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THE EVOLUTION OF AERIAL THREATS AND THEIR IMPLICATIONS ON ARMY OPERATIONS

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ABSTRACT

The increasing evolution of aerial threats presents an ever-growing challenge for force protection. The accelerated development of unmanned aerial systems (UAS) and long-range precision strikes highlights the urgency of developing comprehensive air defense doctrines. This paper explores the nature of these threats and their implications, particularly in the Ukrainian theater of operations, where emerging threats from UAS, artillery, and combined arms tactics are increasingly being used to overwhelm the maneuver of military forces and assets. By leveraging historical data, threat analyses, and military doctrines, this article aims to highlight how armed forces can be better prepared to counter these threats, focusing on leadership, training, and the integration of technologies such as short-range air defense for maneuver (M-SHORAD). The joint nature of military actions will need to manifest as swiftly as possible, not only at the strategic and operational levels but starting with small group, crew-aircraft combinations.

KEYWORDS: air defense, Ukraine conflict, SHORAD, UAS

1. Introduction

If technological evolution with potential military applications is not subjected to adequate strategic analysis, and its implications for battlefield configurations are neglected from a tactical adaptation perspective, the current situation of the Russian armed forces in Ukraine could become a scenario applicable to any army. Such a scenario exemplifies, for instance, the inability to provide a functional and coherent response to drone attacks conducted by Ukrainian forces. The unprofessional and improvised response to drone strikes, manifested through ad hoc attempts to protect military equipment and soldiers' lives, offers a valuable lesson for any military structure.

The study utilizes documentary analysis to gather insights from military manuals, recent reports, and doctrinal publications, especially those relevant to the conflict in Ukraine.

Traditionally, achieving air superiority and supremacy on the battlefield is a key condition in NATO military operations, allowing ground forces to focus on their missions with minimal concern for aerial threats. However, this assumption is no longer valid in light of the new capabilities demonstrated by adversaries like Russia, especially in the Ukrainian theater of operations. Russian military doctrine has shifted, incorporating a heavy reliance on unmanned systems, long-range artillery, and cluster munitions, making it clear that NATO must adapt its air defense strategies to remain effective on the modern battlefield. The operation of drones without the need for a takeoff landing runway, which could have been neutralized, changes the evaluation criteria of air supremacy, as it is currently impossible to maintain complete control of the airspace against such systems.

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This article describes current aerial threats and highlights the necessary steps to mitigate their effects, focusing on the integration of systems such as M-SHORAD and the development of effective combined arms tactics for air defense (CAFAD). By reviewing the literature on aerial threats, including unmanned systems, helicopters, and long-range precision strikes, this article aims to provide context for the changing challenges faced by armed forces.

2. Unmanned Aerial Systems (UAS)

The rapid improvement of unmanned aerial systems (UAS) has become a significant threat to ground forces. The Russian armed forces, for example, have prioritized the development and deployment of UAS capabilities, as seen during the conflicts in eastern Ukraine (2008-2016). A wide spectrum of UAS has been employed, ranging from high-altitude military systems to commercial quadcopters, effectively used for surveillance and directing artillery strikes. This capability allows Russian forces to carry out long-range precise attacks on critical assets, including fuel depots, ammunition stockpiles, and troop concentrations.

The conflict in Ukraine has highlighted the evolving role of unmanned aerial systems (UAS) as both offensive and defensive assets in modern warfare. In 2022, Iran began supplying drones to Russia, which added a critical layer to Russia's unmanned capabilities in response to Ukraine's robust air defense strategies (Eslami, 2022). This influx of drones has allowed Russian forces to target Ukrainian infrastructure, but Ukraine's air defense forces have effectively countered many of these attacks, maintaining control over critical areas of airspace. Tactical aviation in Ukraine has continued to adapt, with Ukrainian forces successfully utilizing both traditional and advanced air defense systems to challenge Russia's aerial operations, ultimately preventing Russia from establishing air superiority (Horobets, 2023). These developments demonstrate the pivotal role that UAS technology plays in shaping the strategic outcomes of modern conflicts, particularly in scenarios where airspace control is contested.

