



From littoral zones to cyberspace, modern warfare is shaped by disruptive innovations such as autonomous drones, hypersonic aircraft, human augmentation, weaponized social media, and transparent battlespaces. (U.S. Army photo by Spc. Alyssa Robertson)

# Battlefield Now: Emerging Threats and Technologies

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## Introduction

By Retired Command Sgt. Maj. Dr. Robert Nelson

**T**he multi-domain battlefield is a complex and dynamic operational environment (OE) undergoing a profound transformation driven by rapid advancements in technology, pervasive surveillance, and escalating ethical challenges.

From littoral zones to cyberspace, modern warfare is shaped by disruptive innovations like autonomous drones, hypersonic aircraft, human augmentation, weaponized social media, and transparent battlespaces.

These developments, coupled with the return of high-casualty attrition warfare, challenge traditional military doctrines and ethical frameworks, requiring adaptive strategies, robust countermeasures, and international cooperation to maintain strategic superiority.

NCOs play a critical role in determining how the Army overcomes multidomain battlefield challenges. As you read, consider what you'd do if you were faced with these multi-domain challenges during your next deployment. It's essential to consider what actions leaders must take to succeed in this battlespace, as the challenges aren't waiting for the next deployment, they're here now.

## Drones and Littoral Space Challenges

By Retired Sgt. Maj. Robert Shawlinski

Rapidly evolving drone technology has reshaped military operations, particularly in littoral zones, coastal regions vital for maritime sustainment, and amphibious operations.

These areas, characterized by complex geography, shallow waters, dense maritime traffic, and congested electromagnetic environments, pose unique challenges. Adversaries in this environment are increasingly deploying autonomous drone swarms and artificial intelligence (AI)-enabled underwater vehicles capable of sophisticated communication, coordination, and targeting.

These advancements threaten traditional naval dominance, as evidenced in conflicts like the Russo-Ukrainian War and Red Sea tensions, where low-cost and advanced drones, including AI-equipped smart drones, underwater reconnaissance drones, and "super swarms," proved extremely effective and difficult to counter (Forum Staff, 2024).



The rapid evolution of drone technology has reshaped military operations, particularly in littoral zones, coastal regions vital for maritime sustainment and amphibious operations. (U.S. Navy photo by Eddie Green)

Smart drones (human out-of-the-loop, or human on-the-loop) enhance precision and situational awareness but are vulnerable to electronic warfare and cyberattacks (Wolfe, 2019).

Autonomous underwater vehicles (AUVs) extend naval operations into previously inaccessible domains, offering intelligence and offensive capabilities but they face challenges in underwater communication, detection, and security (InsideFPV, 2025).

Countering these threats requires a multi-layered defense strategy, integrating kinetic interceptors, directed-energy weapons, and soft-kill systems like RF jammers (Khawaja et al., 2022). Strategic alignment of counter-drone innovations is essential to avoid redundancy and optimize resources.

## Nuclear Torpedoes in the Littoral Battlespace

By Retired Sgt. Maj. James Perdue



Nuclear armed torpedoes represent a new and formidable threat in littoral warfare, blending tactical utility with strategic deterrence (Siu, 2022; Kaur, 2023). (U.S. Navy photo by Petty Officer 1st Class Charles J Scudella III)

Nuclear bombs are no longer restricted to bomber or missile delivery. Nuclear armed torpedoes represent a new and formidable threat in littoral warfare, blending tactical utility with strategic deterrence (Siu, 2022; Kaur, 2023).

Capable of delivering devastating underwater attacks, these weapons endanger naval and amphibious forces operating near shorelines and in the deep. Their effects, shock waves, water column displacement, and radioactive fallout, threaten both military and civilian infrastructure, disrupting sea lines of communication and complicating evacuation efforts (Joint Chiefs of Staff, 2023; Glasstone & Dolan, 1977).

