sought to promote its narratives to domestic, Russian and international audiences (with substantial success, though least of all inside of Russia), countering disinformation and misinformation.<sup>38</sup> This includes through charismatic leadership on the part of the Ukrainian president,

has also emphasised the enduring seams between services, military and civilian agencies, and between the public and private sector. This includes the integration of cyber, electromagnetic (EM) and space capabilities in novel ways, drawing on input from the commercial sector. There is, however, uncertainty as to how, and at what levels, one can most effectively operationalise emerging concepts like MDOs.<sup>34</sup> Further, the Ukrainian experience demonstrates the need for working with allies, international partners and partners across government (PAGs), industry, academia and civil society in ways that challenge traditional hierarchical approaches to C2. This entails moving away from C2 to more networked collaborative approaches engaging institutions and individuals beyond the military.<sup>35</sup>

32 Kostyuk & Brantly (2022); Murphy (2023).

33 Detsch (2022f).

34 Atlantic Council (2022); Favaro & Williams (2023); Kempe & Demus (2023); Kroenig & Starling (2023).

35 Zabrodskyi et al. (2022).

36 Microsoft Threat Intelligence (2023).

37 Connable et al. (2019); McNerney et al. (2018).

38 Helmus & Holynska (2024).



an effective campaign of pre-bunking or debunking false Russian or pro-Russian claims, and efforts to mobilise a wide range of influential voices from across all walks of society to bolster morale domestically and encourage support for Ukraine internationally. Equally, Ukraine has found itself facing difficulties in maintaining morale and mobilising new recruits as it has faced operational setbacks in the east through much of 2024. The experience of the heavy fighting since February 2022 has also raised questions about whether the UK or other NATO countries would exhibit similar levels of national will to fight as Ukraine, and what Defence could do to address this (including via doctrine).

- **The moral, legal and practical challenges of widespread human security violations:** The war has re-emphasised the challenges of providing for human security and the protection of civilians, including dealing with war crimes and abuses, and preparing for the reconstruction of Ukraine.<sup>39</sup>

- **Concurrency of international crises:** The unfolding of several crises requiring attention beyond Ukraine – including the war in Israel and Gaza, and the Houthi attacks on commercial shipping in the Red Sea – has highlighted the challenge of managing concurrency, both in political bandwidth and military capacity.<sup>40</sup> This raises wider questions about force design and the degree to which certain countries (e.g. within NATO) or capabilities should be tailored to specific roles or geographies, as well as about how nations can mobilise their industrial bases and wider societies onto a war footing in a world facing multiple major threats to global peace and security.

The following chapters delve into observations from the literature about specific domains (land, air, maritime, CyEM or space) or actors in the conflict (Ukraine, Russia and NATO/UK).

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39 Baev (2022); Cherniavska et al. (2023); Shatz et al. (2023); Sherman (2023).

40 The Economist (2023).

## Chapter 3. Operational domain-specific observations

This chapter presents a breakdown of the open-source literature's purported insights and observations from the war regarding each of the land, air, maritime, CyEM and space domains.

### 3.1. Land

#### Box 3.1 Overview of findings relating to the land domain

Since February 2022, the integration of new tactics and technologies – including uncrewed systems, AI and space-based intelligence, surveillance and reconnaissance (ISR), alongside more traditional military capabilities – has significantly complicated fighting in the land domain. This has sparked debates over the effectiveness, cost and value of various capabilities (e.g. tanks) or doctrinal approaches (e.g. manoeuvre versus positional warfare).

The complexities of contesting both the close and deep battle in the face of pervasive enemy surveillance and fires have reinforced the need for force dispersal, careful signature management and robust C2 systems. The war has also underscored the challenge of quickly concentrating sufficient forces to launch an offensive push or achieve surprise, at least without a concerted campaign of deception. It has also shown the heavy toll that comes with trying to breach well-prepared fixed defences, especially in the absence of air superiority. It has also re-emphasised the difficulties of urban warfare and the need for specialised training and equipment to operate in such complex environments. Additionally, logistical challenges in dispersed and contested environments, alongside the insecurity of rear areas, have driven innovation in areas such as using UxVs for last mile resupply.

With regards to the land domain, the following key findings were identified from literature:



A more transparent and lethal battlespace is driving tactical and technological innovation in the face of heavy losses on both sides, while emphasising mass.



The need to contest the deep battle is similarly driving forces to disperse, complicating efforts to win the close battle and concentrate for a breach.



The need to operate dispersed, without air superiority, and in complex, degraded environments, in turn brings new logistical and training challenges.



### 3.1.1. A more transparent and lethal battlespace is driving tactical and technological innovation in the face of heavy losses on both sides, while emphasising mass

Since February 2022, the use of new technologies alongside legacy systems has added to the transparency, lethality and overall complexity of the battlespace. Recurring observations in the literature include:

- **The importance of reconnaissance-strike complexes:** The war has demonstrated the increasing range, precision, volume, tempo and lethality of fires, including artillery, multiple launch rocket systems (MLRS) and use of uncrewed aircraft systems (UAS), and the proliferation and diversification of sensors, including ground moving target indication, synthetic aperture radar, acoustic, electro-optical (EO), EM, infra-red and space-based ISR. This has been complemented by more novel forms of ISR, including the use of civilian-inputted data or civilian infrastructure's networked sensors, the proliferation of vast numbers of UAS across all levels, and the application of AI and data analytics to enhance C4ISR (e.g., in Ukraine's Delta system). Such trends have come together to accelerate kill chains in pursuit of sensor and fire dominance, albeit often only local and fleeting.<sup>41</sup>
- **High levels of attrition, including for armour:** The loss of thousands of armoured vehicles, including Soviet designs as well as Western-supplied main battle tanks (MBTs) and infantry fighting vehicles, has reignited debates over armour and protection technologies (e.g. hard and soft kill active protection systems, explosive reactive armour, slat and cage armour etc.) in the face of proliferating anti-armour threats (including anti-tank guided missiles with top-attack capabilities, UAS and mines).<sup>42</sup>

41 Colom-Piella (2022); Kunertova (2023); Pomper & Tuganov (2023).

42 Paier (2022).

- **The increased use of human-machine teaming (HMT) and UxVs:** Similarly, the proliferation of UAS (including FPV drones), the deployment of lethal uncrewed ground vehicles, and the use of millions of mines alongside cluster and smart munitions have reignited debates over the survivability of crewed vehicles or dismounted infantry in an age of proliferating UxVs. This includes questions over force structure and finding the right balance between humans and machines.<sup>43</sup> Such discussions have also driven inconclusive debates among commentators regarding the appropriate balance between mobility, protection and firepower for land forces on the modern battlefield.<sup>44</sup>



### 3.1.2. The need to contest the deep battle is similarly driving forces to disperse, complicating efforts to win the close battle and concentrate for a breach

The war has demonstrated the complexities that come with fighting the deep battle and having to disperse, conceal or continuously move forces to survive. Observations from the literature include:

