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Required operational capabilities of the recognition subsystem in the anti-access/area denial system

Szymon MARKIEWICZ
s.markiewicz@akademia.mil.pl (Corresponding author)
https://orcid.org/0000-0002-0299-9132
War Studies University, Warsaw, Poland

Marek WRZOSEK
m.wrzosek@akademia.mil.pl
https://orcid.org/0000-0002-1369-9434
War Studies University, Warsaw, Poland

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Abstract

The subject of this article is the issue of "the required operational capabilities of the reconnaissance subsystem in the anti-access/area denial system".
When defining the assumptions for the reconnaissance subsystem in the A2/AD system, several assumptions were adopted for the analyses resulting from the concept of military operations from the beginning of the 21st century. These assumptions were derived from analyses carried out as part of conferences, seminars, research work, and army command and staff exercises. Moreover, epistemological achievements in the field of military thought were used to generate solutions.
The accumulated knowledge is the basis for concluding that the current reconnaissance subsystem does not meet the requirements, full perception of various reconnaissance data obtained from the area of operations and the translation of aggregate knowledge into the cognitive sphere of commanders and staff. Additionally, it was established that in the current organizational and functional solutions, the commander's knowledge is based on an understanding of the area of operation and the enemy troops' situation. Meanwhile, the new scope of reconnaissance tasks under the A2/AD system requires collecting knowledge from all domains where the fate of a military conflict is decided.

Keywords: Anti Access Area Denial System, Defence, Electronic Warfare, Intelligence

1. Introduction

The term Anti Access / Area Denial (A2/AD) was generated as a military term encompassing the operational possibilities of preventing the enemy from entering the theatre of war (area of operation). Actions in this area are undertaken using long-range weapons. A wide range of surface-to-air missiles, anti-ship ballistic missiles and cruise missiles, as well as unmanned aerial vehicles, are used to carry out tasks related to the enemy isolation outside the area of operations (theatre of war). Also, as part of the impact in the A2/AD zone, measures are taken to deprive the enemy of freedom of action using short-range weapons (e.g., rocket artillery, homing missiles, smart mines or unmanned aerial vehicles). Such a threat has been generated by China in the Indo-Pacific area (Bhattacharya & Eadon, 2021).

Defining operational requirements is generally a specific analytical process to develop armaments and military equipment requirements, whose acquisition will ensure that the armed forces achieve the required operational capabilities. In this context, operational capabilities should be viewed as a category used to quantify the armed forces' operational capabilities, their combat

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elements, support, and security necessary to perform their tasks. Therefore, concerning the operational capabilities of the reconnaissance subsystem in the A2/AD system, the essential and general requirements for the forces and means functioning in the reconnaissance system will be defined. The term "operational needs" encompasses the level of the armed forces' operational capabilities that enable the effective implementation of their missions and tasks. In such a situation, the operational needs regarding the reconnaissance subsystem include an indication of the essential operational capabilities that accommodate the given operational need. It can be assumed that the determination of operational capabilities takes place in two main stages. The first one is the identification of operational needs. It includes analyzing the directions of the development of threats and tasks (missions) for the reconnaissance subsystem to identify any gaps in operational capabilities. The second stage is to define the operational requirements for technical modernization. Beyond any doubt, the "operational requirement" must be achievable, that is, realistic to achieve in the assumed time perspective. Also, it must reflect the need or purpose for which there is a technically feasible and financially sound solution. When generating assumptions for the reconnaissance subsystem in the A2/AD system, financial issues were disregarded because their analysis goes beyond the scope of the subject.

2. Reconnaissance subsystem priority operational capabilities

A general view of the issue should assume that the presented forecast and scenarios of the enemy's actions in the A2/AD system should be prepared by a team of highly qualified, well-trained analysts – operators who can analyses large sets of information with a different thematic cross-section and the way of aggregating data in the context of a specific situation. The trend in the organization of future systems of reconnaissance information sets goes for a modular solution in this area. The reconnaissance data modules are assumed to be fully automatic, with a broad thematic area of data collection and a specific precision of objects' and targets' location. Therefore, it is assumed that designing an open architecture of the recognition subsystem within the A2/AD system based on standard technology may not merely shorten the time of information development and transfer but also increase the situational awareness of human intelligence.