Strategically, nuclear torpedoes enhance adversarial anti-access/area-denial (A2/AD) capabilities, restricting U.S. amphibious operations and requiring integrated planning across joint force components (Clark et al., 2018).

Commanders must incorporate nuclear response policies, escalation management, and deterrence signaling into contingency plans to preserve freedom of maneuver.

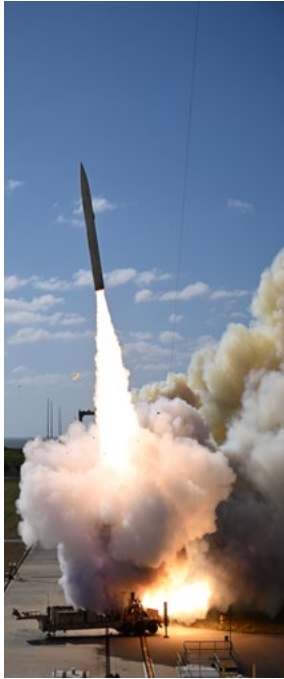
Ground forces operating in contaminated environments need enhanced decontamination protocols and protective measures (Kristensen & Norris, 2018).

As nuclear torpedoes blur the line between conventional and strategic weapons, they demand flexible, survivable, and technologically adaptive force structures to rethink traditional littoral warfare paradigms (Office of the Secretary of Defense, 2020; Siu, 2022).

## Hypersonic Aircraft in the Air Warfighting Domain

By Retired Sgt. Maj. James Perdue

Hypersonic technology, capable of exceeding Mach 5, five times the speed of sound, is revolutionizing air warfare by offering unmatched speed, range, and maneuverability (Thibert, 2024).



Hypersonic technology, capable of exceeding Mach 5, is revolutionizing air warfare by offering unmatched speed, range, and maneuverability (Thibert, 2024). These systems enable rapid global strikes and enhanced missile survivability in contested environments, outpacing current air defense systems (Besser & Göge, 2017). (Photo courtesy of Office of the Secretary of War Public Affairs)

survivability, and precision to reshape global deterrence and strategic competition.

### Loitering Munitions

By Sgt. Maj. Benjamin Pingel

Loitering munitions, often called kamikaze or suicide drones, are unmanned aerial systems designed to loiter (drift) over target areas before executing precise strikes.

Their strategic significance surged during conflicts like the 2020 Nagorno-Karabakh War, the Russo-Ukrainian War, and Israel-Hamas hostilities (Deveraux, 2022; Melville & Freebairn, 2024).

These systems enable rapid global strikes and enhanced missile survivability in contested environments, outpacing current air defense systems (Besser & Göge, 2017). Their unpredictable, nonlinear flight paths make detection and interception challenging, rendering them ideal for penetrating fortified defenses and delivering precise strikes from standoff distances (Esposito, 2021).

However, hypersonic weapons compress decision-making timelines, increasing the risk of misjudgments and unintended escalation. This requires updated doctrines, improved command-and-control (C2) systems, and potential arms control agreements.

As global powers like China and Russia develop hypersonic capabilities, the U.S. must prioritize innovation to maintain strategic balance (White, 2025). Hypersonic systems are redefining air combat, merging speed,

Modern loitering munitions vary widely in range, endurance, and warhead types, with systems like Israel's Harop, which is capable of loitering for up to nine hours, overwhelming air defenses, and targeting ground assets effectively (Melville & Freebairn, 2024).

These munitions, often man-portable and deployable by small units, challenge assumptions about deep strike capabilities, armor survivability, and traditional indirect-fire systems (Deveraux, 2022).

Their integration of autonomous functions raises ethical concerns, particularly regarding human targeting and civilian risks (Atherton, 2021). Countermeasures, like advanced radar, electronic warfare tactics (e.g., GPS spoofing, frequency jamming), and decoys, are critical as these systems proliferate among state and non-state actors (Melville & Freebairn, 2024). International regulation, such as mandating human-in-the-loop control, is urgently needed to mitigate indiscriminate harm (Atherton, 2021).



