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Introduction

In the past two and a half years, the Russo-Ukrainian War has uncovered how war on the modern battlefield is no longer exclusively waged on the physical domain, and new capabilities can be leveraged instead of conventional approaches to defence. Armed conflict has expanded to encompass new battlefronts that increasingly depend on the virtual domain (Furlong et al, 2022). Cutting-edge technologies like Artificial Intelligence (AI) are reshaping armed conflict, impacting every aspect of warfare from automated frontline systems to logistics, and enhancing multi-domain situational awareness. According to the Land4Developers platform, a marketplace and network of industrial engineering experts from Ukraine, over a dozen Ukrainian companies offer products and services in predictive analytics (Land 4 Developers, 2022). The partnership between tech firms and the Ukrainian military, which allegedly includes having a software engineer within each battalion, is sparking a new wave of development and testing with military AI (Bergengruen, 2024). In resisting Russia's invasion, the Ukrainian defence proved to be better equipped than anticipated (Furlong et al., 2022). Ukraine's military performance has offered valuable lessons for both emerging and already established military powers on the benefits of partnering with tech companies to gain quicker access to the latest innovative technologies.

Although the Russo-Ukrainian conflict's outcome is still uncertain, it has highlighted the critical role of public-private partnerships in rapidly advancing military technology. The integration of AI-enabled tools in Ukraine's defence demonstrates that collaboration between governmental bodies and private tech firms is essential for the swift development and deployment of cutting-edge military technologies. This paper explores how the partnership between the public and private sectors has shaped Ukraine's defence strategies and examines the implications for enhancing military interoperability across Europe.

First, this research analyses the changing nature of warfare, focusing on the strategic role of AI. The analysis of modern battlefield dynamics will be based on the European Defence Agency's definition of 'emerging disruptive technologies'. The following section examines the deployment of AI-enabled tools by the Ukrainian defence forces and analyses the role of European countries and commercial entities in providing Ukraine with such tools. Offering insights on how AI can enhance interoperability among European military forces, this paper investigates/ reflects on the implications of the use of AI for European defence. The goal of this paper is to demonstrate how Ukraine's experience with integrating AI-powered military tools developed by tech firms can serve as a model for improving collaboration and interoperability among European military forces. By examining Ukraine's use of these technologies and their impact, this paper aims to highlight a unified approach to leveraging AI to strengthen defence capabilities and foster better coordination between European states.

The Changing nature of Warfare: the rise of AI

In 2021, the European Defence Agency characterised emerging disruptive technologies (EDTs) as "significantly changing the rules or conduct of conflict within one or two generations" (EDA, 2021). The Agency identified a dozen EDTs, six of which distinguished themselves for their strategic impact: Artificial Intelligence (AI), Big DataAnalytics, Robotics and autonomous systems, hypersonic weapons systems and space, new advanced materials, and quantum-based technologies. Listing these advanced tools lays the groundwork for collaboration among various institutions in Brussels and EU Member States, promoting a common understanding of the capabilities and strategic implications of EDTs (EDA, 2021). With the possible exception of Big Data Analytics which provides the large-scale datasets required to train and improve AI models, no other EDT affects military operations across various domains as profoundly as AI. (EDA, 2021). Artificial Intelligence's strength derives from the algorithms' capability to make optimal or near-optimal decisions aimed at achieving specific objectives based on the existing data. Nevertheless, SparkCognition CEO Amir Husain explains that "Artificial Intelligence is not like a nuclear weapon; a great big tangible thing that can be easily detected (...). It is a science (...). Its application will lead not merely to incremental enhancements in weapon systems capability but require a fundamental recalculation of what constitutes deterrence and military strength" (2021).

A new kind of warfare is taking place, and it can be witnessed on the battlefields of Ukraine. The integration of AI with other technologies and systems is leading to the development of advanced military capabilities. Notably, AI is not functioning in isolation but is combined with various other technologies, such as advanced sensors and, as mentioned above, sophisticated data analytics tools. Combined, these integrated systems enhance the effectiveness and efficiency of military operations in several ways. Furthermore, AI is replacing human analysts with models that are trained to swiftly spot patterns and anomalies in data., This capability allows the processing of information to develop an intelligence picture of the enemy's position. When AI models detect a potential target, this information is sent to military commanders who then decide how to act on it. AI-enabled models can present military officials with the most effective options to target an enemy, since the models learn and improve with each strike. AI has the potential to revolutionise battlefield predictions and remarkably enhance real-time situational awareness across all operational domains, leading to quicker, more informed decisions for military and political leaders alike (DoD, 2023). Some scholars remain sceptical about the enthusiasm surrounding high-tech innovations like AI, suggesting that AI tools do not significantly change wars of attrition (Horowitz & Lin-Greenberg, 2020; Goldfarb & Lindsay, 2022). Regardless, Ukraine and its private-sector partners are strategically positioning themselves to serve as a testing ground for such future warfare innovations (Bergengruen, 2024).