- **Increased challenges of deep operations and dispersal:** The war has demonstrated both the importance and evolving challenges of the deep battle – an issue also highly relevant to other domains (e.g., air and maritime) but posing substantial challenges for land forces, given their unique role in the close battle and physical limitations on their movement.<sup>45</sup> The increasing ‘transparency’ of the battlespace to enemy ISR and fires has complicated efforts to conceal, move or concentrate forces, necessitating dispersal to ensure survivability. Such threats have also reignited interest in counter rocket, artillery and mortar (C-RAM) systems, organic air defences and counter-UAS capabilities, multispectral camouflage, decoys and deception as ways to maximise the ‘survivability onion’ for land forces in such a threat environment.<sup>46</sup>
- **The difficulty of avoiding fratricide in a congested battlespace:** The intermingling of dispersed forces has in turn emphasised the need for the deconfliction of friendly forces, including ways of managing C2 seams between units and means of identifying friend from foe. Troops have often opted to compromise camouflage (e.g. placing bright yellow or blue tape over their uniforms, or marking vehicles with unique identification marks) to reduce friendly fire.<sup>47</sup> Nonetheless, fratricide remains a significant problem, as reflected in losses of Russian aircraft in the vicinity of their own ground-based air defence (GBAD).
- **The need for improved signature management:** Relatedly, the deep battle has emphasised the need for more vigilant signature management (see section 3.4 on CyEM below) and demonstrated the acute vulnerability of large, immobile and high-signature C2 nodes to detection and engagement by enemy forces. This necessitates a different approach to the design, composition and interaction

43 Zabrodskyi et al. (2022).

44 Colom-Piella (2022).

45 Halem (2023).

46 Pomper & Tuganov (2023).

47 Zabrodskyi et al. (2022).



between headquarters at different levels to bolster C2 systems' resilience.<sup>48</sup> The literature includes many anecdotes of both Russian and Ukrainian forces being exposed and targeted (e.g. with artillery or drones) due to lax signature management, to include even use of mobile phones rather than more secure military communication systems.

- **The impact of static warfare and difficulty of breaching prepared defences:** While the war has demonstrated the evolving challenges and importance of the deep battle it has also reiterated those of the close battle.<sup>49</sup> While the successful Ukrainian counteroffensive of 2022 showed the enduring possibility of achieving significant breakthroughs using manoeuvre warfare, the conflict has since descended into trench warfare, with both sides preparing field fortifications and minefields, and employing large numbers of drones and artillery to detect and then blunt any attempt at a breach. The much more successful Russian defence-in-depth against the 2023 Ukrainian counteroffensive demonstrated the difficulties and costs that come with breaching fortified positions, particularly in the absence of air superiority. Commentators have inconclusively debated whether the Ukrainian setback reflected deficiencies in Ukrainian or Western doctrine (including the focus on combined arms manoeuvre) or related more to faulty planning, execution and insufficient troops or materiel.<sup>50</sup>



### 3.1.3. The need to operate dispersed, without air superiority, and in complex, degraded environments brings new logistical and training challenges

The war has also demonstrated the logistical challenges that arise from force dispersal and fighting in such contested environments. Major observations from the literature include:

- **The increased vulnerability of logistics:** Force dispersal poses significant challenges to logistics in a contested environment. The war has shown the vulnerability of logistics hubs, ammunition dumps, fuel depots and ground lines of communication to long-range fires, drones or attacks by special operations forces (SOF) and partisan forces.<sup>51</sup> This makes logistical and medical support to units in combat less timely and efficient.<sup>52</sup> This has driven experimentation, for example with the use of UxVs for last mile resupply or casualty evacuation (CASEVAC) missions.
- **The renewed challenge of rear area (in) security:** A range of high-profile attacks and acts of sabotage by Ukrainian SOFs, stay-behind forces and armed resistance, as well as the Russian use of special forces (Spetsnaz) to sow confusion during the attack on Kyiv in the IPoW, have emphasised the need for a renewed focus on rear area security and counter-intelligence.<sup>53</sup> This includes mitigating the growing threat of attacks on critical ports of debarkation and embarkation, transport

48 Black et al. (2024); Colom-Piella (2022); Watling & Reynolds (2023).

49 Cranny-Evans (2023).

50 Detsch & Mackinnon (2022).

51 Gilliam & Van Vie (2022).

52 Dalsjö et al. (2022); Davydiuk & Zubok (2023); Johnson (2022); Skoglund et al. (2022).

53 Gady (2023c); Halem (2023); Microsoft Threat Intelligence (2023).

infrastructure, industrial facilities, stockpiles or important individuals. This extends to a horizontal escalation of the conflict to include strikes against proxies and interests in third countries (e.g. Russia's sabotage, arson and assassination campaign against targets across Europe, or reported Ukrainian actions against Russian PMCs and interests in Syria, Mali and Sudan).<sup>54</sup> In summer 2024, Ukraine has even exploited the lack of defences in Russian territory to launch a surprise attack across the border to temporarily seize lands between Ukraine and the Russian city of Kursk.

- **The need to adapt to complex environments and re-emphasis on urban warfare:** The war has also prompted many observations in the literature about the salience, difficulty, specialist requirements and human cost of urban warfare, where forces have been unable to bypass population centres and avoid civilian casualties.<sup>55</sup> In part, this has meant re-emphasising themes emerging from previous studies of urban fighting in Iraq, Syria and elsewhere, but with the addition of insights relating to new trends such

as the proliferation of large numbers of UxVs in the battlespace. The conflict has also demonstrated the need for training and doctrine to equip forces to operate safely and effectively in other complex environments, including but not limited to damaged nuclear power plants, contaminated industrial sites, flooded areas and contested wet or dry crossings.<sup>56</sup> The destruction of the Nova Kakhovka Dam and subsequent flooding of the lower Dnipro river has also urged a relearning of riverine warfare skills and operations in the littoral, marshlands and flooded urban areas, with potential lessons for Western doctrine.<sup>57</sup>

- **Increased training requirements to reflect a changing operating environment:** While the provision of training (including by the UK) has been an important component of Western military aid to Ukraine, the stalled 2023 counteroffensive suggested a need for more specialised and advanced command, staff and unit training and exercises in order to be able to operate in larger formations. It also highlighted a need for more ambitious support to prepare Ukrainian planners for the complexities of designing and executing operations involving combined arms manoeuvre at scale, including at the brigade, divisional or above levels.<sup>58</sup>

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54 Kostyuk & Brantly (2022); Pomper & Tuganov (2023).

55 Konaev & Brathwaite (2022).

56 Gilliam & Van Vie (2022); Gleick et al. (2023).

57 Gleick et al. (2023).

58 Atlantic Council (2022); Gady (2023c); Washington Post (2023a).

## 3.2. Air

### Box 3.2 Overview of findings relating to the air domain

The war in Ukraine has highlighted the permeability of integrated air defence systems (IADS) and an increased reliance on GBAD systems due to the absence of sufficient control of the air to enable the joint campaign. A variety of observations have been made as a result including on the challenges of achieving such control, the importance of dispersal of air assets in response to the rising threats of UAS and missiles to vulnerable airbases, and the proliferation of IADS and GBAD systems that have reduced the use of rotary-wing assets.

Since February 2022, the widespread use of UAS has been a defining feature of the war. While failing to provide sufficient control of the air, the increased reliance on these systems has fostered a transparent battlespace, complicated force concealment and movement, and provoking a 'race' to enhance counter capabilities. The war has also revealed significant cost and capacity asymmetries, where high-cost missiles have been deployed against low-cost drones, underscoring the need for more cost-effective solutions in the longer term. The rapid expenditure of munitions has highlighted a lag in production capacity to replenish stockpiles effectively.