Loitering munitions, often man-portable and deployable by small units, challenge assumptions about deep strike capabilities, armor survivability, and traditional indirect-fire systems (Deveraux, 2022). (U.S. Army Photo by Sgt. Cody Nelson)

### Adaptive Camouflage

By Retired Sgt. Maj. Cregg Cannon

Adaptive camouflage is a type of camouflage that changes based on its surroundings. BAE Systems developed its version of this technology under its ADAPTIV system, an adaptive camouflage that enhances survivability and enables forces to evade infrared technology (Adaptiv, n.d.).

Unlike traditional camouflage, ADAPTIV uses lightweight hexagonal pixels powered by vehicle systems to mask or disguise thermal signatures, making armored vehicles blend into the terrain or appear as smaller

civilian vehicles. This technology reduces detection range and enhances friend or foe (IFF) identification capabilities (Mraz, 2011).

Mounted on ballistic plates, approximately 450 metal pixels per vehicle side are controlled via a semiconductor-based heating and cooling system. An onboard library allows crews to program signatures for wooded, desert, or urban environments (Adaptiv, n.d.).

In contested OEs, where enemies use advanced sensors and long-range fires, adaptive camouflage provides a critical survivability advantage, enabling forces to engage without compromising their position during day or night operations (Department of the Army, 2025a; Department of the Army, 2025b).



Advancements in exoskeletons, genetic engineering, and cyborg technologies are transforming warfare by enhancing Soldier performance across all domains. (U.S. Army photo by Ron Carty)

## Exoskeletons, Genetic Engineering, and Cyborgs

By Sgt. Maj. Fabio Lusiani, Italian Army

Advancements in exoskeletons, genetic engineering, and cyborg technologies are transforming warfare by enhancing Soldier performance across all domains.

Exoskeletons, such as the U.S. TALOS suit, boost mobility, endurance, and strength, allowing Soldiers to carry heavier loads and sustain prolonged operations (McLeary, 2019).

Near-peer competitors like China and Russia are developing similar systems, escalating the global race for human augmentation (Mittal, 2025; McDermott, 2020).

Genetic engineering uses tools like Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR-Cas9), enable DNA modifications to enhance physical and cognitive abilities, such as endurance, strength, and disease resistance (Doudna & Sternberg, 2017; Shah, 2019).

Cyborg technologies integrate electronic components into the human body, improving intelligence gathering and combat efficiency through neural implants and sensory enhancements (Ritharson, 2023; Emanuel et al., 2019; Kania, 2020).

However, becoming a cyborg is not as unstoppable as it sounds, since these technologies introduce vulnerabilities to cyberattacks and raise ethical concerns about coercion, autonomy, and long-term societal impacts (Abed et al., 2023; Henschke, 2017; National Human Genome Research Institute, 2017).

To address these challenges, military doctrine must incorporate robust cybersecurity, international regulations, and ethical oversight (Snyder & Heitzenrater, 2024; Henschke, 2017).

Counter-technologies like electromagnetic pulse (EMP) weapons and adaptive training programs are essential to neutralize adversary enhancements (Abed et al., 2023).

Collaborating with allies to monitor and regulate these technologies will help maintain strategic superiority in an increasingly complex battlefield (Corbett & Danoy, 2025; Billing et al., 2021).

## Human Bio Enhancements

By Retired Sgt. Maj. Jesus Gonzalez

Human bioaugmentation, historically used to enhance performance, is evolving with modern “smart drugs” or nootropics (Sutherland, 2024). These



Special Operations Forces (SOF) are exploring performance-enhancing supplements/drugs (PES/Ds) to extend resilience in combat, despite ethical dilemmas (Wigger & Oelschlagler, 2017). (U.S. Air Force photo by Senior Airman Kendra A. Ransum)

supplements, including vitamin B12, guarana, and salt mixtures, enhance alertness, energy, and cognitive function, offering alternatives to illegal substances (Davidson, n.d.).

