NOVEMBER 2024

Understanding the Military AI Ecosystem of Ukraine

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Executive Summary

This report is the first part of a series on military artificial intelligence (AI) development and its application in the war in Ukraine. It will focus on two critical aspects of AI adoption in Ukraine's military:

1. The conditions and factors that contributed to military AI development from the beginning of the war with Russia in 2014
2. The key government institutions and initiatives responsible for driving AI adoption, along with a summary of their major AI-related initiatives

The summary section below presents key findings and insights on both of these aspects.

1. **AI is in experimental deployment and is overwhelmingly geared toward supportive functions.**

Although AI is frequently discussed in the context of the war in Ukraine, its full deployment on the battlefield remains limited. Numerous AI-driven capabilities and technologies are being tested along the frontlines, in long-range strikes within Russian territory, and across multidomain operations, but these efforts are largely experimental rather than indicative of AI systematically replacing human functions in warfare. AI currently assumes a predominantly supportive and informational role, and even when AI capabilities advance and improve, they are not yet implemented in fully autonomous modes on the battlefield.

2. **There is growing government involvement in AI development in Ukraine through organizational, regulative, and technological initiatives led by various government stakeholders.**

Initially, the development of AI-driven technologies in Ukraine was spearheaded by the private sector and volunteer initiatives. However, government institutions and agencies have recently begun to

build their own capacities for advancing new technologies. This shift is evident in the creation of new organizational divisions and units within government institutions and the Armed Forces of Ukraine (AFU), which are specifically dedicated to AI-focused technologies and their deployment. These efforts mark a significant step toward the institutionalization of AI innovation within the public sector.

3. **The Ukrainian government is focusing on the adoption of commercial AI rather than on developing new technology within government institutions.**

Ukrainian authorities, having recognized that the speed and quality of technology development in the private sector far exceed those of the government sector, have prioritized creating infrastructure and procedures for the fast adoption of commercial technology. This approach has resulted in simplifying regulations on the adoption of innovation by the AFU, initiating programs for prototype testing, and providing grant funding to early-stage start-ups, among other initiatives. Moreover, most newly established units within Ukraine's military, such as the Unmanned Systems Forces, are dedicated to integrating new technologies into military operations rather than participating in combat itself.

4. **The absence of a long-term strategy for military AI development poses significant challenges to the sustained and effective adoption of these technologies.**

The lack of a long-term strategy for military AI development represents a critical gap within the government's approach to emerging technologies. Despite Ukraine's recognized technological potential, there is no unified vision guiding the use of AI in defense. This strategic void is primarily driven by limited management capacity across government institutions and by the inexperience of political leadership in addressing the complexities of warfare. As a result, the focus has been on immediate, tactical solutions rather than on establishing a cohesive, forward-looking strategy to harness the full potential of AI in military operations.

5. **Between 2014 and 2022, two grassroots applications—analytics for situational awareness and drones for intelligence, surveillance, and reconnaissance (ISR)—laid the groundwork for the post-2022 surge in military AI. Following Russia's full-scale invasion, military AI expanded significantly across six major applications, with a growing number of companies focusing on autonomy.**

This report categorizes AI applications in Ukraine's military operations into six major areas, listed below. A more detailed analysis of these applications will be provided in subsequent reports in this series.

- **Autonomy.** The most significant advancements have been in autonomous systems, where Ukraine is making strides in areas such as GPS-denied navigation and swarm operations.
- **Open-source intelligence and fighting disinformation.** AI helps to analyze large volumes of digital content from media and social networks and to identify Russian narratives, propaganda, and information campaigns spreading disinformation.
- **Situational awareness and command and control.** AI enhances situational awareness with numerous software platforms used by the military to analyze battlefield and intelligence data and to facilitate real-time efficient decisionmaking.

- **Demining.** AI-powered analytic software and AI-enabled unmanned ground vehicles improve the efficiency and safety of mine clearance.
- **Training and simulation.** AI-driven training simulations are helping soldiers adapt to complex battlefield conditions by playing close-to-real combat scenarios with AI adjustments to address warfighters' skill gaps.
- **Damage assessment.** AI is crucial in damage assessment, utilizing satellite data and drone imagery to analyze damage, losses, and devastation and to estimate future recovery efforts.

6. **Several factors have facilitated the rapid development of military AI in Ukraine, creating a unique environment for defense innovation.**

The situation in Ukraine over the last decade, particularly the ongoing conflict with Russia, has affected all aspects of society and necessitated rapid adaptation in defense and related fields. These factors have enabled Ukraine to test and deploy AI-driven solutions in real battlefield conditions, leading to numerous innovations, particularly in the realm of autonomy and autonomous weapon systems.

- **Existential need for advanced technology.** The Russian invasion of 2022 created an urgent, existential need for Ukraine to develop advanced defense technologies rapidly. The high-stakes environment pushed both government and private sectors to prioritize technological advancements, such as AI, to enhance military capabilities. This urgency also catalyzed a willingness to experiment with AI, leading to quicker deployment of AI-driven capabilities in combat.
- **Active civil society and a robust private sector.** Ukraine's vibrant civil society and entrepreneurial private sector have been instrumental in driving defense innovation. Even before the full-scale invasion, the Ukrainian entrepreneurial spirit, combined with a deep sense of national defense responsibility, led many private companies and start-ups to actively contribute to the war effort. These organizations have developed AI-driven solutions ranging from autonomous drones to advanced surveillance systems, with many innovations coming from small teams responding quickly to military demands. The active participation of nongovernmental actors in AI-enabled defense technology development and the fast deployment of commercial technology have significantly accelerated progress in this area.
- **Permissive regulatory frameworks.** Ukraine's regulatory environment for military AI was absent before the invasion. Unlike in many other countries, where regulatory bottlenecks can slow down innovation, Ukraine's government refused to regulate military AI, allowing innovators to respond quickly to frontline needs and develop AI applications that could be immediately deployed in combat settings. The Ministry of Digital Transformation (MDT) prioritizes a soft, business-friendly approach, aiming to avoid overregulation. Instead of imposing strict rules, the ministry uses a bottom-up strategy, offering voluntary guidelines and tools to prepare businesses for future regulations. This approach extends to the defense sector, as the MDT has indicated that it does not plan to introduce regulation of AI in the defense sector.
- **Direct communication between engineers and military personnel.** One of the most significant accelerators of military AI development in Ukraine has been direct communication between engineers and military personnel. Through a well-established network of technical

workshops positioned near the frontline or within military units, including mobile drone repair vans, engineers from private companies are able to closely monitor and assess the performance of their systems in real combat scenarios. This proximity enables engineers working on unmanned systems and autonomous capabilities to receive real-time feedback, allowing for the rapid refinement of their technologies.

- **Foreign assistance providing access to new technologies.** International support, from both governments and private companies, has been crucial in allowing Ukraine to leap forward in its technological capabilities. This support has facilitated Ukraine's adoption of new technologies, such as analytical tools from Palantir, communication infrastructure via Starlink, and the migration of critical government data to Microsoft's cloud services, to name just a few examples. This external assistance has not only equipped Ukraine with essential tools for innovation but has also fostered opportunities for collaborative development between Ukrainian and foreign companies, thereby strengthening Ukraine's military and technological capabilities.