With regards to the air domain, the following key findings were identified:



Attrition from the proliferation and large-scale use of UAS on the battlefield is driving the need for control of the air.



The war has simultaneously emphasised the difficulty of operating without sufficient control of the air and the imperfection and permeability of air defences.



The need to develop cost-effective munition stockpiles, in a context of rapid expenditure, brings sustainment challenges.





### 3.2.1. Attrition from the proliferation and large-scale use of UAS on the battlefield is driving the need for control of the air

A defining feature of the conflict has been the proliferation of UAS, where key observations include:

- **The large-scale use of UAS:** The proliferation of UAS of all types, including loitering munitions, has been a defining feature of the conflict, albeit without decisive breakthroughs. The deployment of hundreds of thousands of UAS per month has added to the challenges of concealing, moving or concentrating forces in the face of attrition.<sup>59</sup> After some initial high-profile victories, including the sinking of the Moskva by anti-ship missiles launched in concert with Turkish-built drones, smaller, attritable UASs have increasingly replaced medium altitude long endurance remotely piloted aircraft systems such as Bayraktar TB2, given the latter's vulnerability to hostile EM warfare (EW) and IADS.<sup>60</sup> The pervasive UAS threat has provoked a race to enhance counter UAS capability at all levels and a renewed interest in air and missile defence, especially ground-based, given the lack of control of the air and offensive/defensive counter-air (OCA/DCA) systems and C-RAM.<sup>61</sup> The Russian willingness to harass and down a US Air Force MQ-9 Reaper has also demonstrated unstable escalation dynamics and potentially reduced deterrent effects of deploying uncrewed versus crewed assets.



### 3.2.2. The war has emphasised both the difficulty of operating without sufficient control of the air and the imperfection and permeability of air defences

We have seen a lack of air superiority on both sides of the war in Ukraine, where the conflict has demonstrated the permeability of IADS, an increased use of GBADs and the vulnerability of fixed airbases in the face of drone, missile and SOF attacks. Observations from the literature on air defences include:

- **The permeability of air defence and A2/AD:** Contrary to pre-war predictions about impenetrable 'anti-access/area denial (A2/AD) bubbles', the conflict has demonstrated the permeability of IADS, but only when attacked by coordinated, multi-faceted missions, as well as difficulties of establishing control of the air given the lack of OCA/DCA capabilities, particularly for the destruction and suppression of enemy air defences (DEAD/SEAD). Lack of combat airpower has left Ukraine more reliant on ground fires – e.g. the M142 High Mobility Artillery Rocket System (HIMARS) – in lieu of close air support (CAS) or aerial strikes.<sup>62</sup> Russia has used its limited stockpiles of modern weapons for SODCIT, counter-C2 and supporting key offensives, alongside a mass use of unguided or loitering munitions.<sup>63</sup> In the absence of effective DEAD/SEAD, Ukraine has had to carefully coordinate the use of force packages based on a mix of UAS, EW, SOFs and/or crewed aircraft (e.g., using Storm Shadow/SCALP), to create and exploit temporary gaps in IADS to enable attacks on high-value targets.<sup>64</sup>

59 DeVore (2023); Kunertova (2023); Zabrodskyi et al. (2022).

60 DeVore (2023).

61 Halem (2023); Zabrodskyi et al. (2022).

62 Halem (2023); Pomper & Tuganov (2023); Skoglund et al. (2022).

63 Cranny-Evans (2023); DeVore (2023); Johnson (2022); Pomper & Tuganov (2023).

64 DeVore (2023).

- **The importance of air dispersal in the face of missile and drone threats:** Though the Russian Air Force (VVS) initially failed to destroy the Ukrainian Air Force on the ground in the IPoW, enduring missile and drone threats show the importance of dispersed air operations.<sup>65</sup> The conflict has re-emphasised the vulnerability of fixed airbases in the face of drone, missile and SOF attacks.<sup>66</sup>
- **The deployment of IADS and GBAD:** The deployment of GBAD has underscored the poor survivability of rotary-wing assets on both sides, with a reduced use of platforms including helicopters for tactical air mobility manoeuvres and CASEVAC, compared with operations in Afghanistan and Iraq. Here, attritable UAS have substituted many reconnaissance or attack roles and the initial airborne assault on Hostamel in the IPoW proved a costly failure even in the face of relatively light Ukrainian defences.<sup>67</sup> The war has shown the poor survivability of Russian airborne early warning and control (AEW&C) aircraft and a lack of industrial or workforce capacity to replace these low-density, high-value assets and the skilled crews that operate them.



### 3.2.3. The need to develop cost-effective munition stockpiles, in a context of rapid expenditure, brings sustainment challenges

The scale and tempo of the conflict and the use of missiles and drones have rapidly expended munitions stockpiles, calling for

greater and more sustainable production capability as well as more cost-effective solutions. Some key observations on cost and capacity asymmetries include:

- **Asymmetries of cost and capacity:** Surface-to-air missile (SAM) systems such as the Patriot have proven highly effective while Russian hypersonic missiles have appeared 'over-hyped'. However, there remain significant integration and capacity challenges to establishing genuine integrated air and missile defence, particularly beyond Kyiv. The war has also demonstrated some acute cost asymmetries, in using ~\$1M missiles to down ~\$1,000 drones, calling for more cost-effective solutions to make such exchanges more sustainable and swing the offence-defence balance back in favour of the defence.<sup>68</sup>
- **Stockpiles and sustainment:** The scale and tempo of the conflict as well as that of drone and missile use have rapidly expended stockpiles of munitions. The war has demonstrated a notable lag in the build-up of production capacity both in Europe and in the US at the necessary levels to replenish munitions at the speed at which they are expended in the war. While innovation has ensured that forces have been able to make the most of Western and Soviet equipment (including FrankenSAMs), it cannot offset industrial bottlenecks.<sup>69</sup>

65 Dalsjö et al. (2022).

66 Sherman (2023).

67 DeVore (2023); Halem (2023); Pomper & Tuganov (2023); Skoglund et al. (2022).

68 DeVore (2023).

69 Atlantic Council (2022); Kroenig & Starling (2023).

### 3.3. Maritime

#### Box 3.3 Overview of findings relating to the maritime domain

The war in Ukraine has re-emphasised the strategic importance of securing sea lines of communication (SLOCs) and the potentially disastrous impact of maritime blockades on global supply chains. Ukraine's use of asymmetric weapons, including anti-ship cruise missiles and UxVs, has allowed them to exercise a degree of sea denial against a numerically superior Russian fleet, effectively limiting Russia's use of its naval and amphibious capabilities and enabling a reallocation of Ukrainian land forces. This dynamic has demonstrated a need for navies globally to consider the proper balance and roles of crewed versus uncrewed systems and platforms, as well as the importance of counter A2/AD capabilities. The high expenditure rates of Russian equipment combined with the attrition of its Black Sea Fleet raised questions about the sustainability of its long-term naval operations in that theatre, and emphasised the importance of innovative approaches for the replenishment and reconstitution of naval assets. Successful attacks on ships and submarines in port and alleged sabotage of undersea infrastructure have re-emphasised the vulnerability of naval assets in port as well as the growing contest over the undersea environment.

