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The Air Defence System of the Republic of Poland in the Era of Armed Forces Transformation

Abstract

The article analyses the evolving Air Defence System of the Republic of Poland as an integrated ecosystem of forces, assets, command structures and procedures designed to ensure the inviolability of national airspace and to protect the population, the Armed Forces and critical infrastructure from the full spectrum of airborne threats. Polish modernisation efforts are situated within a deteriorating European security environment and in light of recent conflicts – above all the war in Ukraine – which have demonstrated the operational salience of ballistic and cruise missiles, long-range stand-off weapons and the mass employment of unmanned systems. Against this background, the article examines the layered architecture of PL ADS, including the Wisła, Narew and Pilica/Pilica+ programmes, very-short-range systems (Grom, Piorun, Poprad) and an emerging reconnaissance and strike layer based on drones, all integrated through the network-centric Integrated Battle Command System (IBCS) and an expanded radar and radiotechnical component.

Particular attention is devoted to ensuring interoperability with NATO's Integrated Air and Missile Defence (IAMD) posture and to European initiatives such as the emerging missile shield and associated financial instruments (EIB loans, EU funds, SAFE). The author highlights the strategic importance of integrating fifth-generation F-35 aircraft with ground-based air and missile defence, as well as the parallel development of air-to-air refuelling

capability, airborne early warning platforms and a national satellite programme to secure information superiority. On the basis of current procurement decisions, the state of implementation of key programmes and operational lessons from Ukraine, the article identifies major shortfalls: an insufficient scale of C-UAS capabilities, delays in integrating Wisła and Narew, legacy systems that are technologically obsolete, limited interoperability at the operational level and an underexploited potential for industrial participation and technology transfer.

The article concludes that the transformation of Poland's air defence is a long-term, capital-intensive process whose success will depend on coherent sequencing: building a genuinely multi-layered architecture, prioritising missile defence and C-UAS, investing in space and AI-enabled network-centric C2, and deepening European defence cooperation. Full readiness and effective interoperability of PL ADS – understood as a credible pillar of deterrence and defence on NATO's eastern flank – appear attainable only in the early 2030s, provided that high levels of investment are sustained and the identified gaps are systematically addressed.

Key words

air defence system, air and missile defence, Republic of Poland, Narew programme, F-35 integration, unmanned aerial systems (UAS), counter-UAS (C-UAS), network-centric command and control (C2/IBCS), NATO Integrated Air and Missile Defence (IAMD), European missile shield

Introduction

The Air Defence System of the Republic of Poland (PL ADS) is understood here as the integrated set of forces, assets, command arrangements and procedures organised to assure the inviolability of national airspace and to safeguard the population, the Armed Forces and critical functions of the state from the full spectrum of airborne threats. In practical terms, this encompasses early warning and air surveillance, battle management, command, control, and communications; kinetic and non-kinetic effectors; and supporting logistics, training, and infrastructure. Its immediate tasks are to provide persistent coverage for key political-administrative centres, military installations, defence-industrial nodes and critical infrastructure; to deny or disrupt hostile airborne reconnaissance and strike; and, when ordered, to contribute to the attainment of air superiority at the operational and - where feasible - strategic levels. In joint and combined operations, PL ADS must deliver responsive air

cover and fire support to other branches of the Armed Forces and, by shaping the air environment, facilitate the isolation of designated areas of operations.

A deteriorated European security environment and the demonstrated salience of air and missile threats in recent conflicts define the strategic context for Poland's air defence. Adversary capabilities now span legacy manned aviation, increasingly precise ground-launched ballistic and cruise missiles, long-range air-launched stand-off weapons, as well as a rapidly proliferating ecosystem of uncrewed systems – from massed, expendable first-person-view (FPV) drones to larger reusable platforms. These developments compress warning timelines, complicate attribution and saturate traditional point-defence architectures. Accordingly, the Polish approach emphasises a multi-layered, network-centric design that combines medium-range area defence, short-range and very-short-range components, and a growing counter-UAS portfolio, all fused by modern battle-management systems and underpinned by resilient communications and electromagnetic spectrum discipline.

Institutionally, PL ADS forms a critical component of the state defence system and is designed to be interoperable with NATO's Integrated Air and Missile Defence posture. In peacetime, round-the-clock duty provides continuous surveillance, identification and air policing, with defined transitions to heightened readiness or wartime rules of engagement. Responsibilities are apportioned between the Operational Commander (assuring day-to-day functioning and operational control) and the General Commander (force generation, preparation and allocation of forces and assets). This dual structure is codified in ministerial decisions and implementing instructions. It is complemented by legal and procedural arrangements governing cooperation with allied forces operating in or above Polish territory.

From a capability perspective, the system under construction is explicitly layered. At the upper tier, medium-range effectors (e.g., the Wisła segment) provide area defence against ballistic and aerodynamic threats. At the lower tiers, the Narew and Pilica/Pilica+ segments deliver short- and very-short-range defence of manoeuvre forces and key points, while indigenous MANPADS and mobile launchers extend coverage and mobility at the tactical edge. Equally decisive are the enablers: modern 3D surveillance radars, passive location systems, height-finding sensors, airborne early warning contributions, and a battle management/command system capable of sensor-to-shooter

pairing across services and, where mandated, across allied formations. The introduction of fifth-generation combat aircraft will further expand the sensor and shooter portfolio, provided that air-to-air refuelling, hardened basing and secure datalinks mature apace.