7. **Collaboration on AI between Ukraine and the U.S. government can be mutually beneficial.**

What follows are several key recommendations for the U.S. government to foster closer collaboration in AI development between the United States and Ukraine in a way that will be beneficial to both countries.

- **Strategic support.** The United States should leverage its technological leadership to help Ukraine develop a cohesive long-term strategy for integrating AI into defense operations. By providing strategic guidance, the United States can help to align Ukraine's national priorities in AI development while gaining valuable insights into AI applications in active warfare.
- **Closing the feedback loop.** A structured feedback system for evaluating the performance of U.S.-provided drones and military technologies in Ukraine would benefit both nations. U.S. companies could quickly iterate and improve their technologies, while Ukraine would receive more tailored and effective capabilities, enhancing battlefield operations.
- **AI in U.S. foreign aid.** The United States should integrate AI development into its foreign aid programs for Ukraine, providing essential computing infrastructure to support AI innovation. This would strengthen Ukraine's defense capabilities and establish the country as a hub for military AI development, benefiting U.S. strategic interests in global AI leadership.
- **AI-focused training and entrepreneurial development.** The United States should establish AI-related programs for Ukrainian defense entrepreneurs and business leaders. These initiatives would foster Ukraine's defense tech ecosystem and strengthen U.S.-Ukraine collaboration, positioning both countries to lead in AI-driven defense innovation.

Understanding Ukraine's AI Ecosystem

This section provides a comprehensive overview of Ukraine's military AI ecosystem. It begins by providing a background to Ukraine's commercial AI sector, which for more than a decade has been quite successful—more than is commonly recognized in the West. Next, the paper examines how Russia's invasion of Ukraine in 2014 resulted in major changes to the Ukrainian military's approach to

software and data, changes that were critical to the foundation of the military's post-2022 introduction of AI technologies. Finally, it provides an overview of the key government organizations responsible for driving AI adoption throughout Ukraine's military as well as a summary of their AI-related initiatives.

COMMERCIAL AI IN UKRAINE: A DECADE OF QUIET SUCCESS

In the race for leadership in artificial intelligence, Ukraine may appear an unlikely contender. However, this comparatively small nation is demonstrating significant potential, with a highly skilled and technologically adept population. Notably, nearly **two-thirds** of Ukrainians express optimism regarding AI's potential to enhance human life, reflecting widespread public confidence in the transformative capabilities of the technology.

Indeed, for more than a decade, Ukraine has quietly served as a developer of innovative AI capabilities that have captured the world's imagination. While a full list is beyond the scope of this paper, three companies—Looksery, Respeecher, and Augmented Pixels—provide a helpful illustration of how Ukraine's commercial AI sector has long been more impactful and more capable than is commonly understood outside technology communities.

First, in 2015, Snap Inc.—a Santa Monica-based technology company and the maker of the popular Snapchat social media app—spent $150 million to **acquire Looksery**, a two-year-old Ukrainian AI tech firm. **Looksery's** AI-based facial recognition and augmented reality technology laid the foundation for Snapchat's Lens portfolio, which today boasts **250 million daily users**. In 2022, Snap Inc. **stated** that the company still employed 300 Ukrainian staff, almost all of whom are engineers.

Second, Ukrainian AI companies have also been involved in Hollywood, providing AI technology for audio generation. In 2020, Disney sought to include a younger version of Luke Skywalker in the television series *The Mandalorian*, but faced a challenge in that *Star Wars* actor Mark Hamill was 68 years old. Disney contracted with the Ukrainian AI company **Respeecher** to **synthesize** a younger voice that was sufficiently high-quality to meet Disney's exacting standards.

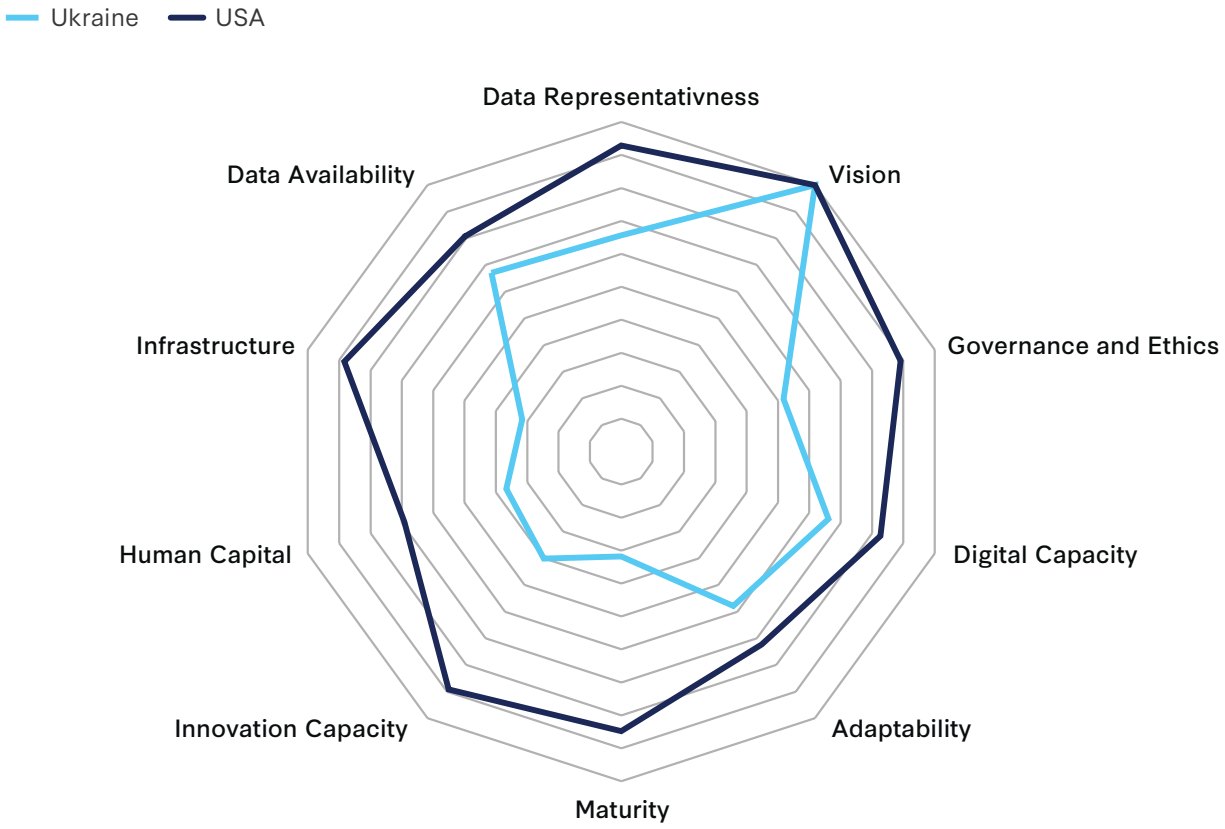
Third and finally, Qualcomm **acquired** Augmented Pixels in 2022. **Founded in 2010** in Odesa, Augmented Pixels developed AI navigation technologies, such as 3D mapping and localization, for drones and AI glasses. At the time of purchase, Augmented Pixels' commercial customers included **National Geographic**, **LG Electronics**, **Intel**, and more.