With regards to the maritime domain, the following key findings were identified:



The disruption of maritime infrastructure and SLOCs have global effects, including on supply chains and regional economies beyond Europe.



The need to exercise sea denial, through effective use of asymmetric weapons, brings new replenishment and sustainment challenges.





### 3.3.1. The disruption of maritime infrastructure and SLOCs has had global effects, including on supply chains and regional economies beyond Europe

The conflict has reiterated the importance of the maritime domain to the economic dimension of war, where threats to maritime infrastructure and SLOCs have featured prominently. Some key insights on maritime infrastructure and SLOCs include:

- **Increased threats to maritime infrastructure:** Successful air, missile and SOF attacks on Russian-controlled ports in Crimea, leading to the destruction of ships and submarines in port as well as strikes on headquarters personnel, have demonstrated the vulnerability of port-based naval assets and the need for extensive GBAD and security measures to protect them.<sup>70</sup> The conflict has similarly emphasised the growing salience of the undersea environment and critical maritime infrastructure, given the apparent sabotage of Nord Stream 2 and damage to several undersea cables in the Baltic Sea, leading to the invocation of a Joint Expeditionary Force Response Option for the first time. It has also exposed seams between different actors relevant to undersea critical national infrastructure.<sup>71</sup>
- **Heightened challenges to securing SLOCs:** The conflict has reiterated the economic importance of ensuring the safe passage of goods as well as securing access to SLOCs. Related to this is also the enduring importance of maritime blockade to the

economic dimension of warfare, mine warfare, and the effective use of strategic maritime chokepoints (including legal chokepoints like the Montreux Convention). The Russian blockade of Ukraine has affected not only the latter country's economy but the wider global supply of grain and fertiliser, driving up inflation and threatening stability in the Middle East and North Africa (MENA) region.<sup>72</sup>



### 3.3.2. The need to exercise sea denial, through effective use of asymmetric weapons, brings new replenishment and sustainment challenges

The conflict in Ukraine has once again drawn attention to the importance of the maritime domain to the wider war effort on land, the effective use of asymmetric weapons against a superior enemy fleet to exercise sea denial, and the sustainment challenges arising from naval replenishment. Some key insights include:

- **The cross-domain impact of sea denial:** Ukraine's success in destroying or damaging a significant portion of Russia's Black Sea Fleet, to limit the scope for offensive amphibious action to threaten Odesa and the southern flank, enabled it to shift most of its land forces to other fronts, demonstrating the cross-domain impact of naval efforts.<sup>73</sup> Anti-ship missiles, coastal artillery, mines and UxVs, combined with apparent deficiencies in Russian tactics, equipment, maintenance and training, demonstrated again the ability of effective A2/AD capabilities to counter maritime

70 Grady (2024).

71 Kalm (2024).

72 Colom-Piella (2023); Microsoft Threat Intelligence (2023).

73 Atlantic Council (2022).

power projection ashore.<sup>74</sup> Further, Ukraine has also demonstrated that the destruction of naval assets, targeting of Sevastopol, or the liberation of strategic assets including Snake Island, carry enormous symbolic weight with potential political impact, information operations and attempts to shape the narrative.<sup>75</sup>

- **Vulnerability from anti-ship missiles and UxVs :**

The sinking of the Moskva demonstrated again the vulnerability of surface combatants to anti-ship missiles and UxVs, especially when used as part of saturation attacks together with and from multiple vectors. Ukrainian uncrewed surface or underwater vehicles have also proven to present efficient low-cost and low-risk means of attacking Russian surface combatants, as well as in the approaches to Russian-controlled ports or the Kerch bridge. The war thus emphasises the need for navies to counter the threat from UxVs and to reconsider the relative mix and roles of crewed vessels and different UxVs, and that doctrine, training and other enablers are needed to make the most of human-machine teams at sea.<sup>76</sup>

- **Challenges to control in the Black Sea:**

While Russia initially boasted a numerical advantage at sea, its Black Sea Fleet has failed to establish sea control and make any meaningful contribution to the war.<sup>77</sup> This is in great part due to Ukraine's effective use of land-based anti-ship missiles and UxVs to achieve sea denial. Lacking substantial

naval assets, Ukraine has thus managed to clear the Russian Navy from much of the Black Sea, drive it out of its main operating base at Sevastopol, and force it to move to Novorossiysk. Crucially, it has done so using weapons that are much less costly or time-consuming to manufacture than the Russian Navy vessels they have destroyed, which are subject to decade-long procurement cycles.<sup>79</sup> Equally, there are differences between the types of operations possible in the comparatively calm waters and short distances of the Black Sea, and those that NATO navies might engage in elsewhere in the world. Thus the maritime dimension to the conflict provides valuable insights for contemporary littoral warfare but may be a less useful guide for future blue and green water operations (e.g. in the Pacific Ocean).<sup>80</sup>

- **Continued stockpiles and sustainment challenges:**

The expenditure rates for Russian ship-launched anti-air and land attack missiles, and the attrition rate of its Black Sea Fleet in the face of Ukrainian missile and UxV threats, raises questions about how best to sustain the long fight. This includes mass, weapons stockpiles replenishment, and the reconstitution of naval assets amid long lead times for naval shipbuilding. Alternative or complementary approaches, including UxVs, increased use of commercial technology and containerised solutions, could be needed to help expand capacity.<sup>81</sup>

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74 Giles et al. (2022).

75 Favaro & Williams (2023); Fenstermacher et al. (2023); McCrory (2020); Microsoft Threat Intelligence (2023).

76 Bielieskov (2022).

77 Germond (2023).

78 Joiner et al. (2024); Taylor & Parker (2022).

79 Germond (2024).

80 Dickinson (2023).

81 Colom-Piella (2022); Kroenig & Starling (2023).



### 3.4. Cyber and EM

#### Box 3.4 Overview of findings relating to the CyEM domain

Since February 2022, the war has highlighted the critical importance of a robust and holistic approach to cyber defence, emphasising the value of involving other actors to enhance capabilities. Space-based services like Starlink and private sector actors such as Microsoft and Cisco have been crucial in bolstering Ukraine's cyber defences.

However, despite significant cyber warfare elements, the war has not escalated into the cyber war many anticipated, with both sides potentially exercising restraint to avoid unintended escalation. EW and use of the EM environment have been confirmed as fundamental to warfighting. High-value EW capabilities have also become attractive targets, calling for a selective use to create temporary windows of spectrum dominance. Contested access to the EM spectrum further complicates C2, reinforcing the need for mission command, communication and adaptability in the face of long-range fires and pervasive sensors.

With regards to the CyEM domain, the following key findings were identified:



The need to increase the resilience and integrity of cyber capabilities is driving close cooperation with private and non-state cyber actors.



The need to control the EM spectrum and ensure C2 for dispersed units is driving the increased use and importance of EW capabilities.





