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Evolution of NATO's Air Defense System Between 1950 and 2015

The author presents the results of research on the genesis of the air defense system of NATO countries and its development in the years 1955-2015. He discusses the course of NATO air defense integration during the Cold War - in the years of intensive arms race and dynamic development of means of transporting nuclear weapons by strategic aviation and long-range rockets. It focuses in particular on technical changes and new technologies that have been successively implemented in the NATO integrated air defense system (NATINADS).

An important part of the article is a reflection on the concepts of air defense development developed and implemented in the XXI century, constituting the basis for the transformation of NATO's integrated air defense system, including equipping it with the capacity to fight ballistic missiles and other types of rockets.

Keywords

air defense system, ballistic missile, missile systems, strategic aviation, integration

The organization of effective air defense in order to preserve the combat capability of the armed forces, including freedom of action in air and missile emergencies, has been a key issue for NATO from the outset. It was recognized that such capabilities can only be guaranteed by an air defense system that is fully integrated to counter airborne threats in times of peace, crisis and war. Over time, it turned out that the integrated PO system is also important in the context of changes in the theory and practice of armed combat. It is especially about a change in the way operations are carried out - they take the form of joint actions[1]. It is widely recognized that such activity is more effective than independent operations carried out by a particular type of armed force. Air defense has become an integral part of this type of activity. On the other hand, the specificity of combined operations makes it necessary for NATO air defense to meet certain requirements. Its essence is to bring together the efforts of all elements involved in air defense into a coherent whole[2]. Synergies shall be sought between the subsystems (elements), including

[1] M . Wind, the *probable nature of modern operations*. "Myśl Wojskowa" 2000 No. 4, p. 93; L. Konopka, S. Czmur, *Problems of Air Force and Air Defense Development*. "Air Force and Air Defense Review" 2000 No. 7, p. 4-5; *National Doctrine. Combined operations. OP/01*, Ref. 800/2002.

[2] B. Zdrodowski, *Air Defense and Air Safety,* in: *Air Defense Planning. Materials from the symposium,* Warsaw 2003, p. 25.

command, mainly in terms of developing uniform rules for joint programming of tactical actions aimed at achieving a single and common operational or strategic objective.

And while this seems relatively easy to achieve, it is more complicated in practice. This is due, among other things, to the complex structure of integrated air defense, which includes, in addition to fighter aircraft, target detection and tracking systems and command and communication systems, anti-aircraft defense troops with modern missile and artillery sets[3]. Importantly, it is not a matter of interfering with the functions of air defense forces, as they are not an objective but only a means to achieve it. The aim is to increase the effectiveness of air defense by skillfully and rationally combining the individual capabilities of OPL forces, radiotechnical troops and aviation into an integrated system. If they are integrated, the combat capabilities of all the elements forming the air defense system can be used to a greater extent.

The idea of building the NATO Integrated Air Defense System (NATINADS), as well as the creation of the North Atlantic Alliance, was born out of the fears of Western countries about the expansion of the Soviet Union's military potential. After the end of World War II, the West largely demobilized its armed forces, while the USSR did not intend to do so to a similar extent. The maintenance of significant military potential, as well as the tough communist regime and the introduction of undemocratic methods of exercising power in the controlled countries of Central and Eastern Europe, including the upheaval in Czechoslovakia and the blockade of Berlin in 1948, reinforced the conviction of Western countries of the growing danger and possibility of a third world war. In a situation of growing threat, the European countries - Belgium, France, the Netherlands, Luxembourg and the UK - have decided to join their defense efforts, as demonstrated by the signature of the Treaty of Brussels in March 1948. These countries later entered into negotiations with the US and Canada to form an alliance based on security guarantees and common commitments. The negotiations, in which other European countries also participated, ended in April 1949 with the signing of the Washington Treaty, which established a common Euro-Atlantic security system called the North Atlantic Treaty Organization (NATO). Of the 12 founding countries, five were signatories to the Treaty of Brussels, five European countries were invited - Denmark, Iceland, Norway, Portugal and Italy - and two countries, the USA and Canada, came from outside the Old Continent. In 1952, Greece and Turkey joined NATO, in 1955 the Federal Republic of Germany, in 1982 Spain, in 1999 the Czech Republic, Poland and Hungary[4], in 2004 Bulgaria, Estonia, Latvia, Lithuania, Romania, Slovakia and Slovenia, in 2009 Albania and Croatia and in 2017 Montenegro.

