POLICY BRIEFS

BLUE AND YELLOW ANNEX

TO THE WHITE PAPER ON THE FUTURE OF EUROPEAN DEFENCE

The idea of the Commissioner for Defence and Space and the High Representative for Foreign Affairs and Security Policy to prepare a White Paper on the future of EU defence was directly prompted by the war in Ukraine. This document is intended to provide answers both to the question of how to develop Europe's defence potential and to the question of how to ensure military support for Ukraine. The Ukrainian battlefield therefore provides an invaluable basis for laying the foundations of a new European defence policy and cooperation with partners.

The Foreign Policy Council "Ukrainian Prism" has initiated a consortium of Ukrainian think tanks to prepare contributions that reflect the battlefield experience of modern warfare and to make a specific contribution to the discussion on the White Paper preparation process. The group also includes: the Sahaidachnyi Security Centre, the Analytical Centre of the Ministry of Defence of Ukraine, Reforms Support Office, the NGO Aerorozvidka, the NGO Price of Freedom.

The set of short contributions "Blue and Yellow Annex to the White Paper on the Future of European Defence" addresses the issues of modern drone warfare, rethinking the air defence architecture to meet the challenges of mass hybrid drones and missiles, mobilisation and recruitment practices for next-generation warfare, and high-tech military procurement in modern warfare.

The aim of this initiative is to present key ideas on current and future military doctrine, the future force concept and the development of military capabilities from the perspective of Ukrainian experts.

The set of policy briefs is prepared within the framework of 'Strengthening Ukrainian expert voice in the European Union and EU member states and partners' project, supported by a grant from the Foundation Open Society Institute in cooperation with the Open Society Foundations

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Introduction into modern warfare

The Russian-Ukrainian war has emerged as a defining inflection point in the evolution of armed conflict, marking the end of previous-stage warfare and the dawn of a new high-tech paradigm. As of early 2025, this technological seismology reveals a profound shift: civilian innovations, based on open code, standard microelectronics, and artificial intelligence (AI) have been seamlessly transferred into the defense sector, empowering smaller actors to achieve outsized impact through asymmetric capabilities. The mass deployment of unmanned systems has not only redefined operational dynamics but also spurred the rapid development of counter-drone technologies. Simultaneously, electronic warfare (EW) systems have undergone a qualitative leap, while AI and machine learning have faced their first large-scale combat testing, compressing innovation cycles from years to months.

On the battlefield, by 2025 the synergy of drones and artillery ensures near-certain elimination of any target at the tactical level. Battlefield transparency has rendered traditional offensive campaigns and frontal assaults untenable, shifting reliance toward small and ultra-small tactical groups equipped with high-tech systems. Human roles are now augmented by unmanned and semi-autonomous platforms, while air defense systems have been forced to adapt to long-range precision unmanned aerial systems and combined missile-drone assaults. Tactical intelligence has been wholly reimagined through unmanned aerial systems and satellite technology, with frontline logistics undergoing a similar transformation via ground robotics. Early glimpses of autonomy - driven by machine learning algorithms optimizing real-time analysis, navigation, and targeting decisions - herald a future of cross-domain operations dominated by fully automated units, minimizing human presence on the battlefield while enabling remote offensive with unprecedented precision, affordability, and resilience against EW.

Furthermore, the economic and social context of this tech evolution underscores these shifts. Amid looming global recession and local economic strains, traditional defence funding models face a crisis, prompting a pivot toward cost-effective, high-tech solutions over large-scale conventional programs. Demographic challenges - particularly manpower shortages and dwindling mobilization reserves in Europe, East Asia, and North America - fuel demand for autonomous combat ecosystems, high-tech private military companies, and the overall corporatization of warfare.

In an era where the speed of research and development dictates strategic advantage, a new paradigm of defense planning demands a holistic recalibration of operational, doctrinal, and strategic frameworks. Policymakers need to grapple with funding agile, tech-centric defense initiatives amid economic constraints, while fostering cross-sector collaboration — between governments, militaries, and private tech firms - to accelerate R&D, as well as balance technological escalation with ethical and strategic stability, ensuring that democratic institutions keep pace with adversaries who may lack similar constraints. Failure to adapt risks ceding both military and geopolitical initiative in an increasingly unpredictable world.

Drone Warfare: Strategic Implications for EU Defence Strategy

Revisiting the EU Capability Development Priorities in the Coming Age of Autonomous Systems

Problem Statement

The current EU defense capability development framework, while comprehensive in scope, requires fundamental recalibration to address the rapidly evolving nature of modern warfare. The 2023 Priorities are inclusive of employment of unmanned and autonomous systems (US/AS) but fail to prioritize their transformative potential or grasp the fundamentally new logic of warfare they introduce. This brief outlines the strategic pivot towards autonomous systems as the cornerstone of future defence capabilities.

Analysis

The convergence of unmanned systems and data science catalyze a significant transformative change in military technology. Within the next few years, a quantum leap in battlefield architecture is expected due to the emergence of intelligent ecosystems of lethal autonomous weapons systems (LAWS). This shift demands a complete reconceptualization of how the EU develops and prioritizes defence capabilities.

Functional autonomy represents an emerging specific metric on the battlefield, not only transforming operational control on weaponry but fundamentally reshaping human involvement in the decision-making processes throughout the kill web[1]. This evolution is fundamentally altering battlefield architecture from linear, static formations to fluid, hyper-adaptive networks of dispersed, semi-autonomous units integrated through AI.

By 2030, virtually every substantial element of legacy combat architecture will require transformation across three dimensions: integration with autonomous systems (*"**m**asters"*), reliable protection capabilities against such systems (*"**m**avericks"*), or embracing partial / complete autonomy to transform from manned to unmanned architectures (***m**etamorphs*).

This taxonomic revolution demands a corresponding command and control (C2) revolution - the emergence of C6ISR[2] architecture, where *combat systems* integration transcends traditional C4ISTAR[3] frameworks to orchestrate human-machine teaming at a new scale, with autonomous systems moving from the periphery to the gravitational center of warfare.

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1 Unlike the traditional "kill chain", kill web is a non-linear, distributed model operating with a network of interconnected nodes (systems, platforms, sensors, and people) working collaboratively to achieve a mission objective, such as neutralizing a target.

2 C6ISR - Command, Control, Comms, Computers, Cyber, Combat Systems, Intelligence, Surveillance, Reconnaissance.

3 C4ISTAR - Command, Control, Comms, Computers, Intelligence, Surveillance, Target Acquisition and Reconnaissance.

Autonomous kill-web systems represent the cutting edge of this innovation trend, automating the critical path from sensor data to precision strikes. These systems transform raw visual intelligence into actionable targeting coordinates, offering flexible engagement protocols with optional human oversight. The ultimate goal is a nearly closed reconnaissance-strike loop that minimizes human intervention while maximizing operational tempo and combat effectiveness.

Besides purely operational considerations, the economic rationale for this transition is no less compelling. Timely full-scale deployment of US/AS - centric capability development framework offers radical cost advantages through staffing level adjustment, lower per-unit costs, and enhanced operational efficiency. Furthermore, the scalability of autonomous systems allows for rapid force generation and replacement of losses at a fraction of the cost of conventional systems.

Case Studies

Black Sea Fleet Postmortem. Ukrainian unmanned surface vessels (USVs) have fundamentally altered the strategic balance against Russia's conventional naval forces during late 2022 - 2024. These semi-autonomous platforms have dismantled over 30% of the Black Sea Fleet (27 out of 80) and forced the rest to abandon the base in Sevastopol, demonstrating how relatively low-cost unmanned systems can effectively neutralize billion-euro capital ships and their supporting infrastructure.

UAVs vs Heavy Armor. Massive use of unmanned aerial systems (UAS) has obscured the role of armored vehicles. Traditional armor formations now face unprecedented vulnerability to drones and precision-guided munitions. Ukrainian drones are responsible for wiping out 50 to 70 % of all the eliminated combat vehicles of the Russian army. This has necessitated a fundamental reimagining of mechanized warfare, adopting counter-UAS systems and developing new doctrines emphasizing dispersed operations and active protection systems.

RCSs Transformation. Drone-based reconnaissance-strike complexes (RSCs) has brought virtually unlimited precision-strike capacity to the tactical level. These systems further develop to integrate autonomous sensors, AI-powered data processing, and precision strike capabilities into a unified battle network, dramatically reducing the sensor-to-shooter cycle. This capability, scalable to operational depths with advancements in drone range and autonomy, profoundly shifts combat from direct engagements to a “drone destroys, man occupies” paradigm.

