Beyond Attrition

Interpreting the Limits of Lessons in Ukraine for Future U.S. Force Development

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Introduction

For over four years, the Ukrainian army has defied the expectations of many military experts in its fight against Russia's invasion. Ukraine's forces, aided by Western support and frontline innovation, have upended predictions of a quick Russian victory. This conflict has not only disrupted Russia's assumption of an easy triumph but has also accelerated the dramatic evolution of drone warfare as a viable substitute for traditional, more expensive battlefield capabilities.

First-person-view (FPV) drones, swarms of surveillance and strike unmanned aerial systems (UASs) operating in concert, and their ability to change the cost-exchange ratio on the battlefield appear to be reshaping the character of modern war. According to many reports, nothing in Ukraine now moves without being observed, and nothing maneuvers without the risk of disruption.[1] Thousands of online videos have vividly demonstrated this reality, capturing both Western attention and imagination, and calls for defense policymakers to heed their lessons in innovation are ubiquitous.[2] Drones have undeniably proven valuable, particularly in the integration of coordinating fires from massed and precision artillery, but it is equally important to recognize what is absent from this war when assessing their impacts and its implications for future warfare. This paper aims to provide an initial analysis of these factors and successive guidance for allied planners and policymakers on the demonstrated principles and formations that are most compatible with the U.S. and NATO way of war.

While NATO and U.S. observers continue drawing lessons from Ukraine, there is a risk of overstating the utility of or misapplying these innovations. Any changes to force structure must be based on data-driven analyses that include all aspects of operations, ranging from the systems and forces being employed to concepts of operations and training and doctrine. For example, the dominance of drones on the battlefield must be evaluated in the context of failure by either side to establish and maintain air superiority with a modern, integrated air force with fifth-generation capabilities. Many other elements of the war in Ukraine, characterized as they are by attritional fighting across static lines separated by vast "dead space," cannot be directly applied to all future conflicts. Critical warfighting functions central to the Western way of war – for example, interconnected systems, scalable joint operations, and highly trained volunteer forces – are not represented. U.S. and NATO operations on the same terrain would look markedly different across the incorporation of robotics, ground operations, and other elements.

To assume that the U.S. should prepare for future wars by precisely replicating the Ukrainian way of war is a dangerous oversimplification. Future force structures built predominantly around attritable drones would risk skewing U.S. military modernization toward a style of warfare that is limited to a subset of potential adversaries. To assign too much universal truth to outcomes that are otherwise unique to the specific conditions and parameters of this war risks making premature assumptions about the next, and by extension shaping U.S. defense policy around what may only be transitional challenges. Before the U.S. and NATO consider retiring or reducing viable legacy capabilities in favor of heavy reliance on UASs, it is worth taking a moment to carefully understand the attritional 'war of defense' observed in Ukraine and its use of UASs. This would then support an examination of how these systems would realistically integrate into modern Western warfighting concepts, force structure, and command and control (C2) architecture. For policymakers and force planners looking to learn from Ukraine, this may mean focusing on thoughtful robotic integration into manned maneuver forces at scale rather than complete replacement of existing capabilities.

Evaluating Distinctive Characteristics of the Russo-Ukraine War

The technological evolutions witnessed on the Russo-Ukraine battlefield are real and offer legitimate opportunities for the U.S. to add additional capabilities to its formations. However, these so-called "transformative shifts in the character of war" are taking shape within a set of unique factors that must be critically examined. These factors include geography, forces available to both sides, and the underlying strategy and doctrine on both sides. While said advancements remain noteworthy, analysis of these factors underscores that they are not definitive for how the U.S. and NATO should approach force modernization efforts due to the dubious likelihood that they would be replicated, one-for-one, in the exact same way, in a future allied conflict.

Much of Ukraine's success with UASs stems from battlefield necessity and is enabled by geography. Ukrainian soldiers, facing numerical disadvantages, have used attritable drones produced in makeshift factories as improvised precision munitions. These systems thrive in Ukraine's relatively open terrain, where minimal

1 See for example, Zagorodnyuk, Andriy. "Ukraine's New Theory of Victory Should be Strategic Neutralization." Carnegie Endowment. June 18, 2025. https://carnegieendowment.org/research/2025/06/ukraines-new-theory-of-victory-should-be-strategic-neutralization?lang=en