The aim of the article is to indicate the most important qualitative changes in the field of NATO air and missile defense, obtained as a result of the progressive integration of forces and resources allocated by Member States in the 20th century. This was achieved by putting the further research steps in order by formulating the[5] general problem as a question: How did the integration of NATO's air defense and missile defense system proceed in the 20th century and the first decade of the next century and what qualitative changes did it bring about?

On the basis of a preliminary analysis of the literature on the subject and factual knowledge, it was assumed that the solution of the main research problem will be possible after verifying the following working hypothesis: the system of the integrated NATO air defense has been

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[3] Vide: S. Miodek, *Rocket Air Defense of the Republic of Poland. Stage III of research*, Warsaw 1998, p. 3.

[4] S. Koziej, *NATO and EU security strategies*, Warsaw 2008, p. 4 [online], HTML version of the file, www.koziej.pl [access: 12.06.2016].

[5] The importance of the problem is indicated by Joseph Pieter: ...] the *precision of the problem, its justification and the identification of questions related to it are, as we know, fundamental tasks in any scientific work, including research work*. J. Pieter, *General Methodology of Scientific Work*, Wrocław 1967, p. 26.

subject to continuous integration actions since its establishment in the 1950s. They are undertaken in the international structures of NATO air defense, and their result is to unify the characteristics of air defense elements and functions. This is particularly relevant for joint operations of air defense forces - ground and airborne, separated by NATO members from different types of forces - in the immediate vicinity or in common areas of responsibility.

Establishment and Development of an Integrated NATO Air Defense System in the Second Half of the 20th Century

The concept of an integrated air defense system was developed in the early 1950s. The AIR DEFENSE system created by NATO countries was to balance the threat feared by the Soviet long-range bombers. This was especially true for the USSR's ability to use strategic bombers, including Tu-16 Badger and Miashniyev M-4 Bison, which were capable of long-range attacks. The strategic bombers allowed the Russians to strike at key NATO facilities within minutes after the planes took off from Soviet territory. The creation of a system that would deter a potential aggressor, warn of and effectively counteract the air threat was a priority for NATO[6].

The first concept of an integrated AIR DEFENSE system was approved by the NATO Military Committee in December 1955 and its final version[7] was adopted in 1960. As a first step, an early warning system for Western European countries was launched, comprising 18 fixed radars. In 1962 they were connected by an IT network and thus the NADGE (NATO Air Defense Ground Environment) system was created. In the 1970s, it processed information from as many as 84 radars and distributed it to the first CRC (Control And Reporting Centers) in NATO[8].

In those years, it became clear that military planes no longer had the technical ability to fly at altitudes so high as to avoid the fire of anti-aircraft missiles, so the concept of performing impacts at low and very low altitudes, in the range of 50-100 m, appeared. This meant that air defense must be able to detect low-flying aircraft. In December 1978, the NATO Defense Planning Committee approved the acquisition by the Alliance of 18 E-3A AWACS planes for an early warning system[9]. They have been integrated into the NATO Airborne Early Warning & Controle Forces (NAEW&CF). NATO adopted a different principle for the use of AWACS aircraft from that of the United States: there each aircraft could operate independently as an autonomous command and control center[10], the Alliance retained sovereign control over hunting interceptor planes, so AWACS data was transferred to a pool common to all ground centers.

The inclusion of AWACS aircraft in the air defense system has ensured the recognition of targets at very low altitudes, thereby increasing the NATINADS' recognition capabilities. On the other hand, the increasing automation of Germany's ground-based command and control

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[6] A . Radomyski, K. Dobija, *Planowanie działań tacttycznych w zintegrowanej obronie powietrznej*, Warsaw 2008, p. 34.