New Tech doctrine

Ukraine was first to achieve a historic milestone in bringing bridges between military innovation and capability development framework by establishing the Unmanned Systems Forces (USF) as a distinct service branch, marking the first time that unmanned systems have been systematically integrated across air, land, and maritime domains under unified command. The USF Command has successfully developed comprehensive doctrines and operational procedures for unmanned systems deployment, including command & control (C2), reconnaissance, logistics, communications, and combat applications across three key domains. The integration of unmanned systems into situational awareness networks has significantly enhanced C2 capabilities and decision-making processes.

The organizational framework includes different forms of new reconnaissance and strike unmanned systems units, as well as maintenance units, integrated within brigade structures. Most effective units that demonstrated exceptional operational capabilities such as *Magyar*

Birds or *Achilles* got promotion to expand from battalions to brigades. Within the recent most ambitious project, the *Drone Line*, Ukrainian MoD has allocated over $110m to bringing together five of the most advanced and combat-experienced UAV brigades to integrate cutting-edge drone technologies, reconnaissance, strike capabilities, and electronic warfare to establish an effective "killzone" at a distance of 10-15 kilometers in the Donbas frontline area. Each brigade within the initiative receives specialized training, advanced UAV systems, and logistical support to maximize the effectiveness. In the case of success, the initiative is to be scaled on other operational zones.

The Ukrainian military backed by the civil society has also developed a comprehensive support structure for this new capability through various state initiatives. The Ministry of Digital Transformation's "Drones for Points" program and the UNITED24 platform have successfully established sustainable procurement and development channels. The government has streamlined bureaucratic procedures, enabling rapid scaling of production and technology implementation. Both governmental and civil training centers operate to multiply successful operational experiences.

This systematic approach has created asymmetric advantages against Russian forces which still outnumber Ukraine in key combat capabilities.

Recommendations

Rather than retrofitting unmanned systems into a conventional framework, as the 2023 priorities suggest, the EU should establish US/AS as the core of its force structure to maintain strategic relevance and operational effectiveness.

The development of US/AS capabilities is to be prioritized across several critical domains: AI-native C6ISR architecture that builds upon advanced fleet management and situational awareness systems, unmanned systems units generation and deployment, protected digital communications infrastructure, electronic warfare capabilities, and AI-powered analytical tools. This technological ecosystem will form the foundation for effective semi-autonomous operations while providing resilience against adversary counter-measures.

Economically, the shift promises long-term savings by reducing personnel demands and leveraging scalable, dual-use technologies, aligning defense budgets with strategic efficacy. This requires not only technological investment but also doctrinal innovation, training transformation, and organizational adaptation. The EU capability development framework must evolve to prioritize the rapid acquisition and integration of unmanned and autonomous systems while maintaining interoperability with legacy platforms during the transition period.

This strategic reorientation demands immediate action to avoid capability gaps and ensure EU forces remain competitive in future conflicts.

Important note: the development of semi- and fully autonomous AI-driven lethal systems emerges as a strategic priority for major geopolitical powers over the next five years, as it offers solutions to their operational, demographic and economic constraints in armed conflicts. The race for autonomous systems superiority has started. For Europe, the strategic choice is to either lead this transformation or risk being outpaced by potential adversaries pursuing these capabilities regardless of conventional frameworks and ethical issues.

Quality vs Quantity in EU Drone Acquisition Policy

Leveraging Ukraine's Drone Production Capacity to Strengthen European Defence Industrial Base

Problem Statement

The ongoing war in Ukraine has fundamentally transformed modern warfare, particularly through the widespread deployment of drones in three key operational domains: air, land, and maritime. Such a shift has exposed a critical vulnerability in European defence capabilities, as current drone production volumes fall dramatically short of operational requirements. This policy brief examines the critical gap between Europe's current industrial capacity and its required capabilities. To address EU needs in this area, it advocates for strategic investment in the Ukrainian drone industry having demonstrated the ability to scale production to millions of units annually. Its success stems from a unique ecosystem that has enabled the development of a decentralized production model based on a distributed network of small-scale manufacturers, startups, and volunteer initiatives, allowing for rapid iteration and continuous improvement of designs based on real-world combat experience.

Analysis

During 2023 - 2024 the battlefield has more cogently witnessed the divergence between two distinct yet equally vital drone segments, each serving specific purposes. The *first* one comprises mass-produced tactical and partly operational level drones that became essential disposable assets in day-to-day military operations. These relatively simple platforms have proven invaluable for reconnaissance, combat, and support missions within the 30-kilometer contact zone. The *second* segment consists of more sophisticated, high-technology systems designed for specialized missions, including precision strikes on critical infrastructure, multi-purpose weapons platforms, and advanced ISR and EW capabilities.

Ukraine's experience has demonstrated that success in warfare requires mastery of both segments. However, the current European Defence Industrial Strategy (EDIS) remains largely focused on producing small quantities of expensive systems. While the EU maintains high quality standards[4] in drone manufacturing, its production volumes are inadequate for contemporary warfare needs, especially against the backdrop of potential competitors like China and Russia manufacturing hundreds of thousands to millions of units annually. Without immediate and dramatic changes, Europe risks disadvantages in future conflicts.

The European drone industry[5] currently faces three critical challenges: insufficient production volume, high unit costs, and limited-to-no battlefield experience. Worthy of note, in the drone

4 Primarily those by the European Aviation Safety Agency (EASA) and NATO (incl. STANAG 4671).

5 Key players in the market include Airbus (France/Germany), BAE Systems (UK), Leonardo (Italy), Thales (France), Saab (Sweden), Quantum Systems (Germany) and others, as well as more agile and rapidly adapting to the modern scalability needs players like AI-powered Helsing (Germany).

era the concept of mass production has evolved significantly from its traditional understanding. Modern drone manufacturing requires continuous adaptation and innovation at every stage of production. Unlike the historical pattern of completed R&D followed by years of virtually unchanged production, today's warfare reality demands constant technological evolution to meet emerging battlefield requirements. The critical challenge facing the EU defence preparedness lies in industrial capacity - specifically, the ability to rapidly establish mass production capacities. Modern requirements dictate that such production must be highly decentralized and economically efficient.

The Ukrainian Growth Landscape

Ukraine's drone production capacity is now supported by a robust ecosystem of over 500 companies engaged in combat drone manufacturing throughout Ukraine. It has undergone extraordinary expansion, with domestic manufacturers supplying 96.2% of all UAVs used by Ukrainian Armed Forces (UAF) in 2024, producing over 1.5 million first-person-view (FPV) drones that year alone. Such production surge reflects battlefield requirements where a typical Ukrainian brigade deploys a dedicated drone strike company equipped with FPV systems, while battalions maintain specialized small UAV reconnaissance and munitions-dropping elements, with daily operational needs varying significantly based on combat intensity. Effective brigades report they need 7.000-8500 strike fpv-drones per month to operate in full might. The scale is impressive: UAF increased monthly drone acquisition from 20,000 units in early 2024 to approximately 200,000 by year's end, with projections indicating production capacity will reach 2.5 million military drones in 2025, with the capacity to produce 4 million annually.

The backbone of this production miracle is Ukraine's decentralized manufacturing network that spans from formal enterprises to grassroots initiatives. This ecosystem includes kitchen laboratories where civilians with online training contribute to national production targets, creating a distributed manufacturing model that proved remarkably resilient to Russian targeting. The production infrastructure now encompasses specialized facilities for various drone types: reconnaissance platforms, kamikaze aircraft, copter-bombers, and long-range systems, with plans to manufacture 30,000 long-range drones this year. This output exceeds that of any NATO member, including the United States.

Strategic Implications for EU

The Ukrainian experience offers valuable lessons for developing a robust and adaptable drone manufacturing ecosystem for the European defence forces preparing to defend against adversaries willing to accept high personnel losses. A proven template combines formal industrial production with nimble, distributed networks that can rapidly iterate designs based on combat feedback, while maintaining production rates of approximately 2 million drones annually to sustain modern drone-centric warfare.

European defense planners should consider a brigade-level requirement of thousands of FPV drones monthly, supported by hundreds of reconnaissance platforms to maintain battlefield superiority against numerically superior forces. The Ukrainian model shows that AI integration multiplies drone effectiveness significantly, with systems trained on classified battlefield data providing critical advantages.

However, sustainable implementation requires systematic industrial transformation and significant economic investment. The EU has to consider how to effectively integrate and scale Ukraine's successful approaches while addressing long-term sustainability challenges.

While this strategy is on the way, a more expedient and pragmatic “quick-win” approach lies in strategic investment in Ukraine's existing drone production capacity, which has already demonstrated efficiency and scalability. By channeling European investment into Ukraine's proven cutting-edge manufacturers, with particular emphasis on scaling “success stories”, the EU can rapidly address its defence requirements while simultaneously strengthening Ukraine’s defence capabilities. This approach offers immediate tangible benefits: access to battle-tested designs, established production networks, and operational expertise that would take years to develop independently.