This article proceeds from the premise that air defence is an ecosystem, not a single programme. It examines (I) the governance and legal framework that anchors PL ADS, (II) the current and planned composition of its layered architecture, (III) the sensor and command-and-control backbone required for genuine network-centric operations, (IV) the international setting – NATO interoperability and European initiatives – together with financing instruments, (V) the integration of fifth-generation air power with ground-based defence, and (VI) the implications of emerging technologies and recent operational lessons, particularly in the counter-UAS domain. It concludes by identifying priority gaps and recommending sequencing choices that would accelerate the transition from disparate acquisitions to a coherent, resilient and sustainable Air and Missile Defence posture fit for the next decade.

Architecture and Governance

The Air Defence System of the Republic of Poland constitutes a crucial component of the state's defence system and should be compatible with NATO's air defence architecture. In peacetime, round-the-clock combat duty is maintained within the system. Responsibility for ensuring the system's functioning lies with the Operational Commander of the Branches of the Armed Forces. Responsibility for the preparation and allocation of forces and assets to carry out tasks rests with the General Commander of the Branches of the Armed Forces. The detailed rules governing the organisation and performance of combat duty within Poland's air defence system are set out in decisions of the Ministry of National Defence and in the „Instruction on the Organisation and Performance of Combat Duty in the Air Defence System".

Capability Layers and Effectors

In cooperation with the United States, the United Kingdom and the European Union, Poland is building a multi-layered air defence system. It has been undergoing systematic modernisation for many years, and this process has accelerated markedly since the outbreak of the war in Ukraine. Contracts have been signed for the procurement of the Patriot system and of the Narew system. 360-degree radars – an innovation – will be introduced. We are implementing the Integrated Battle Command System (IBCS), the world's most advanced command and control system, which provides network-centric capabilities. The Patriots will be integrated into a single network together with the Narew system's i-Launchers. In addition, artillery rocket launchers will be connected to this network. The 37th Air Defence Missile Squadron achieved Initial Operational Capability (IOC) in December 2024. In September 2025, the first live missile firing from a Polish Patriot battery was conducted at the Ustka training range—an essential step towards Full Operational Capability (FOC) of the system. Live-fire exercises have also been conducted with the "Small Narew". The first Patriot batteries are already operational, and the system is being expanded. The introduction of a multi-channel system into the air-defence troops can already be described as a revolution. We have completed tests of the Pilica+ system at the Ustka range, where its capabilities were verified. These tests were conducted against real targets simulating airborne means of attack. At the current stage, the functionality of Pilica+ is promising. The first validated and tested Pilica+ batteries are scheduled for delivery next year. It must, however, be remembered that building an integrated air and missile defence system – including its financing – is a highly demanding, long-term and costly process. At present, funding is provided from the Ministry of National Defence budget, the Armed Forces Support Fund, including foreign financial instruments (e.g., Foreign Military Financing – FMF), as well as resources obtained from the European Union.

In the near future, the F-35 aircraft will also operate within the Air Defence System. Polish pilots are currently training on them in the United States, and in 2026, both the aircraft and the trained pilots will be redeployed to Poland.

The air defence system being developed in Poland is designed to protect three tiers. The first – Wisła – comprises Patriot missile launchers with

a range of up to 100 kilometres. The second – batteries under the Narew programme – are equipped, inter alia, with CAMM-ER missiles with a range of 45 kilometres. The third – lowest tier is the Pilica programme, under which Poland will purchase over 20 batteries equipped with CAMM missiles with a 25-kilometre range. We also possess Polish short-range man-portable air defence systems (MANPADS) of the Grom and Piorun types (which occupy the lowest level of this architecture), launched from shoulder-fired launchers. Mesko S.A., a company within the Polish Armaments Group, had delivered approximately 3,000 missiles by February 2025. This system is in active use in Ukraine. Another element in this architecture is the self-propelled Poprad surface-to-air missile system from PIT-Radwar. The system is mobile and equipped with a turret comprising four launchers and two cameras – daylight and night – along with a rangefinder. Poprad can perform tasks in two modes. The first entails integrating the vehicle within the broader air defence system, from which the crew receives orders and target designations. The second is autonomous operation, in which the crew independently selects the sector of the sky. It employs Grom and Piorun missiles. The contract was signed in 2015. A total of 79 systems have been delivered to the Polish Armed Forces, including to the 8th Koszalin Air Defence Regiment and the 12th and 17th Mechanised Brigades.

Poland has also ordered MQ-9 Reaper military uncrewed aerial vehicles produced by the American company General Atomics. The procurement documentation was signed on December 12, 2024, with a value of approximately USD 310 million. Deliveries to Poland are scheduled for the first quarter of 2027. We possess a Coastal Missile Unit (two missile squadrons). Contracts have been signed for the manufacture and delivery of two additional CMUs. In 2016 and 2019, the CMU conducted live-fire exercises at a range in Norway. We are building a Polish satellite programme and will also form part of the European missile shield.

Another crucial element of the Air Defence System is the radiotechnical troops, whose core is the 3rd Radiotechnical Brigade (3rd Radiotechnical Brigade, 3BRt). Among the most modern radar stations in service with the Brigade's units – forming the equipment of radar posts – are the NUR-12M and RAT-31DL sets, the mobile three-coordinate medium-range radar stations NUR-15 and NUR-15M, and the mobile radar altimeters NUR-41. Orders

have been placed for Bystra radars (for Pilica batteries), P-18PL early-warning radars, and the Passive Location System. Awaiting execution contracts are the long-range RDL-45 Warta radar and the Sajna multifunction fire-control radar. Warta can detect objects at distances of up to 470 km. Sajna is a precision radar station used to guide surface-to-air missiles. Their acquisition will fill the remaining critical gaps in Poland's multi-layered air and missile defence.