The main takeaway from these cases is that Ukraine's AI sector was a meaningful player in commercial technology markets—taken seriously even by leading Western companies—long before Russia's full-scale invasion in 2022. A **2024 study** conducted on behalf of Ukraine's MDT found that Ukraine has 243 AI-focused companies and a broader information technology (IT) and software workforce comprising more than **307,000 specialists**. Additionally, Ukrainian universities have launched a remarkable 106 specialized AI and machine learning (ML) programs across 42 institutions, resulting in a 122 percent increase in enrollment over five years. The report found that Ukraine produces more IT graduates than any other Central or Eastern European country, with a quarter of these graduates specializing in AI/ML.

Despite Ukraine's aforementioned strengths, its AI sector continues to encounter substantial challenges. According to the **2023 Government AI Readiness Index** by Oxford Insights, Ukraine was ranked 60th out of 193 countries in AI integration into public service. The country's AI development is hindered by

several factors, including insufficient computing infrastructure and a shortage of skilled human capital due to the **relocation** of IT engineers fleeing the war (although some have continued working remotely for their Ukrainian employers). Additionally, Ukraine's low government research and development investment further constrains the sector's growth.

Figure 1: Comparison of Ukraine and United States in Government AI Readiness Index 2023



Source: "Government AI Readiness Index 2023," Oxford Insights, https://oxfordinsights.com/ai-readiness/ai-readiness-index/.

Surprisingly, the Oxford Insights report found that Ukraine matches the United States—the index's top-ranked country—in one crucial aspect: vision. However, vision alone is not enough to boost AI development and deployment. Ukraine's position in the index underscores a critical gap between the ambitious plans of its tech sector and the resources needed to execute them.

MILITARY AI IN UKRAINE SINCE 2014: NECESSARY GROWTH

Pre-2022: Laying a Digital Foundation

Though the 2022 full-scale invasion shocked the world, for Ukrainians, it was not the start of the war with Russia. Russia's occupation of Ukrainian territories in 2014 was a major wake up call for Ukrainian society—including Ukraine's tech sector, which became **increasingly willing** to directly support Ukrainian armed forces.

The 2022 full-scale invasion, however, did mark a watershed moment in Ukraine's approach to military artificial intelligence. Prior to 2022, Kyiv had not prioritized AI in its defense strategy, despite the ongoing war in the Donbas region. However, groundwork laid by **volunteer groups since 2014**—focused not on AI but on software for data collection, analysis, and warfighting operational support—has proved instrumental in facilitating rapid military AI development and adoption since 2022.

This subsection will examine two key military use cases from the 2014-2022 period that enabled AI integration after the full-scale invasion: situational awareness systems and drones. After 2014, volunteers from Ukraine's tech sector developed systems using modern data and software techniques (though not ML/AI). Over time, these systems dramatically improved Ukraine's intelligence, surveillance, target acquisition, and reconnaissance (ISTAR) capabilities and even overtook competing official systems in adoption and impact.

SITUATIONAL AWARENESS

Between 2014 and 2022, Ukraine's tech-savvy and patriotic workforce developed and **introduced** 11 new situational awareness and battlefield management systems to the Ukrainian military. Because they were unofficial and unsanctioned, one might think that these volunteer initiatives would be divorced from real military requirements. In practice, however, the volunteer groups had direct communication with front line operational forces, allowing them to focus their development efforts on high-priority military needs. One of the initiatives, the situational awareness system Delta, was eventually adopted and formally integrated into the Ukrainian military. The remarkable fact is that some unofficial volunteer systems and software have achieved near-universal adoption by the relevant Ukrainian forces, vastly exceeding the adoption rate of some official military technology initiatives that sought (and usually failed) to provide similar capabilities.

The diverse capabilities of these systems—generally originating from explicit military requests—ranged from fire control, artillery optimization, and air traffic management to combat command and control. These systems not only significantly enhanced Ukraine's operational effectiveness but also helped transition the Ukrainian military to a modern data- and software-enabled fighting force.

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One of the most noteworthy volunteer groups is **Aerorozvidka**, whose situational awareness system **Delta** has become a linchpin in Ukraine's multidomain operations. Started in 2016 and **transferred** to the Ministry of Defense of Ukraine (MoD) in 2023, Delta seamlessly **integrates** NATO ISTAR standards to provide essential situational awareness across all branches of the Armed Forces of Ukraine (AFU). Building on this foundation, Aerorozvidka has spearheaded the creation of **situational awareness centers** in eight cities, each focused on gathering information from its respective section of the front. These centers serve as technological hubs, uniting and coordinating intelligence from a wide variety of

sources—drones, satellites, stationary cameras, sensors, field scouts, and data from allies. The system even digitizes information from loyal informants in temporarily occupied territories, who interface with **government apps and chatbots**. Bringing all these different data sources together in a unified software platform is a challenge **even for the United States military**, but Delta achieves this and enjoys high user satisfaction among Ukrainian forces. As will be discussed further in this paper, Delta has recently been enhanced with AI/ML-enabled capabilities. At one point, there was an officially sanctioned military system—Dzvin—in development that promised similar capabilities as the volunteer-built Delta. However, this **fell victim** to bureaucratic hurdles and corruption and never achieved meaningful adoption despite its **official introduction** into the AFU in 2022. A diverse range of military officials told CSIS that Delta now is the de facto standard and Dzvin is functionally irrelevant. Delta is also of keen interest to NATO, which has **described** the system as "ground-breaking" following its victory in a 2017 NATO hackathon and prominent testing in **NATO military exercises**, most recently in 2024.

The **Kropyva artillery software system** improves target accuracy and routinely reduces the time between receiving orders and striking targets by up to tenfold. Ukrainian artillerymen access Kropyva through a tablet or mobile phone, then enter enemy coordinates, which are automatically translated to the nearest available artillery battery along with precalculated aiming trajectories. The **Army SOS** volunteer organization developed Kropyva in 2014, and **90 to 95 percent of Ukrainian artillery units** have adopted it as their primary artillery fire control system. Another military system helping to coordinate artillery strikes, **GisArta**, attracted **widespread attention** in the Western press as "Uber for artillery," even though Kropyva is more widely used and impactful according to Ukrainian military officials in conversation with CSIS.

Kropyva and Delta are just two of dozens of examples demonstrating how systems initially developed by tech industry volunteers changed Ukraine's armed forces after 2014. Many of these systems began with the modest goal of supporting warfighter decisionmaking and have since evolved into advanced situational awareness and battle management systems routinely used by hundreds of thousands of soldiers. Prior to 2022, the adoption of these modern software and data-driven platforms also laid the groundwork for AI/ML integration. As critical information sources were networked and digitized, the data they generated became the raw material for training AI models and enabling AI-driven capabilities.

