

THE IMPORTANCE OF GEOINT IN SUPPORTING MILITARY ACTIONS IN UKRAINE

Lieutenant Colonel Cristian PANAIT, PhD

"Henri Coandă" Air Force Academy, Braşov

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Geospatial Intelligence (GEOINT) has proven to be a crucial component in modern warfare, especially in the context of the conflict in Ukraine. This paper aims, through documentation, to evaluate and analyse the applications, impact, and strategic significance of GEOINT in creating and developing an accurate image of the area of operations for supporting military actions in Ukraine.

The Russo-Ukrainian conflict serves as a case study to determine how GEOINT contributes to data fusion and the necessary information for the targeting process, as well as the monitoring, assessment, and validation of military courses of action, particularly in the decision-making process. By analysing perspectives from various sources, this article underlines the importance of GEOINT in contemporary military strategy and its implications for future conflicts.

Keywords: GEOINT; Ukraine; modern warfare; data fusion; Big Data;

INTRODUCTION

The ongoing conflict in Ukraine has brought to the forefront the evolving role of Geospatial Intelligence (GEOINT) in military operations. As an intelligence discipline, GEOINT uses data from diverse geospatial sources such as satellite imagery, drone surveillance, and Geographic Information Systems (GIS), to generate actionable intelligence. This intelligence involves analysing spatial images and data to understand military movements, landscape structures, and human activities on a broad geographical scale.

In the Ukraine conflict, GEOINT has been widely used for strategic mission planning, real-time monitoring, and evaluating military actions. By fusing commercial satellite images, drone surveillance, and open-source intelligence (OSINT), the battlefield has become more transparent, enabling the parties involved to adapt their strategies and quickly respond to changes on the ground. This adaptability and rapid reaction are essential in modern warfare, where battlefield dynamics can be extremely swift and unpredictable.

Authors such as Dr. Robert Clark (NDS Show, 2023), a long-standing expert in geospatial intelligence, or Michael J. Ard and Jack O'Connor from Johns Hopkins University (2022), have analysed the implications and progress of GEOINT in the Ukraine conflict, providing crucial perspectives on the changing nature of intelligence gathering and its strategic use in warfare. These insights highlight the need for modern armies to enhance their geospatial analysis capabilities to gain a strategic advantage in future conflicts.

The importance of GEOINT in creating a precise (both unique and local) aerial image for military actions in Ukraine and detailing how the integration of GEOINT has influenced the Ukrainian armed forces' ability to adapt to the war's dynamic nature, information fusion, and collaboration between geospatial intelligence agencies have been an essential support to Ukraine's defence efforts.

THE ROLE OF GEOINT IN UKRAINE'S MILITARY OPERATIONS

To understand the role of GEOINT in Ukraine's military operations, it is necessary to acknowledge the foundation upon which GEOINT is built: *"GEOINT is an intelligence discipline and a tradecraft that evolved from the integration of imagery, imagery intelligence (IMINT), and geospatial information"* (National Geospatial-Intelligence Agency, 2006).

From this perspective, the Ukraine conflict serves as a case study for modern warfare, where GEOINT plays a vital role in the collection, processing, and dissemination of geospatial data to support military actions. This role includes providing real-time aerial imagery, analysing enemy troop movement patterns, identifying artillery positions, and monitoring critical infrastructure. Therefore, GEOINT's capability is extremely effective in offering a comprehensive view of the battlefield and is highly efficient in enabling Ukrainian forces to make strategic decisions perfectly adapted to the realities on the ground.

Data Fusion

The use of GEOINT *"products"* in the Ukraine conflict has been conditioned by the implementation and development of capabilities to integrate information from multiple sources. Ukraine's command, control, and intelligence systems, mentioned by the United States Geospatial Intelligence Foundation (USGIF), use data from commercial satellites, drones, smartphones, and social media platforms to create an accurate aerial image. This fusion of information includes combining high-resolution satellite images with ground-collected data from both civilians and military personnel. In this way, a detailed picture of the real-time situation is created, which can be used to guide tactical and strategic decisions.