Maritime defence will be served by the Miecznik programme, which is still in its early stages. Every effort should be made to bring this programme to a successful conclusion. This is feasible, but it requires continuous financing. Under the programme, three frigates are to be constructed – one prototype and two serial-production vessels – equipped with CAMM missile launchers.

Sensors and Command-and-Control: International Context and Financing

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In October 2022, during the NATO Defence Ministers' Summit, fifteen states signed a letter of intent in Brussels concerning the construction of the European Sky Shield Initiative - Poland was not among them. Germany launched the coalition of states wishing to strengthen Europe's air defence in autumn 2022 and now comprises over twenty countries. However, in April 2024, Prime Minister Donald Tusk announced that Poland would join the European initiative to create a missile shield: "A missile shield, to be built not only on our own but within a European initiative, is a cornerstone of Poland's

deterrence and defence plan," the Prime Minister stated. Subsequently, in June 2024, he added: "A safe sky over Europe, a safe sky over Poland, is becoming before our eyes a priority for the entire EU. We have grounds for moderate but real satisfaction for now. I am very pleased". The point is to ensure that what we introduce is compatible with what the Germans, Czechs and Slovaks possess. Only then can we interoperate – for example, using the same missiles across different types of launchers. On our own, we are not able to secure ourselves against an attack by airborne means from the Russian Federation – there would be too many of them. Hence, both resources and forces must be mobilised to repel such an attack, and this can be achieved only collectively.

The Polish government has signed an agreement with the European Investment Bank under which it will receive a loan of €300 million. The funds will be allocated to the development of Poland's satellite programme, which forms part of the European missile shield.

In March 2025, the President of the European Commission, Ursula von der Leyen, announced a plan to rearm Europe, intended to mobilise up to €800 billion for defence. The plan includes a loan package of €150 billion, among other things, for air defence. Meanwhile, on June 9, 2025, in London, NATO Secretary General Mark Rutte called on Allied countries to quadruple their spending on air defence, AFP reported. He emphasised that the danger would not disappear even once the war in Ukraine ends: "[We] must have more forces and capabilities in order to implement our defence plans fully. We see how Russia strikes Ukraine from the air. Therefore, we will reinforce the shield that protects our skies".

Poland will be the largest beneficiary of European funds for defence and security. Of the €150 billion earmarked for this purpose under the new programme, Poland will receive €43.7 billion (September 2025). This is the most considerable amount allocated to a member state, the European Commission announced. Nineteen member states submitted applications to the Commission. "This decision is a great success for Poland and a guarantee of continued investment in our security and the development of our defence industry. We aim to utilise the funds from this fund to enhance the key capabilities of the Polish Armed Forces, including air and missile defence, artillery systems, ammunition procurement, drones, and counter-drone systems. It will also support strategic capabilities, the protection of critical

infrastructure, military mobility and cyberspace", said Deputy Prime Minister Władysław Kosiniak-Kamysz.

F-35 Integration: Roles, Enablers, Gaps

In March 2025, at the 3rd Air Defence Missile Brigade in Sochaczew, a Polish-American intergovernmental agreement was signed for the implementation of Phase II of the Wisła programme, valued at almost USD 2 billion. The agreement provides for the further development of air-defence systems, logistics systems and training equipment for the Patriot batteries already in service. This represents a further step toward building a multi-layered missile defence system and strengthening the strategic alliance with the United States. Deliveries of two additional batteries are scheduled to take place at the turn of 2026 and 2027, with completion of the deliveries planned for 2029. Despite the many important decisions taken – especially recently – regarding the Wisła and Narew programmes, the modernisation of the air-defence forces is still ongoing and remains unfinished. Current plans for the modernisation of air and missile defence envisage, above all, the acquisition of eight medium-range Wisła batteries and twenty-three short-range Narew batteries. According to this plan, two medium-range Patriot batteries have been acquired to date, which will only partially satisfy the Armed Forces' needs for short- and medium-range systems. In 2018, Poland purchased two Patriot batteries for USD 4.75 billion. The price – which differs substantially from the figure cited in some Western media (around USD 1 billion) – reflects the fact that these were not baseline sets. Each battery includes not one but two AN/MPQ-65 radars, eight M903 launchers (the standard is six), and we also purchased 208 of the most advanced PAC-3 MSE missiles. The transaction additionally covered integration of the systems with the Integrated Air and Missile Defence Battle Command System (IBCS).

Unfortunately, the implementation of Phase II of Wisła, which was to include the delivery of six further batteries, was postponed in 2019. It was only in 2023, at the defence fair in Kielce, that another contract was signed for the purchase of six systems. The package includes forty-eight M903 launchers, twelve GhostEye radars and PAC-3 MSE missiles. The price is USD 9.3 billion. Including the purchase of technology enabling domestic production of

components for the Patriot system (e.g., M903 launchers), Poland has so far invested USD 17.3 billion in American systems. These will constitute the main component of the Wisła programme within the modernisation of medium-range air defence to counter airborne means of attack such as medium-range ballistic missiles, guided missiles, aircraft and uncrewed aerial vehicles.