The success of volunteer-led grassroots projects underscores a crucial point: in the face of existential threats, innovation in Ukraine has primarily thrived outside traditional channels. However, this decentralized approach is not without its challenges. Many of these teams still operate on shoestring budgets, **relying heavily on donations**. The lack of systemic support and funding raises concerns about the long-term sustainability and interoperability of this **diversity of systems**. Ukraine still possesses a hard-won technological edge, but the government needs to ensure that these successful initiatives are put on a more secure long-term foundation and incorporated into official plans and strategies. Unfortunately, multiple executives in Ukraine's defense technology ecosystem told CSIS that the scale of Ukraine's technological edge is shrinking as Russian forces improve their own technology and their pace of innovation adoption. Whereas previously Russian forces would take a month or more to adapt to new Ukrainian innovations before adopting countermeasures in the form of new tactics or technologies, now Russian forces may need as little as two or three days.

DRONES

Prior to 2022, drones were in use by both sides, mostly for remotely piloted ISR missions and without AI/ML capabilities. Drones have become a ubiquitous feature of the post-2022 war with Russia, widely **recognized** as a transformational capability for both sides. However, the impact of drones during the 2014–2022 period was considerably more limited.

The war in Donbas served as an early testing ground for commercial drones, with both sides exploring their potential. While Russian forces **made early strides** in drone warfare, the Ukrainian side's attempts to leverage commercial drones were met with **mixed results**. The lack of trained operators, coupled with the high attrition rate of these relatively expensive items for Ukrainian soldiers who usually had to buy them at their own expense, initially dampened enthusiasm for their widespread adoption. Volunteer organizations, which have played a crucial role in supporting Ukraine's military efforts, did not—prior to 2022—prioritize drone acquisition. Similarly, official military decisionmakers were slow to recognize the potential of these systems, focusing instead on more traditional assets.

In cases where Ukrainian forces did use drones, the priority use case was ISR. China was a **major supplier** of commercial drones to Ukraine, primarily for civilian purposes such as agriculture and event photography, often referred to as "wedding" drones. However, these also **saw usage in combat**, even prior to 2022, again mostly for ISR. Hence, Ukrainian defense companies focused their military drone development efforts primarily on medium and long-range reconnaissance and artillery fire correction. Notable examples include the **PD-2** from UkrSpecSystems, the **Furia** from Athlone Avia, the **R18** from Aerorozvidka, and the **ACS-3M** from Skyeton. Companies like DeVIRo also contributed with their **Leleka-100**, further expanding Ukraine's domestic drone capabilities, while the **Punisher**, a strike drone produced by UA Dynamics, represents Ukraine's foray into offensive drone technology.

Despite the early use of drones in the war in Donbas, neither Ukrainian nor Russian drones were equipped with ISR AI/ML capabilities. However, increased familiarity with drones would set the stage for later AI adoption.

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Post-Invasion AI Surge: Wide-Ranging Military AI Applications

Despite Ukraine having been at war with Russia for nearly a decade, Russia's 2022 full-scale invasion was a shock to the Ukrainian military system. The survival of Ukraine as an independent state was at stake, and leaders across civilian, military, and commercial structures reacted accordingly. Society as a whole mobilized to support the armed forces, and in many cases, everyday citizens volunteered to participate in combat and defend Ukraine.

The commercial technology sector of Ukraine was also swept up in this wave. What had been a volunteering side project for many became the dominant focus of their professional life. In numerous cases, these efforts were centered on maintaining and enhancing existing digital platforms like Delta

and Kropyva. However, a new suite of volunteer-built capabilities focusing on the opportunities of AI technology also emerged.

As with the pre-2022 era, there was no centrally guided plan to accelerate the adoption of AI for priority use cases. Rather, experimentation with AI emerged organically, as technically proficient volunteers explored solutions to the diverse security challenges facing all of Ukrainian society—from disinformation to cyberwar to front-line conflict.

While much of the technology development and drive behind Ukrainian AI efforts originated in the private sector and volunteer communities, the Ukrainian government and military responded with significant organizational changes to accelerate and improve the adoption of AI-enabled capabilities.

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THE INSTITUTIONAL LANDSCAPE FOR MILITARY AI DEVELOPMENT IN UKRAINE

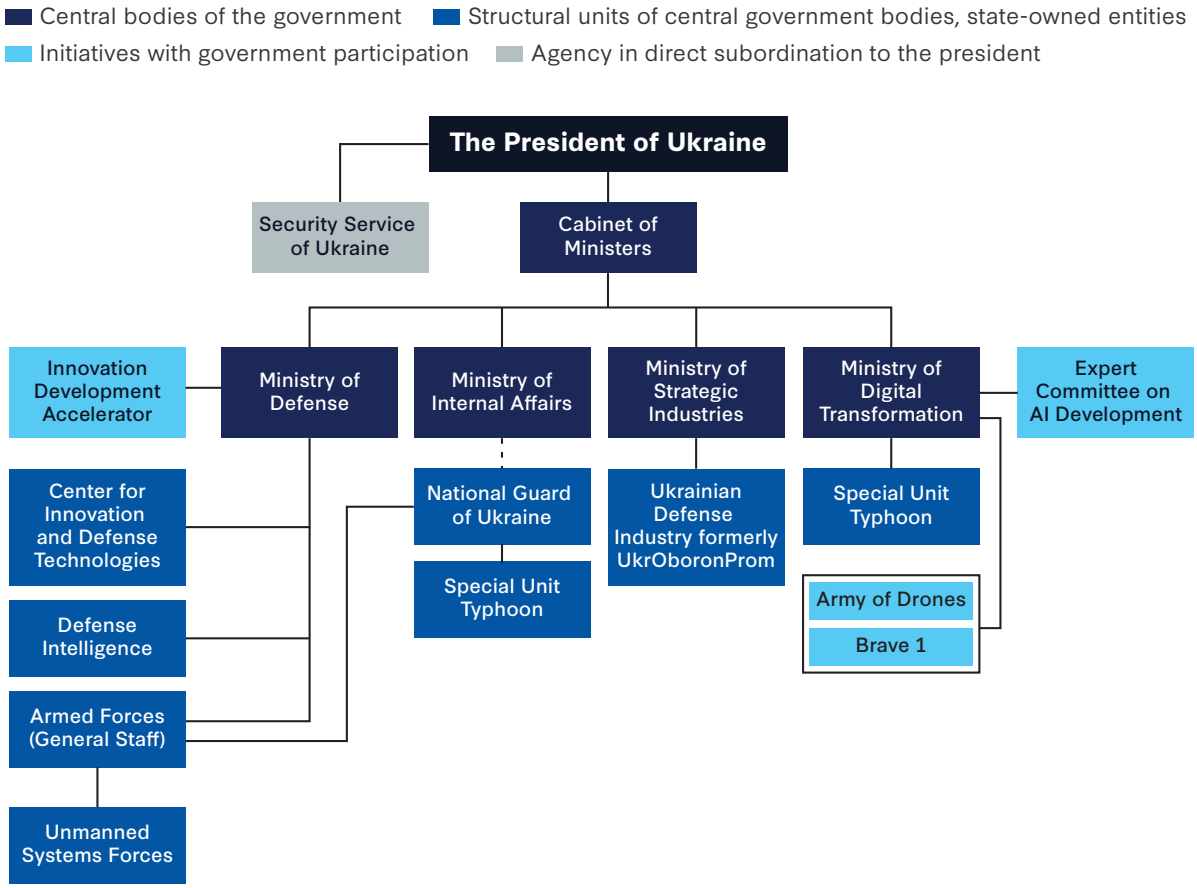
The institutional landscape supporting AI development in Ukraine has evolved significantly since 2022, with many government agencies and institutions shifting from initially neglecting AI to actively creating specialized departments and units dedicated to developing AI capabilities. This transformation has been driven largely by the pressing demands of the ongoing war against Russia, where AI technologies have repeatedly demonstrated the potential to provide an advantage on the battlefield.