The Ukrainian military's resilience in the air war did not only depend on defensive tactics but also on innovative uses of its own air capabilities to disrupt Russian aerial offensives. Ukrainian forces have deployed tactical aviation to provide critical air support while simultaneously employing real-time intelligence to mitigate Russian attacks on command centers and logistical hubs (Dzyubenko et al., 2023). Ukrainian drones have been used effectively to monitor Russian movements and direct artillery strikes, demonstrating how UAS can provide a tactical advantage on the battlefield. Moreover, the capability to monitor airspace in real time, facilitated by advanced online platforms and technical monitoring systems, has given Ukrainian forces a substantial strategic advantage, allowing them to anticipate and respond quickly to Russian aerial threats (Neto, 2022). This coordination of aerial assets with ground operations exemplifies the importance of maintaining a flexible and integrated approach to air defense in contemporary conflict environments.

In addition to tactical adjustments, the strategic implications of NATO's support for Ukraine have influenced the air defense dynamics in Eastern Europe. In response to the Russian Federation's aggression, NATO has coordinated military assistance, including the provision of advanced air defense systems, to bolster Ukraine's defensive capabilities (Rublovskis, 2023). This support has not only reinforced Ukraine's immediate defense but has also enhanced NATO's posture in Eastern Europe, signaling a broader commitment to counter potential Russian aggression in the region. Additionally, Russian aerial strategies, heavily reliant on Soviet-era technology, have proven to be limited in effectiveness. Despite their substantial number of airborne missile

attacks, Russian forces have struggled to overcome Ukraine's air defenses, underscoring the challenges of achieving air superiority in a well-defended theater (Korunov et al., 2023). Together, these factors highlight the complex interplay of tactical adaptation, technological support, and strategic alliances shaping the air defense landscape in the Ukraine conflict.

The advantages UAS provide on the modern battlefield are numerous, but the major impact comes from their real-time surveillance capabilities of enemy positions, enabling long-range precision fire with alarming accuracy. Russia's new-generation warfare manual underscores how Russian UAS operators use real-time video streams to adjust artillery strikes, extending operational reach and providing critical battlefield information. These capabilities have the potential to paralyze force maneuvers by targeting command centers, logistics nodes, and reserve units.

A critical challenge associated with UAS is their ability to evade traditional air defense systems. Many UAS platforms, especially small commercial drones, are difficult to detect with conventional radar systems due to their small radar signature and their ability to fly at altitudes below ground-based sensor detection thresholds. This challenge is compounded by the increasing use of UAS swarms, which oversaturate current air defense systems designed to counter a limited number of aerial threats at a time. The proliferation of UAS presents a major challenge to achieving air supremacy. These unmanned systems are increasingly being used to target objectives behind the frontlines, making them a formidable threat to troops relying on tactical dispersion and camouflage for survival.

UAS systems, combined with long-range artillery, extend the operational reach, utilizing drones to identify command posts or troop concentrations. In Ukraine, Russian armed forces have demonstrated the capability to track and strike a target within 10-15 minutes of detection, using indirect fire support to inflict significant damage. Analysis by specialists from the Asymmetric Warfare Group (AWG, 2016) highlights how artillery and rocket fires, often directed by UAS, make tactical dispersion and camouflage essential for countering these threats.

In terms of direct attacks, UAS can also be used as weapons. These direct attacks have the potential to overwhelm current air defense systems, especially when combined with other sensor saturation elements, such as decoys or false targets. By deploying incendiary or fragmentation munitions over troop concentrations, UAS can cause significant casualties, particularly against units lacking adequate air defense systems.