[7] *MC54/1(Final). Military Committee Concept of the NATO Integrated Air Defense System (NATINADS)*, 30 September 1960.

[8] CRC - notification and control centre. Its counterpart in the Polish Air Force is the Command and Guidance Centre (ODN), the main executive body in the field of command and control of active means of air combat.

[9] *AWACS: NATO's eyes in the sky*, NATO/OTAN [online], http://www.nato.int/cps/ru/SID-48017896 C1166132/natolive/topics_48904.htm [accessed 21.07.2016].

[10] The AWACS Early Detection and Guidance System is one of the most important elements to support the NATO Command System. It complements NATO's ground-based object detection and identification systems. This comprehensive and universal system provides the operational capability to command and direct active, defensive and offensive combat measures in times of peace, crisis and war, and completes the picture of airspace situation in and over sea areas and over land and land. B. Grenda, *Early detection and guidance systems in support of the Polish Air Force*, "Zeszyty Naukowe AON" (AON Scientific Papers) 2013 No 2, p. 243.

system and long-range surveillance radars has contributed to shortening the time needed by military commanders to counter aerial threats, making Germany and a large part of Western Europe more resistant to attacks by a possible aggressor. The modernization work mainly concerned the German Air Defense Ground Environment (GEADGE) and Hughes Air Defense Radar (HADR). Two three-dimensional radars have been assigned to ensure radiolocation reconnaissance of the southern and northern part of Germany.

HADR radar had a range of up to 500 km. He detected targets - planes - with an effective 1 m^2 reflection area from a distance of 320 km and at a maximum height of over 30 km. It transmitted data on air targets in the range: azimuth, altitude and speed. This data was provided in digital form. The device also used modern interference mitigation systems: an early warning/air environment integration section (AEGIS) to integrate the new E-3A airborne radar fleet with GEADGE's command centers over a two-year period, and TTTT class terminals (JTIDS) to provide safe and interference-free digital and audio communication between GEADGE destinations and AWACS aircraft in a potentially hostile electronic interference environment over Western Europe.

From February 1982 to May 1985, in addition to the inclusion of 18 E-3A planes in the NATINADS system, a program to strengthen the NATO Defense Ground Environment (NADGE) network was also implemented. At that time, 40 modern radars were deployed in the area from northern Norway to eastern Turkey. All Member States participated in the financing of this costly undertaking, it was agreed that they would use the system on a common access basis, but the system would remain under the responsibility of the Alliance[11].

In the course of the creation of the Integrated Air Defense System, it was also agreed that the command over the air defense forces of NATO countries during the war period will be held by the Supreme Allied Commander Europe (SACEUR), while during the peace period it will be held by the dedicated air defense forces of individual Alliance countries in the field of operational control (Operational Control Air Defense Artillery Bulletin - OPCON).

As a result of the consolidation of the technical and military thought of Western European countries and the substantial assistance provided by the United States in the framework of NATINADS, air defense zones to the east have been created in which aviation activities have been coordinated with those of land forces. All forces and means planned to be deployed in air defense areas were to be under NATO command. The main contractor for direct shielding of objects and troops were anti-aircraft rocket units, grouped in zones in two projections along the borders with Warsaw Pact countries. This way of grouping air defense forces was to allow them to move freely and concentrate the main effort in the area where the airborne danger was expected to occur. The concept of the use of anti-aircraft missiles by NATO during the Cold War assumed the inclusion of American subunits of anti-aircraft missiles (stationed in Europe) in the uniform NATO Defense Ground Environment system.

Working together with NADGE, Hawk missile anti-aircraft subdivisions formed a continuous fire zone in the range from small heights of 100-300 m to the maximum flight altitude of the then Soviet frontal aircraft. The shielding zone stretched from the military contact line to about 50 km deep. The second line of anti-aircraft agents, formed on the basis of Nike Hercules and partially Nike Ajax, was to supplement the anti-aircraft fire system and destroy air targets at high and medium altitudes.