Of special note, Ukraine has gone so far as to create an entirely new branch of its armed forces, the **Unmanned Systems Forces**. While smaller than the other branches of the Ukrainian military, it is nevertheless technically their peer, and it serves as evidence that Ukrainian leadership views as critical the task of driving organizational reforms to account for new technological realities.

Other defense and security institutions have also created new organizations and empowered them to accelerate technology innovation, such as Special Unit Typhoon, a new part of the National Guard of Ukraine. One newly created organization within the MoD, the Center for Innovation and Defense Technologies (CIDT), is a direct outgrowth of the tech volunteer community's efforts. In 2023, the CIDT took official responsibility for upgrading and developing situational awareness technologies, including the Delta system discussed in a previous section. In 2024, the developers began **integrating** AI/ML capabilities into Delta with an initial focus on video and text processing for the identification of enemy forces in real time.

In other cases, the war has led organizations to reinvent their mandate. Both the Defense Intelligence of Ukraine (DIU, a subordinate body of the MoD) and the Security Service of Ukraine (SSU) have taken a leading role in developing and executing long-range precision strikes on Russian infrastructure. In previous years, these organizations would not have been responsible for such missions. AI is a useful enabling technology for long-range precision strikes, and both organizations have developed the relevant competencies to be

Figure 2: Map of Military AI Stakeholders in Ukraine



Source: CSIS analysis.

at the forefront of AI adoption. For example, AI-based computer vision is helpful for accurate navigation in GPS-denied environments, such as the territory on both sides of the Russian border. More broadly, both the DIU and the SSU have **adopted AI** for processing and analyzing vast volumes of battlefield data.

Beyond creating new institutions and changing the mandate of existing ones, Ukrainian authorities are also implementing regulatory reforms and launching diverse initiatives to make it easier for companies to develop AI—and for military units to adopt it. The MDT, which is responsible for policymaking in AI development, is fostering an innovation-friendly regulatory environment, avoiding overregulation and promoting AI development through initiatives such as the Army of Drones and the Brave1 platform (further discussed below). These initiatives have accelerated the deployment of unmanned systems—including AI-driven ones—by providing essential financial and organizational support to early-stage projects.

Profiles of Organizations in Ukraine's Military AI Ecosystem

The development of AI-enabled warfare is not occurring in isolation; it is shaped by a complex institutional landscape of government agencies and stakeholders. This section provides an overview of key institutions, along with their initiatives specifically related to developing military AI and drones, while excluding the broader scope of these institutions' functions as it falls outside the focus of this research. Due to the classified nature of much of the information on government initiatives, this overview remains

general, without going into the technical specifics of the projects and technologies involved. The purpose of this section is to offer a clearer understanding of Ukraine's somewhat unstructured governmental approach to military AI development, as well as to facilitate the identification of relevant counterparts for collaboration where Ukrainian models or initiatives align with U.S. government objectives.

MINISTRY OF DEFENSE

The MoD of Ukraine is the government body responsible for overseeing national defense and the AFU. The MoD is headed by the minister of defense, while the president of Ukraine holds the position of supreme commander-in-chief of the armed forces.

Organizational AI Initiatives

- **Center for Innovation and Defense Technologies.** In 2021, the MoD **established** the CIDT to reform its approach to IT project management. Its primary objective is to modernize automated combat management systems and develop future operational-strategic, tactical, and situational awareness systems. A notable achievement in this workstream is the **formal adoption** of the Delta situational awareness system by the MoD in 2023, which the CIDT inherited from the volunteer organization Aerorozvidka. Public information on the CIDT's AI-related initiatives is limited, particularly beyond its focus on the Delta platform. However, **recent job postings** for machine learning engineers, MLOps specialists, and computer vision researchers suggest that the CIDT is prioritizing the integration of AI-enabled solutions into Delta.
- **Unmanned Systems Forces.** A dedicated branch of the AFU, the **Unmanned Systems Forces** (USF), was established to systematize and expand the experience gained in the deployment of unmanned systems while formalizing a doctrinal approach suited to the realities of asymmetrical warfare. The USF is responsible for operations across all domains and levels, ranging from frontline engagements to deep strikes within enemy territory. Under the leadership of Colonel Vadym Sukharevsky, the USF **plays** a central role in introducing unmanned systems throughout the AFU, adopting emerging technologies, sharing innovations, and training units and brigades to use new systems. The USF is tasked with identifying the most effective systems to address the diverse challenges faced by the AFU on the battlefield. To date, over **170 models** of unmanned systems have been integrated into frontline operations, positioning the USF as a critical driver of technological innovation in combat.

AI Technology Initiatives

- **Innovation Development Accelerator.** The MoD has sought to accelerate the development and adoption of defense technologies through the creation of the **Innovation Development Accelerator**. Established in 2023, this initiative is designed to streamline and modernize the ministry's operations by addressing issues of overregulation, lengthy processes, and inefficiencies in collaboration with defense companies. The accelerator aims to reduce the time required for the implementation of weapons and equipment from more than two years to approximately 45 days, while simplifying bureaucratic procedures to enhance operational efficiency. One of its six core priorities is the advancement of robotization and AI tech adoption for unmanned aerial vehicles, as well as ground and water drones.

Initiatives in AI Regulation

- **Doctrine for Unmanned Systems Forces.** The USF has developed a **comprehensive doctrine and statute** for all branches of the Armed Forces of Ukraine, which is currently being tested in operational units. The documentation is developed for every level, from squad to battalion, and it will standardize tactics and procedures for the use of unmanned systems across the AFU. The creation of this statute marks a significant step toward the formalization and regulation of unmanned system deployment, ensuring consistent operational practices across the military.
- **Political Declaration on Responsible Military Use of AI and Autonomy.** The only AI-related regulatory initiative in which the MoD is currently involved is the ***Political Declaration on Responsible Military Use of AI and Autonomy***, launched in 2023. This provides a framework for the responsible use of military AI and aims to build international consensus, guiding states in the ethical development, deployment, and use of military AI technologies. Besides this international initiative, the MoD has not yet released any public strategies or formalized vision regarding AI implementation or the development of autonomous systems.

DEFENSE INTELLIGENCE OF THE MOD OF UKRAINE

The Main Directorate of Intelligence of the MoD, also known as the Defense Intelligence of Ukraine (DIU), serves as the military intelligence agency to the country's leadership and the AFU. Its **portfolio** includes intelligence, cyber, technology development, and occasionally direct execution of high-priority missions.