2 Lowe, Matthew and Epstein, Jake "Ukraine's cheap interceptor drones are rewriting the air war playbook." Business Insider. October 18, 2025. https://www.businessinsider.com/ukraine-interceptor-drones-air-defense-2025-10; Kirichenko, David. "Drone superpower Ukraine is teaching NATO how to defend against Russia." Atlantic Council. October 2, 2025. https://www.atlanticcouncil.org/blogs/ukrainealert/drone-superpower-ukraine-is-teaching-nato-how-to-defend-against-russia/; Newton, Michael. "How are Drones Changing War? The Future of the Battlefield." CEPA. November 3, 2025. https://cepa.org/article/how-are-drones-changing-war-the-future-of-the-battlefield/

cover and clear lines of sight allow drones to operate effectively and coordinate with artillery at range. This is not globally replicable. Other environments, like dense forests, jungles, mountains, or dense urban areas, would negate many of these open terrain advantages. This is especially the case for fiber-optic drones, which have increasingly been adapted for use by both sides since spring 2024. These platforms address the threat of jamming attacks and electronic warfare, to which traditional drones are highly vulnerable, by connecting operators to FPVs using miles of fiber-optic cable. Any battlefield environment with more crowded or complex terrain would naturally pose significant challenges to the deployment of these cables.[3] The multiple vulnerabilities of small UASs and their physical limitations give good cause for prudence against proposals to supplant traditional combat elements entirely with UASs.[4] With the persistent U.S. need for capabilities that can be employed anywhere, 24/7, on the move, at speed, in every weather condition, and are capable of seizing and retaining terrain, legacy systems will remain a critical component of maneuver formations.

Equally important, when considering how effective standalone UAS formations will be in future conflicts, is the lack of air superiority present on the Russo-Ukrainian front. UASs dominate the skies in Ukraine not solely due to their effectiveness, but because neither side has been able to field a modern air force capable of close integration with ground assets. The Russian Air Force, lacking the capability to overcome the Ukrainian Air Force and air defenses, limits itself to operate as a mere extension of indirect fires, "conducting standoff artillery bombardments with unguided rockets or glide-bomb strikes that mirror ground artillery rather than supporting or enabling ground maneuver."[5] This relegation to usage of air support in an imprecise stand-off role, whether from an inherent lack of ability to achieve air superiority or from a deliberate doctrinal preference for imprecise massed fires, leaves the Russian Air Force in the role of "bit player" in a way that would not be the case for the U.S. Air Force and NATO.

A Western military equipped with advanced airpower, precision munitions, and a more evolved concept of air superiority and close air support doctrine would present a far more challenging environment for drone operations, especially for their operators on the ground. In order for drones to control a frontage 40 km deep, operators must establish stable control locations to assemble, launch, operate, and return these platforms. Such fixed-site C2 establishments will not be possible when facing an air force capable of hunting down precise signal locations and eliminating operators with precision-guided munitions or simply rendering the front line uninhabitable via saturation bombing. In summary, the ability to wage a war with a front line dominated by drones requires a front line that is static enough to permit the stability necessary to command and control those drone assets. A NATO air armada, led by the U.S. Air Force and teamed with a comprehensive, layered C-UAS system to protect the area of operations, would not permit such stability in an enemy C2 architecture.

As an example, Ukraine is fighting an air force incapable of establishing air superiority or any degree of local supremacy to support combined arms operations on the ground. This results in significant aspects and principles of joint and combined arms warfare being compromised. The limited effectiveness of combined arms maneuver, as evidenced by the absence of integrated joint capabilities across both sides, is indicative of suboptimal operational capability. This calls into question the integrity of ongoing discussions about how much the character of war has truly changed. Further examples of missing components in the Russo-Ukraine war of modern high-end warfare include the lack of coordinated artillery fire in support of heavy maneuver units, the absence of close air support tied to ground maneuver, and the lack of integrated combat engineer assets working together with other supporting suppression and obscuration forces operating at scale in support of the breach efforts. The inability to establish air superiority, achieve adequate suppression, and secure direct fire dominance at breach points by either side has hindered maneuver operations amid entrenched defensive positions and sophisticated obstacles.

Other distinct features of the Russo-Ukraine war lie in the constrained number of replacements and the readiness of the combatants themselves. While Ukraine has demonstrated considerable ingenuity by integrating post-Soviet equipment with various Western assets, it still faces manpower deficits that hinder its ability to counter Russia's numerical dominance, with some estimates indicating a threefold disadvantage in troop strength.[6] Conversely, the Russian military's shortcomings in professionalism and cohesive operations have been noted.[7] For example, they struggle with efforts to deal with high attrition and effectively integrate a conscript

3 Kirichenko, David. "A New and More Deadly Drone on Russia's Battlefields." CEPA. March 3, 2025. https://cepa.org/article/a-new-and-more-deadly-drone-on-russias-battlefields/

4 Bolen, John. "Achtung-Swarm! A Proposal for Swarm Maneuver Groups." Journal of Advanced Military Studies. 2025. https://www.usmcu.edu/Outreach/Marine-Corps-University-Press/MCU-Journal/JAMS-vol-16-no-2/Achtung-Swarm/

5 Revels, Matthew and Uribe, Eric. "Drones Won't Save Us: Learning the Wrong Lessons from Ukraine Will Cost the US Army its Edge in Maneuver Warfare." Modern War Institute. November 5, 2025. https://mwi.westpoint.edu/drones-wont-save-us-learning-the-wrong-lessons-from-ukraine-will-cost-the-us-army-its-edge-in-maneuver-warfare/