A critical aspect of this strategy is reducing component dependence from China, a challenge equally relevant for Europe. Much of drone components are now manufactured domestically in Ukraine or exported from other Asian states, with remaining dependencies being actively addressed. This capability could be scaled significantly with European partnership support, leading to complete self-sufficiency.

The time for action is immediate, as the evolution of drone warfare continues to accelerate. Developing an integrated European-Ukrainian drone production network that leverages Ukraine's expertise in rapid scaling and battlefield testing while incorporating European quality standards, advanced technologies and working capital provide a framework for addressing current and future potential strategic vulnerabilities.

Success indicators for 2030

Below is a set of illustrative success indicators the EU could adopt to measure progress toward a robust, sustainable, and battle-ready drone manufacturing ecosystem by 2030.

1. Production Capacity and Scale

Indicator: Annual Drone Production Volume

Target: Ability to produce 2+ million military-grade drones per year (tactical and operational levels), with at least 20% annual growth in manufacturing capacity.

2. Cost Efficiency and Affordability

Indicator: Per-Unit Manufacturing Cost

Target: 30–50% reduction in average cost of tactical drones relative to 2025 baseline, cost parity or advantage over major competing producers (like China).

3. R&D Agility

Indicator: Design Iteration Cycle Time

Target: Rapid prototype-to-production cycle of under 6 months for new or upgraded drone designs, adoption of continuous feedback loops from active military exercises or battlefield data.

4. AI and Advanced Systems Integration

Indicator: AI-Enabled Drone Fleet Ratio

Target: 50%+ of newly produced EU drones feature integrated AI capabilities for target recognition, electronic warfare, and advanced ISR.

5. Supply Chain Resilience and Localization

Indicator: Share of European (or Allied) Manufactured Components.

Target: < 20% reliance on non-allied supply chains for key components (motors, chips, sensors), with close to full self-sufficiency in critical systems (guidance units, cryptography modules).

6. Industrial Decentralization and Workforce

Indicator: Distributed Manufacturing Network Coverage.

Target: EU Member States (and key partners like Ukraine) host nodes in a decentralized production system.

7. Partnership and Joint Ventures with Ukraine

Indicator: EU–Ukraine Joint Production Output.

Target: at least 30% of total EU drone acquisition sourced from, or co-produced with, Ukrainian manufacturers.

8. Battlefield Readiness and Operational Deployment

Indicator: Standing Drone Fleet Readiness Level

Target: 80%+ readiness rate of all EU drone assets (availability for immediate deployment). Each EU brigade-level unit maintains sufficient stock of tactical and strike drones to conduct sustained operations for 90+ days.

9. Innovation Ecosystem and SME Participation

Indicator: SME (Small and Medium Enterprise) & Startup Participation in Drone Supply Chain

Target: 50% of drone-related R&D and production contracts awarded to small and medium-sized enterprises (SMEs) or startups. Each Member State incentivizes local “kitchen-lab” innovation through grants and streamlined certification processes.

10. Export Competitiveness and Market Share

Indicator: Global Share of Drone Exports

Target: Double the EU’s share of the global military drone export market compared to 2025 levels. Exports include both high-end systems and cost-effective tactical drones appealing to a wide range of international partners.

Ukrainian Pillar for a Modern Air Defence Architecture

Policy Requirements to Address Mass Drone and Hybrid Drone-Missile Challenges

Problem Statement

The legacy air defence paradigm was designed to counter primarily aircraft and cruise and ballistic missiles - high-speed targets that require powerful active sensors for detection and stationary anti-aircraft missile systems for interception. However, modern warfare distinguished by massive drone employment and integrated drone-missile offensives, have rendered the classical air defence paradigm economically unsustainable and operationally invalid in the long run. This change in the nature of aerial threats has created a significant gap in the European air defence shield conceived in an era when aerial threats were limited in number and comparable in cost to defensive measures, necessitating a paradigm shift from object-based to territorial air defence paradigm.

The Creepie Cost of Air Raid

The current air defence challenge stems from a fundamental mismatch between defensive capabilities and emerging threat profiles. Recent evidence from the Russo-Ukrainian war demonstrates that adversaries can now achieve strategic objectives through saturating attacks that combine low-cost drones (including drone decoys) with conventional missiles, overwhelming or exhausting air defence systems both operationally and economically.

> *Since the full-scale invasion began in February 2022, Russia has launched over **19,000** missiles against Ukraine, including more than **14,700** one-way attack drones.*
>
> *The scale of drone attacks has escalated significantly, with recent data indicating an average of **700** strike UAVs deployed monthly in 2024, **3,907** drones in February 2025 alone, and **870** attack drones in just the first week of March 2025.*
>
> *In terms of nightly attacks, a typical large-scale assault involves between **70-130** drones.*

The economic asymmetry is stark when examining actual cost figures: a Patriot interceptor missile (PAC-3) costs **$3.8 million** and a NASAMS interceptor (AIM-9X variant) costs slightly over **$1 million**, yet these sophisticated systems are being used to counter Shahed drones estimated to cost between **$20,000-$50,000** each. This creates an unsustainable cost ratio of *28:1* to *85:1* in Russia's favor. Projecting these figures quarterly, Russia's drone campaign (based on the average of 700 drones per month from 2024 statistics) costs approximately **$24.5 million** monthly, while interception costs in case it used Western air defence missiles only could exceed **$700 million** monthly. Over a full year, this represents a potential financial burden of approximately **$8.4 billion** for air defence operations of a country engaged in war with Russia against drones alone, while Russia's annual expenditure on Shahed drones at

current deployment rates amounts to roughly **$294 million** - a devastating economic asymmetry that threatens to exhaust defensive resources of any European country at risk.

Moreover, the economic impact of mass drone and hybrid campaigns extends far beyond direct military costs, creating much more substantial financial damage to civilian infrastructure. The direct physical damage is estimated at about **$170 billion** as of late 2024. This includes tens of thousands of destroyed buildings, roads, and facilities across the country. Critical lifelines have been ravaged: transport infrastructure losses are about **$38.5 billion** (including 26,000 km of roads and hundreds of bridges and rail facilities), and the energy sector has taken at least **$14.6 billion** in losses, with major power plants and high-voltage substations destroyed by missile strikes. Industries, agriculture, health care, and education have also faced heavy damage, bringing the total financial burden of destruction to unprecedented levels. Notably, just in 2024 an additional **$12.6 billion** in new damage was recorded due to ongoing missile/drone attacks and fighting underscoring how each new wave of air raids adds billions to Ukraine's bill for reconstruction. These economic impacts demonstrate that the true cost ratio of attack-to-defence becomes even more unfavorable when accounting for infrastructure damage: for every **$1** million Russia spends on drone and missile attacks, Ukraine and its partners must spend approximately **$114** million on air defence and reconstruction combined.

The scale of destruction in Ukraine underscores how catastrophic a similar war on EU soil would be. Ukraine's **$170 billion** infrastructure damage is nearly equal to its pre-war annual GDP, and its wrecked assets will cost nearly half a trillion dollars to restore. If a comparable percentage of infrastructure were obliterated in a large EU country (which generally has higher-value infrastructure), the financial toll would be staggering. For example, Poland's economy is roughly three times larger than Ukraine's; war damage on the Ukrainian scale could easily exceed **$500 billion** for Poland alone, given the higher cost of European infrastructure. No country's budget could withstand such costs without massive outside help. This underscores why Ukraine's allies consider its fight not just a regional issue but one with broader European security and economic implications – preventing such devastation from spreading is crucial, as the financial (and human) cost would be unthinkable for the EU.

Ukraine's Air Defence Challenges and Adaptation

The response to this challenge transcends a simple migration from costly legacy air defence systems to more cost-effective alternatives. Ukraine has adopted a multi-layered approach that significantly reduces costs while maintaining effectiveness. Mobile fire groups equipped with machine guns with laser designation, electronic warfare and portable air defence systems have proven effective against low-flying drones at a fraction of the cost of missile interceptions, while stationary systems, physical protection and aircraft worked against ballistic and cruise missiles.

Stationary Defences vs. Combined Attacks. At the war's outset, much of Ukraine's air defence network consisted of stationary, Soviet-era systems (like S-300 and Buk) designed decades ago. These fixed defences proved insufficient against Russia's modern, combined air assaults, which come in complex waves mixing cruise missiles, ballistic missiles, and kamikaze drones. Since late 2022 Russia deliberately conducted combined strikes to overwhelm air defence, sending dozens of missiles from different directions and altitudes simultaneously, accompanied by Iranian-made Shahed drones. This tactic exploited any gaps in coverage. Ukraine's legacy systems struggled to cope: low-flying cruise missiles and drones slipped past jet-adopted radars, while high-speed ballistic missiles like Iskander or Kinzhal were extremely hard to intercept without advanced systems.