AI Technology Initiatives:

- **AI for analytics.** The DIU has emerged as one of the most advanced users and adopters of AI technology within the military. **According** to Lieutenant General Kyrylo Budanov, chief of the DIU, the increasing volume of acquired intelligence data necessitated the enhancement of analytical capabilities. To address this challenge, the analytical branch has been significantly bolstered with technologies for automated data processing, integrating artificial intelligence to improve the efficiency and accuracy of analysis. This integration of AI has been critical in managing large datasets and enhancing the decisionmaking process within the intelligence operations of Ukraine.
- **Drones for long-range strikes.** The DIU is a leading agency in conducting long-range strikes into Russian territory using drones equipped with some elements of autonomy. These autonomous drones play a crucial role in Ukraine's ability to carry out precision strikes at extended distances, significantly expanding the operational capabilities of its military. The use of such autonomous systems represents a forward-looking approach to modern warfare, where AI-enabled technologies enhance the effectiveness of long-range operations while minimizing the need for direct human intervention. While the Ukrainian government has not disclosed all of the functions that AI plays in this mission, government officials told CSIS that AI does play an important role. This positions the DIU as a key player in the development and application of autonomous military technologies in Ukraine.

SECURITY SERVICE OF UKRAINE

The Security Service of Ukraine (SSU) serves as the country's **principal security and intelligence agency**, tasked with safeguarding national security, conducting counterintelligence operations and

counterterrorism efforts, and combating organized crime. It operates under the authority of the president of Ukraine.

AI Technology Initiatives

- **Naval drones.** One of the SSU's most innovative contributions to the war effort is its **use of naval drones**, which have significantly impacted the balance of power in the Black Sea. These drones are not just simple unmanned vessels; due to constant close interaction between the SSU and its drone operators and engineers, they have evolved into **multifunctional platforms** that are constantly undergoing technological improvements. For example, the **Sea Baby drones**, initially designed for explosive attacks on Russian naval ships and infrastructure, have been enhanced to perform additional functions such as offensive sea mining. They have **successfully laid mines** in strategic locations, significantly impacting Russian naval operations. Moreover, due to recent upgrades, the drones are **equipped** with rocket systems—specifically the Grad multiple rocket launchers, which have already shown effectiveness in targeting Russian positions.

NATIONAL GUARD OF UKRAINE

The National Guard of Ukraine is a military force under the command of the Ukrainian Ministry of Internal Affairs, and it is tasked with protecting public order, securing strategically important facilities, and countering illegal paramilitary groups. During martial law periods, the units of the National Guard are **subordinate** to the AFU.

Organizational AI Initiatives

- **Typhoon.** In 2024, the National Guard of Ukraine **established** a specialized unit known as Typhoon, which is focused on the deployment of unmanned aerial systems for military operations. This unit, composed of seasoned Special Forces veterans, has been created with the objective of enhancing the operational capabilities of combat brigades by integrating advanced unmanned systems into their strategic and tactical frameworks. The veterans within the unit bring a wealth of combat experience, which is crucial for the effective deployment of unmanned aerial vehicles (UAVs) in complex battlefield environments. By integrating unmanned systems into combat operations, the Typhoon unit aims to increase both the flexibility and responsiveness of brigade-level engagements, enhancing operational efficiency and reducing risks to personnel.

MINISTRY OF DIGITAL TRANSFORMATION

The Ministry of Digital Transformation of Ukraine (MDT), **established** in 2019, is responsible for shaping and implementing state policy in digitalization, the digital economy, and digital innovation. It focuses on e-government, digital democracy, the development of digital skills and rights, open data, national electronic resources, and broadband infrastructure.

Organizational AI Initiatives

- **The Expert Committee on AI Development.** The **Expert Committee on AI Development**, established under the MDT in December 2019, plays an important role in enhancing the country's competitiveness in the field of AI. Composed predominantly of business and science representatives, the committee's main task is to drive AI policy recommendations, facilitate research and development, and nurture talent across various domains.

AI Technology Initiatives

- **Army of Drones.** Launched in July 2022 by the MDT, the Army of Drones initiative represents a significant effort to integrate unmanned aerial vehicles into Ukraine's defense capabilities. Initially conceived as a fundraising campaign, the initiative quickly **evolved** into a systematic and comprehensive program aimed at both procuring drones and training operators for their effective deployment on the battlefield. The program's scope has grown to encompass not only the direct supply of drones to frontline units but also the promotion of domestic UAV production, significantly bolstering Ukraine's defense industrial base. One of the core objectives of the Army of Drones initiative is to equip Ukrainian armed forces with modern, locally produced UAVs that can be used for reconnaissance, surveillance, and tactical strikes.

  Moreover, the initiative places significant emphasis on the training and skill enhancement of drone operators, ensuring that personnel are proficient in utilizing the advanced technologies embedded in contemporary UAV systems. By the end of 2023, **20,000 operators** had successfully completed the training. This comprehensive approach—combining procurement, production, and operator training—has had a transformative impact on the use of drones in frontline operations, making the Army of Drones a pivotal component of Ukraine's broader defense strategy.

- **Brave1.** As an effort to support projects and companies in their early stages, a platform dubbed "**Brave1**" was established in July 2023. It is designed to facilitate collaboration among all major stakeholders in the government's defense sector, the tech industry, and investors and volunteers. Manufacturers who meet the **12 priority verticals** of technological development identified by the general staff of the AFU for the Brave1 cluster and have passed a defense expert review can apply to get military expertise; testing opportunities; and organizational, informational, and financial support for their projects. Brave1 also **funds** early-stage miltech start-ups, giving grants up to UAH 8,000,000 (approximately USD 194,000). As of September 2024, the program has awarded 299 grants totaling USD 6.5 million.

  In October 2024, the MDT **stated** that the list of priority verticals of technological development will be revised, with a larger focus on electronic warfare and AI-enabled capabilities.

  Events organized by Brave1 provide valuable insights into the urgent technological needs and priorities of the AFU, as the topics and competition areas reflect requests gathered by the Brave1 team from various military institutions and agencies. For example, the deputy commander-in-chief of the AFU has **identified** key areas for technological advancement, including alternative navigation systems, jamming-resistant communications, drone swarm technologies, "friend or foe" identification, and improved target identification and engagement capabilities. Events such as the **Precision Hackathon** exemplify the immediate demand for AI-driven solutions in defense technology—including advanced targeting systems, real-time data integration, and innovative smart munitions capable of adjusting their trajectories to engage dynamic targets. The emphasis on autonomous and semi-autonomous systems with precision targeting capabilities and network-centric tools for combat operations reflects a broader shift toward AI-enabled autonomy in military applications. Furthermore, events like the **AI for Ukraine Recovery Hackathon**, which focused on topics such as cybersecurity, damage

assessment, and disinformation prevention, underscore the pivotal role of AI in strengthening Ukraine's defense capabilities and supporting its recovery efforts.