Under the Wisła programme, an American Patriot battery in its basic configuration costs around USD 1 billion and requires a crew of ninety. The set comprises an AN/MPQ-65 radar capable of detecting targets at distances exceeding 150 km, which can simultaneously track many targets and guide missiles towards them. The system's maximum range depends on the missile variant used. The PAC-3 MSE missile provides a fantastic range of 160 km, with a maximum altitude of 30 km.

For many years, Poland's ground-based air defence has still included obsolete surface-to-air missile (SAM) systems:

1. Short-range (up to 25 km) S-125 systems – modernised S-125 Newa sets purchased in 1974–86 and in service with air-defence units.

2. Short-range (up to 24 km) Kub SAM systems acquired in the mid-1970s, forming the core equipment of the Land Forces' air-defence regiments.

3. Self-propelled Osa SAM systems with a range of up to 10.5 km, purchased in 1984–1990 and likewise in service with the Land Forces' air-defence regiments.

These systems are based on Soviet technological solutions from the 1960s and 1970s and were partially modernised by the Polish defence industry. Technologically, they are now outdated and cannot counter all potential threats. Owing to their age and combat capabilities, they will have to be completely withdrawn from service in the near future.

The construction of the Armed Forces' Air Defence System should guarantee the acquisition of new technologies for Poland's industry. Access to maintenance and repair facilities, as well as the restoration of combat potential, should be critical, while also creating opportunities for potential export. The purchase price of new equipment – such as a launcher, tank, howitzer, aircraft, or missile – accounts for only a third of the total expenditure. The remaining two-thirds must be allocated to sustainment, modernisation, overhauls, adaptation of infrastructure to equipment operation and the creation of a support system for at least three, and even four, decades of service life. For

this reason, purchases of new armaments – worth hundreds of billions – must be judicious, transparent and intelligible.

For example, in January 2020, Poland signed a contract for the purchase of thirty-two F-35 aircraft for USD 4.6 billion. The first were to be handed over to Poland in 2024 (we received them in 2025 for the training of Polish pilots in the United States). They will achieve operational readiness four years later. They will replace the obsolete MiG-29 and Su-22 aircraft, which have been practically withdrawn from service.

The F-35 is indeed the latest – and, one may confidently say, the best – fifth-generation multirole aircraft available on the Western market. It was developed in collaboration with scientists from seven countries. Currently, over 1,230 F-35s are in service in twelve countries, and the type has accumulated over one million flight hours. The first F-35 took to the air in 2006, but its first basing in operational units occurred only in 2019 – at a US base in the United Arab Emirates. Two weeks later, the F-35 was used in its first combat mission, bombing ISIS tunnels. Outside the United States, the F-35 is in service with the air forces of the United Kingdom, Australia, Israel, Italy, Japan, the Netherlands, Canada, Belgium and Norway.

Polish F-35s are expected to achieve full operational capability by 2030. The aircraft will be able to perform a broad spectrum of tasks – not only air-to-air and air-to-surface/sea missions, but also reconnaissance, including radar (AESA), electronic, and electro-optical missions, utilising organic passive systems and all-aspect reconnaissance suites. While retaining low-observability features in a ground-attack configuration, the aircraft can alternatively carry two AARGM-ER anti-radiation missiles, the same number of JDAM bombs, or eight Small Diameter Bombs (SDB-I or SDB-II), together with two AIM-120 AMRAAMs for self-defence. The F-35 itself will engage only the most difficult and most important targets; other aircraft or branches of the armed forces will prosecute other targets. Therefore, the aircraft should be integrated into Poland's ground-based air and missile defence system. To this end, the IBCS battle-management system, introduced within Wisła and planned for Narew in the near future, is designed to cooperate with the F-35, even to the extent of enabling these fighters to serve as a "flying radar" for the air-defence system. Thanks to this, ground-based air-defence systems will be able to see further and select means of countering aerial targets more rationally.

Synchronising command systems will be a significant challenge for Polish and American forces and will undoubtedly require additional procurements.

The Armed Forces of the Republic of Poland are not yet fully prepared to operate in conjunction with the F-35. A key problem is the lack of air-to-air refuelling capability. This results from the decision taken by the United Right government in 2016 to withdraw Poland from the European MRTT programme. Analyses are currently underway in this area – no decision has been made. Prime Minister Donald Tusk publicly criticised the withdrawal from the programme. No new policy decision – either to return to the MRTT programme or to build national capabilities – has yet been taken. Air-to-air refuelling capabilities are considered by NATO to be in very short supply and should be developed, including in quantitative terms, to be fully usable in a crisis or conflict. Without air-to-air refuelling, the operational employment of F-35s and F-16s will be severely constrained.

Another area of concern regarding cooperation with the F-35 is the command system for Land Forces units. Information transmitted by the aircraft can support even the actions of a tank company or mechanised sub-units on the battlefield. Modernisation of communications within the Land Forces is currently far less advanced, and there is a need to take further appropriate decisions – for example, to standardise communications systems at the tactical level and to build a unified battle-management system.

Based on the available materials, it can be stated that the comprehensive logistical support for the aircraft and equipment provided by the contractor under the global support system, which is only scheduled to last until 2030, is too short, as it will end when the last aircraft is handed over to Poland. This conclusion is based on experience with operating the F-16.

The signed contract likewise does not provide for the construction of the infrastructure necessary for operating the aircraft. There is very little time to prepare and modernise the air bases. Depending on location, the costs of these works may, according to Ministry of National Defence estimates, amount to nearly PLN 2 billion.