[11]The NAEW&CF system is based on two operational components: the first, located in Germany in Geilenkirchen, comprises 17 NATO Boeing E-3A aircraft and is operated by international crews from Belgium, Canada, Denmark, Germany, Greece, Hungary, Italy, the Netherlands, Poland, Portugal, Spain, Turkey and the USA, while the second component, equipped with 7 E-3D machines, is stationed in the UK in Waddington and is operated by English crews.

Nike's rockets could fire on air targets from a distance of about 100 km. Behind the fire zones of anti-aircraft missiles was the area of responsibility of NATO's fighter aviation. In the 1960s these were mainly F-104 and F-4 aircraft. Particularly important objects were additionally defended by Nike and Bloodhound anti-aircraft missile units and less important by anti-aircraft artillery. This structure of the air defense system of NATO countries survived until the Warsaw Pact broke up.

In the early 1970s, radio-technical units for detecting low altitude air targets were established, equipped with MPDR 30 radars (range 30 km). Their task was to detect aircraft at altitudes ranging from 0 m to 3000 m above sea level. The units were deployed along the border between Germany and the GDR and the Czech Republic at places called DEST (*Dauereinsatzstellung*). In total, there were 24 such places in Germany.

An important complement to NATO's integrated air defense system was the GEADGE (German Air Defense Ground Environment) Automatic Air Defense Management System, designed to detect and identify air targets, to determine (assess) the scale of the threat, and to provide guidance and data on the management of anti-aircraft missile systems. This system was to cover the southern part of Germany. It was executed under a contract worth $150 million. It was based on four stationary command centers and mobile radars. He could receive air situation information from AWACS E- 3A early warning aircraft.

The GEADGE system was deployed in the southern part of Germany because this part of the country was not included in the original NATO Defense Ground Environment (NADGE) air defense structure. GEADGE was therefore to fill a gap in the NATO air defense system. During the fight, the GEADGE system received data from both NATO's NADGE air defense system and Lara's mobile low-flying target detection stations along Germany's eastern borders. The first two command centers within the GEADGE system were started in the years 1983-1984 and the next two - in 1985.

In conclusion, NATO's integrated air defense system was, and continues to be, designed to ensure the integrity of the Alliance's air borders and to defend Member States and their armed forces against aerial attacks throughout the area of responsibility. This also applies to the territory of countries where NATO troops are present[12]. It has been assumed that the forces and resources allocated to NATO by individual states will be subordinated to a joint allied command - the Supreme Commander of NATO in Europe (SACEUR) both in time of peace and war. In this way the integrated air defense system has taken over responsibility for the air defense of NATO countries. The sustainability of this system can be demonstrated by the fact that the objectives and targets of NATINADS air defense in Europe, as formulated in the 1960s, have only slightly changed over the years and remain largely valid.

Transformation of NATO's Air Defense System in the First Decade of the 21st Century

At the beginning of the 21st century, the NATO Integrated Extended Air Defense (NATINEADS) system began to be transformed to achieve the standards of the NATO Integrated Extended Air Defense concept. The essence of this concept has been discussed in numerous NATO documents, issued by both political and military bodies.

[12]{\pos(192,210)}Wider: A. Radomyski, K. Dobija, *Tactical Action Planning...*, op.cit, pp. 35-38.

The NATINEADS structure included four main elements, the so-called pillars of the extended integrated air defense[13]: the Battle Management/Command, Control, Communication, Computers and Intelligence (BMC4I), Active Defense, Passive Defense and Conventional Counter Force.

The combat management subsystem is designed to provide information security for the other extended air defense subsystems: active and passive extended air defense and conventional impact forces. It provides timely and continuous information on the air situation, as well as early warning of the aerial danger and its probable nature and of the anticipated type and area of impact of air strike measures (AED). In addition, it coordinates the activities of all forces forming the PO system (also at the planning stage)[14].