6 AFP. "Russia has three-fold frontline advantage: Ukraine army chief." CTV News. September 8, 2025. https://www.ctvnews.ca/world/article/russia-has-three-fold-frontline-advantage-ukraine-army-chief/

7 MacFarquhar, Neil. "Russia Planned a Major Military Overhaul. Ukraine Shows the Result." New York Times. May 16, 2022. https://www.nytimes.com/2022/05/16/world/europe/russia-military-ukraine.html

replacement Army into a unified force, resulting in increasingly obvious struggles in executing coordinated combined arms warfare.[8,9]

The integration of unmanned ground vehicles (UGVs) into the conflict is just beginning, which is notable given the advanced proposals for human-machine integration concepts being put forward by the U.S. Army today.[10] Both sides have engaged in limited experimentation with mine deployment, casualty evacuation, limited logistics missions, and remote-controlled small UGV platforms outfitted with machine guns,[11] but to date, there have been no reports of large-scale, massed operational use of autonomous or tele-operated UGVs. A handful of instances involving small groups of robots targeting specific line breaches have occurred, and Ukrainian defense officials have publicized early-stage development initiatives with ground robots for suppressive fires.[12] However, these efforts fall significantly short of planned Army initiatives that include tactical-level deployment of UGVs to support "no blood for first contact."[13]

Although viral videos of tanks and other armored fighting vehicles being successfully targeted by FPV drones continue to fuel narratives of the obsolescence of legacy ground systems, it is worth considering what may happen once integration of tactical ground combat vehicles is fully completed. Legacy maneuver platforms, working side-by-side with autonomous systems as coordinated stablemates, will present a vastly different capability than tanks working alone. The potential enhanced operational impact of drones, if employed in conjunction with more integrated combined arms assets, is precisely the enduring vision of the U.S. Army. Rather than asking "Is the tank dead?", the better question may be what would happen if integrated swarms were made to operate on the move, controlled by a networked C2 multi-agent system. What kind of combat power could be generated if the U.S. and NATO integrated UAS, UGV, and USV platforms, at scale and designed to move alongside large, combined arms forces capable of rapid maneuver?

Assessing Potential U.S. and NATO Approaches to a Comparable War

Any future U.S. or NATO conflict would likely differ dramatically from that taking place in Ukraine; therefore, deployment of UASs by Ukrainian and Russian forces cannot be directly translated to the operational context of the U.S. military or NATO forces. Both parties must consider how to evolve their existing approach and doctrine – for example, from sole reliance on low-cost, precision-guided unmanned systems at the squad level for intelligence, surveillance, and reconnaissance (ISR) to a more integrative strategy that encompasses both sophisticated systems and versatile payload options, enabling multi-agent command and control capabilities. Similarly, this process should not reduce the discussion to a false, binary choice between building exquisite systems and affordable assets; instead, a hybrid approach integrating both advanced and attritable systems can balance a range of operational needs. While some unmanned systems, particularly low-cost FPV drones, may be regarded similarly to conventional munitions, it is vital that some of them possess more enhanced capabilities and payloads.

Furthermore, whereas the Russians and Ukrainians have predominantly used their unmanned aerial systems and limited UGV assets along relatively static front lines, any systems the U.S. designs must be adaptable to a Western force model built around dynamic maneuvering and combined arms integration. In its doctrine, fighting concepts, and demonstrated execution, U.S. ground forces fight as integrated teams. The inclusion of UGVs at scale and across maneuver formations – intentionally tested to work alongside manned maneuver assets – sits at the very core of the Human Machine Integrated Formation (HMIF) transformation effort.[14] A U.S. fight on the ground in a future conflict would therefore almost certainly look vastly different than the fragmented and isolated static warfare currently seen along the 1200 km Ukrainian front line, as U.S. formations would operate with a degree of intentional offensive mobility, supported by integrated Joint and combined arms assets, not currently demonstrated in Ukraine.

8 Congressional Research Service. "Russian Military Performance and Outlook." Congress.gov. October 10, 2024. https://www.congress.gov/crs_external_products/IF/PDF/IF12606/IF12606.4.pdf

9 Association of the United States Army. "Reflections on Russia's 2022 Invasion of Ukraine: Combined Arms Warfare, the Battalion Tactical Group and Wars in a Fishbowl." AUSA. September 29, 2022. https://www.ausa.org/publications/reflections-russias-2022-invasion-ukraine-combined-arms-warfare-battalion-tactical

10 Young, Capt. Timothy and Winstead, Mark. "Human-Machine Integration: Tactical-Level Employment and the EXFOR RAS Platoon." U.S. Army. January 7, 2025. https://www.army.mil/article/282372/human_machine_integration_tactical_level_employment_and_the_exfor_ras_platoon