Assuming that the future reconnaissance subsystem capabilities for the needs of the A2/AD system will be based on the reconnaissance system architecture different from the one used so far, some practical recommendations can be identified. Firstly, the reconnaissance subsystem technical modification means, in practice, a technological change in acquiring, processing, and distributing reconnaissance data. The reconnaissance subsystem's real value will be better understood when the reconnaissance information recipients are convinced that the reconnaissance subsystem allows for maintaining the required pace of operations, high efficiency of destruction and survival capability in the A2/AD system. Secondly, for the A2/AD system, further education and specialist training for the reconnaissance staff is required. The current organizational solutions prepare reconnaissance staff to operate in the conditions of classic armed conflicts (Więcek, 2019). Therefore, there is a need to correct the entire system of preparing officers for operational functioning within the A2/AD system. Thirdly, reorganization of the reconnaissance system structure is recommended. For example, currently, the structure of many formations does not include full-time reconnaissance units, and the reconnaissance departments of tactical units do not have the required operational capabilities. The adopted solutions for the organization of the reconnaissance subsystem are a derivative of the operational capabilities and needs.

In order to effectively manage the A2/AD reconnaissance subsystem in the future, reconnaissance personnel should have the knowledge and skills appropriate to the new combat method. Therefore, when perceiving the scope of competence requirements for reconnaissance officers through the prism of combat in the A2/AD system, it can be assumed that the ability to dynamical and variant reconnaissance planning will be necessary, including coordination and synchronization of subordinate subsystems. To this end, both theoretical and practical preparation of participants – performers of tasks in the reconnaissance subsystem seems necessary. Furthermore, considering the high dynamics of activities, an assumption can be made that having an extensive IT infrastructure to enable real-time supervision of the reconnaissance tasks performed is a necessity. With such capabilities, the reconnaissance personnel will be able to reorganize the reconnaissance subsystem dynamically and modify (change as needed) reconnaissance tasks and shift the focus of the reconnaissance effort. They will do so by updating the coverage of the area of responsibility with reconnaissance elements locating and tracking both already detected and new important objects and goals more effectively.

The results of observations of armed conflicts at the beginning of the 21st century are the basis for concluding that as the number of sensors in the area of operations increases, the amount of available data will grow, and the pace of current and future operations will require high-quality reconnaissance data. The quality of reconnaissance data should be understood as a set of features (criteria) conditioning their use in assessing the situation and identifying objects for impact. Taking into consideration the amount of such data on individual platforms (and the limited capacity of their transmission), a transfer of the initial exploitation of reconnaissance data even to the lowest elementary level (the platform – reconnaissance device level) is required. All that is supposed to shorten the path and time of information flow and increase the effectiveness of reconnaissance teams' analytical groups. The results of direct

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interviews with reconnaissance subsystem users allow for the conclusion that the means of communication (communication and IT) currently used in reconnaissance require technical modification of their current capabilities. The primary problem in ensuring comprehensive information services for all users is synchronized reconnaissance data at the level of the primary combat unit (battalion). The situation is also aggravated by the fact that, despite attempts to reactivate reconnaissance battalions at the division level, no real action has been taken in this regard. Therefore, the tactical level of reconnaissance activities is burdened with some flaws and imperfections. It seems that the concept of transferring some or all of the reconnaissance resources, especially situational information from lower-level units, to the "cloud" is an urgent operational need.