GEOINT has also enabled Ukrainian forces and their allies to monitor enemy troop movements, identify strategic targets, and optimize military operations. Satellite images, together with geospatial analyses, have provided real-time information on battlefield changes, identifying adversary positions and elements of critical infrastructure. These data have been used to precisely guide artillery and missile actions, coordinate drone flights, prevent surprise attacks, and minimize civilian casualties.

In the process of collecting and integrating data from multiple sources, commercial satellites play an essential role. Companies such as Maxar, ICEYE, and Capella have provided high-resolution images that allow the identification of Russian troop positions, military equipment, and critical infrastructure. The pieces

of data collected by these companies are then analysed in the context of other information sources, such as drone images, on-ground reports, and communication service data. This integrative approach allows Ukrainian forces to obtain a clearer perspective of the situation, offering a strategic advantage in anticipating and countering enemy movements.

The importance of information fusion becomes evident when looking at how Ukraine has managed data sharing and coordination with its allies. According to USGIF, the Ukrainian armed forces have used a communication system that enables the rapid sharing of on-ground information with both national military structures and international partners. This *"hyperconnectivity"* of information exchange facilities has led to efficient collaboration between different command levels, thus ensuring better coordination of operations.

In addition, international partnerships have played a vital role in providing geospatial data and building Ukraine's analytical capabilities. Vice Admiral Robert Sharp (National Geospatial-Intelligence Agency-1) underscores the role of the National Geospatial-Intelligence Agency (NGA) in facilitating the sharing of intelligence data, and providing training and support for using geospatial intelligence platforms. These partnerships have strengthened Ukraine's position against Russian aggression and provided a model for future collaborations in similar conflicts.

Civilians have also become a valuable source of information, contributing to data fusion in the GEOINT system. Images and videos taken with smartphones, as well as on-the-ground reports, have been analysed to validate and complement data collected by other means. This civilian participation has added an additional level of situational awareness, which is difficult for Russian forces to counter. Additionally, Open-Source Intelligence (OSINT) has provided access to a wide range of information, from military vehicle movements to artillery equipment positioning, contributing to a more informed decision-making process.

Targeting and Big Data on the Battlefield

GEOINT has become an essential tool for the targeting process in the Ukraine conflict. Data obtained from SAR satellites, such as those provided by ICEYE and Capella, and from radio-frequency systems, like HawkEye 360, have enabled Ukrainian troops to accurately locate and strike enemy targets. This capability to obtain exact information about the enemy's position and movements has been crucial for Ukraine's operational success.

Another important aspect of GEOINT's use in Ukraine is collecting and analysing *"Big Data"* from the battlefield. As Dr. Robert Clark (NDS Show, ib.) highlights, data collected from drones, satellites, smartphones, and other sources are processed using artificial intelligence to speed up the decision-making cycle. Thus, the *"Observe-Orient-Decide-Act"* (OODA) cycle is accelerated, allowing Ukrainian troops to make decisions more quickly and informed than their adversaries.

A critical role in providing on-the-ground information has been played by civilians who have used smartphones to collect and send geospatial data, thereby expanding the targeting process of the Ukrainian armed forces. This involvement of civilians not only extends the reach and precision of the targeting process, but also adds an element of operational flexibility that is difficult for enemy forces to counter. However, this approach also presents risks, as civilians may become targets if identified as information providers.

Validation and Monitoring of Military Movements

GEOINT has played a central role in validating and monitoring military movements, offering Ukraine a powerful tool for anticipating and countering enemy strategies. This continuous monitoring capability of the battlefield has provided essential information for both defence and attack operations.

One of the most valuable GEOINT contribution to this conflict has been monitoring Russian troop movements and military equipment. Jack O'Connor (John Hopkins University) points out that, through satellite imagery and radar data, Ukrainian forces could observe the troop concentrations, the deployment of heavy equipment, and the logistical movements of the enemy. This information has been used to adjust defence strategies, prepare ambushes, and coordinate attacks on the weak points of Russian forces.