The Active Combatants Subsystem is made up of the forces of fire and electronic attack means in the air. They include fighter aircraft, ground missile and artillery air defense firearms and active electronic interference systems.

The passive extended air defense subsystem includes projects aimed at minimizing the impact of enemy air assault agents against the population, forces, means and facilities of the Alliance. It is designed to perform such tasks as: air alert and warning; masking and confusing means of air strike; reducing the sensitivity of potential air strike objects and increasing the ability to restore the operational capability of the forces under attack from the air[15].

The conventional striking force subsystem is intended to prevent the enemy from using primarily rocket air-attack vehicles by means of an immediate direct attack on their detected and recognized launch sites, as well as elements of the command system and logistical security. These actions shall be taken, inter alia, by aircraft and helicopters to combat means of air strike on the ground or at sea, ground-to-ground missiles or long-range artillery and special forces[16].

Further changes in the architecture of NATO's air defense system were introduced due to the growing threat of a ballistic missile attack. In 2010, during the NATO summit in Lisbon, it was proposed to combine the existing functions of the NATINADS system and the NATO BMD (Ballistic Missile Defense) system with the preservation of the proven NATINADS command structures. In this way the NATO Integrated Air and Missile Defense (NIAMD) system was created. Its objective, as with previous PO systems, is to ensure the integrity of the Alliance's air borders and to defend the Member States and their armed forces against aerial attacks from all threats generated by the SNF, including in particular ballistic missile threats. It was assumed that this defense would be extended over the entire area of responsibility, including the countries where NATO troops are present (as part of expeditionary operations)[17].

It is assumed that the elements of the NIAMD system may be maintained in different combat readiness, depending on the duration of the operation, but in the case of elements of the command structure and passive means of the air defense, this readiness is constant and unchanging. The NIAMD system operates in times of peace, crisis and war.

The tasks of the NIAMD in times of crisis, as in times of peace, are to supervise and manage the airspace and to demonstrate its readiness to repel an unexpected air strike and to provide convenient conditions for the use of other types of armed forces. During this period, airborne

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[13] *AJP-3.3. Joint Air & Space Doctrine,* June 1999, 405.9.

[14] \n-You know, the *directions for the development and improvement of air defense in the land forces. Automation of command in air defense troops. Current state and development prospects*, AON, Warsaw 2008, 101-103.

[15] *AJP-01 B. Allied Joint Operations Doctrine*, 2001, pkt 1105b.

[16] AJP-3.3, point 405. 9d.

[17] *Podstawy obrony powietrznej (Principles of Air Defense)*, A. Radomyski (ed.), Warsaw 2015, p. 151.

units shall maintain an increased capacity of fighter planes compared to peacetime in readiness for rapid response in the event of the need to intercept airspace violators and to apply a procedure for identification, identification and intervention, including shooting down. In times of crisis in well-defined areas of airspace, NIAMD air traffic management units may introduce restrictions for civil aviation.

All available NIAMD forces, both airborne and ground-based, including naval forces, are used during the conflict. They carry out aerial reconnaissance, flight supervision, identification and readiness to use all kinds of hunting aviation weapons and ground-based air defense fireworks. Ultimately, NIAMD will be prepared to perform tasks in the following areas[18]: Ballistic Missile Defense, designed to defend the territory of the countries of the Alliance against short range ballistic missiles (SRBM), medium range ballistic missiles (MRBM), intermediate range ballistic missiles (Intermediate Range Ballistic Missile) and long range ballistic missiles (Intercontinental Range Ballistic Missile)[19]; Theatre Ballistic Missile Defense (Theatre Ballistic Missile Defense) understood as the defense of a part of the continent's territory with coastal ocean waters, with internal seas and airspace above them, within the limits of which warfare activities can be developed or are conducted in order to achieve the strategic objectives of war or one of its stages; Cruise Missile Defense; Airborne Air Defense, including Air Policing operations and interventions against Renegade[20]facilities; Surface-based Air Defense, which is carried out by anti-aircraft systems deployed on land and sea platforms; and Counter Rocket Artillery and Mortars[21].