The implications of these attacks are vast. As adversaries continue to develop more advanced UAS platforms capable of ISR (intelligence, surveillance, and reconnaissance) missions and direct attacks, NATO must adapt its air defense strategies to mitigate these threats. In addition to traditional air defense, electronic warfare plays a crucial role in countering modern aerial threats, particularly UAS. Many UAS systems rely on data communications, GPS, and other electronic signals to function effectively. Disrupting these signals through electronic means can disable UAS functionality and reduce their battlefield effectiveness.

Electronic warfare tools, such as jamming systems, can be employed to interrupt UAS communications, forcing these platforms to lose control and become ineffective. Additionally, the use of electronic countermeasures can prevent direct attacks by kamikaze drones or other UAS platforms used to directly attack troops or military equipment.

Integrating these technologies down to the platoon/crew level is vital to effectively counter the widespread use of UAS by adversaries. As UAS technology evolves, it becomes essential to develop electronic warfare capabilities to remain effective

against these threats. This also requires close collaboration between electronic warfare specialists and unit/subunit commanders to ensure that these electronic countermeasures are employed effectively and at the right time during an operation.

3. Helicopters: Flexible but Vulnerable Weapons

Although UAS dominate discussions of modern aerial threats, the role of attack helicopters remains crucial in large-scale armed conflict. Attack helicopters, such as the Kamov KA-52 Alligator, provide an extremely flexible and lethal force capable of engaging both ground and air targets. However, helicopters are increasingly vulnerable to enemy air defenses. As Russian forces and other adversaries develop more sophisticated air defense capabilities, including long-range surface-to-air missiles and radar-guided systems, helicopters' vulnerability on the battlefield becomes more pronounced.

Attack and transport helicopters provide direct support to troops, enabling rapid operations in areas inaccessible to ground vehicles. This flexibility allows them to play an important role in modern warfare, especially in medium and high-intensity conflicts where close air support and rapid mobility are essential to the success of ground operations.

Helicopters can perform a wide range of missions, including reconnaissance, close air support, troop transport, medical evacuation, and direct attacks on enemy targets. For instance, the AH-64 Apache attack helicopter is equipped with a varied arsenal of missiles and machine guns capable of destroying armored vehicles, command posts, and other critical enemy assets. This ability to deliver precise fires during combat makes them essential for gaining a tactical advantage on the battlefield.

Moreover, helicopters play a key role in supporting troop logistics and mobility. Transport helicopters, such as the CH-47 Chinook, are used to deploy troops and equipment in hard-to-reach areas or dense urban environments. This is a significant advantage as they can quickly and efficiently move entire units without being constrained by geographic obstacles.

One of the key vulnerabilities of attack helicopters is their susceptibility to radar-guided air defense systems. Many modern air defense systems, such as the Russian S-400, are capable of detecting and engaging helicopters from long distances, making it difficult for attack helicopters to operate in contested airspace. In addition, helicopters are vulnerable to man-portable air defense systems (MANPADS), which can be deployed by ground forces to counter low-flying aircraft. These systems pose a significant threat to helicopters, particularly when operating near the frontlines or enemy forces. Portable systems, such as the SA-24 Grinch (Igla-S) or Stinger, are relatively easy to use and can be quickly deployed by infantry, making them especially dangerous in urban or mountainous environments where helicopters must operate close to the ground and at low speeds, rendering them vulnerable to these infrared-guided missiles.

MANPADS attacks against American helicopters in recent conflicts, such as the wars in Afghanistan and Iraq, where helicopters were shot down by portable missiles launched by Taliban fighters and ISIS militants, have highlighted helicopters' vulnerability to these portable systems.

Furthermore, helicopters are becoming vulnerable to modern drone warfare tactics, particularly small drones, which can operate in swarms to attack military aircraft. Drones equipped with explosives or electronic jamming devices can disrupt helicopter operations or carry out direct attacks on them. Although drone swarm attack tactics are not yet widely used against helicopters, this possibility is increasing as drone technology continues to advance.

Small UAS equipped with surveillance cameras can also be used to direct artillery

fire against helicopters that have temporarily landed or are operating near forward bases. These drones can be used to detect attack helicopters in real time to guide indirect attacks against them.