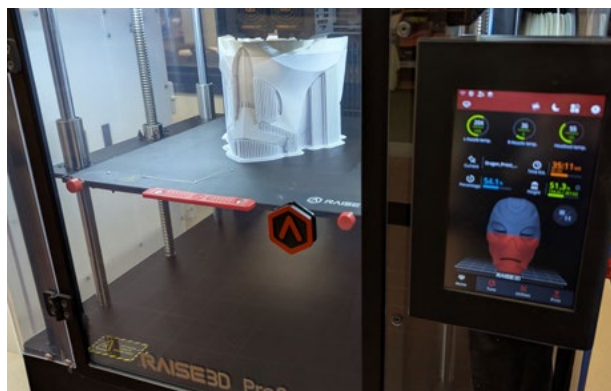
Special Operations Forces (SOF) are exploring performance-enhancing supplements/drugs (PES/Ds) to extend resilience in combat, despite ethical dilemmas (Wigger & Oelschlager, 2017).

Adversaries, like China, are reportedly advancing genetic enhancements to create “super soldiers” with superior cognitive and physical abilities (Morgan, 2020).

The U.S. must reconsider ethical and medical implications to remain competitive, balancing risks with the need to counter near-peer threats. Continued research and policy development are critical to responsibly integrating bio-enhancements into military operations.

## Non-State Actors: Deepfakes and Additive Manufacturing

By Retired Sgt. Maj. Vernon Yates



Additive manufacturing, including 3D and 4D printing, enables non-state actors to produce untraceable weapon components, such as improvised explosive device (IED) parts that change shape for effective smuggling and detection avoidance (Department of Homeland Security, 2022).

Non-state actors (NSAs), as well as conventional enemies, have been exploiting accessible technologies like AI-generated deepfakes and additive manufacturing to disrupt military and political environments.

Deepfakes, mimicking authentic communications, spread disinformation and sow confusion, like the fabricated video of Ukraine’s president urging surrender (Department of Homeland Security, 2022; Kreps, 2021). Detection remains challenging, requiring advanced authentication tools and heightened public awareness (Kreps & Li, 2022).

Additive manufacturing, including 3D and 4D printing, enables NSAs to produce untraceable weapon components, such as improvised explosive device (IED) parts that change shape for effective smuggling and detection avoidance (Department of Homeland Security, 2022).

These dual-use technologies are commercial availability, complicating countermeasures, and necessitating coordinated intergovernmental and interagency efforts between governments, industry, and civil society to enhance detection, attribution, and regulation.

## Social Media as a Weapon in Modern Global Conflicts

By Sgt. Maj. Danny Del Castillo

Social media has evolved into a potent weapon, enabling state and non-state actors to achieve strategic goals through information warfare, intelligence gathering, strategic influence, and psychological operations (PSYOP) (Joint Chiefs of Staff, 2022).

Russia’s disinformation campaigns, like those used during the 2016 U.S. presidential election, and China’s “Three Warfare” strategy in the South China Sea exemplify how platforms like X, TikTok, and WeChat shape narratives and destabilize adversaries (Prier, 2017; Morgan et al., 2021; Cook, 2022).

Intelligence gathering through open-source intelligence (OSINT) and human intelligence (HUMINT) routinely exploits social media posts to reveal sensitive military details (Rid & Hecker, 2009; Brennan et al., 2023).

Strategic influence, like in Ukraine’s “Ghost of Kyiv” narrative, boosts morale and garners international support (Walker, 2024; Beauchamp-Mustafaga, 2024).

PSYOP campaigns, like Russia’s fake surrender announcements in Ukraine, undermine public will (Katikar, 2024). Countering these threats requires enhanced digital literacy, cybersecurity, and international cooperation to regulate malicious use.