The functional structure of the NIAMD system is divided into four main subsystems[22]: Air Surveillance; Battle Management Command, Control, Communication and Intelligence (BM3CI); Active Air Defense and Passive Air Defense.

The airspace control and surveillance subsystem is designed to monitor the movement of objects in airspace, to track, identify and classify them. By using various sources of information and communication means, it enables early warning of an air hazard. It uses both ground-based reconnaissance means and airplane mounted means[23].

The combat command, control, communication and reconnaissance subsystem collects and collects all information provided by the airspace control and surveillance authorities, processes it and transmits it to active air defense measures.

The Active Combatants subsystem includes forces of fire and electronic attack means in the air[24]. They include fighter aircraft, ground missile and artillery air defense firearms and active electronic interference systems. It is anticipated that these forces will be used against the classical SNF, while missile defense assumes the use of a variety of defensive and offensive weapons, including: aircraft and helicopters, ground-to-ground missiles, long-range artillery, as

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[18]Ibidem, p. 152.

[19]Ibidem, pp. 152-153.

[20]The Renegade Status ("deviator," "rebel") is given to aircraft that can be used as a means of aerial terrorist attack. Depending on the extent to which the criteria are met, they are classified in one of three categories: Suspect Renegade (suspect), Probable Renegade (probable) and Confirmed Renegade (confirmed). S. Zajas, *Counteracting terrorist threats at airports*, "AON Scientific Papers" 2007 No 2, p. 43.

[21]{\pos(192,210)}The *Air Defense Basics...*, op.cit, p.153.

[22] Ibidem.

[23]The airspace control and surveillance subsystem consists of multinational Combined Air Operations Centers (CAOCs) and their Subordinate Control and Reporting Centers (CRC). The CAOC with the CRC is connected to the radio and IT communication network. The Notification and Control Centers are the principal implementing bodies for the command and direction of active combat measures.

[24]Ibidem, p. 154.

well as special forces to combat detected and recognized rocket launchers on the ground or at sea, their command elements and logistical security. However, hunting aviation, anti-aircraft defense systems and electronic warfare still play a major role among the potential for active combat measures.

The passive air defense subsystem shall include measures taken to minimize the impact of adversary air strike measures against the population, forces, means and facilities of an Alliance[25]. It is designed to perform the following tasks: alarming and warning about the threat from the air, masking and confusing the means of air attack, reducing the sensitivity of potential air strike objects and increasing the ability to restore the operational capability of forces under attack from the air.

An important role for the efficiency and effectiveness of NIAMD will be played by the Integrated Air Command and Control System (ACCS) for the management of NATO air operations in the Euro-Atlantic area and beyond. It will replace the various NATO and national air systems that are currently deployed throughout the Alliance. This will unify the airspace command and control system, thus enabling NATO and its members to manage the various air operations both within NATO's European area and when deploying Alliance forces outside this area. The adopted concept assumes that in a situation where NATO forces are used regardless of the theatre of warfare, the ACCS ensures effective management of air operations conducted in an area of up to 10 million km2.

The NATO Air Defense Command and Control System (ACCS) is to replace the systems previously used in Europe, such as NADGE, GEADGE and STRIDA. It is designed to integrate tactical planning, performance of tasks and conduct all defensive and offensive air operations, as well as to support air defense forces and measures operating in one system. It goes beyond air defense. It is implemented under the supervision of NATO Management Organization ACCS (NACMO) and is expected to provide full operational capability in the next few years[26]. The ACCS will be implemented in all European NATO member countries as permanent (static) control centers. It will also be introduced in the new member states of the Alliance.

ACCS creates very good conditions to command a variety of possible joint air operations, from long-term mission and airspace planning to real-time management of sensors, weapons and communication networks. According to military experts, it guarantees stability, reliability, ease of maintenance and high standard of system security. It provides both command of operations at the tactical level and air campaigns with hundreds of operators deployed in high-performance computer centers. Furthermore, it is interoperable with all relevant military and civil communication systems. The ACCS will provide the Alliance with the ability to command and control air operations within and outside the Euro-Atlantic area using a single integrated system.