### 3.4.1. The need to increase the resilience and integrity of cyber capabilities is driving close cooperation with private and non-state cyber actors

The conflict in Ukraine has not turned into the decisive 'cyber war' some had predicted, though offensive cyber operations remain an important feature of the ongoing war – with offensive cyber capabilities deployed selectively, primarily controlled from higher echelons, and often with long lead times.<sup>82</sup> Moreover, activities in the CyEM domain can support and reinforce wider information operations, including a narrative-led approach, seeking to influence perceptions and behaviours of different target audiences.<sup>83</sup>

Facing such threats, the conflict has reiterated the importance of ensuring a robust and holistic approach to cyber defence and resilience. It has also demonstrated the value in bringing in private sector and other non-state actors into the cyber effort to boost capabilities. Some key insights include:

- **The unexpected resilience of Ukrainian infrastructure:** Critical infrastructure, including access to space-based services (including Starlink), has proven more robust than some had feared even while it may be the case that Russia, and indeed Ukraine,

exercised a degree of restraint in their offensive cyber operations to avoid unintended escalation. The war has re-emphasised that a holistic approach to cyber resilience (including deterrence, preparedness, planning, cyber defence/offence, incident response and post-incident recovery) is essential.<sup>84</sup> Further, cyber-attacks attribution can be difficult, but there may be a higher political appetite to call out hostile activities in times of war, when a lower threshold of evidence may need to be met before public disclosure.<sup>85</sup>

- **The increased role of private sector actors:** Microsoft, Cisco and others have provided Ukraine with increased cyber defence capacity and Starlink has been deployed throughout the country.<sup>86</sup> Close cooperation with PAGs and the private sector (including multinational actors like Microsoft) and the mobilisation of local tech start-ups have proven essential for situational awareness, cybersecurity and rapid recovery.<sup>87</sup> While they may be more difficult to coordinate and control, with potential consequences for controlling the narrative and escalation management, hacktivists and citizens also play a significant role in cyberspace beyond private firms.<sup>88</sup>

82 Davydiuk & Zubok (2023); Whyte (2022).

83 Atlantic Council (2022); Microsoft Threat Intelligence (2023).

84 Colom-Piella (2022); Davydiuk & Zubok (2023).

85 Davydiuk & Zubok (2023); Fenstermacher et al. (2023).

86 Atlantic Council (2022); Farrell & Newman (2023); Favaro & Williams (2023).

87 Atlantic Council (2022); Farrell & Newman (2023); Favaro & Williams (2023).

88 Davydiuk & Zubok (2023); Favaro & Williams (2023); Fenstermacher et al. (2023); Kepe & Demus (2023); Lonergan et al. (2023).



### 3.4.2. The need to control the EM spectrum and ensure C2 for dispersed units is driving the increased use and importance of EW capabilities

EW has proved to be a key feature of the war, with high-value, low-density EW capabilities being attractive targets for adversary forces. An important consequence is that EW challenges efforts of maintaining effective C2 for dispersed units in the face of pervasive sensors and long-range fires. Some key insights include:

- The increased use of tactical EW and ECMs:** EW and EM countermeasures (ECMs) have once again been shown to be a key features of peer-on-peer conflict, having played a more limited role during the counterinsurgency operations of the 2000s and 2010s. Militaries are now having to relearn how to do this at scale.<sup>89</sup> EW has emerged as particularly important in the Counter Unmanned Aircraft System mission and in belligerents' attempts to achieve sensor and fires dominance at the tactical level.<sup>90</sup> In practice this means that the battlespace, rather than being 'transparent', is characterised by different and frequently changing bubbles of control over, contested access to or denial of the use of the EM spectrum, resulting in different levels of situational awareness.<sup>91</sup>
- Contested EW capabilities:** High-value, low-density EW capabilities are attractive targets for adversary forces. Combined with the potential for some EW systems to interfere with friendly forces, this necessitates selective use to help create temporary windows of spectrum dominance or denial in support of movement, concentration and offensive operations.<sup>92</sup>
- Impact of EW capabilities on C2:** Contested access to the EM spectrum can significantly impede C4ISR and reach-back to higher echelons (necessitating reversionary modes for equipment, training and TTPs to help deconflict forces, maintain battlespace management etc.), as well as the coordination of fires and combined arms manoeuvre.<sup>93</sup> EW further complicates the challenge of maintaining effective C2 for dispersed units in the face of pervasive sensors and long-range fires. It also emphasises the need for more vigilance in signature management and selectivity when choosing what and when to broadcast.<sup>94</sup> Therefore, limitations on the ability to transmit and share data safely have consequences for the volume, content and tempo of interactions between different echelons and headquarters, and reinforce the need for mission command, clear communication and a culture encouraging creativity, flexibility and adaptability.<sup>95</sup>

89 Rushing & Hunter (2023).

90 DeVore (2023).

91 Atlantic Council (2022); Whyte (2022).

92 Davydiuk & Zubok (2023).

93 Davydiuk & Zubok (2023).

94 Davydiuk & Zubok (2023); McCrory (2020).

95 Davydiuk & Zubok (2023); Lonergan et al. (2023).

### 3.5. Space

#### Box 3.5 Overview of findings relating to the space domain

The war in Ukraine has highlighted both the increased importance of the space domain and the benefits and risks associated with the proliferation of and increased access to space technologies.

The democratisation of space, driven by the emergence of a new space sector with non-state and private sector commercial players like SpaceX, has made space services accessible to a broader range of actors. These include EO; ISR; positioning, navigation and timing (PNT); and satellite communication (SATCOM). The fast development of space capabilities has supported military operations and shaped narratives, but also contributed to emphasise vulnerabilities and dependencies, including the influence of Elon Musk on the rules of engagement for uncrewed systems. The war has also demonstrated the importance of space domain awareness (SDA) and risks posed by hostile activities, including Russian sub-threshold operations including the anti-satellite missile test and cyber-attacks on space infrastructure like Viasat's KA-SAT network. Such activity has underscored the potential for harmful effects and escalation, and the importance of effective coordination between government, military and the private sector. The conflict also emphasised the need for robust SDA to understand, attribute and mitigate these space-based threats with significant impact on C4ISR.

With regards to the space domain, the following key findings were identified:



The democratisation and proliferation of space technologies across the battlespace fosters capabilities, while underlining potential vulnerabilities.



The need to mitigate against increased hostile and sub-threshold activities in the space domain is driving efforts, among all actors, to increase awareness.





### 3.5.1. The democratisation and proliferation of space technologies across the battlespace fosters capabilities, while underlining potential vulnerabilities

The war has demonstrated both the added value and risks that come with increased access to space technologies. Some key insights include:

- **The increased proliferation and democratisation of space technologies:** Increased access to space technologies, falling costs of launch, and the emergence of the NewSpace sector, including major commercial players such as SpaceX or Maxar, have all made EO, ISR, PNT and SATCOM services accessible to a wider range of actors. Military use of space is no longer restricted to major powers.<sup>96</sup> Commercial EO, ISR, media and non-governmental organisational data has contributed not only to military operations but also in helping shape the narrative, using satellite imagery to expose Russian war crimes.<sup>97</sup> While the speedy provision of Starlink has helped support both the Ukrainian military forces and its civilian population, it has also introduced vulnerabilities and dependencies, including questions over Elon Musk's influence on rules of engagement for UxVs.<sup>98</sup>



### 3.5.2. Increased hostile activities in the space domain are driving efforts, among all actors, to increase awareness and mitigate impact

The war has demonstrated both the added value and risks that come with increased SDA as well as the wide spectrum of space activities that can impact operations. Some key insights include:

- **Increased hostile activities:** Signalling and hostile activities in space, including the provocative Russian direct-ascent anti-satellite missile test in late 2021, contributed to Kremlin's attempts to coerce Kyiv and deter the West (and NATO) before the 2022 invasion.<sup>99</sup> Non-kinetic counter-space capabilities have been used from the outbreak of hostilities and include the initial hack of Viasat's KA-SAT network, jamming, spoofing and cyber-attacks on Starlink. Such attacks demonstrate the risk of potentially harmful effects and unintended escalation (the KA-SAT hack also affected German windfarms downstream), exacerbated by the increasing entanglement of military and civilian systems.<sup>100</sup>

96 Atlantic Council (2022); Colom-Piella (2022); Favaro & Williams (2023); Kempe & Demus (2023); Kroenig & Starling (2023); Ogden et al. (2024).