Social media has evolved into a potent weapon, enabling state and non-state actors to achieve strategic goals through information warfare, intelligence gathering, strategic influence, and psychological operations (PSYOP) (Joint Chiefs of Staff, 2022). (U.S. Army National Guard photo by Staff Sgt. Terry Rajsombath)



Clyde Stanfield, left, and Sgt. Joshua McKee, Michigan Army National Guard, work in the Orbital Effects office at the Camp Grayling Maneuver Training Center, Michigan, Jan. 28, 2021. The space domain, starting at the Kármán line (where Earth's atmosphere ends and space begins), has shifted from a secure frontier to a contested environment, entering the "Anti-Satellite (ASAT) Age" (Cooper, 2024; Joint Chiefs of Staff, 2023). (National Guard photo by Senior Airman Tristan Viglianco)

## Threats in the Final Frontier: The Space Domain

By Sgt. Maj. Jorge Rivera

The space domain, starting at the Kármán line (where Earth's atmosphere ends and space begins), has shifted from a secure frontier to a contested environment, entering the "Anti-Satellite (ASAT) Age" (Cooper, 2024; Joint Chiefs of Staff, 2023).

It faces threats from satellites and infrastructures in its three highly contested segments: land, link, and space (Department of the Army, 2019b, pp. 1-11, 1-12).

The land segment includes ground infrastructure and personnel; the link segment involves electromagnetic data transmission; and the space segment spans satellites from Low Earth Orbit to Highly Elliptical Orbit (Department of the Army, 2019b).

Space is no longer an uncontested sanctuary. Non-kinetic threats like jamming, spoofing, dazzling, and cyber interference by states like China, Russia, and non-state actors dominate, blurring peace and conflict lines (Cooper, 2024).

China's 2007 and 2013 ASAT tests, 2024 on-orbit maneuvers, and dual-use satellites highlight its capabilities (Burnham, 2025). Its Aerospace Force and 2050 space leadership plan, including lunar bases with Russia, signal their aggressive military ambitions (Shoeman & Liu, 2024). China further seeks to shape cislunar (the moon) norms for strategic dominance.

As offensive tactics in space evolve, they are likely to parallel those employed in terrestrial

conflict, including swarming, direct and indirect attacks, cyber intrusions, jamming, dazzling, spoofing, and signal blocking (Cooper, 2024).

Space threats will mirror terrestrial tactics, requiring land forces to understand space dependencies and capabilities (Cooper, 2024).

Commanders must use center of gravity analysis to target enemy vulnerabilities and protect friendly systems. Training for degraded environments, using analog methods or fiber-optic networks, safeguards resilience in other domains (Epstein, 2025).

In addition, the U.S. must bolster land segment defenses, develop non-kinetic countermeasures, and counter China's cislunar influence to maintain U.S. space superiority.

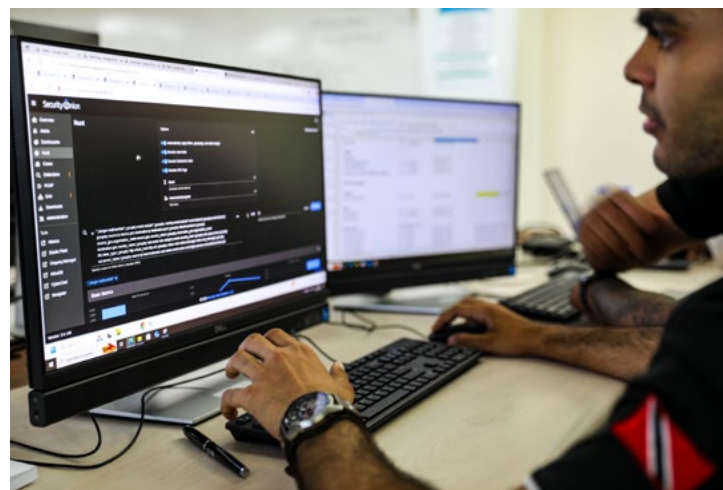
## The Cyber Domain: Emerging Convergence Challenges on the Modern Battlefield

By Retired Command Sgt. Maj. Richard Adams

The cyber domain is critical for achieving convergence, employing synchronized multi-domain capabilities to target decisive points (Department of the Army, 2025).