Initiatives in AI Regulation

- **Approach to AI regulation.** The MDT is **responsible** for overseeing Ukraine's digital development, digital economy, and innovation, with AI being an integral component of this policy. Consequently, the ministry also holds responsibility for AI regulation. However, it has explicitly emphasized a commitment to **avoiding overregulation** by adopting a soft, business-friendly approach. The MDT plans to implement a **bottom-up strategy**, initially preparing businesses for future regulations before moving toward formal implementation. In the early stages, the state will provide businesses with tools such as general and sector-specific recommendations, voluntary codes of conduct, a legal assistance platform, and a regulatory sandbox for product testing, all aimed at facilitating compliance with forthcoming legislation.
- The current regulatory framework includes the ***Concept of Development of Artificial Intelligence in Ukraine***, adopted in 2020, followed by the ***AI Regulation Roadmap*** introduced in 2023. While neither document constitutes formal regulation, they provide guiding principles for AI development within the country.
- The MDT also plays a significant role in fostering defense innovation, making its approach to AI regulation in the defense sector particularly clear in its white paper "**Artificial Intelligence Regulation in Ukraine: Vision of the Ministry of Digital Transformation of Ukraine**." The ministry has stated that it does not intend to propose any regulation of AI systems within the defense sector, emphasizing a noninterventionist stance in this domain.
- **Simplifying regulation for local high-tech defense industry.** To boost local production, the MDT has made some considerable steps in terms of regulatory simplification for private drone companies. By implementing regulatory changes, the allowed profit margin for Ukrainian drone manufacturers was **increased** from 1 percent to 25 percent. This change makes the drone production business more financially viable and attractive for local companies. Previously, the low profitability cap of 1 percent limited potential earnings, discouraging investment and innovation. By raising the limit to 25 percent, the government aims to stimulate growth in the domestic high-tech defense industry, encouraging companies to scale up production and invest in advanced technologies.

  Furthermore, regulations governing contract negotiations, goods acceptance for military use, operational clearance, and delivery to the front were **streamlined**. **Measures** were also implemented to accelerate the operational approval process for UAV manufacturers, facilitating faster integration into state procurement contracts and supply chains for frontline operations. The government **eliminated** the requirement for export service control documents, simplifying the import of drones and their components, and removed the need for Security Service approvals, significantly expediting the overall approval process. Additionally, drone manufacturers can opt into the **special "Diia.City" tax regime** for IT companies, which allows up to 50 percent of employees eligible for military service to be exempted from active duty.

INNOVATIONS DEVELOPMENT FUND

The **Innovations Development Fund** (previously called the Ukrainian Startup Fund) is the first and only state institution dedicated to helping innovative projects and tech start-ups secure early-stage funding and launch their ventures. **Established in 2018** by the Ministry of Finance of Ukraine, it has been **managed** by the MDT since 2023.

AI Technology Initiatives

- **Program for defense start-ups.** The "**Fast Track to Victory**" program is an example of Ukraine's capacity to rapidly adapt and use existing infrastructure to foster innovation in defense technologies. This program streamlines the interaction between the MoD and UAV manufacturers, facilitating a more efficient approval process for drone technologies. By leveraging the fund's web portal, UAV developers with finished products can apply directly for official ministry approval. This approval is essential as it authorizes the MoD to procure the products and allows the AFU to deploy them.

  According to government documents describing the program, the application process is designed to be efficient, with all submissions reviewed by MoD representatives in a timely manner. The program specifically targets UAVs that meet the tactical and technical characteristics required by the military, ensuring that the products are immediately relevant to the operational needs of the AFU. Once approved, the products can be integrated into military service, streamlining the deployment of innovative drone technologies on the battlefield.

MINISTRY OF STRATEGIC INDUSTRIES AND UKRAINIAN DEFENSE INDUSTRY

The Ministry of Strategic Industries is responsible for overseeing Ukraine's military-industrial complex, which includes a state-owned enterprise named **Ukrainian Defense Industry** (formerly known as UkrOboronProm). This entity manages over **100 defense-related enterprises**, many of which are remnants of Soviet-era companies. While efforts are underway to modernize some of these enterprises to meet the demands of the current war, the ministry and its associated industries remain predominantly focused on traditional defense platforms—such as artillery production and missile programs—rather than on emerging technologies like software-driven systems and AI, which are increasingly defining modern warfare.

AI Technology Initiatives

- **AI implementation together with the MDT.** In 2021, Ukrainian Defense Industry **signed** a memorandum of intent with the MDT to coordinate efforts in advancing the digital economy and fostering innovation, with a specific focus on AI technology. Formerly, UkrOboronProm had also expressed plans to establish a dedicated unit for AI development. However, Ukrainian Defense Industry sources told CSIS that these initiatives have not yet been realized or advanced, highlighting a gap between stated intentions and actual implementation in the area of digital and AI-driven defense innovation. This suggests that while there is recognition of the importance of emerging technologies, the practical shift toward their integration in Ukraine's defense industry remains limited.
- **Cooperation with Helsing.** In 2024, the Ministry for Strategic Industries **signed** a memorandum with Helsing GmbH, a German company specializing in software development and AI integration in defense technologies. This cooperation aims to enhance Ukrainian defense technologies by integrating AI into drones, particularly Ukrainian-made UAVs. This is probably

the only public mention of ministry- or state-owned enterprises introducing AI technology in their production.

Initiatives in AI Regulation

- **Upcoming strategic AI project for key economic sectors.** Somewhat unexpectedly, given the ministry's responsibilities and the current situation in the country, the Ukrainian government has approved a **concept** for a state program using artificial intelligence in strategic sectors of the economy and has designated the Ministry of Strategic Industries as responsible for the development of a detailed AI program for these priority sectors. The program aims to enhance Ukraine's economic potential and strengthen its global market position by 2026 in such sectors as machinery, chemicals, defense, nuclear industry, agriculture, healthcare, and scientific activities.

MONEY MATTERS

The development of the defense industry and the sustainability of military operations are heavily dependent on the government's purchasing capacity, regardless of the scale and quality of research, development, and production. In FY 2024, the Ukrainian government has allocated **UAH 58.8 billion** (USD 1.4 billion) for the acquisition of UAVs and an additional **UAH 1.5 billion** (USD 36 million) to support the Brave1 platform.

However, Ukrainian defense companies face significant challenges, including export bans imposed since the onset of the full-scale war due to the need to satisfy the demand for weapon systems for the AFU first. As a result, many defense factories remain underutilized due to **insufficient funding** for weapons procurement in the state budget and the consequent low purchasing capacity from the government. Although the defense industry's capacity is **estimated** at around USD 20 billion, the maximum government procurement budget for 2024 is only USD 6 billion. In response, discussions have recently begun regarding the reopening of defense exports. A parliamentary working group is currently evaluating risks and developing a mechanism to enable Ukraine's reentry into the global arms market.

Drone production represents a significant area of expansion. Ukrainian Defense Industry sources told CSIS that the current production output for FPV drones alone exceeds 2 million units in 2024, although only **1 million** have been contracted by the government to date. A **survey** conducted among defense companies revealed that 38 percent of them have more than half of their production capacity idle, while 85 percent are considering relocation abroad. The primary factors that could prevent such relocation include the reopening of exports, an increase in government procurement orders, and the establishment of long-term contracts.

Besides that, the Ministry of Strategic Industries is actively working to address current challenges in the industry, with a key focus on securing external funding for the purchase of Ukrainian defense products, including UAVs. **ZBROYARI: Manufacturing Freedom** is a global fundraising campaign aimed at raising USD 10 billion from partner countries to produce Ukrainian weapons in 2024. Of **EUR 60 million** in Dutch contributions, EUR 20 million is for FPV drones, EUR 22.5 million for Dutch drones, and EUR 17.5 million for Ukrainian-made naval drones.