11 Mittal, Vikram. "Russia And Ukraine Deploy Unmanned Ground Vehicles Into 'Kill Zones.'" Forbes. October 12, 2025. https://www.forbes.com/sites/vikrammittal/2025/10/12/russia-and-ukraine-deploy-unmanned-ground-vehicles-into-kill-zones/

12 Magnuson, Stew. "Ground Robots to Proliferate on Ukraine Battlefields Following Success of Drones." National Defense Magazine. September 2, 2025. https://www.nationaldefensemagazine.org/articles/2025/9/2/ground-robots-to-proliferate-on-ukraine-battlefields-following-success-of-drones

13 Young, Capt. Timothy and Winstead, Mark. "Human-Machine Integration: Tactical-Level Employment and the EXFOR RAS Platoon." U.S. Army. January 7, 2025. https://www.army.mil/article/282372/human_machine_integration_tactical_level_employment_and_the_exfor_ras_platoon

14 Lacdan, Joe. "Army advances human-machine integration tests to enhance, fight with combat units." U.S. Army. October 29, 2024. https://www.army.mil/article/280910/army_advances_human_machine_integration_tests_to_enhance_fight_with_combat_units

The U.S. military's approach to maneuver warfare as a component of Large-Scale Combat Operations (LSCO) is currently characterized by offensive mobility and the intended integration of human-machine formations that operate at brigade or division levels or larger.[15] In contrast, the operations seen in the Russia-Ukraine conflict involve smaller company-sized incursions, which are not representative of U.S. military operations. While there is potential to refine small unit tactics and enhance operational tempo at the platoon level by equipping these units with organic attritable unmanned systems, for a U.S. or NATO-style army, one must also envision an increase in offensive operational tempo across all echelons. This will ensure allied unmanned systems are configured to function effectively alongside a first-world military rather than one designed to fight in an attritional mode.

There also exists a risk of overestimating the effectiveness of these unmanned systems, particularly when integrated with larger formations on the move. The use of small UASs by Ukrainian forces often stems from necessity rather than tactical advantage. History demonstrates, dating back over two millennia to the Roman legions, that ***ground forces must retain the ability to actively occupy and control terrain.*** This enduring reality persists today. Ground formations, augmented by both sophisticated and attritable robotic systems but still retaining infantry and manned ground combat platforms, remain essential for terrain acquisition and retention. There are no drone swarms yet invented that can take and retain terrain by themselves. This principle is observable in the Russia-Ukraine conflict, as demonstrated by the increased targeting of drone operators by both sides,[16] and it would become increasingly evident within a Western military context that prioritizes maneuver and operation with manned platforms at scale.

Use of artillery by the U.S. will also differ significantly from the approaches adopted by Russian and Ukrainian forces. Historically, the Russian military has been characterized as an artillery-centric organization with armored units as a secondary component. Similarly, the Ukrainian forces, building on an evolution from former Soviet military structure, have maintained a comparable doctrine for their artillery, with only the advent of some Western systems beginning to change their methods and capabilities.[17] This is not to dismiss the seemingly dramatic impact drones have had in giving the individual infantryman operating in Ukraine his own responsive fires.

Mass, in the form of sheer volume of shelling, remains their preferred method of artillery employment. However, it is crucial to recognize that the reliance on the volume of massed fires and the extensive consumption of ammunition – reminiscent of World War I-era quantities – is not aligned with Western military doctrine. Even when employing non-precision guided munitions, the deployment methodologies of coordination and precision targeting in Western armies are different. When the U.S. military masses its fires, it focuses on massed effects and in so doing exhibits distinctly different characteristics. U.S. artillery doctrine relies more on directly observed fires to improve the precision of its targeting and increase accuracy.[18] U.S. and NATO artillery units also place an increased emphasis on use of precision guided munitions. Essentially, lower volume of fires results in greater and more lethal effects, as more rounds actually hit intended targets.

Furthermore, the U.S. would likely deploy its own improved version of HIMARS and its rocket munitions differently. The latest, more advanced guidance systems capable of operating more effectively in a degraded electronic warfare environment are important components of the most modern Western munitions. In addition, the U.S. will use a wider range of precision-guided munitions different from those available to Ukraine that have been retained for strategic purposes and have not yet been provided to Ukraine in this war. Thus, the true arsenal at the United States' disposal extends beyond what has been publicly observed.

One can also envision the implementation of a greater range of robotic and autonomous systems; if such capabilities are present for unmanned aerial vehicles, it stands to reason that similar autonomy will be available for unmanned ground vehicles equipped with rocket and artillery systems. Imagine an unmanned HIMARS-like platform tied into a sensor-to-shooter pairing network, functioning continuously, navigating from firing point to firing point autonomously, and supported by autonomous resupply. Imagine that system now capable of executing strikes and relocating at a higher operational tempo and risk than manned systems. This vision of robotized artillery is indicative of potential future capabilities that may incorporate a variety of sizes and payloads yet unseen on the battlefields of Ukraine.