Treating Department of Defense (DoD) networks and data as foundational weapon systems enhance decision-making and operational effectiveness (Fogarty, 2023). However, achieving convergence requires concerted planning, coordination, and intelligence integration across all U.S. Armed Forces (Brown, 2025).

Challenges include synchronizing complex operations in dynamic OEs and countering sophisticated cyber threats. Robust cybersecurity measures, such as



Treating Department of Defense (DoD) networks and data as foundational weapon systems enhance decision-making and operational effectiveness (Fogarty, 2023). However, achieving convergence requires concerted planning, coordination, and intelligence integration across all U.S. Armed Forces (Brown, 2025.) (U.S. Army photo by Sgt. Timicia GeorgePetrus)

advanced encryption and anomaly detection, are essential to protect networks.

As adversaries exploit cyber vulnerabilities, joint force collaboration and intelligence-driven operations will be crucial to maintain dominance in the cyber domain.

## Intelligence and Targeting Analysis in the Contemporary OE

By Sgt. Maj. Antonio Pires, Brazilian Army

Targeting analysis in the modern OE is increasingly complex due to adversaries' use of advanced technologies like drones, cyber warfare, and electronic warfare (EW) (Rickli & Mantellassi, 2024).

Intelligence preparation of the operational environment (IPOE) drives targeting by creating prioritized target lists, updated continuously to reflect enemy movements (Department of the Army, 2019a). Tools like the CARVER matrix, while effective, are time-consuming and require experienced staff members (Department of the Army, 2019a).

AI enhances targeting efficiency by integrating sensor data and providing near-real-time analysis, surpassing human capabilities (Bhattacharjee, 2023; Fazekas, 2022).



Soldiers operate an unmanned aerial system and call for artillery at Fort Indiantown Gap, Pennsylvania, July 28, 2025. AI enhances targeting efficiency by integrating sensor data and providing near-real-time analysis, surpassing human capabilities (Bhattacharjee, 2023; Fazekas, 2022). (U.S. Army National Guard photo by Maj. Travis Mueller)

As technology inflates the number of targets, AI-driven solutions are critical to maintain lethality and precision, ensuring U.S. forces can effectively counter sophisticated threats in contested environments.



From littoral zones to cyberspace, modern warfare is shaped by disruptive innovations such as autonomous drones, hypersonic aircraft, human augmentation, weaponized social media, and transparent battlespaces. (U.S. Army photo by Spc. Nicole Miller)

## The Transparent Battlespace

By Sgt. Maj. Daniel Shealy

The modern battlespace is increasingly transparent because of pervasive surveillance and advanced sensor technologies, fundamentally challenging traditional principles of war such as mass and surprise.

In May 2022, Ukrainian forces used drone surveillance to devastating effect, annihilating a Russian motorized battalion attempting a river crossing over the Donets River, destroying more than 70 armored vehicles and causing approximately 500 casualties.

This success stemmed from identifying the target location, enabling precise artillery strikes (Garnier & Neron-Bancel, 2024). The proliferation of diverse sensor systems in conflicts like Ukraine highlights the difficulty of concealing troop movements, rendering tactical surprise nearly obsolete (Garnier & Neron-Bancel, 2024).

Battlefield transparency is amplified by technologies such as commercial space platforms, the Internet of Things (the networking capability allowing information to be sent to and received from objects and devices using the Internet), autonomous systems, and real-time data fusion, making it nearly impossible for large formations to remain undetected (Transparency and Training Command [T2COM], 2024, p. 11).

As a result, "if a target can be seen, it can be killed" (T2COM, 2024, p. 11).