AI in the Russo-Ukrainian Conflict

Ukraine's resilience in the war against Russia can be partly attributed to the advanced technical support received from its Western allies. This section dives into the AI-enabled military tools being used in Ukraine, from drones to advanced targeting systems. Indeed, advanced AI-powered unmanned aerial vehicles (UAV) are a major tech breakthrough in the Ukrainian war, changing the way modern combat is perceived. Older systems, like US-made Skydio drones, are now being replaced by advanced deep-learning drones that enable the weapon to interpret and respond in real time to video and camera footage (Ivashkiv, 2024; Mozur & Satariano, 2024). The most advanced versions of this technology, like those drones produced by the Ukrainian company Vyrivmake have proven more effective on the battlefield (Makaryan, 2023; Thompson, 2024). In an effort to rearm the Ukrainian army by providing modern tools that meet NATO's standards, in 2019 Ukraine purchased its first Turkish Bayraktar TB2 drones (Varfolomeeva, 2019). The unmanned combat vehicle (UCAV) TB2 is a medium-altitude long-endurance (MALE) aircraft system that can either be controlled remotely or operate on its own. Since the 2022 Russian invasion of the country, TB2 drone have been used by Ukraine's armed forces to attack Russian forces and equipment (Jankowicz, 2022). Ukrainian defence forces are also using loitering munitions like the WB Electronics Warmate, provided by Poland (Defense Express, 2023).

Additionally, Ukrainian forces are also using Czech-made Primoco One 150 drones for longer-range reconnaissance, which was provided by Luxembourg (Lambert, 2022). For short-range operations, the UK and Norway supplied the Ukrainian defence forces with Black Hornet Nano micro UAV. These miniature UAVs help soldiers get a better view of their surroundings, allowing them to look over corners and walls (RFE/RL, 2022). On the ground, Ukrainian troops have received unmanned ground vehicles (UGVs) from Germany. The versatile THeMIS vehicles were supplied by Milrem Robotics in partnership with the German defence company Krauss-Maffei Wegmann (KMW), and can perform various tasks on the battlefield, such as protection and assistance to infantry units, performing reconnaissance and surveillance tasks, handling ordnance disposal, or transporting supplies (KMW, 2022). These examples highlight just a fraction of the support Ukraine has received. Indeed, many more Western allies have contributed AI-powered tools to support their defence, and the range of advanced technologies provided reflects the significant international backing Ukraine has received in its resistance.

In 2022, Alex Karp, CEO of the data-analytics firm Palantir Technologies, decided to open an office in Kyiv and leverage Palantir's data and AI software to support Ukraine's defence efforts against Russia. Since Karp pledged to support Ukraine, Palantir has become deeply integrated into the daily operations of a foreign government at war in an unprecedented way. Over half a dozen Ukrainian agencies, includingthe Ministries of Defence, Economy, and Education, are now employing Palantir's technology (Bergengruen, 2024). According to Karp, Palantir's software, which leverages AI to process drone footage, satellite images, ground reports, and open-source data, is credited for most targeting in Ukraine (Dastin, 2023). A Ukrainian engineer using Palantir can quickly go through an overwhelming amount of battlefield data that would have previously required hundreds of analysts. The software processes raw intelligence obtained from various sources, including ground reports, thermal images tracking troop movements and artillery fires, drones, and satellites. Palantir's software combines this data with commercial and classified information from the Ukrainian government and its allies. This integration helps military officials relay enemy positions to commanders on the ground and/or decide on striking a target, a process which Karp refers to as digital "kill chain" (Raiss, 2024).