Since the beginning of war, few cities like Kyiv were well shielded, but most suffered being bombarded as their stationary air defence batteries were outnumbered or outmaneuvered. Tying air defence units to specific regions or branches (e.g. army vs. air force) also hindered coordination. This exposed the vulnerability of relying on a few stationary systems – any downtime or blind spot could be fatal. It also suggested possible enemy reconnaissance spotting weak points.

In summary, Ukraine's old static air defence infrastructure was not designed to handle the sheer volume and diversity of threats now thrown at it. Patriot or SAMP/T batteries were scarce as Ukraine only started receiving these Western systems in 2023, and trying to use a limited number of high-end systems to cover everywhere was impossible. Analysts calculated that facing drone swarms of 100+ in a night, it was impossible to rely solely on expensive systems like Patriot, which were too few in number and too costly per shot to tackle every cheap UAV. This forced Ukraine to rethink its air defence approach.

Object-Based, Multi-Layered Defence. Over 2022–2023, Ukraine adapted by shifting to an air defence strategy with multi-layer protection. Instead of simply trying to cover broad regions, Ukraine began assigning units to shield specific critical sites – especially infrastructure like power plants, substations, and dams that Russia was targeting. Military experts note this so-called "object-centric air defence" as one of the most effective ways to guard the power grid. In practice, this means stacking multiple layers of defence around key facilities: long-range stationary systems to engage high-flying or fast threats at a distance, medium- and short-range weapons to catch anything that leaks through, and man-portable air-defense system (MANPADS) for drones at low altitude. By late 2022, Ukraine had to prioritize – not every asset could be covered, but major power nodes were given dedicated protection.

In the fall of 2022, as Russia's barrage on the energy grid intensified, Ukraine's government launched a crash program to harden and protect energy infrastructure with three layers of defence. This three-tier system included: passive defences – physical fortifications to blunt blast and shrapnel effects (like concrete walls, gabion barriers filled with sand/stone, and burying critical equipment); anti-drone/low-altitude defence – structures and systems to stop drones and glide bombs; anti-missile defence – measures against cruise and ballistic missiles. The passive defence level was the hardest: Ukraine, with partner help, developed engineering solutions to shield critical gear from direct missile hits. By the end of 2024, 22 critical substations in 14 regions were equipped with experimental missile-resistant constructions.

In 2023 – 2024, Ukraine also embraced innovative electronic warfare solutions, such as the domestically produced Kvertus EW backpack systems that costs approximately $7,000 per unit and can effectively jam Russian drones within its operational range, and fighter aircraft into the air defence system. EW units jammed drone guidance, while MiG-29 (subsequently - also F-16) pilots have shot down some cruise missiles with air-to-air missiles when possible. All these layers – engineering fortification, EW jamming, ground-based interceptors, and occasional fighter intercept – formed a multilayered shield.

The layered defence strategy - combining early warning radar networks, electronic warfare for first-line defence, mobile fire groups for low-altitude threats, and reserving expensive missile systems only for high-value targets that breach initial defences - has proven both operationally effective and economically sustainable against Russia's saturation strategy. By diversifying defensive capabilities and integrating them into a unified system, Ukraine has demonstrated that the asymmetric challenge posed by mass drone and hybrid attacks can be countered without exhausting limited defence resources.

Ukraine's experience has conclusively demonstrated that even a multilayered object-based system cannot adequately protect the country's 603,500 km² territory against Russia's

combined attack strategy. The Ukrainian military estimates that Russia can simultaneously attack from up to 16 different vectors, using multiple aircraft types and launching platforms, which overwhelms fixed-position defences. This has forced Ukraine to make difficult strategic choices about which critical infrastructure to protect, leaving approximately 70% of high-value civilian targets with minimal or no dedicated air defence coverage as of early 2024. Currently, interception rates for attacks against protected objects reach 87-93%, compared to 40-60% for unprotected sites.

Territorial Multi-Layered Defence. This new paradigm, which is on the proof-of-concept stage in The Grouping of Forces and Means of Kyiv Defence, goes further to address the problem of vast vulnerable, completely unprotected areas abandoned to their fate by object-based air defense systems.

The newly developed system is a distributed, small-scale, and cost-efficient air defense solution designed to detect and neutralize drones, cruise missiles, and other airborne threats effectively across all regions on a continuous 24/7 basis, with minimal latency in data transmission. The system leverages a network of numerous low-cost firing assets strategically dispersed throughout a country's territory. To ensure operational efficacy, seamless and rapid data exchange must be maintained between radar sensors, command centers, and mobile fire units.

Effective resource allocation across distinct altitude tiers is critical:

- Up to 500 meters (primarily for occasional drone threats);
- 500–1,500 meters (medium altitudes, addressing drones and missiles);
- Above 1,500 meters (manned aircraft and cruise missiles);
- Above 5,000 meters (strategic aviation).

The system employs either kinetic or non-kinetic countermeasures, selected based on altitude, threat type, and situational variables. Primary interception methods rely on kinetic solutions, including machine guns, cannons, and short-range MANPADS, with a strong emphasis on maximizing fire control automation. MANPADS play a pivotal role in countering cruise missiles at low to medium altitudes, necessitating a substantial increase in their deployment - an estimated shortfall for Ukraine is 300–400 additional launchers.

Cost-effective laser-guided missiles, such as the Advanced Precision Kill Weapon System (APKWS) "*Hydra*" or comparable systems (ideally priced at approximately **$10,000** per unit), provide significant advantages. These include the use of modern, widely available sensors, reduced costs compared to conventional air defense systems, and the ability to intercept cruise missiles with precise guidance. Additionally, interceptor drones (e.g., FPV drones paired with radar systems) offer an effective countermeasure against reconnaissance drones and, perspectively, kamikaze UAVs. However, their success depends on a high degree of automation - minimizing human intervention and ensuring high-quality radar data - as well as the standardization of data exchange protocols across diverse radar platforms.

However, until these innovative adaptations are on the go, Ukraine cannot do without **European-led Integrated Air Protection Zone (IAPZ)**[6], as it remains significantly outmatched in terms of overall air defence capacity when facing the scale and persistence of Russian aerial attacks. Statistical analysis from Ukraine's Air Force suggests that integrating just 8-12 combat aircraft in coordinated CAP rotations could potentially intercept 65-75% of cruise missiles currently penetrating western and central Ukrainian regions, thereby protecting critical infrastructure. Military experts recommend deploying approximately 40 to 120

6 employing combat air patrols (CAPs) over uncontested areas of Ukraine within Sky Shield Initiative

European fighter jets to protect Ukraine's airspace effectively. Without that, Ukraine will continue to face a 10–25% leak-through of threats, with all the attendant human and economic costs those strikes carry.

Acquisition and Deployment Recommendations

The new framework for comprehensive territorial air defence support needs to address a differentiated range of aerial target types - - from decoy and strike drones to hypersonic missiles - and ensure tailored responses for each case by blending detection and strike capabilities within a more intelligent and adaptive multi-tiered air defence architecture.

The key aspects of this approach should incorporate:

- **Implementation of Distributed defence Architecture.** EU member states should transition from centralized, object-based air defence to a distributed, territorial system. This requires the deployment of numerous small, mobile air defence units equipped with cost-effective kinetic interceptors and integrated sensor networks, capable of providing flexible and rapid response to diverse aerial threats within the area of responsibility;
- **Adjusted C2 Framework.** Implementation of AI - driven command and control system can minimize human intervention while maximizing response efficiency. This includes automated target recognition, threat classification, and engagement prioritization systems. It is critical to implement a standardized digital command protocol that enables data sharing and response coordination across all air defence assets;
- **Technological Integration.** Modern air defence requires the seamless integration of multiple systems, including radar networks, stationary anti-aircraft complexes, mobile fire groups, and EW capabilities. The critical component is establishing rapid and accurate data flow between detection systems, command centers, and response units. Conventional high-cost radar systems, originally designed for high-altitude target acquisition, are to be supplemented with low-cost passive radar systems effective against small aerial objects operating in the sub-1000-meter envelope;
- **Cost-Effective Innovation.** Development of affordable interceptor drones and missiles, equipped with modern digital seekers and laser guidance systems, is critical to provide a more sustainable economic model for countering mass drone and combined attacks. These systems must be complemented by distributed networks of inexpensive radars optimized for low-altitude detection. Establishing a program for developing and manufacturing specialized counter-drone systems should consider specific capabilities against both reconnaissance and strike drones, as they need specific critical components such as specialized microprocessors, power systems, and navigation technologies;
- **EW component**. Contemporary cognitive electronic warfare systems must be integrated as a complementary layer of defence, particularly for soft-kill capabilities against electronic systems of air targets. The development of directed-energy weapons, including laser and microwave systems, offers promising capabilities for future integration.