97 Atlantic Council (2022).

98 Atlantic Council (2022); Colom-Piella (2022).

99 US Space Command Public Affairs Office (2021).

100 McCrory (2020).

- **Strengthened SDA across actors:** Close coordination between government, the military and commercial operators combined with SDA are essential to help understand, attribute and mitigate the proliferation of threats to space infrastructure.<sup>101</sup> For example, there has been significant impact on C4ISR, where GPS jamming has affected the reliability

and effectiveness of precision-fires, which affects the balance of precision versus mass in reconnaissance-strikes and, by extension, logistical and sustainment efforts.<sup>102</sup>

The next chapter looks at actor-specific observations made in the literature on Ukraine, Russia and NATO and the UK respectively.

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101 Kroenig & Starling (2023).

102 McCrory (2020).

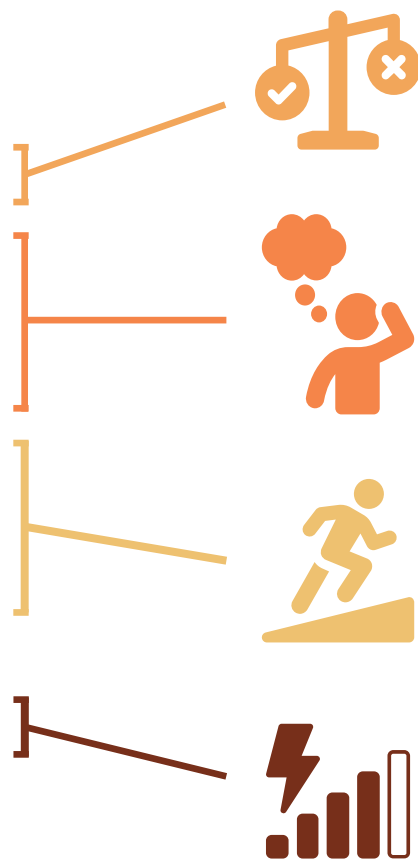
## Chapter 4. Actor-specific observations

This chapter presents an overview of the observations gathered from the literature review that relate specifically to the parties involved in the war – Ukraine and Russia. In addition, the study also aims to summarise the literature’s proposed insights relating to the conduct of the UK and its allies within NATO in supporting Ukraine through military, financial and other forms of aid.

To capture actor-specific insights in a structured manner, the study team organised the recurring themes in the open-source literature around the three components of fighting power<sup>103</sup>:





- **Moral component:** ‘the will’, understood as ‘the ability to get people to fight’.
- **Conceptual component:** ‘the thought process’ – ways in ‘which military personnel can develop understanding about both their profession and the activities that they may have to undertake’.
- **Physical component:** ‘the means’ comprising ‘the means to operate and warfight’ such as personnel, equipment, training and performance, sustainability and readiness.

In addition to these, the RAND Europe team also captured any prominent issues in the literature in relation to **force multipliers** likely to strengthen the warfighting capacities of the respective actors. Observations and insights gathered for each of the three groups of actors are presented in Tables 4.1 to 4.3 below.



## 4.1.Ukraine

**Table 4.1 Overview of insights on Ukraine warfighting power components**




 <p><b>Moral component</b></p>	 <p><b>Conceptual component</b></p>	 <p><b>Physical component</b></p>
<p>Russian underestimation of Ukrainian will to fight (whether the leadership, military or wider populace), central to the failure to achieve objectives of 'special military operation' in IPoW.</p> <p>Strong political and military leadership with high levels of popular support.</p> <p>Willingness to bear heavy casualties for the cause.</p> <p>Proactive measures to bolster morale and motivation.</p> <p>Efforts to shift to more Western-style military ethos and culture.</p> <p>Mobilisation of all Ukrainian society in a people's war, but only after criticism for an initial failure to fully mobilise.</p>	<p>Underestimation of threat of Russian invasion (vs US/UK).</p> <p>Debates over Ukraine's long-term military strategy and related political ambitions (e.g., likelihood and timelines for NATO and EU membership).</p> <p>Debates over Ukraine's theory of victory, and especially its planning and execution of the counteroffensive in 2023.</p> <p>Fusing of Soviet and Western concepts (with some tensions).</p> <p>Rapid innovation in use of TTPs and doctrine, out of necessity, incorporating lessons and operating rules from the battlefield.</p>	<p><b>Personnel:</b> Mass mobilisation, use of territorial defence forces.</p> <p><b>Equipment:</b> Foreign aid and embrace of UxVs at all levels.</p> <p><b>Training and performance:</b> Limited time for training or rotation off the frontline; foreign training for new recruits; need for more complex collective training in future.</p> <p><b>Sustainability:</b> Receipt of foreign military and financial aid alongside efforts to bolster domestic capacity for maintenance, repair and operations (MRO) etc.</p> <p><b>Readiness:</b> Acute pressure on force generation cycles, equipment availability, industrial capacity and supply chains.</p>
 <p><b>Force multipliers</b></p>		
<p><b>Interoperability:</b> Challenges of integrating a wide mix of Western-donated and Soviet systems.</p> <p><b>Responsiveness:</b> Rapid learning and adaptation. Different attitude to risk given threat. Efforts to implement rapid reforms, and embrace new concepts and associated tech (e.g., new military branch focused on embracing UxVs at vast scale).</p> <p><b>Orchestration of fighting power:</b> Efforts to economise effort (especially amid ammunition shortages); good use of deception and surprise in 2022; challenges achieving concentration of effect.</p>		

Source: RAND Europe analysis.