For the revolution associated with introducing the F-35 into the Armed Forces' armament to materialise truly, a tremendous amount of work and further investment will be required, including in areas such as communications,

logistics, and the protection and defence of own forces. A separate issue is the training system and the procurement of armaments.

The Air Force requires two further squadrons of combat aircraft, and the F-35 – alongside air-superiority aircraft such as the Eurofighter and the F-15EX – may be among the leading candidates.

Irrespective of the above, doubts also concern the manner in which negotiations with the American side were conducted and, plainly speaking, what we managed to "win" during the purchase of the F-35 aircraft. Decisions on the acquisition of military equipment of such high value should be made based on a national consensus, as their effects will be long-term and will influence the decisions of subsequent governments. They were taken very quickly, and the entire procedure was completed in under a year, while foregoing a competitive tender and offset requirements – even though Lockheed Martin offered opportunities for technology transfer. When executing an order both so costly and so important, it is crucial to conduct an analysis addressing issues such as acquisition and operating costs, life-cycle costs, verification of requirements defined by the end-users, logistical and training needs, the need to build the requisite infrastructure, and, for example, risks that may arise at the delivery or operational stages.

Western states that purchase the F-35 do so via competitive tenders. For instance, Finland, Germany and Switzerland conducted comparative evaluations of multiple aircraft from different manufacturers. Based on such tenders, they additionally secured substantial investments in their economies and in new technologies. For example, Switzerland will pay CHF 6 billion for the F-35 aircraft, but the Americans are to invest CHF 2 billion in the country under offset arrangements. A similar situation exists in Germany.

In our case, it is unclear what compensation will be received for such enormous expenditure, or whether any will be received at all. Technology transfer, production in Poland, or the issue of long-term sustainment were, at the time of purchase, secondary matters. Real success can only be guaranteed by tangible technology transfer, the ability to leverage existing Polish solutions, the production of components in Poland, and securing the rights to develop the acquired equipment further. Moreover, a US government report dated September 23, 2023, states that the aircraft can perform missions in only just over half of cases. It is also expensive to produce and maintain. According to

US government estimates, by 2040, the costs of sustaining the F-35 fleet will be 79 per cent higher than those of its older-generation predecessors, the F-16 and F/A-18. From the outset, the F-35 has been relatively failure-prone and requires sophisticated maintenance, which has led to criticism. This does not, however, prevent the US government from planning to spend USD 1.7 trillion on the purchase, sustainment and repair of nearly 2,500 of these aircraft. The US government relies heavily on subcontractors, some of whom are located outside the country, thus limiting its decision-making latitude. There is also a shortage of spare parts and support equipment, causing repair delays. The report likewise identified delays in establishing workshops for conducting complex repairs. It should also be emphasised that the procurement process for the F-35 was not conducted transparently, which, given an order valued at over PLN 20 billion and operating costs that, over 40 years, may be estimated at a further c. PLN 50 billion – must be assessed particularly critically. The classification of the F-35 procurement and the abandonment of a competitive purchase significantly reduced the chances of obtaining a favourable offset offer.

To fully leverage the capabilities of the F-35, the Polish Air Force will need to undergo a profound transformation, including integration into the global logistics support system. This will represent a generational leap relative to the F-16 – not only technologically and operationally, but also financially.

Of course, the purchase of F-35 aircraft is an important step towards strengthening the Armed Forces' capabilities; however, without continued modernisation of ground-based air defence under the Wisła, Narew and Pilica programmes, it will not be possible to ensure the security of the air bases from which these aircraft will operate.

At the same time, it should be noted that the F-35 will not replace dedicated reconnaissance aircraft or operational- and tactical-class unmanned aerial systems, the acquisition of which has been planned under the Płomykówka, Zefir, and Gryf programmes, respectively.

Poland needs at least 160 multirole combat aircraft. At present, we have 47 F-16 fighters and 12 of the 48 ordered FA-50s (practically without armament). The FA-50's combat capabilities are minimal. Even supplementing these purchases with the 32 fifth-generation F-35s bought in 2020 will not deliver the required capability. We must decide to procure additional fighters.

Three proposals are under consideration: further F-35s (which would allow fleet unification), as well as aircraft intended for achieving air superiority – the F-15EX from the United States or the Eurofighter Typhoon from Europe.

Given the rules of the SAFE programme, it will not be easy to opt for American designs. Poland could, for example, acquire Eurofighters. These aircraft enable the attainment of air dominance. An advantage of the Eurofighter is the substantial technology transfer proposed by its manufacturer. Approximately 50 per cent of the costs associated with investing in Eurofighters could remain in Poland. This is an opportunity to enhance the capabilities of our aerospace industry.

To increase air defence capability, it is also necessary to acquire air-to-air refuelling aircraft, which are also produced in Europe. Poland could avail itself of Airbus's offer and purchase, for instance, A330 MRTT aircraft. Continuous control of the airspace should be provided by early-warning aircraft. Poland operates two Saab 340 AEW aircraft, which are considered outdated. This is a bridging solution, and further aircraft must be ordered. The Swedish Saab GlobalEye may be an attractive option. For both tanker aircraft and early-warning platforms – and given the critical nature of airborne threats – it would be prudent to purchase three to four such aircraft. Currently, we can rely on NATO-owned AWACS; however, possessing at least partial autonomy in this area would be highly valuable.