A Hub for Innovation

Smaller international tech firms from the US and Europe, especially those working on autonomous drones, have also started setting up in Kyiv. As a result, local young professionals have started calling some of the city's bustling co-working spaces "Mil-Tech Valley" (Bergengruen, 2024). Based in Kyiv, Unit City is a hub that merges infrastructures with an innovation ecosystem for entrepreneurship and field research in IT. The project, which in 2020 received a €50 million loan from the European Investment Bank (EIB) and has since been attracting high-profile foreign investors , aims to be the main innovation hub in Central and Eastern Europe (European Investment Bank, 2020). In 2023, the Ukrainian government engaged in new efforts to boost innovation in producing AI-enhanced drones and other crucial tools that have been instrumental in the efforts against Russia. One of these initiatives is known as BRAVE1. With the goal of giving Ukraine an edge on the battlefield, the BRAVE 1 project aims to unite the government, the military, and private developers focused on defence into a single platform (Arhirova, 2023). Other than drones, the BRAVE1 initiative covers AI tools for translating Russian military terminology, such as radios that block Russian interference, protective cybersecurity measures, and gear for clearing landmines. However, AI tools go beyond just military use. Dmytro Zavgorodnii, Ukrainian Deputy Minister for Digital Transformation, reported how they have been using Palantir's software to track schools hit by air raids or power outages, monitor road conditions, and estimate how long it takes for students to reach shelters with Wi-Fi (Bergengruen, 2024). Importantly, Palantir's tools are helping the ministry find ways to keep schools operational, provide laptops and internet access in conflict zones, and manage national testing with minimal interruption.

Ukraine and the European Defence Agency

The advancement of the Russo-Ukrainian War highlights the pivotal role of AI and advanced technologies in modern military operations. Ukraine's innovative use of these tools in defence has been significantly strengthened by its collaboration with private tech companies and allies. The lessons learned and the technologies tested in Ukraine can be directly applied to improve European military interoperability. In a 2023 guest essay for the New York Times, Alex Karp called for "a more intimate collaboration between the state and the technology sector, and a closer alignment of vision between the two" (Karp, 2023). Subsequently, EDA tries to bridge that gap through its Research & Technology projects, which are the top priority of the organisation. Indeed, the agency supports the development of defence capabilities and military cooperation through the launching of new initiatives, promoting the strengthening of the European defence industry. As disclosed in its 2023 Annual report, last year EDA continued rolling out the steps outlined in its 'Artificial Intelligence Action Plan'.

The European Defence Agency has partnerships with various third parties both within the EU and beyond, including Ukraine, and is empowered by Member State's authority to conclude bilateral Administrative Arrangements with desired organisations and third countries. The Administrative Arrangement with Ukraine was signed on 7 December 2015, facilitating cooperation in defence capability development, research, and technology. This arrangement allows Ukraine to participate in EDA projects and activities, despite not being an EU member. Furthermore, the Administrative Arrangement provides Ukraine access to the EDA's knowledge base, while benefitting from EDA's expertise and contributing to interoperability with EU member states' armed forces. Similarly, the 2015 agreement establishes that the Ministry of Defence of Ukraine has to provide EDA 'the fullest possible transparency regarding defence plans, current and future capability requirements, and industrial capacities, to facilitate the identification of potential areas for cooperation' (European Defence Agency, 2015). Therefore, any breakthrough related to AI-enabled tools tested in Ukraine can be applied and will end up benefitting Europe as a whole. By aligning standards and sharing knowledge about AI-enabled technologies, European armed forces can ensure smooth coordination during joint operations, leading to improved responsiveness, flexibility, and overall combat effectiveness.

Conclusion

The ongoing Russo-Ukrainian conflict has uncovered the critical role of AI and advanced technologies in modern military operations. Ukraine's defence strategy, marked by strong partnerships with private tech companies and Western allies, highlights how AI tools can boost military effectiveness and situational awareness. This paper analysed Ukraine defence forces' strategic employment of AI-enabled technologies and the implications of the public-private sectors collaboration in defence for military cooperation across Europe.

AI is changing the face of warfare, helping military forces to make decisions faster and more accurately. Ukraine's use of AI-powered military tools offers important insights into how technology can be channeled in the defence industry. This paper aims to illustrate that the involvement of international tech firms in Ukraine, exemplified by Palantir and its AI-driven solutions, underlines the power of public-private partnership in advancing military capabilities. The public-private collaboration in Ukraine has not only reinforced the country's defence capabilities but has also turned its capital, Kyiv, into a center for military tech innovation.

In conclusion, this research highlighted how the Russo-Ukrainian conflict brings out the importance and the need to integrate AI and advanced technologies into military strategy. Ukraine's effective use of state-of-the-art technologies provides a blueprint for other countries, showing the advantages of strong public-private partnerships in the defence sector. The insights gained from Ukraine's experience with AI can be applied in other European member states to improve military cooperation, ultimately strengthening Europe's collective defence capabilities.

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