After each attack, Ukrainian forces have used GEOINT to assess the damage caused and determine the effectiveness of the strikes. Satellite images provided by commercial companies such as Maxar have been analysed to identify destroyed vehicles, fortified positions, and changes in the terrain structure. The assessment has been crucial in determining whether a target was neutralized or if further attacks were necessary. Additionally, damage assessment has provided critical information for the tactical improvement of future operations.

GEOINT has also served as a validation tool for information from other sources, such as OSINT and ground reports. In an operational environment where misinformation and information warfare are widely used strategies, the ability

to independently verify reports is vital. Satellite imagery and radar data have been used to confirm or refute claims related to troop movements, enemy positions, or damage extent. This validation has improved the quality of information available to military and political decision-makers, providing a more solid basis for decision-making.

Apart from monitoring military movements, GEOINT has been used to oversee critical infrastructure, such as nuclear power plants, dams, transport networks, and fuel depots. This monitoring has been essential to detect potential threats and ensure the protection of these assets. It has also allowed Ukrainian authorities to plan emergency actions in the event of an attack on these infrastructures, thus contributing to national resilience in the face of aggression.

STRATEGIC AND FUTURE IMPLICATIONS OF GEOINT

The successful use of Geospatial Intelligence (GEOINT) in Ukraine has extensive implications, both for current military operations and for future conflicts. The Ukraine conflict has demonstrated that GEOINT is not just a support technology but also a fundamental element that can change the dynamics of warfare. This chapter details the strategic implications, including international collaborations, technological integration, and the need to redefine global military strategies.

Collaborations and Partnerships

One of the most significant lessons learned from the use of GEOINT in Ukraine is the importance of partnerships and international collaboration. In the context of the conflict, cooperation between Ukraine and its allies from NATO and other international organizations has enabled the rapid mobilization of resources and geospatial data. These collaborations have highlighted that no country can fully develop or exploit GEOINT technologies in isolation. Instead, success depends on the efficient exchange of data and expertise among nations, intelligence agencies, and the private sector.

Vice Admiral Robert Sharp (National Geospatial-Intelligence Agency-2), emphasizes that these partnerships are essential for providing real-time situational awareness to military commanders and political decision-makers. Collaborations between NGA and international partners have included sharing satellite images, radar data, and image analyses to create a complete operational picture of the battlefield. This information-sharing has facilitated faster and better-informed

responses to dynamic changes on the ground, which proved vital in the Ukraine conflict.

In addition to governmental partnerships, collaboration with the private sector has been also crucial. Companies such as Maxar, ICEYE, and HawkEye 360 have provided access to commercial satellite images and essential geospatial data for military operations. Maxar, for example, provided high-resolution images that helped identify Russian military positions and monitor their movements. These private companies have become key players in the global GEOINT ecosystem, providing advanced technologies that complement and extend the capabilities of government agencies.

Another important dimension of collaboration has been the interaction with the academic environment. Universities and research institutes have provided expertise and developed new methodologies for geospatial data analysis while preparing the next generation of GEOINT analysts. Vice Admiral Sharp praises the role of the academic community, stating that top-tier education and research are essential for enhancing GEOINT capabilities. Research partnerships have led to the development of advanced technologies, such as artificial intelligence applied to image analysis, which has enabled the rapid interpretation of large volumes of collected data.

Technological Integration and Adaptation

The integration of various geospatial technologies into a single operational structure has been essential for Ukraine's success on the battlefield. The ability to gather and analyse data from multiple sources, including satellite imagery, radio signals, radar data, and drone information, has allowed the Ukrainian armed forces to obtain a comprehensive perspective of the situation on the ground.