To fully exploit the capabilities of the F-35, it is also necessary to build an integrated system of air defence, reconnaissance, electronic warfare and air-to-surface strike, supported by modern network-centric command-and-control systems.

Moreover, the decision to purchase F-35 aircraft should not result in postponing other modernisation programmes such as Wisła, Narew, Płomykówka, the Zefir and Gryf UAV programmes, or those related to the acquisition of reconnaissance satellites, new electronic warfare (EW) assets, and further multirole combat aircraft geared towards achieving air superiority – all of which together will create a system enabling the full exploitation of the F-35's capabilities. Without building a modern air-defence system, fully leveraging the F-35 will be difficult, if not impossible. Consequently, the task of constructing a modern air-defence system should receive the highest priority in the modernisation process. Lacking such a system, in the event of

a conflict, the F-35s would be at risk of destruction while still on the ground, and the Air Force would be forced to redeploy them beyond the range of the potential adversary's aviation and rocket artillery, which in practice would mean relocating the aircraft to air bases outside the territory of Poland.

Another vital factor affecting the full utilisation of the air-defence system is the necessity of building a national space-based reconnaissance system. It should be a raison d'ětat for Poland to develop indigenous national satellite competencies. Space competencies ought to be among the key elements of air defence. Satellite information is becoming the foundation of the contemporary battlespace. Situational awareness on the battlefield is the condition that determines the effective use of the latest technologies and the combat potential of the Polish Armed Forces.

Within the Air Defence System, satellites provide early warning against missile attacks. Systems such as the American SBIRS (Space-Based Infrared System) detect ballistic-missile launches and track their trajectories. They also enable the coordination of defensive actions and the transmission of data to missile-defence systems. Poland should invest in satellite systems for detecting ballistic missiles and other threats originating in outer space. Such technologies are crucial for missile-defence systems and for rapid response to potential attacks. Systems like SBIRS (Space-Based Infrared System) could be integrated into Poland's air defence system. Poland should invest in satellite systems for detecting ballistic missiles and other space-based threats.

A notable example of foreign acquisition of space technologies is Israel, which, along with Italy, is developing the OPSAT-3000 satellite system. It will operate in conjunction with Italy's COSMO-SkyMed and utilise the combined use of radar and optical data. Further examples of the latest modernisation decisions in some countries include Israel again, which will become the first state in the world to employ laser weapons in air defence to counter aerial threats (artillery, rocket projectiles and UAVs). The Iron Beam system complements traditional air-defence systems. A good example is also the United Kingdom's DragonFire, Ukraine's Trident (Trójząb), and the US DEM-SHORAD.

In January 2021, work began in the United States on a pod enabling laser communications between various types of aircraft and geostationary satellites. Unlike traditional radio-frequency communications, this technology will operate more effectively in environments with electromagnetic interference.

The US is building a constellation of 150 communications satellites that will interconnect using laser beams. The Americans are already putting into practice the following principles of armed forces modernisation:

1. A networked (network-centric) command-and-control system, the idea of which is to connect everything with everything. The Air Force is, of course, the testbed.

2. Autonomous systems that cooperate with humans are being implemented at scale across all branches of the armed forces.

3. Artificial intelligence - which today is the key to data, and data is now the battlespace.

There is decreasing talk of tanks, aircraft, missiles, warships, or even satellites; rather, the focus is on networks, communications, data, and the potential of technology (artificial intelligence) that automates processes, anticipates future events, estimates risks, and proposes preventive actions. Nevertheless, do we all appreciate that this is the path to the future – that the true potential lies here, not merely in tanks or missiles; that no materiel, however cutting-edge on the modern battlefield, matters at all if it is not plugged into a highly resilient, high-throughput information network? The rapid development of information technologies has driven their application to operations in cyberspace, particularly to damage critical infrastructure (banks, energy, industrial facilities, or military infrastructure systems). All this increases the importance of non-contact operations, in which belligerents are beyond the reach of direct observation. In the short term, robotisation will lead to the complete autonomy of task execution by most combat systems.

A question thus arises: are the selected examples outlined above feasible, given our state's current economic potential, assuming we intend to meet the rapidly changing new requirements of the contemporary battlespace? One must bear in mind that we live in a period of revolutionary technological change – the Fourth Industrial Revolution – which, before our eyes, is transforming the world and our lives, and which also has a profound influence on the development of new weapons systems. One cannot prepare for the next war and achieve success by repeating established, previously employed patterns. Examples include lost wars by France, Egypt, Iran, Armenia, and, most recently – and all indications suggest – Russia.

In 2022, President Emmanuel Macron, speaking at a defence exhibition in Paris, stated that spending large sums to buy elsewhere is not a good idea – calling the defence industry a "sector of the future". In March 2021, UK Prime Minister Boris Johnson assessed that "cyber power is revolutionising the way we live and fight wars, much as air power did a hundred years ago". Michèle Flournoy, President Joe Biden's nominee for Secretary of Defence, said in her Congressional hearing the memorable words "megabits instead of megatons" (she was, of course, not selected). The Americans place digital technologies, autonomous and unmanned systems – working with crewed aircraft or manned vessels – and artificial intelligence at the top of their priorities. The Pentagon anticipates that in the coming decade, autonomous robots will become a primary instrument of warfare.

