



LOITERING MUNITIONS – POSSIBLE “GAME CHANGER” IN FUTURE WARFARE

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While the nature of warfare remains constant, it is important to acknowledge that its character is evolving due to the influence of new technologies and weapon systems. Recent armed conflicts, such as those in Nagorno-Karabakh, Ukraine, and the Gaza Strip, highlight the importance of technology in military operations’ planning and execution, as well as the need to integrate new technologies and weapon systems within the existing military capabilities in order to enhance their effectiveness.

Loitering munitions, also known as “kamikaze drones” or “suicide drones”, are new and versatile weapons that are increasingly used in both conventional and unconventional military confrontations. Military organizations show growing interest in the opportunities and benefits of using these new capabilities. In this context, we aim to investigate the integration of these capabilities into land operations, with a focus on their potential to shape future battlefields and warfare. The study topic is of interest to military planners, military commanders, and defence decision-makers.

Keywords: loitering munitions; operational asymmetries; positions of advantage; windows of opportunity;



INTRODUCTION

Determining whether *loitering* munitions can be a game changer in the future is a challenging task due to the numerous factors that influence the nature of conflict and armed combat. Military organizations have continuously sought to anticipate how conflict and armed combat will develop. It is understandable, given the constant need to anticipate potential adversaries and counter their actions aimed at achieving doctrinal, operational, or technological surprise. Thus, military theorists, based on careful conflict assessments and taking into account emerging trends in the evolution of technologies, have often put forward solutions for preparing armed forces for success in future confrontations. These solutions have involved new doctrinal benchmarks for the organisation and deployment of forces¹, the employment of new weapon systems to gain a decisive advantage², and new tactics to compensate for existing asymmetries³. Not infrequently, however, scholastics have failed to correctly predict the character of a future conflict, with history providing ample examples of such mispredictions (Cohen, 2020, p. 5). The reasons for these failures are varied. They include: misidentification of the potential adversaries and the evolution of their capabilities, misjudging how present technologies and their products influence and shape the requirements of the future battlefield, ignoring the indicators needed to make timely adjustments to one’s military capabilities.

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¹ This text refers to the German armoured divisions during the Second World War. Those tactical entities were an innovation, organised according to the combined arms’ principle. They brought together tanks, mechanised infantry, self-propelled artillery, reconnaissance, air defence and engineer elements, all of them having the same mobility.

² The success of US forces during Operation Desert Storm (1991) was primarily attributed to the implementation of new weapon systems, collectively known as The Big Five. Those systems included the M1 Abrams tank, the M2 Bradley infantry fighting vehicle, the AH-64 Apache and UH-60 Black Hawk helicopters, and the MIM-104 Patriot air defence system.

³ The conflicts in Iraq and Afghanistan required deployed forces to adapt their tactics, techniques and procedures, and the actions of insurgents in those conflicts necessitated such adaptation. The adaptation involved a reconsideration of doctrine.



In the case of *loitering* munitions, military theorists have considered their impact on the character of warfare (Williams, 2017). Therefore, it is obvious that exploring the performance of these new *loitering* capabilities is of interest, particularly to the military organization, as well as to the general public.

From a methodological perspective, I have established critical questions to guide the research effort and support the scientific approach. Answering these questions provides the basis for identifying how these munitions will be used in future conflicts. The correlation between the technical and tactical characteristics of the analysed models and the requirements of ground operations has allowed for the identification of opportunities to employ these capabilities, including the advantages and disadvantages arising from their exploitation. The analysis of image and video material, particularly from the Russian-Ukrainian conflict, has enabled a partial assessment of the effects created by these munitions, as well as the identification of patterns in their use. It is important to acknowledge that information on how to use these systems on the battlefield may be limited due to security concerns. In addition, media content demonstrating the effects of *loitering* munitions may be altered to manipulate a particular audience.

WHAT ARE LOITERING MUNITIONS?