This integration has required the rapid adaptation of existing technologies and the development of new analytical tools. Dr. Robert Clark points out that, in the past, the intelligence cycle was divided into distinct phases – *collection, processing, analysis, and decision-making*. In the modern context of the Ukraine conflict, this cycle has become much more fluid, allowing real-time collaboration between collectors, analysts, and decision-makers. This collaborative approach has led to a more efficient process of geospatial data collection and interpretation, thus accelerating military decision-making.

A remarkable example of this integration is the use of artificial intelligence (AI) algorithms for processing and analysing satellite images. AI has been used to detect patterns in troop movements, identify targets, and assess target effects. By using

AI, Ukraine has managed to significantly reduce the time required for data analysis, providing military commanders with information in a very short time. Furthermore, AI-based predictive models have allowed for anticipating enemy movements, thus providing a strategic advantage on the battlefield.

The integration of commercial technologies, such as drones and civilian communication platforms, has also contributed to operational success. Ukraine has used drones to collect data in inaccessible or dangerous areas, while commercial communication networks have been used to quickly transmit this data to command centres. For example, the Starlink platform, provided by SpaceX, was used to ensure stable and secure communications in areas where traditional infrastructure was compromised. These commercial technologies have been integrated into a military communication system in which information could be quickly transmitted to troops on the ground.

Technological adaptation has not been limited to integrating new tools as it has also included the development of innovative tactics. For example, the use of geospatial data by civilians to provide information on enemy positions have enabled extensive effects, whereby armed forces can use crowdsourced data to identify and strike targets. This decentralized approach has significantly extended Ukrainian forces monitoring capability and added a level of adaptability difficult for Russian forces to anticipate.

Implications for Military Strategy

The Ukraine conflict has underscored the need for military forces to revise and modernize their strategies to better integrate geospatial intelligence. In the past, GEOINT was considered a niche field, used primarily for reconnaissance and mapping missions. However, the Ukraine conflict has demonstrated that GEOINT can fundamentally change the course of modern warfare, providing critical real-time advantages.

A key aspect of this strategic shift is recognizing the importance of informational superiority. Geospatial intelligence offers a level of situational awareness that cannot be reproduced by other means. The ability to monitor enemy movements in real time, assess target effects, and foresee future actions provides a strategic advantage that can determine the outcome of a conflict. However, this information superiority requires ongoing investments in GEOINT technologies and in training the personnel to efficiently exploit these resources.

Integrating GEOINT into military strategy also requires a shift in how military operations are organized and conducted. Traditionally, collecting and analysing geospatial information were centralized tasks managed by national intelligence agencies. The Ukraine conflict has shown that these processes need to be decentralized to respond quickly to changes on the battlefield. It means that every military unit, from the tactical to the strategic level, must have access to relevant geospatial data and be able to make decisions based on it.

Furthermore, the use of GEOINT in the context of the Ukraine conflict has raised questions about the future of conflicts in which non-state actors, including private companies and civilians, play a significant role in collecting and disseminating information. Armed forces must develop strategies to coordinate these resources and ensure information security in an increasingly interconnected environment. In this regard, collaboration with the private sector and the academic community has become essential to develop the technologies and tactics necessary for the complete exploitation of GEOINT.

CONCLUSIONS

By detailing how GEOINT has been used in information fusion, targeting, and monitoring the military movements, it has become clear that this discipline has played an essential role in Ukraine's defence strategy. The integrated use of geospatial technologies has allowed not only for tactical advantages on the battlefield but also for the development of adaptive strategies that have contributed to Ukraine's resilience and operational success.

The Ukraine conflict has changed the paradigm of GEOINT use, demonstrating that it is essential for achieving and maintaining informational superiority in modern warfare. By integrating data from multiple sources and collaborating with international partners, Ukraine has managed to create a detailed operational picture of the battlefield, facilitating rapid and adaptive responses to changes on the ground. The implications for global military strategy are profound, highlighting the need to invest in geospatial technologies, develop partnerships, and re-evaluate tactics and organizational structures to address the challenges of modern warfare.

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