In Poland, there is a noticeable absence of joint projects with EU states akin to those pursued by Germany, Italy or France. Poland is arming as if it belonged to no alliance. Furthermore, the procurement process under our predecessors was not transparent. We have inherited a substantial debt that needs to be repaid. We bought the latest armaments [F-35s, HIMARS, Abrams tanks, Patriots (2014)], satellite imagery (France – electro-optical satellites), FA-50 aircraft, Korean tanks and self-propelled howitzers in the manner of Arab states, which can afford it and have vast billions they do not know how to spend.

For us, unless we produce it ourselves or participate in production, it will be unaffordable. Moreover, buying off-the-shelf armaments is very costly. The "spike" in armaments means that over PLN 100 billion could initially flow to Washington, and even more to Korea. The so-called "off-the-shelf purchases" have raised – and continue to raise – controversy, particularly when conducted without a tender allowing comparison of the merits of the weapons procured, without meaningful offset, and without opportunities for localisation and modernisation by the domestic industry.

Drones in the Air Defence System – the example of Ukraine

The war in Ukraine has become a war of drones – to such an extent that the United States, despite possessing the world's most advanced military and defence-industrial complex, has found itself lagging and unprepared to

produce rapidly large quantities of small, inexpensive drone systems. Although missiles, artillery and anti-tank munitions are indispensable, roughly 80 per cent of Kyiv's success in destroying targets derives from drones. The goal on the modern battlefield is for soldiers to treat drones as if they were their personal weapon, radio, night-vision goggles or grenade – simply part of their standard kit. Drones are now successfully replacing the forward observer who identifies targets for artillery fire or air support. Drones and new technologies provide a critical advantage to troops in harm's way. With the proliferation of drones on both sides, the battlefield has become paralysed. The area within a 15-mile radius of the front line is now considered a closed zone, because most drones can reach it and are capable of destroying even small groups of soldiers, halting vehicle movement, and preventing resupply or force rotation.

Ukraine's plan for 2025, according to President Zelensky, envisages producing almost five million drones of various types – twice as many as in 2024. Drones will undoubtedly provide valuable support, but they will not furnish full capabilities to defeat the adversary. In this context, NATO (including Poland) must ensure the development of its own counter-UAS means, while also maintaining the growth of classic instruments of warfare such as artillery and aviation, as well as space and electronic-warfare systems. Western states possess a military and technological advantage over Russia that Moscow cannot overcome. Although Russia has largely learned to defend itself against drones, it has not managed to develop methods for effectively countering guided cruise missiles, artillery munitions or bombs, or even GMLRS and ATACMS rockets.

As reported by The Times, the British Army is introducing a new military strategy, known as "20-40-40," aimed at reducing casualties among soldiers. This strategy, part of the periodically conducted Strategic Defence Review, focuses on integrating modern technologies with traditional heavy military equipment. Robots and drones are to complement heavy platforms. Under the "20-40-40" approach, units equipped with Challenger 3 tanks will employ loitering munitions ("kamikaze drones") and long-range missiles carried by robots – for example, THeMIS – in the initial phase of battle. In this scheme, inexpensive expendable drones and missiles are to constitute 40 per cent of the means of combat, while a further 40 per cent will be reusable drones, such as the MQ-9 Reaper, which are more costly and durable. Heavy equipment

can then enter terrain that has been prepared by fire. According to a source at the UK Ministry of Defence, the objective is to integrate heavy platforms with modern technologies to enhance the Army's effectiveness. Heavy equipment, such as tanks, will account for around 20 per cent of combat capability and will remain in the rear until the final stage of the battle - this is a sound example for our planners at the General Staff of the Polish Armed Forces.

In Poland, lessons from Ukraine are being analysed at a NATO institution established on February 17, 2025, in Bydgoszcz: the NATO-Ukraine Joint Analysis, Training and Education Centre (JATEC). "JATEC's task is to enhance the Ukrainian Armed Forces' ability to defend and deter, to strengthen NATO-Ukraine cooperation, and to analyse lessons from the war in Ukraine that will be factored into allied strategies". By contrast, Alex Wang – a 28-year-old American entrepreneur regarded in the AI sector as a visionary, a "prodigy," and a guru of artificial intelligence, who founded Scale AI at the age of 19, quickly becoming one of the world's youngest billionaires, and who is not an engineer and has not engaged in (and still does not engage in) the development of AI algorithms – goes further still and characterises the war of the future as follows.

It will not be mass – understood as the number of soldiers or combat platforms that determines success, but rather "agility," variability and tempo of action, even if our forces are smaller than the adversary's. "Thanks to AI agents" Wang writes, "battle plans will be formulated and adjusted in real time to exploit enemy weaknesses – from the first strike to decisive victory – before technologically inferior forces even realise that the game has begun".

What are AI Agents, to which Wang ascribes such significance? They are specialised programmes that automate and render autonomous the capacity to undertake independent actions in digital environments. In this case, we are dealing with solutions far more advanced than traditional chatbots that merely answer posed questions. AI agents are capable of perceiving their environment, processing information, making decisions, and executing tasks autonomously. Moreover, they communicate with one another and act proactively on behalf of their user. Because they operate based on machine learning, they can take and implement decisions without constant human supervision. They can function in complex environments owing to both their ability to learn from experience and to integrate information from diverse

sources. They also exhibit the ability to cooperate with other agents and IT systems, as well as respond rapidly to changing conditions. "You can define an AI Agent in one word: proactivity", said Enver Cetin, an AI expert at the global firm Experience Engineering Ciklum. "It refers to AI systems and models that can act autonomously to achieve goals without the need for constant human direction. An agentic AI system understands the user's goal or vision and the context of the problem it is trying to solve".