Case Study: Sky Fortress

“Sky Fortress” is Ukrainian acoustic detection network that has gained significant recognition for its effectiveness in detecting aerial threats. According to Riki Ellison, founder of the Missile defence Advocacy Alliance (MDAA), the system has evolved to become highly sophisticated and effective, successfully detecting most Russian attack drones targeting Ukraine. The system's capabilities were recently demonstrated at a military training ground in Europe, where representatives from 11 NATO countries witnessed its performance in detecting and tracking simulated missiles and drones. While detailed technical specifications of Sky Fortress are not publicly available, its proven effectiveness has contributed to growing interest from NATO countries in acoustic detection technology for air defence systems.

Recruitment Strategies in the Age of High-Tech Warfare

Lessons from Ukraine for the European Union

Problem Statement

The advent of unmanned and autonomous systems in modern warfare fundamentally alters the dynamics of military engagement, both exacerbating the lethality of the battlefield and presenting a prospective opportunity to reduce human exposure to the first-line combat zones. This situation demands a comprehensive assessment of its implications for the military personnel policies, particularly in the European context, where demographic challenges further complicate traditional mobilization approaches. Drawing on its experience, Ukraine offers critical insights for the European Union, tasked with balancing demographic constraints, technological imperatives, and the specter of conventional confrontation with a peer adversary like Russia.

Ukraine's Path: From Mass Mobilization to Tech Adaptation

Ukraine's recruitment approach evolved significantly over three years of the Russian-Ukrainian war. Its successes - rapid mobilization, TDF resilience, and efficient drone integration - stemmed from inherent adaptability and societal buy-in.

The initial phase in 2022 was characterized by largely voluntary mobilization with centralized recruitment. Having erupted in February 2022, the war initially underscored the enduring relevance of large conventional armies, evoking memories of 20th-century total war. Ukraine's response was swift: a general mobilization tapped an operational reserve of experienced veterans - former servicemen from the 2014 Donbas anti-terrorist operation - and swelled the ranks with over 110,000 volunteers joining Territorial Defense Forces (TDF) within the first month. The TDF system demonstrated several key strengths: rapid mobilization capability, integration of civilian expertise into military structures, and local knowledge enhancing defensive operations. However, significant challenges emerged, including inconsistent training standards initially, equipment shortages and distribution challenges, and sustainment issues in protracted conflict.

By the end of 2022, the Ukrainian Defense Forces (UDF) ballooned to approximately 1 million personnel, doubling pre-war levels. This human wave, fueled by patriotism, secured early victories, notably in defending Kyiv, Kharkiv and Sumy regions.

Yet, the grueling course of war soon exposed the limits of this first-wave enlistment and it shifted to **a middle phase in 2023** that saw increasing challenges with voluntary recruitment as the conflict prolonged. By this time, voluntary pool waned - only one in four recruits was a volunteer - and forced conscription became the norm. Financially, sustaining this force also became staggering. Basic training for a rifleman costs $5,300 over six weeks, rising to $8,000 for specialized roles like machine gunners. Annual maintenance per soldier - salaries, food, and gear—reaches $32,000, excluding weapons. Frontline salaries exceeding $3,000 monthly - six times the national average - retained career soldiers but burdened the budget, with defense consuming over 60% of state expenditures in 2023. Equipping an infantryman,

including body armor ($1,212), helmets ($485), and tactical gear, adds another $2,500–$3,000, often supplemented by volunteers.

Exactly at that period mass troop deployments also revealed its unsustainability against the progressively scaling threat of drones and precision munitions, resulting in casualty rates that strained medical, logistical, and economic systems. The first large-scale deployment of funds on drones in 2023 ($1 billion) signaled a pivot: technology could amplify effectiveness while reducing human risk.

This was a critical lesson: traditional mass armies remain vital for territorial control, but their survival hinges on integration with unmanned systems. Another lesson has been the importance of establishing effective rotation systems to prevent combat fatigue and maintain morale. The prolonged nature of war has demonstrated that even the most motivated forces require predictable rotation schedules and rest.

The current phase (2024-2025) has witnessed a shift toward decentralized recruitment models and targeted incentives. The “Reserve+” app, launched in May 2024, digitized records for 3.5 million citizens, tripling mobilization rates. Recruiting centers, allowing specialty and unit selection, attracted 22,000 applicants in six months, with 25% selected. A notable innovation has been the decentralization model, empowering high-performing units to handle their own recruitment, which has proven more effective than centralized approaches for certain roles. Most recently, Ukraine has implemented specific reforms to target younger demographics (18-25 year-olds) who were initially exempt from mobilization. This represents a critical shift in recruitment philosophy, recognizing the need for digital-native personnel for technology-intensive warfare, physical fitness requirements of modern combat, and personnel capable of adapting to rapidly evolving technologies.

The Technological Dimension

The fundamental lesson *learned thus far is:* mass mobilized armies do not become obsolete but rather face a new existential crisis. On a high-technology battlefield, the massive deployment of troops along front lines leads to catastrophic consequences. These forces become little more than targets in a technological slaughter. The denser their deployment, the greater the toll resulting in unsustainable casualties, with each drone or projectile potentially causing multiple casualties. This in turn creates an untenable burden on state resources for evacuation, medical care, funeral services, family compensation, and long-term demographic and economic damage mitigation.

Technological solutions like unmanned systems and robotic platforms proved to mitigate this problem by reducing frontline exposure, with a single $400 FPV drone capable of neutralizing enemy armor, sparing dozens of infantry from direct engagement. The transition, while resource-intensive, marked a strategic recalibration: technology became a force multiplier, preserving lives amid a shrinking manpower pool.

The escalation of drone usage on the tactical level - both reconnaissance to kamikaze strikes - exemplified Ukraine’s move to supplant human-centric warfare with high-tech alternatives, a trend solidified by 2024-2025. At the same time, it has primarily augmented rather than replaced human combatants in UDF, and showed that massive use of drones initially requires a larger workforce, not a smaller one, to manage and sustain advanced capabilities effectively. The most efficient brigades increased manyfold their query for operators capable of maintenance, repair, technical troubleshooting, data analysis, quality assurance, and decision-making support. However, as such personnel operate away from the direct line of contact, this dramatically reduced casualties bringing them to dozens annually for the top-performing units, while improving mission success rates.

Efficiency of unmanned systems units on the battlefield in the traditionally human roles has yielded important insights into the relative costs and benefits of human personnel versus technological solutions. Small unmanned systems ($400-3,000) provide disproportionate combat value. Ukrainian assault groups now typically deploy with nearly a 1:1 ratio of soldiers to drone operators, while the cost ratio of using drones to target military assets reaches up to 1:1000. Therefore technology has shifted the cost equation but not eliminated the need for human personnel in the battlespace.

For today, Ukraine's defense industry goes further and actively develops AI-driven software that can be integrated across various platforms to expand battlefield capabilities. This suggests a future where human decision-making is augmented by AI systems, repetitive and high-risk tasks are increasingly automated, and human resources are concentrated in roles of analysis, technical support and decision making. This demands a fundamentally different quality of mobilized personnel, emphasizing analytical and engineering skills. As systems become more autonomous and intelligent, the priority shifts to high-level operators, where mental capacity and intelligence quotient become more crucial than basic military competencies developed within the “drill-to-skill” paradigm.

Policy Recommendations

While recruitment remains a national issue, several areas benefit from EU-level coordination. Joint exercises to establish and validate requirements for readiness and interoperability, command and control standardization, and shared training resources and standards all represent areas where EU-level coordination can enhance national recruitment and training efforts.

Ukraine’s insights suggest a new paradigm for military staffing: human-centric capabilities on the frontline must gradually give way to unmanned and autonomous systems, supported by a cadre of highly trained professionals operating safely behind the lines. This model does not entirely eliminate the need for combat-ready troops; a small, elite pool of motivated soldiers, supported by robust incentives, will remain essential for specific high-risk missions. However, the bulk of personnel policy - from mobilization readiness to training and deployment - must pivot toward cultivating a huge diversified reserve of skilled operators, technicians, and analysts capable of managing complex technological ecosystems. Demographic and sociocultural trends reinforce this urgency. Europe’s dwindling youth population, coupled with a growing reluctance to engage in high-risk military service, limits the feasibility of traditional conscription.

To sustain such developments, the EU policymakers should prioritize the standardization and expansion of joint training exercises that incorporate emerging technologies such as drone units, AI-driven surveillance, and electronic warfare capabilities, drawing directly from Ukraine's battlefield innovations. These multinational exercises are to simulate high-intensity conflicts to enhance readiness and interoperability among member states.