It is already stressed that automated data aggregation tools are indispensable to maintain reconnaissance capabilities and reduce the information overload of equipment and analytical overburden of personnel. Furthermore, technical reconnaissance measures are required to correlate data from various sources and assess the situation by analyzing a potential scenario of the enemy's actions based on their previous activity and recognizing new features that identify probable intentions. A critical issue to be considered concerning the A2/AD system will, therefore, be the search for technological solutions to reduce the burden on reconnaissance teams resulting from the need to process vast amounts of data in organizationally inefficient analytical teams, where their creative interpretation is to be implemented. For this reason, it can be assumed that military reconnaissance will increasingly transfer the effort of data gathering into electromagnetic space, including cyberspace (Dela, 2020).

Cooperation and coordination of capabilities between different types of national reconnaissance and, which is also important, between coalition partners should be improved. That also applies to cooperation between intelligence and reconnaissance agencies on a national and international scale. In this aspect, it should be emphasized that any efforts made must comply with specific common NATO standards and technologies (von Loringhoven, 2019).

With the acknowledged need for changes in the environment of future military operations, it can be forecasted that the military reconnaissance subsystem should be based on autonomous reconnaissance means. Therefore, based on the diagnosis, it can be assumed that the reconnaissance for the A2/AD system should be based on the comprehensive exchange of information gathered through the cooperation of unmanned platforms, integrated crew teams and cooperating systems of autonomous types of military reconnaissance.

3. Future operational capabilities of the reconnaissance subsystem

Based on the results of observations of armed conflicts at the end of the 20th and the beginning of the 21st century, one can conclude that when forecasting the reconnaissance system for the A2/AD system, it should be assumed that the new reconnaissance architecture must be capable of automated operation based on information obtained in a short time. The dynamics of changes in the operational space is so great that the dislocation of the operational group elements changes during the combat day. Since the pace of information gathering will be high, the development and dissemination of the acquired information should be equally efficient. Obviously, the quantity and quality of the information provided by the reconnaissance system is and will be of crucial importance for the command in terms of decision-making and attacking (influencing) targets and objects essential for the course of the military operation.

The comparative analyses show that many countries develop satellite systems that ensure systematic control of selected areas of interest within imagery intelligence. According to experts' opinions (Dąbrowski, 2020) satellite systems provide a massive amount of information in various thematic cross-sections, which leads to a comprehensive reconnaissance in A2/AD zones. However, to select and evaluate the collected information resources, specialized reconnaissance devices, together with dedicated software and operational personnel, are necessary. Only if all the conditions are met simultaneously will it be possible to effectively use the reconnaissance subsystem for the needs of the A2/AD system.

According to air reconnaissance military specialists' assessments (Bielawski & Grenda, 2017), the first decade of the 21st century was a period of work on implementing programs to construct new unmanned aerial vehicles. Their development focused on reconnaissance devices that meet the basic requirements of battlefield observation and monitoring. Future-oriented solutions, some of which have already been implemented in the military, assume a combination of reconnaissance systems with effectors (means of destruction), making unmanned means effective instruments in the A2/AD system. Based on the conclusions from the literature and the observation of the use of UAVs, their advantages can be primarily stated as the versatility of use for various missions, low construction and operating costs, a few staff for service and short preparation time for the mission. With solid air defense in the enemy's A2/AD system, the above advantages constitute a strong argument in proving that the reconnaissance system must be equipped with this type of information-gathering means.

In a potential threat scenario, the challenge for the JISR network is, in many respects, asymmetric and more demanding than the existing conditions. It is so because classic indicators, such as troop movements or railways or airport activities, may be limited or completely unrecognizable due to operational camouflage and disinformation. Therefore, JISR systems should conduct reconnaissance by intensive monitoring and analysis of how information is delivered, including the mass media and the use of social

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media and other open sources of information. Furthermore, it cannot be ruled out that situation monitoring will have to be in cooperation with civil institutions and non-governmental organizations, for example, in the field of observing unusual commercial movements of ships and private airlines, increased diplomatic activity, unusual financial transactions, increased cybercrime and acts of organized armed groups. Moreover, as evidenced by the Russian intervention in Crimea, it may be necessary to monitor the population living in ethnic areas and oversee the organization of social movements. Also, it should be noted that the activities of specialized intervention units or formations of "private contractors" such as the "Wagner Group" and the activity of insignificant objects may also signal the opposing party's intentions. After all, such phenomena happened in Syria.