Conclusion

Military AI in Ukraine underwent a rapid transition from being a secondary concern during almost eight years of war in Donbas to becoming a cornerstone of the country's survival after the full-scale Russian invasion of 2022. This dramatic transition is reflected in the growth of private companies developing military AI capabilities, which have increased from two dozen or so in the beginning of 2022 to over a thousand in 2024. The Ukrainian government embraced the role of innovation enabler by streamlining the bureaucratic processes for technology adoption, adapting its organizational structures to meet rapidly advancing technological capabilities, and providing funding to the commercial defense sector.

As a result of these efforts, most of the industry representatives and brigade commanders interviewed by CSIS confirmed that numerous AI solutions are currently being tested on the frontline. They expect a transition to semi-autonomous unmanned capabilities in a year or two, wherein the human role will only be in confirmation of a strike. However, Ukraine may not have the luxury of time and must fast-track the realization of this vision.

To achieve this, Ukraine must overcome several challenges that are hindering its military AI development: insufficient funding, the limited capacity of small companies and their fragmented efforts in developing AI capabilities, competition within the government for resources, and a lack of coordination among key defense and military institutions to create a unified approach to military AI. Additionally, there is a shortage of computing power and experienced AI professionals in the country to work on classified technology, which are critical for making military AI a game-changer in the fight against Russia.

While Russia is investing enormous resources into transitioning to an economy on a war footing with a focus on technological advancement within its military, Ukraine requires support from its international partners to fully leverage the advantages of AI as a competitive edge across all battlefields and frontlines in its fight against a conventionally superior adversary.

The conclusion of this paper presents recommendations on how the U.S. government can collaborate with Ukraine to harness the advantages of military AI development and ensure that both nations remain at the forefront of AI and defense innovation.

1. **Providing strategic support**

The United States, with its technological superiority and numerous AI-related defense programs, is uniquely positioned to assist Ukraine in addressing its challenge of lacking a cohesive, government-led strategy for defense technology development. Given the United States' forward-looking and long-term AI development plans, it can collaborate with Ukraine to craft a comprehensive, mid-term strategy for integrating AI into its military for beyond immediate tactical solutions.

This support would offer Ukraine much-needed guidance to align its decentralized bottom-up approach with a coherent national vision, allowing volunteer groups, start-ups, the defense sector, and government institutions to operate in synergy with national priorities. This approach could help Ukraine align government stakeholders' efforts in accordance with a single strategy in order to avoid wasting resources, and it could increase competition by promoting efficient resource allocation and funding for AI-enabled capabilities development.

The benefits for the United States are twofold. First, by collaborating with Ukraine, the United States can access real-time insights into the application of AI technologies in active warfare, gaining valuable data that can enhance its own AI capabilities. Second, support for Ukraine's efforts is a contribution to strengthening the global security architecture and countering common adversaries.

2. **Unlocking battlefield data for innovation**

To harness the full potential of AI in defense, Ukraine must build a collaborative framework that brings government authorities and private sector innovators together on data-sharing strategies. This framework should regulate access to and use of real-world combat data by establishing clear legal procedures and protocols for data collection, storage, and sharing—all while safeguarding national security. Such an environment would streamline access for approved developers and foster sustainable business models, incentivizing private investment in military AI research.

The United States could play a pivotal role in enabling this effort, helping Ukraine develop a technical and regulative framework by drawing from its own experience of data exchange within global projects such as the Combined Joint All-Domain Command and Control, where military data is shared among allied countries and the U.S. military. This initiative could set a global precedent for responsible data sharing in defense technology development. Ukraine could monetize its combat data by offering access to countries, organizations such as NATO, and even private defense companies in order to improve their AI tech and the interoperability of all parties involved.

3. **Closing a feedback loop**

Currently, the United States sends significant military aid to Ukraine, including drones, and many U.S. start-ups and drone manufacturers are contributing by donating their products through volunteers, NGOs, and Ukrainian government initiatives. However, there is no established system for collecting feedback on the performance and effectiveness of these drones on the battlefield, leaving the feedback loop incomplete. Establishing a more structured and standardized feedback collection process would be highly beneficial for both parties.

For U.S. companies, faster and more organized feedback would enable them to shorten their iteration cycles, update their platforms and software more rapidly, and scale up production of cutting-edge technology. This is particularly important when it comes to AI, where software updates can be implemented much quicker than hardware—without the need to alter supply chains, source new components, or update manufacturing processes. On the Ukrainian side, this would mean receiving more advanced and better-suited capabilities for their battlefield conditions, as U.S. companies have the resources and capital to accelerate drone and AI development, as well as to scale up production. By closing this feedback loop, both the United States and Ukraine can enhance their technological capabilities and improve the effectiveness of military assistance on the ground.

4. **Considering Ukraine's AI in U.S. foreign aid**

Current U.S. financial assistance to Ukraine, primarily through USAID, has been vital for the digital development of the country. However, by integrating an AI component into this aid, the United States can achieve two key objectives: enhancing Ukraine's AI capabilities and securing a role in what could become a global AI development hub.

Ukraine's regulatory environment for AI is highly permissive, and its political leadership is open to embracing technological risks for significant advancements. This combination creates a unique "laboratory" for AI development that the United States cannot afford to overlook. This approach requires more than just funding; it necessitates providing computing infrastructure to key AI innovation centers in Ukraine, such as the MoD, research institutions, and labs. By equipping these entities with the necessary computational power, AI research and development can accelerate at an unprecedented pace.

5. **Offering AI-focused training, experience exchange, and entrepreneurial development programs**

The U.S. government should establish training and experience exchange programs for Ukraine's defense entrepreneurs. These programs would focus on developing expertise in AI applications, the specifics of defense industry, and international market and investor relations to build successful defense-oriented enterprises. Given the rapid growth of Ukraine's defense tech ecosystem, these initiatives would enable entrepreneurs to gain a deeper understanding of how to attract investments, scale innovations, and align with national security objectives. For the United States, such programs offer the opportunity to strengthen collaboration with Ukraine's emerging defense sector. This partnership would give the United States valuable connections with Ukrainian innovators across the defense industry, benefiting both nations in shaping the future of AI in national security and defense.

The development and integration of military AI into future weapon systems is inevitable. While the United States leads in technological innovation, it faces limitations in testing these advancements under real combat conditions. Collaboration with Ukraine presents a unique and mutually beneficial opportunity to bridge this gap. By working together with Ukraine, the United States can gain firsthand insights into the practical applications of military AI and autonomous systems without putting "boots on the ground." Otherwise, real combat environments remain theoretical or simulated for U.S. systems manufacturers. Moreover, this partnership can provide valuable contributions to the international debate on safe and responsible AI deployment, offering concrete evidence from battlefield usage to help construct a global framework for military AI governance. As AI continues to reshape defense landscapes, U.S.-Ukraine collaboration stands to advance technological innovation while setting standards for responsible and ethical AI integration into military systems worldwide. ■

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This report is made possible by general support to CSIS. No direct sponsorship contributed to this report.