The Ukrainian war has also underscored the vital importance of ready reserve forces for immediate, large-scale mobilization when conflicts escalate rapidly. The EU should therefore encourage member states to develop robust reserve structures integrated with regular military units, following successful models implemented in Baltic and Nordic countries. These reserves must operate under standardized minimum training requirements to ensure seamless integration into multinational formations when necessary. To support this initiative, the EU should offer incentives such as partial funding or logistical support for countries enhancing their reserve capabilities and citizen training programs.

Battlefield-Driven Acquisition for 2025 and beyond

A Strategic Framework for High-Tech Military Procurement in Contemporary Warfare

Problem Statement

In the modern era of warfare, the most valuable procurement asset lies in the ability of government institutions, in collaboration with business and civil society, to establish organizational and regulatory frameworks fostering continuous innovation and scalability. Bureaucratic inefficiencies pose significant threats to this process stifling the development of startups and innovative projects critical to the defense sector, particularly with the rise of dynamic, fast-evolving technological landscapes. Ukraine's experience at the first phase of war confirms that lengthy, hierarchical approval processes fail to deliver timely solutions to combat units, leaving critical needs unmet despite substantial budget allocations. However, in the last three years, Ukraine has undertaken significant defense procurement reforms, transitioning from an opaque, intermediary-driven model to a more centralized, transparent, and professionally managed framework. Its experience is relevant in the broader European context, where defense procurement must adapt to rapidly evolving technological warfare while maintaining accountability and efficiency.

Lesson Learned from Ukraine

At the outset of the full-scale invasion, Ukraine's legacy defense procurement framework - structured around centralized approval protocols and specialized export intermediaries - was optimized for weapon exports by few major state-owned and corporate defense companies, rather than massive wartime import or development of an agile domestic DefTech ecosystem. However, as warfare grew increasingly technology-driven, this framework revealed significant limitations, proving especially ill-suited to the imperatives of the emerging “drone war”. Unmanned systems, electronic warfare (EW), and advanced communication technologies evolved at an exponential pace, and Ukrainian commanders reported that by the time contracts were executed, technological shifts often rendered delivered equipment outdated and misaligned with current needs. This created a fundamental disconnect between the formal procurement criteria and the dynamic needs of end-users - namely, frontline personnel. As a result, alternative acquisitions or post-delivery modifications drove up costs and delayed deployment.

The situation was further aggravated by inadequate service support from manufacturers. Combat units frequently lacked access to technical consultations for problem-solving and had to establish separate teams for equipment modification, repair, and modernization. Frontline drone operators still reinvest 5-30% of their near $3,000 monthly allowance into their equipment capability upgrade.

Effective procurement in this context required a dual approach: addressing immediate operational needs while simultaneously ensuring long-term technological superiority through

strategic planning and development. To achieve this, Ukraine's defense procurement modernization comprised *two distinct vectors.*

1. NATO-aligned institutional reforms implemented to ensure operational efficiency and sustainability in wartime conditions.

1.1. Adoption of corporate governance practices. As special exporters inflated prices and extracted commissions (approximately 3% of contract values), sometimes disrupted supply chains, accrued debts, and operated with minimal transparency or oversight, Ukrainian government partially dismantled this system in favor of a more centralized and transparent one. It established two specialized agencies, *Defence Procurement Agency / DPA* for lethal procurements and *Rear State Operator / DOT* for non-lethal acquisitions. Detached from the MoD entrenched bureaucracy, they recruited civilian professionals with reform experience, enabling the professionalization of procurement. Modern IT solutions, price analytics, transparent tender procedures, and quality control mechanisms were implemented.

A cornerstone of this reform was the creation of ***independent supervisory boards*****,** comprising respected Ukrainian and international experts. These boards enhanced transparency and accountability by overseeing agency decisions, ensuring managerial integrity, and aligning operations with global best practices. The inclusion of foreign experts bolstered partners' confidence who sought assurances that financial aid and resources would not be misappropriated.

1.2. Balancing Transparency and Security in Tenders. A critical challenge has been striking a balance between transparency and the secrecy required in wartime. Initially characterized by near-total confidentiality, Ukraine's procurement system faced public and international backlash following high-profile corruption scandals, such as those involving overpriced eggs and jackets. This prompted a gradual shift toward partial disclosure. While sensitive details—such as weapon specifications, delivery schedules, and storage locations—remain classified, broader transparency measures have been adopted. For example, tenders may now occur behind closed doors, with details of expenditures, suppliers, and pricing published months later, safeguarding critical parameters while fostering accountability. This evolving approach underscores a key lesson: absolute secrecy often masks abuses and erodes trust, whereas strategic transparency can maintain public and donor confidence without compromising security.

1.3. **Balancing Standards and Urgency.** While DPA's rigorous multi-tiered quality inspections and contractual penalties reduced the risk of substandard procurements, this was done at the cost of slower procedures. However, wartime acquisitions often necessitate immediate action that cannot wait for standard compliance procedures during time-critical operations. This is why MoD still relies on legacy special exporters as an emergency resource, highlighting the challenges of rapid systemic overhaul amid ongoing conflict. The occasional delegation of near $600m urgent shell procurement to the State Border Guard Service in November 2024 also reflected this tension between speed and oversight.

2. Authentic Ukrainian initiatives emerging from bottom-up innovation and direct operational requirements.

1. Alternative or supplementary acquisitions via charity funds or crowdfunded ad hoc solutions, as a forced measure by combat units to fill critical capability gaps that directly impact operational effectiveness, created by government inefficiency and sharpened by the rapid pace of technological evolution. For instance, Ukraine's largest defense charity foundation has expended over $350 million since 2022, while targeted crowdfunding efforts via Monobank's digital platform have mobilized over 10 million Ukrainian citizens, generating UAH 2 billion (approximately $50 million) in direct contributions to brigade-level units. A government-operated fundraising platform UNITED24 proved to be effective as a key instrument for financing and scaling the production of next-generation unmanned systems.

2. Establishment of horizontal connections between MilTech startups and battlefield units, fostering direct manufacturer-user interaction. This enabled manufacturers to receive real-time, accurate information about their products' combat performance and quickly address identified vulnerabilities. In turn, manufacturers provide technical assistance, operator consultations, and equipment upgrades aligned with battlefield shifts. Notable examples of this best practice include Ukrainian firms such as Roboneers and UkrSpecSystem, alongside international partners like Shield AI. The Brave1 platform exemplifies a systemic solution, uniting scientists, engineers, manufacturers, and military personnel to accelerate the development, prototyping, and field testing of innovative technologies based on direct input from combat units.

Important note: One of the key lessons learned from extensive three-year observations of contemporary warfare is that innovation velocity and data acquisition capabilities have emerged as the predominant variables in the MilTech industry, as the inherent momentum of technological sophistication has accelerated innovation cycles beyond levels that can be predicted and controlled "manually". Effective military technology innovation can no longer be conducted remotely; it necessitates immediate battlefield access, continuous operational feedback mechanisms, and real-time combat data collection.

3. Scaling Brave1 as an Innovation Cluster. Further expansion of the Brave1 initiative as an integrated hub for defense technology development offers comprehensive support for complex solutions. The complexity of modern systems, particularly unmanned and autonomous platforms, requires sophisticated, forward-thinking development strategies and solutions that transcend the limitations of a simplistic 'quick fix' approach. These are not standalone assets but components of broader battlefield ecosystems, reliant on C2 and ISTAR digital tools, communication infrastructure, EW assets and ground control system for optimal performance. Procurement models approaching individual systems based on static technical specifications and neglecting their integration into operational frameworks, falter. Beyond Brave1, this role is increasingly fulfilled by R&D centers established within Ukraine's most effective brigades and battalions. These units reconfigure delivered drones, communication systems, EW assets, and other equipment—adjusting frequencies or integrating them into tracking systems—representing a distinctly Ukrainian innovation to align materiel capabilities with drone warfare demands. The government is currently developing a legal framework to formalize these centers, enabling systematic component procurement and securing intellectual property rights for their innovations.

4. DeCenter. An elegant solution currently being tested by Ukraine is enhancing the decentralized procurement model by substantially increasing allocated state funds, empowering individual brigades to directly acquire military equipment tailored to their specific operational needs (no mediating procurement agency needed!), particularly unmanned systems and EW capabilities. This approach has proven remarkably effective in reducing procurement cycles from months to days, especially as both military units and

companies get properly educated on utilizing a system they previously lacked information about. Funding is allocated based on a unit's demonstrated capacity to utilize resources efficiently: unspent funds are reclaimed at month's end, while units that expend resources swiftly receive additional allocations. For instance, a Territorial Defense brigade utilized UAH 1b ($25m) in a single year, far exceeding the annual average $1–1.5m per brigade.