As the analysis shows, one of the conditions for success in the timely transfer of information is communication and IT. Therefore, in the future, reconnaissance systems must use broadband communication systems and satellite communications. Firstly, it is required by the dynamic development of means of acquiring reconnaissance data from various sources. Secondly, reconnaissance under the enemy's constant influence necessitates the immediate transfer of reconnaissance data. Finally, the third argument arises from the need to ensure data transmission security and maintain an alternative, substitute communication in the reconnaissance system.

In the prospective approach to the analyzed problem, it should be pointed out that in the case of the A2/AD system, in order to shorten the time that passes from the identification and recognition of enemy objects to the time of their destruction, reconnaissance and assault systems are built, which are soon to be the primary means of combat. Therefore, a conclusion can be made that reconnaissance combined with the possibility of direct impact will soon generate the conditions for introducing essential forces into the area of the operation. The conducted analysis shows that the reconnaissance system's current role will change. In practice, this may mean that the reconnaissance system will provide reconnaissance data for the situation assessment and, more often, for the needs of direct impact (attack, disruption, disinformation). The confirmation of the thesis may be the battlefield robotization and automation program implemented in many NATO armies. It is expected that the target solutions, developed as part of independent projects, will be used, among other things, for general reconnaissance (situation) tasks, searching for objects, tracking, and destroying the selected targets.

The accumulated cognitive results enable a conclusion that the use of new technologies in the information space may increase the ability to obtain critical information necessary to carry out tasks. The truth of the presented thesis is proven by technical solutions used in airborne warning and control systems (AWACS). Modern information transfer technologies and reconnaissance data processing technology make this type of reconnaissance system the generators of information about the situation in the air, on land and at sea. Moreover, due to their information cooperation capabilities, they can be used both to monitor the situation and supervise military operations, as well as to direct (command) the means of influence (NATO, 2022).

The computerization of reconnaissance systems means that the amount of information and ever shorter message transmission cycles reduce their processing time. This problem was already noticed during the Persian Gulf War when the excess of reconnaissance data to be processed obstructed both analytical teams and IT systems (Joniak & Polak, 2011).

A thesis can be put forward that future combat in the A2/AD area will focus on the command elements (Erickson, 2017). Hence, from a military perspective, information warfare will be considered the dominant component of military operations. In such a situation, the reconnaissance subsystem should direct all information activities against enemy command centers and control systems, including their physical elimination from the A2/AD area. The operation should aim to deprive the opponent of the ability to maintain continuous command. It can be achieved, for example, by information disruption, which will deprive the enemy command system of some information or make it receive an incomplete picture of the situation, hindering the achievement of the combat objective. The goal can be achieved using airborne and land tactical groups of unmanned vehicles, which will engage enemy combat systems, forcing them to open fire and reveal combat positions and the concept of fighting.

The reconnaissance subsystem for the purposes of combat in the A2/AD system should have the ability to assess the effects of an attack on the enemy command systems. That is because the assault's outcome are the basis for estimating the final effect of the attack and the opponent's ability to maintain information dominance. Recognizing and evaluating the effects of attacks on targets is a new challenge for the future reconnaissance system in technical and organizational dimensions. In principle, there is no doubt that the effective assessment of the attack's effects is essential in the framework of comprehensive combat in the A2/AD system. Firstly, the reconnaissance subsystem should update the location of enemy group elements, so information about the location and operational capabilities of the affected objects is necessary. Secondly, the reconnaissance subsystem is responsible for forecasting the development of the situation, including the most likely actions of the enemy's forces. Therefore, it must have sources of information that will provide the knowledge for indicating the assumed directions of changes in the current manner of the enemy's operation. Finally, there is the third argument, which entails knowledge about the effects of one's own assault systems on the enemy's objects. It will allow for the preparation of an effective counteraction to the opponent, i.e., the development of future combat scenarios.