## 4.2. Russia

**Table 4.2 Overview of insights on Russia warfighting power components**

 Moral component	 Conceptual component	 Physical component
<p>Underestimation of Ukrainian resilience and will to fight.</p> <p>Failures of tactical, operational and military-strategic leadership and followership, especially in 2022; infighting and poor relations between commanders at different levels.</p> <p>Poor quality of junior Russian officers and NCOs, despite military modernisation efforts since 2008 to boost professionalism.</p> <p>Willingness to use human wave tactics. Use of measures such as drugs, blocking units, etc. given unit morale issues.</p> <p>Unclear impact of Western sanctions on Russian will to fight.</p>	<p>Underestimation of Western unity and NATO/EU cohesion.</p> <p>Failure of strategic intelligence and decision making ahead of February 2022 invasion; optimism bias, groupthink, poor information sharing between rival agencies, lack of challenge, etc.</p> <p>Lack of preparation, Russian troops kept in dark initially.</p> <p>Inconsistent application of doctrine; questions over to what extent operations in Ukraine reflect how it would fight NATO.</p>	<p><b>Personnel:</b> Use of PMCs, convicts and separatist militia. Forced to mobilise but willing and/or able to sustain heavy losses.</p> <p><b>Equipment:</b> Loss of vast numbers of equipment, forcing use of old mothballed kit or aid from China, Iran and the Democratic People's Republic of Korea.</p> <p><b>Training and performance:</b> Shortfalls in training for more complex roles (e.g., pilots, naval warfare, AEW&amp;C crew).</p> <p><b>Sustainability:</b> Defence industry and MRO placed onto war footing far more effectively than any country in the West.</p> <p><b>Readiness:</b> Ready for long war but impact of sanctions is growing.</p>
 Force multipliers		
<p><b>Interoperability:</b> Breakdown of relations between competing private armies in spectacular fashion, with Prigozhin's mutiny. But efforts in 2023–24 to reorganise and improve cohesion.</p> <p><b>Responsiveness:</b> Demonstrating ability to learn and adapt after initial setbacks. Embracing use of UxVs and new tactics, dispersal, etc. Executed successful defence-in-depth in 2023.</p> <p><b>Orchestration of fighting power:</b> Some successes on land, after setbacks of 2022, significant performance issues in use of air and naval forces; seeking to attrit Ukraine and outlast West.</p>		

Source: RAND Europe analysis.

### 4.3. NATO/UK

**Table 4.3 Overview of insights on NATO/UK warfighting power components**

 <p><b>Moral component</b></p>	 <p><b>Conceptual component</b></p>	 <p><b>Physical component</b></p>
<p>Russian underestimation of NATO cohesion and willingness of NATO, EU and other nations to incur costs to support Ukraine.</p> <p>Consensus on support to Ukraine fraying from late 2023, driven especially by hold-up of aid by US Congress. Some European nations more willing to send military aid or boost defence spending than others (including the UK).</p> <p>Uncertainty over will to fight of many Western societies, after three decades of 'peace dividend'. Efforts to catch up.</p>	<p>Mixed views within Alliance on likelihood of Russian invasion in Feb 2022 but more coherence of threat assessments since.</p> <p>Efforts to accelerate implementation of NATO Concept for Deterrence and Defence of the Euro-Atlantic Area and associated plans; increase Supreme Allied Commander Europe's peacetime authorities; bolster Supreme Headquarters Allied Powers Europe's central coordination and strategic targeting roles in addition to the Joint Forces Commands.</p> <p>Shift to deterrence by denial (e.g., new NATO force posture).</p> <p>Extracting lessons from Ukraine for MDO (e.g. challenges and opportunities from new C2 tools, AI etc.).</p>	<p><b>Personnel:</b> Questions about mass (e.g., embracing the new NATO Force Model) and possible need for more reserves, conscription etc.</p> <p><b>Equipment:</b> Only tentative moves towards more UxVs, commercial tech, fires, off-the-shelf urgent procurements etc.</p> <p><b>Training and performance:</b> Recognition of need for more realistic training and ambitious joint exercises.</p> <p><b>Sustainability:</b> Hard questions about sustainment, stockpiles, ability to reconstitute mass etc. Efforts to boost industrial production much slower than Russian shift to war footing.</p> <p><b>Readiness:</b> Efforts to bolster (NATO Readiness Initiative).</p>
 <p><b>Force multipliers</b></p>		
<p><b>Interoperability:</b> Integration of Finland and Sweden into NATO, enhancing NATO presence in Nordic-Baltic and High North.</p> <p><b>Responsiveness:</b> Accelerating efforts to promote innovation (e.g., NATO Defence Innovation Accelerator for the North Atlantic, national efforts on UxVs and AI, AUKUS) and derive insights from the experience of Ukraine.</p> <p><b>Orchestration of fighting power:</b> Efforts to increase warfighting capability, capacity and readiness urgently. Challenges of managing concurrency (given Middle East and Indo-Pacific threats). Questions about the US in NATO and possible need to backfill its strategic enablers (e.g. C4ISR).</p>		

Source: RAND Europe analysis.

## Chapter 5. Implications for joint doctrine

This concluding chapter summarises the implications of this study for UK Doctrine at the joint level and highlights priority areas for future consideration by those involved in maintaining and updating doctrine.



## 5.1. Recurring themes and areas for action

### 5.1.1 Literature on the war in Ukraine emphasises the impact of innovation, adaptation, a more transparent battlespace and the challenges of resilience, primarily affecting tactical doctrine or TTPs but also operational-level doctrine

It is premature to try to draw definitive lessons from the ongoing war between Russia and Ukraine when the outcomes of the conflict (let alone the main causes of success or failure) are so uncertain. Furthermore, every war is unique. Russia is not fighting Ukraine in the same way it would fight NATO or the UK. Nor is Ukraine fighting the war how the Alliance would, given major differences in their respective forces and capabilities, including doctrine, equipment and training. Notwithstanding these caveats, several recurring themes emerge from the open-source literature of relevance to joint doctrine. In consultation with the IWC Doctrine team (formerly part of DCDC), the study team grouped these priority issues and identified possible actions to address them, as shown in Table 5.1 below.

Ultimately, having up-to-date doctrine is both an important part of military capability alongside the other defence lines of development (DLODs), and a capability that must be nurtured in its own right. Developing and maintaining effective joint doctrine requires appropriate resourcing, staffing and access to data and analysis. The war in Ukraine has emphasised the rapid pace of change in tactics and technology, with implications too at the operational level. In this context, reviews and updates to UK and NATO joint doctrine must keep up, and those responsible for maintaining, producing and disseminating doctrine must have robust mechanisms in place to access diverse sources of evidence and expertise. Joint doctrine is ultimately one of the least expensive DLODs to resource; conversely, a loss of a relatively small amount of funding or number of key people can have significant impacts on the timely production of doctrine updates.

The formation of a new IWC within UK Strategic Command, bringing together the former Doctrine team of DCDC with the Directorate of Joint Warfare, opens new opportunities to deepen connections between doctrine and the wider warfare development community across Defence – whether at the joint level, with the single services or internationally through NATO.

**Table 5.1 Recurring themes from the literature and implications for joint doctrine**

Issues raised by open-source literature	Implication for joint doctrine	Potential further action for the Doctrine team
Theme: innovation and adaptation		
The messy intermingling of the old alongside the new (e.g. FPV drones alongside trench warfare, or sophisticated C4ISR alongside human wave tactics), confounding simplistic ideas of military-technological revolution.	Emphasises the crucial distinction between innovation (combining old with new) vs adaptation (to counter the enemy's new tactics) and the need to promote both (not necessarily prioritising the new).	<b>Action:</b> Review if these considerations are stressed correctly in existing doctrine.
Emphasis on the need for continuous learning and adaptation to remain competitive given the pace of new tech and threats, necessitating that doctrine encourage traits that enable the Defence enterprise and individuals therein to absorb new ideas and ways of doing things, and that doctrine itself be continuously re-evaluated and updated in an agile manner.	Doctrine mindset to enable organisational and individual innovation and adaptation. Re-evaluate doctrine with agile updates.	How is mindset described in existing doctrine? <b>Action:</b> Review if the doctrine update process itself is agile enough.
Consider how to promote learning and adaptation and the ability to not merely identify but truly learn lessons, boosting the absorptive capacity of Defence for new innovative concepts, tactics or technologies.	Need a learning organisation or mindset.	<b>Action:</b> Check and update references to learning and adaptation in doctrine.
Theme: transparent engagement space		
Renewed debates over the salience of positional, attritional and manoeuvre warfare approaches.	This is not NATO's war and without air power it has descended into trench-style warfare. The manoeuvrist approach is about so much more than physical manoeuvre.	<b>Action:</b> Workshops, TTXs and/or research to engage different stakeholder and expert audiences.