5. Digital Procurement Platform. To further enhance efficiency and scalability, Ukraine's MoD and Ministry of Digital Transformation are developing a unified digital platform—akin to a 'military Amazon'—to automate procurement processes. This marketplace will connect producers, developers, suppliers, and military buyers within a secure, tokenized environment, streamlining interactions and enabling units to select optimal solutions. Real-time data integration will support logistics and resource management, while embedded recommendation algorithms will match vendors with buyers based on analytical insights, expediting acquisitions and fostering competition among suppliers.

Recommendations

Ukraine's experience offers valuable insights beyond its borders, particularly for the EU, where joint defense procurement is under consideration. Operating as a testing ground under the scrutiny of its international partners, Ukraine has demonstrated the efficacy of specialized agencies paired with multinational supervisory boards. This model could inform the creation of a European Defense Procurement Agency, potentially built upon frameworks like the Permanent Structured Cooperation (PESCO) or the European Defence Agency (EDA). Such an entity, equipped with a multinational oversight body akin to Ukraine's supervisory boards, could coordinate large-scale projects - mirroring existing programs like OCCAR - provided these boards wield real authority rather than serving as ornamental fixtures.

On the national level, the innovation-driven transformation of defense procurement systems envisages a comprehensive approach to the contracting mechanisms addressing both immediate operational needs and long-term strategic capabilities:

- Abandoning traditional multi-year contracts in favor of short-term, high-value agreements spanning three to six months. These contracts would target specific, immediate solutions - such as small-class drones or electronic warfare tools - with clear performance indicators derived from frontline feedback. Such a model prioritizes speed and adaptability, enabling rapid deployment of cutting-edge equipment while minimizing the risk of obsolescence;
- Retainment of long-term contracts to ensure stability for defense-tech firms, but incorporating mandatory service and support provisions. For critical systems like unmanned platforms, EW and communication tools, this support should include on-demand troubleshooting and periodic retrofitting, ensuring relevance throughout their lifecycle. To balance these obligations, contracts should offer financial incentives or preferential terms to compliant producers, fostering a mutually beneficial partnership.

The role of Ukraine in shaping EU-NATO cooperation on defence capabilities

Problem Statement

Both Strategic Compass for Security and Defence (2022), as well as the European Defence Industrial Strategy (2024) indicate that "a stronger and more capable EU in security and defence (…) is complementary to the North Atlantic Treaty Organization (NATO), which remains the foundation of collective defence for its members".

To reinforce strategic partnership with NATO, the EU strategies seek to generate financial resources to develop capabilities by the EU Member States in line with NATO capability targets, regional defence plans and command and control structures. The White Paper on the future European defence follows the same logic. After the recent expansion of NATO, 23 of the 32 allies are members of the European Union, which may lead to increased acceptance of NATO standards and common defence policies.

With the start of a full-blown Russian war against Ukraine, a dialogue between the European Union and the North Atlantic Treaty Organisation has intensified in various domains. In 2023, the parties signed the third Joint Declaration on EU-NATO cooperation, outlining directions for cooperation, including assistance to Ukraine. Seven 'Structured Dialogues' were established between the EU and NATO, covering Military Mobility, Resilience, Emerging and disruptive technologies, Climate and defence, Space, Defence Industry, and Cyber. Till the beginning of 2025, the European Union Military Staff (EUMS) and NATO International Military Staff (IMS) held 22 bi-annual conferences. The tenth progress report on implementation is due to appear in the spring of 2025, assessing more than 70 priority directions of EU-NATO interaction.

Despite the profound political declarations of both sides strategic significance of the EU-NATO bond, the level of cooperation is still insufficient when it comes to the search for joint responses to the most severe challenges, including Russian full-scale aggression against Ukraine.

The situation is further aggravated by the inconsistency in the US public position as a core NATO member, undermining unity and trust between allies, and weakening NATO's defence and deterrence posture in Europe and worldwide.

But one can argue that coordination formats between two organisations regarding assistance to Ukraine may bring benefits also to Member States and Allies in the area of capabilities development and facilitation of coordination efforts of the European Defense Technological and Industrial Base (EDTIB).

EU-NATO-Ukraine cooperation since 2022

On the bilateral inter-organisational track, the start of full-scale aggression prompted the EU and NATO to search for closer cooperation and coordination of support to Ukraine. In February 2022 the European External Action Service, the European Commission, and NATO launched the EU-NATO Staff Coordination on Ukraine. As of February 2024, eight meetings

took place, focusing on a wide range of issues, including military and humanitarian support, energy security, chemical, biological, radiological and nuclear (CBRN) preparedness, demining etc.

In February 2023, during the first high-level dialogue EU-NATO-Ukraine, foreign minister of Ukraine Dmytro Kuleba proposed to launch a tri-lateral format EU-NATO-Ukraine. The initial idea was to create a coordination mechanism at the level of arms producers, buyers and national governments. This initiative, unfortunately, did not come to fruition. Partly, it might be explained by the existence of the Ukraine Defence Contact Group ("Ramstein format") where all NATO allies and 25 EU member states participate.

Despite high-level declarations about further alignment of policies towards support to Ukraine, the European Union and NATO act, predominately, in parallel.

The EU utilised the European Peace Facility (EPF) for covering military support to Ukraine through its Member States, Ukraine Facility, EU Civil Protection Mechanism, Foreign Policy Instruments, and The Common Security and Defence Policy missions (EUMAM, EUAM).

At the same time, NATO increased and fine-tuned the Comprehensive Assistance Package (CAP) for Ukraine as a multi-year program to streamline defence and security reforms in Ukraine and increase interoperability with NATO.

In 2024 Allies agreed to set NATO Security Assistance and Training for Ukraine (NSATU) to inherit from the US, the leader of the "Ramstein Format", coordination of military equipment provision and training for Ukraine.

Within the Pledge of Long-Term Security Assistance for Ukraine, in 2024 Allies provided support to Ukraine worth EUR 50 billion, surpassing the minimum baseline funding of EUR 40 billion (60% European Allies and Canada).

Both the EU and NATO have launched their respective offices tasked with studying the experience of the battlefield in Ukraine. In September 2024, the European Commission launched the Defence Innovation Office in Kyiv, a step envisaged in the European Defence Industrial Strategy. In February 2025 in Poland, Ukraine and NATO opened the Joint Analysis Training and Education Centre (JATEC) to collect combat experience and transform it in future NATO's defence planning.

Role of Ukraine in deepening relations between EU and NATO

As the European Commission prepares the White Paper on the Future of European Defence, it is crucial to mention areas where cooperation with Ukraine may bring benefits for common European defence.

A transfer of administrative powers of the Ukrainian Defence Contact Group (UDCG) to the NSATU creates new opportunities to foster EU-NATO cooperation, especially in the capability development area.

Eight capability coalitions have been formed in the framework of the UDCG, featuring the current and future needs of Ukraine in modern warfare. They cover: Air Force Capability; Maritime Capability; Integrated Air and Missile Defense; Artillery; Armored Vehicles and Maneuverability; Drone; Demining Capability; IT. The structure and thematic orientation of the coalitions make them natural pilot initiatives for generating common approaches to capability development within the European Defence Agency (EDA) and NATO Support and Procurement Agency (NSPA).

Provided that these eight coalitions reflect the vital needs of Ukraine on the battlefield, these areas are also in line with NATO capability needs. Each of them is led by the EU Member

State and NATO allies, presuming that some countries might act as a framework nation in the process.

Also, it fits the EU's priority to enhance partnerships with third states, which are at the same time Allies, including Canada, Iceland, Norway, Turkey and the US. Additionally, capability coalitions set preconditions for such partners of both EU and NATO as Australia, New Zealand, and Japan.

As NATO prepares to endorse new capability targets in June 2025, the Joint Analysis, Training And Education Centre (JATEC) and EU Defence Innovation Office must provide a comprehensive assessment of not only Ukraine's current needs for weapons and ammunition but also the potential of the Ukrainian Defence Technological and Industrial Base to meet European defence capabilities goals.