Emerging detection methods, including optical, thermal, electronic, acoustic, and even quantum signatures, further erode concealment capabilities (Antal, 2023).

These advancements threaten offensive and defensive operations survivability, particularly at machine speeds, and challenge the effectiveness of traditional cover, concealment, and stealth measures.

To adapt, the U.S. Army is prioritizing concealment strategies and innovative training. Combat training

centers at Fort Irwin, California, and Fort Johnson, Louisiana, are developing scenarios that simulate sensing saturation, encouraging commanders to minimize physical and electronic footprints (Cavallaro, 2024).

Modern Soldiers face multi-dimensional threats, including persistent surveillance, unmanned aerial system attacks, EW, and social media-based influence operations. These challenges demand new approaches to operations security, force protection, and training to ensure survivability in a battlespace where constant observation is the norm (Cavallaro, 2024).



In May 2022, Ukrainian forces used drone surveillance to annihilate a Russian motorized battalion attempting a river crossing over the Donets River, destroying more than 70 armored vehicles and causing approximately 500 casualties. Military leaders must develop ethical frameworks to navigate the dilemma of attrition warfare, balancing operational priorities with moral obligations. (Creative Commons photo by armyinform.com.ua, the official online media outlet of the Ministry of Defense of Ukraine)

## The Ethics of Attrition Warfare

By Sgt. Maj. Lisa Walker

Modern warfare has seen a resurgence of attrition-based conflicts, as in the Russia-Ukraine War, which echoes World War II's high casualty rates.

In 2024, Russia suffered approximately 434,000 casualties, including 150,000 deaths, equivalent to losing seven to nine U.S. Army divisions (The Guardian, 2025; Feickert, 2025).

Ukraine also endured significant losses, underscoring the scale of modern attrition warfare. Unlike the Global War on Terror (GWOT), where the U.S. benefited from air superiority, rapid medical evacuations, and advanced trauma care, resulting in a case fatality rate of 9.4% from 2001 to 2011, today's contested battlefields feature sophisticated defenses that hinder timely evacuations (Eastridge et al., 2012).

The Army's Warrior Ethos, which prioritizes never leaving a fallen comrade behind, was feasible during GWOT because of robust evacuation capabilities. However, high-casualty scenarios in modern conflicts challenge this commitment, as rapid rescues are often impossible.

Military leaders must develop ethical frameworks to navigate these dilemmas, balancing operational priorities with moral obligations. Training programs that build resilience and ethical decision-making skills are essential to prepare Soldiers and commanders for the harsh realities of attrition warfare, ensuring both operational success and adherence to ethical standards.

The multi-domain battlefield is a complex and dynamic OE undergoing a profound transformation driven by rapid advancements in technology, pervasive surveillance, and escalating ethical challenges.

From littoral zones to cyberspace, modern warfare is shaped by disruptive innovations such as autonomous drones, hypersonic aircraft, human augmentation, weaponized social media, and transparent battlespaces.

These developments, coupled with the return of high-casualty attrition warfare, challenge recent traditional military doctrines and ethical frameworks, requiring adaptive strategies, robust countermeasures, and international cooperation to maintain strategic superiority.

## Conclusion

The world is complex, and the multidomain battlefield is, and will continue to challenge the Army in ways that have yet to be considered. Our adversaries are weaponizing technology to confront our Army and nation with complex dilemmas and emerging challenges.

However, regardless of the challenges that arise, one thing remains true: NCOs will be deeply involved in overcoming them. Are you ready for the challenge? ■

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## Authors' Note

This article provides a cursory analysis of emerging threats, technologies, and ethical dilemmas, while glossing over their implications across multiple domains and offering insights into how the U.S. will fight both now and in the future. The purpose of this piece is to spark curiosity and encourage NCOs to dig deeper and research some of these topics. The original contributions contained in this project have been significantly summarized. The full submissions may be obtained by emailing the authors directly through the "army.mil" Global Address List.

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