It is essential to reiterate that neither the Russian nor Ukrainian Air Forces have achieved sustained air superiority or control during the entirety of this conflict. In contrast, precedents such as the Gulf War, the Kosovo-Serbia bombing campaign, the 2003 invasion of Iraq, and recent engagements against integrated air defense systems in Iran and Venezuela underscore the capacity of the U.S. Air Force and U.S. naval aviation assets to suppress and destroy even the most advanced and integrated air defense networks in the world. The U.S. military's ability to create permissive air corridors, windows of air superiority, and unfettered access sufficient enough to conduct deep strikes using stealth aircraft is

15 T2COM OE Threat Assessment 1.0. "The Operational Environment 2024-2034: Large-Scale Combat Operations." U.S. Army. July 31, 2024. https://oe.tradoc.army.mil/product/the-operational-environment-2024-2034-large-scale-combat-operations/

16 Clover, Charles and Deprez, Fabrice. "The elite Russian unit hunting Ukraine's drone warriors." Financial Review. November 13, 2025. https://www.afr.com/world/europe/the-elite-russian-unit-hunting-ukraine-s-drone-warriors-20251113-p5nfb1

17 Mittal, Vikram. "Artillery Is Still the King of Battle in the Russia-Ukraine War." Forbes. July 16, 2024. https://www.forbes.com/sites/vikrammittal/2024/07/16/artillery-is-still-the-king-of-battle-in-the-russia-ukraine-war/

18 Headquarters, Department of the Army. "Fire Support and Field Artillery Operations." U.S. Army. August 12, 2024. https://rdl.train.army.mil/catalog-ws/view/100.ATSC/9B9879F3-F213-4CD7-9D20-8D4520E8D38E-1397219978180/fm3_09.pdf

unmatched. In 30 years, there has not been any adversary's military forces seen that have proven capable against U.S. airpower. Even when equipped with some of the best Russian and Chinese systems, they proved inadequately prepared and lacking in experience compared to U.S., NATO, and Israeli joint capabilities. To date, both combatants in this war have instead relied on drones and improved access to precision munitions as substitutes for comprehensive air sorties typical of a fully operational air force. This scenario would markedly differ with the U.S. Air Force and naval aviation employing stealth platforms and advanced enemy air defense suppression strategies. The frequent absence of this consideration in the current discourse concerning the applicability of the Russia-Ukraine conflict to potential U.S. military engagement is a critical oversight.

The future of warfare demands more than simply asking how to build more UASs. It will be critical to understand what other systems are potentially being overlooked and how those new technologies can accelerate and enhance the U.S. way of warfare, as the Army's new Transformation and Training Command seeks to do. Already, the Transformation and Training Command is exploring the broader integration of robotics and autonomous systems across other domains – an effort designed to discern how best to place robotic systems operating alongside traditional legacy combat systems, not with the goal of replacing them.

Integrating Autonomous Systems with Next Generation Command and Control

If the character of war is indeed being partially reshaped by the advent of UASs and UGVs in the Russo-Ukraine conflict, a central question to consider is, "How should the advances in robotics and autonomous systems seen in Ukraine be integrated with the U.S. way of war?" One approach suggests pursuing a more comprehensive and multi-domain set of solutions, all integrated to operate under a Next Generation Command and Control (NGC2) architecture. It is worth exploring what the U.S. vision for exploiting advanced C2 of fully robotic and autonomous system-integrated formations might look like, particularly to identify similarities and differences from tactics and operations in Ukraine.

A first step will be to clarify the Army's vision for NGC2 and its key role in Army transformation. NGC2 sits at the core of how robotics will enable legacy systems to fight, teamed alongside unmanned systems. It will be important to understand how concepts like the "transparent battlefield"[19] and NGC2 deployments will support enhanced and accelerated lethality, along with an understanding that these concepts may create new vulnerabilities to elements such as cyberattacks or electronic warfare. The capabilities the Pentagon and Army are pursuing reflect a deliberate prioritization and acceleration of those specific capability goals, technologies, and efforts. Army C2 modernization efforts, including NGC2, prioritize delivery of a range of warfighting capabilities.[20]

A promising area for NGC2 efforts and advancements in drone warfare is tempo acceleration. During the Army's Project Convergence Capstone 4 (PCC4), senior Army S&T officials noted that "the speed of moving data from a sensor to an effector has increased by two orders of magnitude" since the first Project Convergence capstone.[21] Pursuit of these technologies is consistent with U.S. Army Vice Chief of Staff General James J. Mingus' statement to the Senate Armed Services Committee, which notes the Army's commitment to NGC2 as an answer to future operational needs.[22] These advancements in capabilities will allow forces to see the enemy faster, via improved optics and agile forward autonomous and sensor assets, and automate data entry and transfer to enable more rapid processing of sensor feeds. They will also help warfighters analyze adversary disposition, intent, and decision-making; and allow forces to act faster to counter adversary manned and unmanned assets via assurances provided by precision Situational Awareness, precision intelligence products, and an accelerated and more efficient kill chain methodology. Future NGC2 architecture will facilitate an Army that can accept more risks and sustain constant pressure via improved battlefield visibility.[23]