The first element of command that implemented ACCS and obtained operational status was the CAOC in Poggio Renatico, Italy. The new NATO command and control system was launched on 3rd July 2015 and Patrick Auroy, NATO's Assistant Secretary General for Defense Investments took part in this event. Earlier, exercises were conducted during which, for the first time in history, the civil aviation management system was integrated into the military ACCS. On June 17, 2015, an order was sent from the Air Operations Centre in Torrejon, Spain for the take-off of two Eurofighter Typhoon planes, which were controlled by the ACCS party

[25]Ibidem, p. 159.

[26]The original contract to provide basic software, system test and validation capabilities was signed by the parties with Air Command Systems International (ACSI) in November 1999.

in Poggio Renatico. The importance of this event is demonstrated by the words spoken by General Bernhard Fürst, Vice-Chairman of the NATO Air Defense and Missile Committee: *This event is an important milestone for the entire NATO integrated NATO missile and air defense community*[27].

Summary

The analysis of the integrated, and now even extended, air defense shows that the essence of allied air defense is the functioning of all airspace reconnaissance, fire and electronics forces and the command, communication and automation systems integrating them in all types of armed forces in an integrated system. This system is designed to cover the territory, the population and the armed forces of the Alliance by counteracting[28] (mainly combating) any airborne threat. From the outset, NATO's integrated air defense system was designed to ensure the integrity of the Alliance's air borders and to defend Member States and their armed forces against aerial attacks throughout the area of responsibility, including over countries where NATO troops are present. The NATO Integrated Air Defense System (NATINADS) was to be, above all, the guarantor of security in the airspace of European Alliance countries. Its counterpart to US and Canadian territory is an extensive defense system, headed by the North American Aerospace Defense Command (NORAD).

It seems that the basis for further integration of air defense systems of NATO member states is to spend more and more money on research and development of technologies that could be used in the future in modern systems of reconnaissance, firefighting and command support. In all countries where the role and importance of research on the technical development of POs has been recognized, sooner or later there has been a qualitative development of anti-aircraft means of recognition, command and flare. On the other hand, in countries where PO issues were treated marginally, the conditions for the development of air defense were not created, as a result of which its quality was constantly deteriorating. The Polish Armed Forces are a clear example of this.

It is envisaged that the NIAMD system, once fully operational in all task areas, will allow two large and six small combined air operations to be conducted in parallel, also outside the Alliance countries. The main objective of the system is interoperability - both procedural and technical - ensuring the exchange of information between the different elements of the system. Some of these elements, such as airspace reconnaissance and early warning systems, as well as active air defense measures for Air Policing missions, must remain in full 24-hour combat readiness. The remaining elements of the system are expected to remain at lower levels of combat readiness. The readiness of the NIAMD system will also be determined by the phases of the operation, which include peacetime, crisis situation, conflict and post-conflict.

Photo 1. long-range radars (HADR) deployed in the eastern sector of Germany, which are integral components of the GEADGE system

[27] *NATO welcomes activation of new Air Command and Control System*, NATO/OTAN [online], 3.07.2015, https://www.nato.int/cps/en/natohq/news_121623.htm?selectedLocale=en [dostęp: 12.09.2018].

[28] Przeciwdziałanieć - przeciwstawić jakiegoś jakiegoś działania inne działanie, zapobiegać jakie jakie jakie działanie, *Słownik języka polskiego PWN* (multimedia), Warsaw 2004.

Photo 2: Nike rocket family, from left: MIM-3 Nike Ajax, MIM-14 Nike Hercules, LIM-49 Nike Zeus.

Fig. 1. Structure of the NATO integrated air defense system in the years 1960-1980

Author's own study based on: Tactical Air Control System [online], US Army in Germany, https://www.usarmygermany.com/USAFE TACS 2.htm [access: 12.07.2016].