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4. The essential requirements for waging electronic warfare in the A2/AD system

In principle, there is no doubt that the global progress in telecommunications technologies has caused the need for significant changes in the technologies of capturing and using SIGINT information. However, according to the accumulated knowledge, sensors and multispectral devices in our army constitute a minimal share of the entire structure of the military reconnaissance subsystem. Meanwhile, despite the subsystem having moved to a multifunctional team organization (task-oriented – separation of reconnaissance elements and subsystems for the needs of operations) (Depczyński et. al., 2022), the reconnaissance data collection equipment is still limited mainly to one function. The development of multi-module sensor kits should correct this drawback and improve situational awareness by providing alternative data collection to assess situations and pinpoint critical objects of interest. Moreover, such a solution will be helpful in confirming reconnaissance data in a situation where there are operational or technical limitations in using one reconnaissance module. Based on the subject literature analysis and conclusions from contemporary military conflicts, requirements can be defined for electronic warfare systems used for EW projects. The priority undertaking is to support electronic warfare (signal intelligence).

Signal intelligence is carried out in peacetime with regard to countries of operational interest but intensifies from forming a combat group and preparing measures for combat work and is carried out continuously. Interruptions in electronic reconnaissance are due only to the losses incurred and the need to change the combat group. Signal intelligence, and thus the support of electronic warfare for the needs of the armed forces, is carried out from space, earth, air and sea.

The acquired data is analyzed and assessed. The analysis consists of a detailed study of the collected electronic information about the enemy by a specialized team. Its task is to obtain information, for the needs of the command and staff, about the composition and grouping of the enemy's troops, combat status, activities and intentions, the location of command posts, organization of command, communication, and reconnaissance systems, and for the needs of electronic countermeasures. The time of gathering this information should allow for the application of effective disruptive, confusing and fire measures. After its processing, it should allow the commander to familiarize him/herself with the command system's general structure and the extent and form of the enemy's use of forces and resources. The conducted observations show that the nature of the operation (defensive, offensive) does not affect the tasks of electronic intelligence, but it does affect the grouping of forces and resources and the manner of carrying out the tasks. Practical conclusions are the basis for concluding that the distinguishing features of electronic intelligence which influence the operational requirements include:

- gathering information without direct contact with the opponent (the object of reconnaissance);
- ensuring the continuity of reconnaissance (it can be carried out day and night, regardless of the season and weather conditions);
- the ability to immediately shift the reconnaissance effort from one object to another without changing the location of forces and means;
- establishing immediate electronic contact with recognized objects at considerable distances;
- deep reconnaissance (the conditions of electromagnetic wave propagation basically limit the range limits);
- ensuring high timeliness of recognition (decision messages can be intercepted before their implementation);
- ensuring reconnaissance secrecy (the enemy may guess that reconnaissance is in progress, but due to the passive nature of the operation of signal intelligence devices, they cannot determine when and against what they are conducted).

These signal intelligence features make it one of the most vital types of reconnaissance during threats and combat operations, and thus, it is necessary to create and use the A2/AD anti-access system.

When specifying the requirements for the support of electronic warfare (electronic reconnaissance), it can be stated that during peace, it should have the ability to supply emitter databases, ultimately used in the EW and operational and tactical activities planning process. During the threat period, it should have the ability to determine the areas of the deployment of means of carrying weapons of mass destruction, the areas of military centers, command posts and communication nodes, radiolocation stations, combat composition and enemy activity, as well as the location of the aircraft base, aviation activities, areas where the main supply bases are, and changes taking place in the military and electronic situation. During combat operations, on the other hand, it ought to have the ability to determine the deployment of WMD carrying means, areas of rocket launch sites and artillery fire control stations, determine the locations of command posts, detect main supply bases, track air force activities, detect enemy activity in the field of regrouping and transfer of troops, introducing second or reserve echelons into combat, as well as other changes taking place in the combat and electronic situation.