In 2019, Houthi rebels carried out an unconventional and asymmetric attack on two oil refineries in Saudi Arabia with the use of *loitering* munitions. Post-attack assessments initially referred to unknown drone-like strike capabilities in the shape of the Greek letter Delta. Later investigations revealed that the Iranian systems, Shahed 131 (Rubin, 2023), were involved. The attack served as a wake-up call to the international community, highlighting not only the existence of a new strike capability, but also the inadequacy of international law in this area (Block, 2019). In the Nagorno-Karabakh conflict a year later, such munitions were used in conventional combat operations. They were particularly effective in the battlespace shaping phase by neutralising the air defence systems of the Armenian armed forces (Shaikh, Rumbaugh, 2020). These weapon systems are constantly being developed for their utility in combat, as they have the ability to strike

targets across the area of operations by surprise and in unexpected ways. Their reputation has significantly grown during the Russian-Ukrainian conflict due to the diversification of their use, which has been further stimulated by the increased interest of military organisations in identifying the implications of using the system in military operations (Waechter, 2023).

This ammunition is a precision strike vector with Intelligence, Surveillance and Reconnaissance (ISR) capabilities, integrating modern technologies. Although it shares some technologies with Unmanned Aircraft System (UAS), it should not be classified as a drone, as it belongs to a separate category. Additionally, it incorporates features of smart missiles, as noted by experts in the field (Deveraux, 2022). Recent analyses suggest that these strike capabilities behave similarly to precision ballistic missiles, with preset target coordinates and consequently there is no need for prolonged overflight in search of the target (Rubin, 2023). As a result, these munitions provide the military with a versatile, lethal, and highly accurate capability. Their advantage lies in their ability to fly over the battlefield for extended periods, allowing for target selection, surveillance, and strikes. They can also act independently to strike pre-determined targets.

WHAT ARE THE MAIN TECHNICAL AND TACTICAL CHARACTERISTICS OF LOITERING MUNITIONS?

The configuration of the weapon system depends primarily on its purpose and the intended effects. The system is designed according to *range, ammunition mass carried* and *flying range*. These technical benchmarks result in a series of tactical characteristics that enable effects to be achieved at all levels of military operations.

The munitions’ relatively small size allows for easy integration into tactical force structures and transport. Targeting systems can be operated via radio up to a range of approximately 150 km (<https://armyrecognition.com/>, 2024) or through the use of a GPS inertial navigation system (GPS-INS) for very long-range systems (Militarnyi, 2023). The system integrates electro-optical or infrared technologies for battlefield surveillance and target guidance. Warheads used include explosive, anti-tank, incendiary, or thermobaric charges.



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Target engagement is achieved through direct human control (*man in the loop*) or autonomously by pre-programming the targets. The operator’s ability to remain in the air for a certain period of time provides the option to engage and hit the target at the appropriate moment. Many existing systems are referred to as *kamikaze* or *suicide drones* because they must engage the target once launched. However, there are also options that include aborting the mission and returning to base if the target cannot be engaged or is no longer a priority (<https://www.rafael.co.il/>, 2019). The versatility of these systems also comes from the fact that they can be launched relatively easily, using land, air or sea platforms.

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Table 1 presents a classification of the main *loitering* munition models tested in recent military conflicts. The classification is based on three parameters: range, ammunition type, and flight range of the system. Each system is classified according to the level of operations at which it can generate effects.

Table 1: Main types of loitering munitions and the level of operations at which they generate effects (author’s design)

Model/Manufacturer/ Country of origin	Range	Time of flight	Warhead
TACTICAL LEVEL			
Hero 30/UVision/ USA	10 km	30 min	0.5 kg
Hero 90/UVision/ USA	40 km	45 min	1.2 kg
Hero 120/UVision/ USA	40 km	45 min	4.5 kg
Switch Blade 300/ AeroVironment/ USA	10 km	15 min	2.5 kg
Switch Blade 600/ AeroVironment/ USA	40 km	40 min	14.5 kg
Spike Firefly/Rafael/Israel	1 km	40 min	0.35 kg
Lancet-1/Zala/Russian Federation	40 km	30 min	1 kg
Lancet-3/Zala/Russian Federation	40 km	40 min	3 kg
KYB-UAV (KUB-BLA)/Zala/ Russian Federation	40 km	30 min	3 kg
Scalpel/Vostok Design Bureau/ Russian Federation	40 km	45 min	5 kg
RAM II UAV/Deviro/ Ukraine	30 km	1 h	4 kg