NGC2 will also support robotic and autonomous capabilities envisioned within the HMIF initiative, as demonstrated during March's Project Convergence Capstone 5 event.[24] While used during the live experimentation to conduct a live arms breach, these formations also have the potential to achieve recon "shut out," where every first direct or indirect fire contact with U.S. forces is aggressively lethal to enemy manned and unmanned assets and reconnaissance systems. The integration of C2, fires, and HMIF capabilities could also support U.S. Army and Marine maneuver

19 The Operational Arch. "The Transparent Battlefield w/TRADOC G2 (E38)." Apple Podcasts. February 15, 2025. https://podcasts.apple.com/ee/podcast/the-transparent-battlefield-w-tradoc-g2-e38/id1660058003?i=1000692458127

20 Siegner, Michael and Burns, Lt. Col. Michael. "Adaptive C2: Modernizing Army Command and Control." U.S. Army. June 10, 2025. https://www.army.mil/article/286205/adaptive_c2_modernizing_army_command_and_control

21 Carberry, Sean. "Special Report: Army's Project Convergence Goes on the Offensive." National Defense Magazine. March 18, 2024. https://www.nationaldefensemagazine.org/articles/2024/3/18/armys-project-convergence-goes-on-the-offensive

22 Statement by General James J. Mingus, Vice Chief of Staff, US Army. Senate Armed Services Committee. March 12, 2025. https://www.armed-services.senate.gov/imo/media/doc/statement_of_general_james_jmingususa.pdf

23 PEO C3N Public Affairs. "Army announces Next Generation Command and Control (NGC2)." U.S. Army. July 18, 2025. https://www.army.mil/article/287180/army_announces_next_generation_command_and_control_ngc2_prototype_award

24 Enoch, Sgt. Joseph and Miller, David. "Project Convergence Capstone 5 experiments at NTC." U.S. Army. April 3, 2025. https://www.army.mil/article/284397/project_convergence_capstone_5_experiments_at_ntc#:~:text=The%20Mission%20Command%20on%20The,Marita%20Schwab)%20VIEW%20ORIGINAL

units to mass fires in volume and in degrees of precision and intensity that are highly difficult for enemy main body units to endure. Finally, the interconnected NGC2 network of artificial intelligence (AI)-enhanced human C2, groups of sensors, swarms of expendable UGV and UAS assets, and magazines full of smart munitions teamed with human elements may enable U.S. maneuver units to execute the Decide/Detect/Deliver/Assess (D3A) process, reorient, and kill again at scales and speeds no near-peer threat can match. Furthermore, the "transparent battlefield" of tomorrow can only be fully exploited through the existence of a maneuver force designed from the ground up to exploit it through constant autonomous task reorganization. This would be in contrast to rapid cycles of UAS modification to improve battlefield outcomes, which are necessary in Ukraine but not optimal. The Army's pursuit of a much larger scope of effort in its ongoing transformation promises more. With its Transforming in Contact initiative, the Army is exploring a wide range of capabilities to help decide what that ultimately looks like. The notion of these transformed manned and unmanned formations operating under NGC2, all of which could be organized and reorganized several times in a single mission to outmatch an enemy's ability to adapt, is within the realm of the feasible.

Toward a New Way of Warfare

There are numerous appreciable benefits to adoption of a comprehensive, multi-domain approach to warfare that simply is not seen in the Russo-Ukraine war at scale. One could envision UASs operating on a large scale, beyond the squad-level deployment commonly observed in Ukraine. In the context of a U.S. military operation, these systems would all rest on the scaled deployment of autonomy, intended to be integrated across every tactical echelon, from squad to platoon, to company, battalion, and brigade. All would be used in substantial numbers, oriented to fight through and perform in a variety of conditions, and capable of advancing alongside mounted mobile maneuver forces.

The Transparent Battlefield: Next Generation Command and Control Architecture

Groups of robots coordinating, maneuvering, and working together as mission-driven autonomy, integrated under an NGC2 architecture, will unlock more battlefield capabilities than individual FPV drones striking individual targets. The mastery of this integrated, mission-oriented autonomy for multiple systems working together is where the U.S. way of war will increase tactical battlefield dominance. Robotic and autonomous platforms in the air, on the ground and in the sea, however, will likely not achieve their true potential until they operate under some new form of enhanced tactical unit level autonomy. This concept rationalizes the fact that the full capability of advanced robotics, enabled by modern software and communications systems, lies not in mere individual platform autonomy but rather through integration at the unit or organization level. Reconfigurable robotic and sensor assets, operating at formation level under an NGC2 architecture, will offer manned formations the potential to tailor and augment their supporting robotics packages to support each mission with the payloads and capabilities needed to operate effectively. This is far beyond anything seen in Ukraine today.