To mitigate these vulnerabilities, several initiatives are being explored to improve the survivability of attack helicopters on the battlefield. One of these initiatives involves developing defensive avionics and electronic countermeasures designed to disrupt enemy targeting systems. By integrating these technologies with existing assets, such as M-SHORAD, helicopter survivability can be enhanced, and the risk posed by enemy air defenses can be reduced.

4. Adapting to the Challenges of Modern Warfare: Integrating Air Defense, Electronic Warfare, and Maneuver

As highlighted throughout this article, the integration of air defense systems, such as M-SHORAD, into the tactical-level structures of the Land Forces is crucial due to significant threats from unmanned aerial systems (UAS) and long-range artillery guided by drones. Developing integrated solutions that provide mobile protection against these threats is essential. M-SHORAD (Maneuver Short Range Air Defense) represents one of the promising solutions for countering these threats.

In modern operations, the ability to protect troops from air attacks during maneuvers becomes vital. Unlike traditional air defense systems, which are designed to protect fixed assets, M-SHORAD offers a mobile solution that can accompany maneuver forces on the battlefield, ensuring protection against UAS and low-flying aircraft. Although these systems are not new, the increasing need for mobility and rapid reaction times has been a goal achievable only in specific scenarios where protected troops executed maneuvers under the umbrella of an already deployed air defense system. Mobility, however, remains one of the few solutions to counter the effects produced by the speed of current military actions. The integration of air defense with ground operations is not just a technological challenge, but also one of tactics and coordination, requiring commanders to fully understand how air defense systems can be used to protect troops, equipment on the battlefield but also the logistics support (Minculete & Păstae, 2024, p. 287).

In addition to integrating air defense systems, electronic warfare plays a critical role in protecting ground forces from UAS threats. In the modern context, drones and other unmanned aerial systems rely on data communications and GPS navigation to accomplish their missions. Disrupting these systems can significantly reduce the effectiveness of UAS on the battlefield. Electronic warfare has become a crucial component of modern air defense, enabling forces to block or divert enemy communications and prevent drones from operating effectively. For example, electronic jamming devices can interrupt communication signals between drones and their operators, forcing the drones to lose control or abandon their missions. Another advantage of electronic warfare is the ability to prevent direct attacks from kamikaze drones or other UAS platforms carrying munitions. These drones are designed for direct attacks on ground targets, and without effective electronic countermeasures, they can cause significant damage. The integration of electronic warfare solutions into air defense structures and maneuver units is essential to ensure the protection of forces from UAS attacks. This also requires close collaboration between electronic warfare specialists and commanders to develop clear tactics and procedures to ensure the effective use of these countermeasures.

As new technologies emerge, traditional tactics must be adapted to meet the challenges. An important lesson learned from recent conflicts is that dispersing troops and equipment is essential to reducing vulnerability to UAS-guided air attacks. In

the past, concentrating forces on a primary axis of attack was considered an effective way to ensure the necessary firepower, coordination, and communication between units. However, in the modern context, this practice can represent a vulnerability due to UASs' ability to quickly detect large concentrations of troops and direct precise attacks against them, causing significant losses. Thus, dispersion becomes an essential tactic to avoid detection and engagement by the enemy.

The use of passive measures, such as camouflage and reducing the electronic footprint, is crucial to avoiding detection by enemy UAS. For example, reducing the use of radio and radar emissions can significantly diminish the chances of being detected by the enemy's aerial surveillance systems. Avoidance and dispersion tactics must be integrated into every stage of operational planning, ensuring that troops are protected as much as possible against these threats.

5. Conclusions

In the context of the rapid evolution of military technologies and warfare tactics, modern armed forces face an increasingly complex landscape where adaptability and innovation are essential for operational success. One of the key lessons learned from recent conflicts, particularly from the experience of the war in Ukraine, is that traditional air superiority can no longer be taken for granted in the face of new threats such as unmanned aerial systems (UAS), long-range artillery guided by drones, and advanced air defense systems.