Model/Manufacturer/ Country of origin	Range	Time of flight	Warhead
ST-35 Silent Thunder/Athlon Avia/ Ukraine	30 km	1 h	3.5 kg
OPERATIONAL LEVEL			
Harop/IAI/ Israel	200 km	9 h	16 kg
Hero 350/UVision/ USA	150 km	2.5 h	10 kg
Hero 400EC/UVision/ USA	150-200 km	3 h	12 kg
STRATEGIC LEVEL			
Hero 900/UVision/ USA	250 km	7 h	20 kg
Hero 1250/UVision/ USA	over 250 km	10 h	30 kg
Shahed 131/HESA/Iran (Geran 1 Russian version)	900 km	Unspecified	15 kg
Shahed 136/HESA/Iran (Geran 2 Russian version)	1000- 2500 km	Unspecified	30-50 kg

The analysis of the primary technical-tactical characteristics of *loitering* munitions reveals several advantages of their use in both conventional and unconventional military operations:

- The system offers high accuracy and precision, thanks to its varied possibilities to find the target and guide the hit vector;
- The multi-spectral footprint is reduced due to the relatively small size and low heat emissions of electric propulsion;
- It has a high flight range;
- The system provides observation and surveillance capabilities of the battlefield, both day and night, through the integration of high-resolution video cameras;
- It has the ability to hit static and moving targets of different sizes, depending on the model used;
- The system has the capability to hit a target other than the intended one and abort the mission without engaging the target (for some models);
- Certain models also have recoverability;



- Remote operation is possible without major security risks for the operator;
- The *man in the loop* function allows the operator to retain control of the system until the target is hit.

While we have not provided a comprehensive overview of the technical and tactical characteristics of the primary *loitering* munitions, it is important to note that the effectiveness of their combat engagement relies on additional factors. These factors include misleading the enemy, anticipating their decision-making cycle, joint-level integration, and the ability of commanders to exploit opportunities.

WHAT ARE THE EFFECTS OF LOITERING MUNITIONS IN COMBAT OPERATIONS?

Loitering systems have demonstrated their effectiveness against a range of targets, including moving vehicles, fortified positions, anti-aircraft systems, military facilities, and infrastructure elements. They provide a consistent advantage in executing contemporary combat operations. The system can be used by all military echelons, providing rapid deployment and launch capabilities, as well as rapid observation, surveillance, and target acquisition capabilities, either independently or with human intervention. It also has the ability to strike targets by surprise at various distances, generating effects at all levels of operations.

Effects generated at the tactical level of operations

Munitions for tactical level effects typically consist of small variants with a range of up to 50 km, lasting up to 3 hours, and carrying various warheads weighing up to 5 kg. Based on these characteristics, we can conclude that these systems are capable of engaging targets located in the rear area of manoeuvre brigades, and even in the area of the division's second echelon. The targets include the division's air defence system, artillery capabilities, and armoured formations. Additionally, command posts in the division's AO, logistic capabilities' deployment areas, moving or stationary logistic columns, isolated positions or patrols, observation posts, or retranslations points are also targeted.

An analysis of the use of these munitions in the conflicts in Nagorno-Karabakh and Ukraine shows that they are not effective

against cohesive and deep defensive formations, where mutual support and multi-layered air defence are crucial to the success of operations. The study also reveals that variants with low-mass payloads up to 1 kg are less effective against armour capabilities. Their effectiveness also decreases against fortified positions that are often concealed from aerial observation and protected against such threats.

Effects generated at the operational level of operations

Munitions that can achieve specific operational effects typically have greater range and autonomy, and their striking capability is enhanced by the increased payload mass. Despite being larger than tactical-level systems, they maintain a small multi-spectral footprint, allowing for infiltration and effects down to the theatre level. Targets include corps-level command points, long-range artillery, high-precision striking systems, corps air defence systems, airfields, command centres, logistics depots, reserves of forces not engaged in operations, fortified positions in depth, and infrastructure elements. An example of the effectiveness of operational level systems is demonstrated by the successful use of the Israeli IAI Harop system by the Azerbaijani armed forces to neutralise Armenian anti-aircraft defences (Shaikh et al., ib).

As targets may exceed the operator's ability to direct ammunition, target coordinates are likely preset and hit vector guidance is done autonomously.