Rather than establishing a static front line with generally fixed command and control positions, as witnessed in Ukraine, the U.S. must envision a much more dynamic and adaptable force capable of graceful degradation – meaning the ability to absorb losses without complete system collapse – and reconstitution. The roles of these robotically integrated forces would encompass not only layered reconnaissance and strike UAS capabilities but also extensive collaborative swarming efforts to detect and track enemy targets. UGVs should also play a significant part in military operations, functioning autonomously across a range of air and ground logistical applications.

Autonomy-Enabled Logistics

Similarly, logistics missions would leverage autonomous tactical trucks along main and alternate supply routes, with smaller supply carriers managing supply pushes down to the last tactical mile. Aerial resupply UASs would keep remote units in the fight. This arrangement would ensure that even isolated allied forces maintain their operational capabilities and engagement superiority over their adversaries. Automated robotic supply distribution hubs would enable redundancies and disperse critical supply drops, expanding alternate supply routes and increasing the number of logistical depots. The enemy would face greater difficulty in targeting essential resources, which would enhance the operational range and tempo of U.S. battalions, brigades, and divisions.

Drone Integration into Maneuver Forces

U.S. manned reconnaissance and security forces can also benefit considerably from the utility of unmanned air and ground vehicles acting as expendable assets prominently positioned in front of maneuver forces. Unlike unmanned assets operating from fixed locations, layers of UAS and UGVs capable of integrated movement alongside manned armored vehicles would give their human teammates flexible and adaptive standoff, as they gain and maintain contact with encountered threats. These attritable robotic systems would make contact with the enemy first and grant commanders options and advantages in reconnaissance and screening missions by allowing for rapid replacement of autonomous systems in the event of loss. An additional layer of security would provide commanders with enhanced tactical options for repositioning their manned armored assets to positions of advantage and greater lethality. Integrating these systems into cohesive, well-trained Western formations would facilitate operations where robotic systems find, fix, disrupt, defeat and destroy enemy forces and then hand off that enemy to manned maneuver forces for culmination. In an operational context, this would represent a significant divergence from the simple attritional warfare currently observed

in Ukraine as U.S. forces would possess expanded capacity to exploit, pursue, and finish the fight.

Sensor-to-Shooter Pairing: The Integration of Autonomy Into Sensors and Fires and Effects Capabilities

Further, unmanned fire support platforms linked to sensors and electronic warfare assets could strategically engage and suppress enemy artillery and detection systems before they could get into position, thereby complicating adversarial counterbattery operations and increasing the sustainability of our tactical exchanges by essentially winning the first detection and first shot fight against enemy artillery. Ukrainian HIMARS may have accomplished impressive individual strikes early in the war, but an American division artillery group or Corps-level automated indirect artillery brigade, supported by automated resupply assets, could operate at scale 24/7; a deeply disruptive operational capability no peer competitor can yet deliver. Ukraine's attempted offensives in the southern Kherson region provide a case study demonstrative of how U.S. capabilities and doctrine might integrate drone warfare to differing effect.[25] Russian forces, with substantial time to prepare complex obstacles in depth, created defensive belts that proved nearly impenetrable to Ukraine's underequipped forces operating without sufficient combined arms support. U.S. forces, equipped with robust combat engineer assets and augmented with autonomous breaching packages for both light and heavy maneuver forces, would perform far differently. UASs would spot the breach points and target enemy assets operating in overwatch. UGVs and UASs would work together to reduce the obstacles, mark the lanes, and proof the passage points. When supported by robust close air support, precision artillery, adequate suppressive fires, and robotically integrated and equipped assault forces, U.S. maneuver forces would be capable of rapidly exploiting the breaches created by their automated engineering assets.

Incorporating Unmanned Systems Across the Joint Force

Of course, the Army's technological advances and changes in concepts of operations will occur alongside similar changes in the other services and in support of Combatant Command (COCOM) warfighting priorities.

Ukrainian maritime strikes via USV and UUV over the last four years have been impressive in driving off the Russian Black Sea fleet, hinting at the potential that larger, more advanced, and better integrated naval forces could have in dominating the battlespace. U.S. or NATO unmanned submersible vehicles and unmanned surface vessels could conduct a wide variety of surveillance and offensive operations against enemy ships, even exploiting maritime drone swarms for lethal effects. Additionally, unmanned systems will improve the efficiency and speed of logistical deliveries across both the EUCOM and INDOPACOM theaters, thereby mitigating the challenges posed by geographical distances and hostile targeting. This capability would transform operational ranges and ensure more reliable support throughout conflict theaters, moving beyond the limitations of resupply by manned surface vessels alone. Such innovations would allow for greater flexibility in countering anti-access and area denial strategies from U.S. adversaries.