The foregoing examples clearly indicate the direction of further development of the modern battlespace - and the particular role within it of the Air Defence system, and within that, AI. They are important in the context of the accusations levelled at the Ministry of National Defence regarding the alleged disregard for Ukrainian lessons on the use of drones, and for the preparation of a Strategic Defence Review, which is already overdue. We do not intend to fight as in Ukraine; instead, by drawing appropriate conclusions from what has been achieved thus far, we are systematically preparing for the new technological challenges of the theatre of operations.

Current Shortfalls and Priority Actions

In sum, the most important problems affecting the functioning of the air-defence system include the following issues:

– Insufficient quantity of counter-UAS systems at an appropriate scale – the Polish Armed Forces do not yet possess effective systems to defeat drones, nor adequate protection of tanks against drone attacks, which poses a significant risk in the event of potential strikes. Delays in the development and training of drone forces, along with a lack of appropriate structures and specialists to operate modern technologies, weaken the ability to counter contemporary airborne threats;

– Imperfect air-defence architecture – despite the purchase of modern systems (e.g., Patriot under the Wisła programme), the system remains insufficiently integrated. It requires supplementation with early-warning assets, such as airborne early-warning aircraft and radar aerostats;

– Ongoing modernisation and integration of additional elements within air defence – Poland is fielding short- and medium-range systems (Pilica+, Mała Narew, Narew, Wisła), yet operational readiness is still being attained and

further investment is required, especially in the integration of communications and command;

– Procedural and tactical issues – effectiveness is constrained by peacetime rules and procedures that impede immediate response to threats such as low-flying cruise missiles. The risks associated with intercepting a missile over built-up areas lead to caution and delays in decision-making;

– Obsolescent anti-missile equipment and lack of area-defence capability – at present, Polish air-defence units operate predominantly in a point-defence mode, and full area defence remains a challenge for the future.

Poland is systematically modernising its air-defence system, but it still struggles with gaps in defence against drones and modern threats, a shortage of advanced early-warning systems, and procedural and integration problems that limit overall effectiveness.

Moreover:

The principal challenge in integrating Wisła and Narew is the lack of full financing, delays in signing and executing subsequent contracts, misalignment of command systems at the operational level, and the technical complexity of integrating diverse components with differing functions and technologies. There is insufficient funding and contract slippage – particularly for deliveries of IBCS command cabins, mobile communications nodes and support vehicles. Without a rapid contract signature, the integration and operation of the systems could be delayed by years;

Insufficient development of the operational-level command system – the current Dunaj system does not meet modern battlefield requirements and must be replaced or thoroughly modernised. A new operational-level air-defence management system is not yet in place;

Difficulties arise in integrating heterogeneous components and exchanging information across air-defence tiers – protocols such as Link 11B and Link 16 are in use. However, their level of integration is inadequate for the comprehensive employment of Wisła and Narew as a single, coherent system;

Delays in the delivery of key elements, such as fire-control radars (e.g., the Sajna radar for Narew), counter-UAS components (CUAS), and the development and fielding of new missiles (CAMM-MR and FCM);

Personnel and organisational challenges within the military and defence industry that affect the pace of implementation and the effectiveness of integration.

Coordination of Wisła and Narew within the IBCS framework aims to ensure their cooperation as a unified network. However, we are still far from achieving operational readiness.

As I have already emphasised, drones are playing an ever greater role on today's battlefield. Detecting and neutralising them requires entirely different means and tactics. In recent years, Poland has purchased air-defence equipment worth close to PLN 200 billion. In this way, we are preparing above all for full-scale war and for countering ballistic and cruise missiles. The challenge, however, may lie with much less sophisticated drones.

Funds made available to Poland under SAFE could be used to purchase additional counter-UAS systems. Requirements include, among other things, a nationwide system for detecting such threats. What is needed are not only detection systems but also defeat systems - these should be deployed at the border, at critical infrastructure sites, defence industry plants, airports, military units, and other important institutions. For years, there has also been discussion of the SONA programme, under which the Polish Armed Forces would acquire mobile air defence capable of providing cover for manoeuvring troops.

It is necessary to acquire air-to-air refuelling aircraft, which are also produced in Europe. Poland could consider Airbus's offer and purchase, for example, the A330 MRTT aircraft.

Continuous control of the airspace should be ensured by airborne early-warning aircraft. Poland has purchased two Saab 340 AEW aircraft; these are used and obsolete. This is a bridging solution, and further aircraft must be ordered. The Swedish Saab GlobalEye may be an attractive option. For both tanker and early-warning aircraft – and given their critical importance – it would be prudent to consider procuring three to four such platforms.

In a future war, the winner will be the one who updates technology the fastest. This will be a technological shift that, at this point, is irreversible. As the war in Ukraine has demonstrated, Poland should invest particularly heavily in a modern Air Defence system. Building a multi-layered Air Defence architecture is a complex and long-term process that must be continuous

and systematically adapted to rapidly changing technologies and the requirements of the contemporary theatre of operations. Poland's air defence is transforming. To meet modern battlefield demands, our standard should be international cooperation grounded in the exchange of knowledge and the latest technologies. Full readiness and effective interoperability of the entire Air Defence system is expected only at the beginning of the next decade. As the war in Ukraine shows, without modern air-defence systems, there can be no question of effectively defeating an adversary.

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