Effects generated at the strategic level of operations

To create effects at the strategic level of operations, it is necessary to use munition variants with a long range and high destructive capability. Targets may include military objectives such as airports, airfields, depots, and command centres, critical infrastructure elements like bridges, tunnels, power plants, and dams, or civilian objectives such as radio and TV broadcasting stations and GSM communication networks. Attacks may also be directed against targets outside the theatre of operations. These attacks involve the use of swarm tactics and the movement of systems at low altitudes to avoid radar detection. The lessons identified show that, due to the small size of these capabilities, they may be overlooked. Additionally, air defence systems can become over-saturated during swarm attacks. The successful



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attacks on Ukrainian energy infrastructure by Russian forces using Iranian Shahed 131/136 munitions highlight the relevance of the impact of these munitions to the strategic level of operations.

Strategic value systems offer the advantage of creating asymmetries by targeting civilian infrastructure, which is often inadequately defended against anti-aircraft attacks due to insufficient capabilities.

WHAT ARE THE CHALLENGES OF USING LOITERING MUNITIONS IN COMBAT OPERATIONS?

Although the benefits of *loitering* munitions are acknowledged, they are not a decisive capability on the battlefield, especially in a conventional conflict. The asymmetries created by their use in the Russian-Ukrainian conflict have been gradually neutralised by both sides through the improvement of integrated air defence systems, adaptation of ground force tactics, and development of similar systems to counteract these asymmetries. Given these issues, the main challenge for the use of these capabilities remains their integration at the combined-arms level. The advantage of combined-arms integration of *loitering* munitions comes from the concept's essence: compensating for the disadvantages of one weapon system with other systems while reducing the limitations of those weapon systems (Biddle, 2004, p. 39).

The main threats to *loitering* capabilities are integrated enemy air defence and EW systems. Therefore, the neutralisation of these systems to create windows of opportunity is a priority if their effects contribute decisively to achieving the operation's objectives.

Exploiting the effects of this type of munitions presents a challenge. The effects have limited persistence over time and often require augmentation or multiplication through other actions, regardless of the level of operations at which they are carried out. For instance, using tactical munitions to attack isolated enemy positions may have a various impact on morale. However, it is imperative to exploit the situation created and seize those positions through manoeuvre forces. The neutralization of a command post can temporarily disable the enemy's command and control system to some extent, but decisive action should be planned to exploit the tactical advantage created.

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HOW CAN LOITERING MUNITIONS INFLUENCE THE FUTURE OF WARFARE?

Loitering munitions have the potential to revolutionise precision strikes in warfare. Currently, such strikes rely on complex technological systems that use GPS guidance to direct the projectile. It requires access to satellite capabilities to guide the projectile and link it to the command centre. Advanced satellite systems and software are used to perform the target acquisition process, providing accurate target coordinates and updates during the projectile's flight. To effectively hit the target, both the accuracy of the target coordinates and the missile must be met simultaneously. *Figure 1* illustrates the mentioned requirements.



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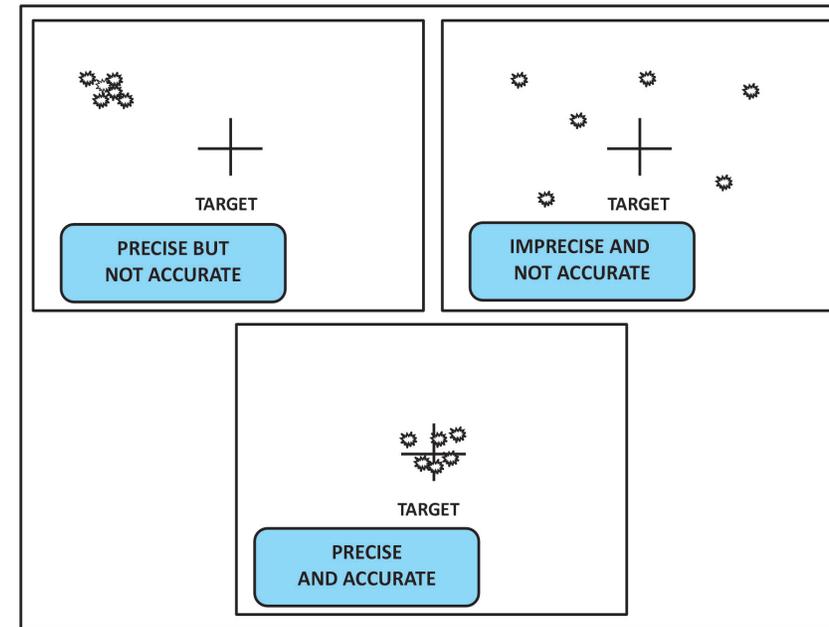