The U.S. military must ensure it retains the ability of its fifth-generation air force, equipped with the latest advanced capabilities, to effectively defeat enemy air defenses and ensure the kind of reliable close air support critical to enabling ground maneuvers. In NATO's most recent Hedgehog 2025 exercises in the Baltics, the absence of integrated close air support with ground assets appears to have led in no small part to failures by some of the NATO ground maneuver employed in simulated combat against Ukrainian drone operators.[26]

Additionally, incorporating stealth fighters and bombers capable of engaging targets without detection or interdiction will fundamentally alter the landscape of future conflicts just as much as anything witnessed in Ukraine. This is an important dimension for air superiority, given that the developing manned-unmanned teaming systems and operational concepts emerging in the U.S. Air Force are yet to be integrated into Russian or Chinese air operations. Further, the integration of ISR UASs with strike UASs and precision artillery as seen in Ukraine can yield new operational advantages; however, they must be adapted to the specific characteristics of U.S. artillery doctrine.

As has been repeatedly demonstrated in Ukraine, any efforts to integrate UASs into warfighting doctrine and C2 architecture will be highly dependent on mitigating vulnerability to electronic warfare and cyberattacks. Russian and Ukrainian forces alike have shown that relatively low-cost jamming, spoofing, and cyber effects can significantly degrade the effectiveness of otherwise capable unmanned systems. For the Joint Force, this underscores the need to treat cyber resilience and electromagnetic spectrum operations as foundational requirements rather than enabling add-ons. To protect NGC2's "robust data and cloud backbone"[27] will require open architectures that allow for iterative upgrades and rapid software improvements, along with greater integration with U.S. cyber forces.

25 Watling, Dr. Jack, Danylyuk, Oleksandr, and Reynolds, Nick. " Preliminary Lessons from Ukraine's Offensive Operations, 2022–23." RUSI. July 18, 2024. https://www.rusi.org/explore-our-research/publications/special-resources/preliminary-lessons-ukraines-offensive-operations-2022-23

26 Melchior, Jillian Kay. "NATO Has Seen the Future and Is Unprepared." Wall Street Journal. February 12, 2026. https://www.wsj.com/opinion/nato-has-seen-the-future-and-is-unprepared-887eaf0f

27 Statement by General James J. Mingus, Vice Chief of Staff, US Army. Senate Armed Services Committee. March 12, 2025. https://www.armed-services.senate.gov/imo/media/doc/statement_of_general_james_jmingususa.pdf

Special operations forces (SOF) will also incorporate unmanned systems in distinct ways mirroring both Ukraine's heavy use of drones for ISR and targeting missions and its short iteration cycles. SOF use of drones will likely lean on low-signature platforms and rapid modifications rather than standardized systems. In fact, SOCOM released a solicitation in November aligned with these priorities, seeking support to train operators to both build and fly FPV drones.[28]

Conclusion

The conflict in Ukraine offers valuable insights, which must be contextualized within the capabilities, training, and doctrines of Western militaries, particularly those of the U.S. Armed Forces. The importance of the emerging capabilities coming out of Ukraine cannot be dismissed, and technology developers and military planners must also ask "What comes next?" This paper is an effort to begin a discussion of what U.S. incorporation of these valuable insights and robotic capabilities into a contemporary conflict might resemble.

It would certainly differ from operations in Ukraine in important ways, given the presence of distinct technologies and capabilities among U.S. service branches, which are absent from current considerations. Therefore, it is crucial to explore how the U.S. can harness these emerging technologies to enhance and exploit the unique capabilities of its military, particularly the Army, which would bear the primary responsibility for executing any major land war operations in Europe or Asia.

A fair and critical assessment should consider whether the U.S. should seek capabilities that address what is needed to fight in conflicts both in Europe as well as the INDOPACOM region, filtering through the lens of U.S. military operational doctrines and the likelihood the U.S. will fight across a global list of probable conflict locations. Any set of solutions must therefore be flexible enough to accommodate those greater demands. Additionally, while this paper considers future objective capabilities and situations, further analysis of the evolutionary path to achieve these objectives would be valuable and should be discussed separately.

Ultimately, it is imperative to explore these experimental systems and new concepts of operation to preserve U.S. strategic and tactical air superiority alongside U.S. dominance on the ground. Any comprehensive future force development plan for the U.S. military must seamlessly integrate lessons from the Ukrainian conflict with the distinct requirements and capabilities of American Joint operations while avoiding simplistic one-for-one adaptations of observed practices or parochial, single-branch-of-service approaches. Demonstrating the advanced integration of robotics and autonomous systems to American strengths and legacy capabilities may be the very thing that creates the more lethal and agile force that deters future aggression by peer competitors. The future of the U.S. military will not be defined by exact replication of the Ukrainian military, but by how effectively it integrates robotics and autonomous systems into its own unique way of war.

28 U.S. Special Operations Command. "Training in the fabrication and flying of First Person View (FPV) small, unmanned aircraft system (sUAS)." Sam.gov. https://sam.gov/workspace/contract/opp/a05ab6fcace54e85b37b4b4288c2b423/view

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