Strefa działania samolotów myśliwskich / Fighter Aircraft Operating Area

Linia mobilnych radarów przeznaczonych do wykrywania celów powietrznych na małych wysokościach / A line of mobile radars designed to detect low altitude air targets

CRC – Centrum kontrolno-meldunkowe / CRC - Control and Reporting Center

SOC – Centrum Operacyjne Sektora / SOC - Sector Operations Centre

Centra dowodzenia obroną powietrzną / Air Defense Command Centers

Strefa osłony systemów rakietowych Nike / Nike Missile System Shielding Zone

Strefa osłony systemów rakietowych Hawk / Hawk Missile Systems Shielding Zone

Fig. 2: Main political and military assumptions of NATO's air defense and missile defense

Author's own elaboration

POŻĄDANE EFEKTY OBRONY PRZECIWRAKIETOWEJ / DESIRED EFFECTS OF MISSILE DEFENSE

BRAK ZAGROŻEŃ / NO RISKS

UNIEMOŻLIWIENIE STARTU / PREVENTING LAUNCH

SKUTECZNE PRZECHWYCENIE / EFFECTIVE SEIZURE

BRAK KONSEKWENCJI / LACK OF CONSEQUENCES

ANTYPROLIFERACJA / ANTIPROLIFERATION

ODSTRASZANIE / DEFINITION

DZIAŁANIA OFENSYWNE / OFFENSIVE ACTIONS

OBRONA AKTYWNA / ACTIVE DEFENSE

OBRONA PASYWNA / PASSIVE DEFENSE

Wymiar polityczny / Political dimension

ZARZĄDZANIE WALKĄ, DOWODZENIE, KONTROLA, ŁĄCZNOŚĆ, ROZPOZNANIE / COMBAT MANAGEMENT, COMMAND, CONTROL, COMMUNICATIONS, RECONNAISSANCE

Wymiar wojskowy / Military dimension

PLANOWANIE / PLANNING

CZAS „P" STAŁY PLAN OBRONY (SDP) / TIME "P" PERMANENT DEFENSE PLAN (SDP)

MC 0133/4 NCRS MANUAL / MC 0133/4 NCRS MANUAL

KRYZYS/KONFLIKT PLAN OPERACJI (OPLAN) / CRISISS/CONFLICT OPERATION PLAN (OPLAN)

Figure 3: Essential elements of an integrated command and control system (ACCS)

Author's own elaboration based on: NATO Air Command and Control System (ACCS), NATO Scanner [online], http://nato.radioscanner.ru/equipment/article14 [accessed 12.06.2018].

ACCS Zintegrowany System Dowodzenia Siłami Powietrznymi i Obroną Powietrzną NATO / ACCS NATO Integrated Air Force and Air Defense Command System

It shall perform functions relating to the planning, transfer and execution of tasks in air operations, such as:
- management of active forces and resources (aviation and air defense units)
- management of system resources (radars, tactical information exchange systems, air defense command posts, etc.)
- airspace management
- airspace observation
- air traffic control
- control of tasks performed by aircraft and weapon systems

Figure 4: ACCS characteristics
Author's own elaboration based on: NATO Air Command and Control System (ACCS), NATO Scanner [online], http://nato.radioscanner.ru/equipment/article14 [accessed 12.06.2018].

Possibilities:
- mission and task planning
- battlefield management (operation)
- management of combat forces and means
- airspace management
- reconnaissance
- air mission control
- airspace control
- coordination of civil operations
-Military

Global power projection:
- full potential

- possibilities for resolving actions in the air
- 30 days of self-defense
- the possibility of adapting the system to the scale of operations (operations)

Characteristics:
- modern, powerful and flexible architecture
- communication protocol, NATO interface and cooperation with national civil commercial systems
- for NATO as a whole, a tactical link, including L-16, and fast data handling
- sharing
- integrated with the airline management services
- usable for defense against ballistic missile attack

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