In this era of modern warfare, the effective integration of mobile air defense capabilities, such as M-SHORAD, and electronic warfare tactics becomes vital. UASs have revolutionized the way military operations are conducted, allowing adversaries to gather critical real-time intelligence and launch precise attacks without exposing themselves to risk. Military forces that are not prepared to counter these threats risk being quickly overwhelmed and losing the tactical advantage.

Beyond the technological component, success on the battlefield also depends on the forces ability to adapt quickly to emerging challenges. Traditional tactics of concentrating forces, for example, are no longer viable in the face of modern UAS, which can quickly detect and engage targets through uninterrupted aerial surveillance. Dispersion combined with passive protective measures, such as camouflage and reducing the electronic footprint, becomes necessary to avoid detection and reduce vulnerability.

Another critical aspect is the need for cooperation and coordination between ground forces and air defense units. On the modern battlefield, collaboration between these forces can no longer be optional; it must be integrated into operational planning from the outset. Air defense must be capable of directly supporting ground forces, providing mobile protection against aerial threats as they carry out their missions. The vulnerability of helicopters on the modern battlefield must also be considered when planning CAS (Close Air Support) missions for the Land Forces. While these assets remain flexible and capable of providing close air support, modern air defense systems and MANPADS (Man-Portable Air Defense Systems) make them increasingly vulnerable.

Maintaining a continuous cycle of innovation and adaptation, both at the technological and doctrinal levels, is another important aspect that emerges from this analysis. Drone and UAS technology continues to evolve rapidly, and the military's response must be equally swift and flexible, through constant updates to manuals, tactics, and training programs. Without this constant adaptation, military forces risk becoming outdated by the speed of technological and tactical changes on the battlefield.

Another major conclusion is that success on the battlefield depends not only on the ability to develop and implement new technologies but also on the ability to

integrate these technologies into coherent strategies and tactics. Military transformation is not an isolated process, but one that involves interdependent variables, such as doctrinal adaptation, proper training, and the efficient integration of new technologies.

Military academies across NATO countries, including Romania, have introduced specialized training programs to address modern aerial threats, particularly those involving drones and combined artillery attacks. These programs have evolved in response to lessons learned from recent conflicts, such as the war in Ukraine, focusing on equipping military personnel with air defense and electronic warfare skills. For example, institutions like the "Henri Coandă" Air Force Academy in Brașov and NATO training centers offer courses on drone identification, countermeasures, and the use of jamming systems to disrupt enemy drone communications and navigation. Training scenarios include simulated UAS attacks, where students practice coordination with mobile air defense systems and apply camouflage and dispersion tactics. Furthermore, academies like West Point in the United States integrate complex simulations to replicate modern battlefield conditions, helping officers develop quick decision-making skills under stress. By incorporating modern technology into tactical and strategic training, these programs ensure that future military leaders are fully prepared to meet the challenges of today's dynamic conflict environments.

To ensure effective adaptation to the new realities of the battlefield, military leadership plays a crucial role in the modernization and adaptation process. Commanders must fully understand the technological implications of new air defense and electronic warfare systems and be prepared to integrate them into the operational structure of their units. Moreover, this leadership must ensure proper and up-to-date training for troops on the ground. Military training must include simulated scenarios that reflect the realities of modern warfare, including UAS attacks, guided artillery fire, and modern air defense systems.

In conclusion, the 21st century brings new challenges for armed forces worldwide, but also new opportunities to improve operational efficiency. The integration of modern air defense systems, the development of effective electronic warfare tactics, and the adaptation of maneuver tactics to the new battlefield realities are essential for operational success. The ability to react quickly and flexibly to new threats will distinguish armed forces that remain relevant and effective in future conflicts from those that fail to adapt. In an era of dynamic conflicts and constant technological innovation, staying at the forefront of technological and doctrinal progress will be the key to maintaining an advantage on the battlefield of the future.

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