Figure 1: Requirements for the use of high-precision striking munitions (author's design)

Normally, precise and highly accurate strikes are achieved using “*smart ammunition*”. These striking capabilities are unique due to the sophisticated and expensive technologies incorporated in them, in terms of both development and use on the battlefield. The imprecision and inaccuracy of unguided munitions are compensated for by their quantity, which results in increased resource consumption,



low efficiency, and a high risk of casualties and collateral damage. High-precision systems have been used to hit important targets, but their accuracy has often been insufficient. The Russian-Ukrainian conflict provides an example, with many instances of Russian precision munitions striking civilian centres (Schneider, 2022).

Regarding *loitering* munitions, they provide an opportunity to utilise a capability that offers both accuracy and precision at a significantly lower cost than other similar options. The integration of multispectral camouflage, concealment and electronic warfare technologies into these systems could significantly enhance their effectiveness, while reducing the possibilities to counter them. Such innovative solutions could contribute to achieving surprise, further increasing the lethality of “suicide drones”. The simultaneous engagements using *swarm tactics* could cripple the enemy’s command and control systems, neutralise their sensors and high-precision detection and strike capabilities, and subsequently cause the collapse of the entire defence system. In conclusion, *loitering* systems’ lethality and increased ability to maintain their operational capability provide them with the opportunity to engage high-value targets (HVT).

The use of this tactic at all levels of operations can create the conditions for disrupting the enemy’s cohesion, inducing shock, and impairing their ability to comprehend. Thus, in future combat operations, these capabilities could render the historical 3:1 ratio irrelevant. Their increased lethality and ability to target critical opponent capabilities could turn them into a force multiplier, thereby changing the dynamics of the situation. If we consider the possibility of developing qualitatively superior warheads, the lethality of tactical systems will increase even further, impacting ground operations with mechanised forces. In this context, it will be necessary to adapt the principle of concentration, most likely through an economy of conventional forces and assets. The contribution of the latter will be offset by the use of *loitering* munitions. Recalibrating the integration of the principle of effort concentration at the operations level can directly impact the principles of economy of effort, surprise, and operational security. A leaner force is more difficult to detect, increasing its chances of survival on the battlefield and the possibility of achieving surprise against the enemy.

Human factor substitution in security operations, such as surveillance, cover, and protection, is a way in which these capabilities can affect the nature of combat operations. The systems’ ability to monitor risk areas for extended periods and to engage the enemy makes them well-suited for such missions. Extending the autonomy of these systems will enhance their versatility. In order to create decisive operational asymmetries, infiltration can be achieved by remaining in the enemy’s device and activating to engage pre-programmed targets.

CONCLUSIONS

Due to their versatility and relatively low cost, *loitering* munitions are expected to be increasingly developed and used on the battlefield across all levels of military operations. The predictions are reinforced by the potential for these weapons to be turned into autonomous ones and their high-precision strike capability, which is easily accessible to actors who do not typically have access to such technologies. Additionally, statistics show that, as of 2018, about two-thirds of existing models were developed in the USA and Israel, with only 12% of new models built in these two countries over the past 5 years. It is worth noting that approximately one-third of the new systems introduced during this time have been designed and developed in Asia (<https://airdefence.in/contact>, 2024). While we refrain from making any definitive statements about global armament trends, we do observe a trend among certain global actors to compensate for the technological lead held by Western states by developing these niche capabilities.

In conclusion, it can be assumed that this type of ammunition may have an impact on the armed conflicts of the future. However, it is difficult to determine the extent of this impact and whether these systems will be a *game changer* in the future. Western military organisations should increase their efforts to understand the requirements for integrating these capabilities into multi-domain operations. Subsequently, the integration of *loitering* munitions must be achieved through sustainable approaches at all echelons. It must take into account the nature and capabilities of potential enemies, the characteristics of the operating environment, and new technologies. By doing so, the Western military superiority of the North Atlantic Alliance member states can be preserved.



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