Recommendations

1. **Tri-lateral structured dialogue EU-NATO-Ukraine.** Despite the current political moment when some allies are reluctant to invite Ukraine to join NATO, strong tri-lateral political dialogue would benefit both EU-NATO coordination efforts to assist Ukraine, and facilitate interoperability and development of European military capabilities. Many EU-NATO Structured Dialogues cover areas of bilateral cooperation, where the Ukrainian experience and expertise from the battlefield are vital to be taken into consideration.
2. **Standardisation of the European types of hardware and ammunition.** The Russian war in Ukraine demonstrated the problems of "free interpreting" of NATO standards on ammunition, produced by different European arms manufacturers. The time is ripe for generating political will within EU MS and NATO allies to strengthen European military preparedness by easing regulations, production standardisation, and shifting bureaucratic obstacles. This unpopular moves among big defence manufacturers may be facilitated with financial incentives from the European Defence Agency.
3. **More trust between EU and NATO in information exchange.** The situation with the absence of sufficient flow of classified information between the European Union and NATO not only slows down the practical level of cooperation but also leaves the European Union in a disadvantage compared to other partners.
4. **Two-way military trainings to boost motivated and prepared manpower both in Europe and in Ukraine.** The Ukrainian Armed Forces benefitted largely from the military preparation of Ukrainian manpower in the framework of the EUMAM and other NATO allies. Now that it is obvious that the US support for Europe might have a prospect of scaling down incrementally or abruptly, the European capitals should pay more attention to tailor special military training for their active duty army and reservists. It should be done based on practical experience the EU Military Assistance Mission in support of Ukraine (EUMAM Ukraine), the NATO Security Assistance and Training for Ukraine (NSATU), and the Joint Analysis Training and Education Centre (JATEC).
5. **Both EU and NATO should be consistent and transparent in providing assistance to Ukraine**. It is a positive development that the allies raised 10 billion more than the pledge's baseline in 2024. At the same time, this pledge is made in a very non-transparent way, which is very difficult to understand even for the Ukrainian side. Currently, each ally uses its own approach to calculate its contribution to the pledge, sometimes far from market prices for equipment and services provided to Ukraine. On the EU and NATO level, the parties have to elaborate a clear methodology of assessment to be utilised in assistance initiatives, led jointly or by one of the organisations.

EU’s autonomous collective defence capabilities

How to defend itself and be a credible European NATO pillar?

Problem setting

Some EU member states' intelligence services claim there is a high probability of large-scale Russian aggression in Europe within five years. Against the background of the bloody war waged by the Russian aggressor against Ukraine, European governments must do everything possible to prepare for a possible conventional war and to acquire sufficient military capabilities for defence and deterrence.

It is a basic scenario that the United States, while remaining the guarantor of Europe's security within NATO, is now demanding that European allies rebalance their capabilities and take greater responsibility for their own security decisions on the continent.

European NATO allies need to reconsider their current levels of troops and weapons needed to repel a potential aggressor with military parameters similar to those of Russia.

In terms of combat-experienced personnel, Ukraine could become a real security provider in the coming years. In a positive scenario, Ukraine could join the EU by 2030, if all political and technical conditions are favourable. This step will strengthen the EU's defence potential in general and on its eastern border in particular.

But even at this stage, EU members need to further align their defence policies and synchronise their elements of the European Defence Technological and Industrial Base (EDTIB) in order to be credible.

The EU's over-dependence on the US military presence and dominance in command and control was based on the premises of the post-World War II arrangements. Now, the unpredictability of the new Trump administration in global affairs is prompting European allies to take definitive responsibility for their preparedness for conventional risks and threats emanating from Russia and the so-called Axis of Evil, including North Korea, Iran and Belarus.

Only these steps, taken swiftly and together, can provide a reliable basis for the Defence Union as a solid international security actor, capable not only of conflict resolution but also of self-defence.

Autonomous collective defence of European nations

The European Union has taken several strategic steps to build sovereign defence capabilities and strengthen defence partnerships. The Strategic Compass, a kind of prototype defence doctrine, laid certain foundations for the development of the EU's security and defence governance mechanisms.

However, this document was finalised before Russia's full-scale aggression against Ukraine, making it no longer relevant to the level of threats that have emerged in the immediate neighbourhood as well as the increased risks to the EU itself. The Strategic Compass confirms the EU-NATO synergy approach and the division of security roles between the two organisations. While the EU focuses on crisis management, peacekeeping missions and the development of the defence industry, NATO provides collective defence and military capabilities. In this light, the EU's Rapid Deployment Capacity, a 5,000-strong modular force, is a purely crisis response mechanism that is unlikely to be equipped and capable of dealing with the military threat to any EU member state.

Based on the EU's authentic analytical toolkit of the Capability Development Plan (CDP), the Coordinated Annual Review on Defence (CARD), the European Commission started a search for defence capability gaps in 2022. The identification of priority areas led to the emergence of several financial instruments, such as the Instrument for the European Defence Industry Reinforcement through Common Procurement (EDIRPA), the Act in Support of Ammunition Production (ASAP) and the EDIP (still in preparation). These programmes have shown that the EU can act quickly and propose new financial instruments to support the European defence industry.

The European Defence Industry Strategy (2024), the White Paper on European Defence and the future EU Preparedness Strategy may lay the foundations for the creation of the Defence Union as a natural response to the level of threats posed by Russia and its allies.

But in order to proceed towards the creation of the Defence Union, the European institutions and Member States will have to agree to move away from the traditional definition of the Union as a peacekeeper. To begin with, the Strategic Compass should be revised as a long-term document, since in its current form it is unclear how the EU intends to strengthen its collective defence mechanism and pool its capabilities. The Defence Union should be visible in the EU's strategic policies.

All financial and technical calculations made in the White Paper should be committed to the EU's future collective defence mechanism, compatible with the mutual defence clause described in Article 42(7) of the Treaty on European Union.

In the current geopolitical environment, it is strategically correct for the EU to align itself with NATO's Concept for Deterrence and Defence of the Euro-Atlantic Area (DDA). At the same time, however, the European Union must benefit from the military capabilities to act autonomously in all areas to defend Europe's borders.

In this respect, autonomous military mobility in Europe is another important part of the EU's preparedness for potential military threats. The European Union has launched a number of initiatives aimed at developing military mobility within the EU. The PESCO project on military mobility is one of the most popular, attracting a large number of Member States and third countries. It could be argued that the complexity of the problem and the need for large investments in the existing European transport and logistics infrastructure make it difficult to implement. At the same time, Russia's full-scale aggression against Ukraine has highlighted the weak links in European military mobility, which need to be addressed urgently.

European allies need to consolidate their ownership in areas where the US has traditionally led, including C2, intelligence, satellite imagery and precision strike. These strategic enablers are critical to the defence and deterrence of European nations. In these areas, Ukraine's participation can accelerate the pace of progress in the co-development of the above-mentioned advanced military or dual-use technologies.

The Ukrainian DTIB will undoubtedly contribute essential technological know-how and deliver much-needed capabilities in the timeframe and to the extent defined by EU and NATO capability development goals. To achieve this, Ukraine will need greater access to European funding and decision-making.

Recommendations

1. **Norway-type status for Ukraine in defence cooperation with the European Union.** In order to create stable conditions for Ukraine's participation in EU defence programmes and initiatives, the European partners need to set an inclusive framework with full access to decision-making and financial resources. In this respect, it may be possible to grant Ukraine the status of an Associated Partner. This type of partnership is currently being extended to Norway. Such a mechanism will allow Ukraine to participate on an equal footing with EU Member States.
2. To fill the gaps in modern defence capabilities, it could be beneficial **to follow the capability coalitions under the UDCG with EU financial instruments.** A revised Permanent Structural Cooperation (PESCO) could serve as a model to bring some of these activities under the EU financial umbrella. These coalitions now include between 14 and 21 members, mostly European NATO allies. Ukraine can contribute new technologies and experience to new PESCO initiatives.
3. The temporary cut-off of Ukraine from US satellite intelligence as a bold move to press Kyiv for concessions has prompted European concerns about long-term US credibility, especially in areas of traditional US dominance. In this context, **European and Ukrainian producers of weapons and dual-use products and technologies have a legitimate interest in improving autonomous capabilities**. Member States and Ukraine need to combine efforts to modernise and expand satellite imagery capabilities, air defence systems and sufficient levels of munitions for them, as well as long-range precision strike capabilities.
4. Threatening messages from European intelligence services about a possible scenario of a Russian attack on European countries by 2030 make it critical for **EU members to rapidly strengthen their defence capabilities while increasing military assistance to Ukraine**. Ukraine has repeatedly spoken of the need to confiscate Russia's sovereign assets located in the EU and use them for defence purposes. More than €200 billion could provide the necessary long-term guarantee for arms and ammunition producers, as well as investment for Ukrainian arms manufacturers, which currently face an annual funding shortfall of €15-17 billion.
5. In addition to increased defence spending, European partners should also come up with **a fixed national contribution to support Ukraine's military and humanitarian needs.** In this context, the proposal by some European partners to set aside 0.25% of GDP to support Ukraine seems to be a good expression of solidarity with the Ukrainian army, understanding that in the future this army could become an important part of a common European defence union.

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