Issues raised by open-source literature	Implication for joint doctrine	Potential further action for the Doctrine team
Consider how to manage the dilemmas posed by proliferation of sensors and fires (i.e., move towards a more 'transparent' battlespace), the shift to dispersal and increased challenges with C2, signature management, concentration of forces and effects, logistics, etc.	Tactical lessons are being relearned. Doctrine already exists but has just been reinforced and may need to be promoted more widely to raise awareness.	<b>Action:</b> Publicise current doctrine, e.g., operational security and deception.
Theme: impact of new technology		
Consider how to capture the full scale of the impacts arising from the rollout of AI, UxVs and HMT at all levels and areas of the force at a greater pace and scale than the UK had likely anticipated.	Innovation and adaptation are vital. Policy may need to change to unlock capability and deliver on ideas in existing doctrine.	<b>Action:</b> Hold workshop to discuss if and how op-level doctrine could evolve to acknowledge the challenge of rapidly changing technology.
Does doctrine adequately account for the impact of new tech (e.g. AI, UxVs) on ways of fighting and operating?	TTPs are constantly changing at the tactical level. Need specific example of where this would affect op-level doctrine.	
Theme: sustainment and resilience		
How should doctrine evolve as the original force (of highly trained professionals using largely high-quality military equipment) is attritted and replaced with a more improvised follow-on force (of reservists or fresh recruits or conscripts, likely using a more heterogeneous mix of military equipment, commercial and military off-the-shelf systems and improvised new solutions)?	Operational-level doctrine is defined as the 'fundamental principles'. These will evolve over time, however, tactical level doctrine may have to consider the impact of a degradation of personnel and equipment during an extended campaign.	Potentially an issue for tactical level doctrine. Wider reforms needed to ensure MOD, Armed Forces and industry are better placed to reconstitute the force.

Issues raised by open-source literature	Implication for joint doctrine	Potential further action for the Doctrine team
<p>Doctrine is ultimately focused on defence and the military instrument. Yet the war in Ukraine emphasises the importance of mobilising and coordinating engagement with a wide range of other actors, e.g., PAGs, industry, civil society, non-governmental organisations (NGOs), academia, the media or the general public. Does wider government have sufficient guidance on how to mobilise society in times of war?</p>	<p>Addressing issues of societal mobilisation and resilience sits outside the remit of Doctrine – or even Defence. Cross-government engagement is needed, supported by political and policy guidance.</p>	<p>No further action for doctrine. Wider reforms needed across government, backed by a robust dialogue with the public about the changing nature of threats to the UK.</p>
<p>Theme: doctrine (general)</p>		
<p>Consider how to improve awareness of and use of doctrine.</p>	<p>Core role of Doctrine team in the new IWC.</p>	<p>Part of Doctrine Development Plan. Action: Exploit new structures and reach of the IWC to promote greater awareness of doctrine across the whole force.</p>
<p>Is the resourcing of doctrine development sufficient, given its importance?</p>	<p>Doctrine is ultimately one of the least expensive DLODs to resource; conversely, a loss of a relatively small number of key people can have significant impacts on the timely production of doctrine updates.</p>	<p><b>Action:</b> Ensure full resourcing of the IWC Doctrine team and minimise any movement of personnel onto other tasks or ops.</p>
<p>Are the tempo and pace of the doctrine development cycle sufficient, given the rate of change in threats etc.?</p>	<p>Continuous reassessment of processes for optimisation. Need to ensure doctrine is changed only if supported by evidence and analysis.</p>	<p><b>Action:</b> Continue Doctrine Development Plan to improve doctrine processes, at both UK and NATO levels. Conduct research 'deep dives' into areas of potential change.</p>

Source: RAND Europe analysis and consultations with DCDC.

**5.1.2. The war in Ukraine is not being fought as NATO would fight, but it nonetheless suggests significant deficiencies in warfighting capability for the UK and NATO to address – sound doctrine is not a substitute for having appropriately resourced and motivated military forces and associated support structures**

This study has sought to review the burgeoning open-source literature on observations, insights and 'lessons' from the ongoing war in Ukraine for the future of the joint (operational- or strategic-level) doctrine. This large and varied literature raises many issues for further investigation or action, as shown in Table 5.1. But it ultimately does not provide definitive evidence of a need to fundamentally rethink the key tenets of UK or NATO Allied joint doctrine. Crucially, though, doctrine is only one part of the picture. The UK and its allies use doctrine to help them fight smarter than their adversaries – out-thinking the enemy to try and resolve any conflict on favourable terms while minimising the costs incurred in terms of lives or materiel. The NATO Alliance, comprising liberal democracies, ultimately seeks to offset possible adversaries' superior numbers, or less restrictive ethical and legal stances around the use of force, by cultivating its qualitative advantages. Yet even the best doctrine cannot escape fundamental constraints of finance or physics.

The literature makes clear that the war has exposed some very serious deficiencies for UK Defence and other NATO countries to address as a matter of utmost urgency. But rather than focusing on doctrine, these principally relate to other DLODs, e.g., insufficient mass of personnel, equipment and stockpiles of munitions, a lack of infrastructure, or limits to training, etc.<sup>104</sup> Alternatively, they relate to structural issues beyond Defence itself,

such as shortfalls in industrial mobilisation or societal resilience and will to fight.<sup>105</sup>

The question is, therefore, less whether NATO and UK joint doctrine is appropriate per se and more whether the means are available to credibly implement it as envisaged, especially over a long war. Key concepts such as the manoeuvrist approach and mission command, or the emphasis on achieving decision and information advantage, all remain salient.<sup>106</sup> The experiences of Ukraine show the need to evolve the practical application of such ideas to reflect changes in the operating environment, the threat or technology. But this has always been the case, and, by its more high-level nature, joint doctrine is not supposed to be wedded to any single theatre or capability. By contrast, tactical level doctrine and TTPs may be more directly affected by battlefield insights from the war in Ukraine, e.g. relating to the transparent battlespace or the use of UxVs.

Ultimately, sound operational-level doctrine is critical for interoperability between military branches or between allies, but it can only get a force so far. If that force does not have sufficient resourcing, personnel, training, arms and equipment, and the underlying political, industrial and societal support to sustain potentially years of warfighting at scale, it will fight well – for a short while – but then it will be attrited and the war will in all possibility be lost. Urgent investment is therefore required in other DLODs to ensure that the UK Armed Forces and NATO Allies are able to translate joint doctrine from theory into practice, given the scale of the threats faced. Such investment would itself have a deterrent effect, with the ongoing war in Ukraine unfortunately providing a timely reminder of the costs that come when deterrence fails.

104 Kroenig & Starling (2023); Joshi (2022); Gilliam & Van Wie (2022); Bieliesskov (2022); Gady (2023a); Republic of Estonia Ministry of Defence (2023a).

105 Lonergan et al. (2023); Walt (2022).

106 UK Ministry of Defence (2022).



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