5. Conclusions and recommendations

Developing the operational capabilities of the military reconnaissance subsystem within the A2/AD system should, therefore, include building an integrated, multi-layer system of reconnaissance forces and means. Reconnaissance equipment should detect and direct attacks on objects and targets from the most significant operational distance possible in all combat environments,

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including cyberspace. With the above recommendations, it can be assumed that the integrated reconnaissance subsystem could consist of high-precision long-range reconnaissance and assault systems, advanced airspace reconnaissance systems, and the ability to recognize maritime units in the coastal zone. Also, for direct impact, the reconnaissance subsystem should ensure the detection and location of artillery systems, including long-range missile launchers. It can be assumed that in a future armed conflict, in order to maintain freedom of action and effectively use operational capabilities, obtaining reconnaissance information may be necessary about a potential enemy's combat formations capable of moving into the conflict area.

As a result of the analysis of the Russian Federation's operational capabilities in the Baltic Sea region, an assumption can be made that in order to prepare and then use the reconnaissance subsystem, some active and passive activities must be implemented both in the physical (land-air-sea) and electromagnetic environment (Banasik & Rogozińska, 2019). The primary goal of the actions taken should be to limit the enemy's ability to be active in the A2AD system.

Based on the previous observations of the armed conflicts' course, it can be concluded that the essential directions of changes in the A2AD reconnaissance subsystem include (Schmidt, 2017):

- undertaking active reconnaissance activities to gain access to the area of interest, with the simultaneous reorganization of the reconnaissance subsystem architecture to meet the next challenges related to overcoming difficulties in obtaining information.
- preparation of the operational area well in advance to facilitate access to reconnaissance objects, both in terms of information and operation;
- deployment of reconnaissance forces and means, taking into account various variants of location (stationing), combining elements of the subsystem into one common system of information and decision-making relations, including air, sea, and land reconnaissance elements;
- use of the possibility of human intelligence;
- gaining advantage and initiative in reconnaissance activity through the deployment and operation of reconnaissance forces and means in many independent configurations of the reconnaissance system architecture, which means using an increased area (both physical and informational) for acquiring reconnaissance data while ensuring the diversity of sources;
- disrupting both passive and active electronic systems of a potential enemy by using modern technologies that reduce the enemy's operational capabilities in the electromagnetic spectrum and cyberspace;
- ensuring the security of own reconnaissance elements deployed on both mobile and stationary platforms, including especially those located in stationary facilities;
- increasing the level of reconnaissance activity by acquiring reconnaissance data from open sources of information (Hudak, 2019), diplomatic environments, civilian information centers;
- monitoring key strategic and operational objects and goals from one's own area, using the means of detecting and combating targets at a distance and with high precision;
- defending cyberspace and IT resources by implementing systemic solutions with the use of innovative technical solutions.

It should be assumed, bearing in mind the integrated, automated and network-centric A2/AD system requirements, that the military reconnaissance subsystem should have several new operational possibilities. The analysis of the development of reconnaissance directions in many countries' armies constitutes the basis for stating that the new reconnaissance equipment should strengthen the capabilities of the reconnaissance subsystem to manage data, their integration, analysis, and processing per the users' needs.

As a result of the undertaken cognitive process in the research subject, the primary operational capabilities of the recognition subsystem in the anti-access system were developed. The basic tasks to be performed in the A2/AD system by the reconnaissance subsystem in gaining an information advantage during a military operation were named. Assumptions for the development of future reconnaissance subsystems leading to achieving operational capabilities in new conditions were indicated. Based on the results of the analytical work, the essential means of data acquisition and the conditions for conducting reconnaissance activities in the A2/AD system were characterized. Also, the relationship was demonstrated between the new organizational and technical solutions and the reconnaissance subsystem efficiency in the A2/AD system.

Declaration of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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