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**The space sector in the state defense and security system. Strategic analysis and recommendations for action****Introduction**

In the era of network-centric warfare and hybrid conflicts, space has been recognized by NATO as the fifth operational domain—alongside land, sea, air, and cyberspace. This study presents the strategic importance of satellite technologies for modern defense systems and the national security of the Republic of Poland, embedding the analysis in the context of the global transformation of the battlefield, where information is becoming a decisive factor of advantage.

Despite the adoption of the Polish Space Strategy in 2017, which envisages building a national space potential by 2030, key implementing instruments—the National Space Program and the Space Activities Act—have not yet been developed and implemented. The Ministry of Development and Technology has failed to prepare the required legal acts, create mechanisms for monitoring the implementation of the National Space Program, and ensure proportionality between Poland's contributions to ESA and the value of contracts awarded. As a result, the participation of domestic companies in ESA tenders is among the lowest in Europe. A lack of coordination between the Ministry of Energy, Technology, and the Ministry of National Defense (MAP) is also problematic. This results in the dispersion of resources, duplication of expertise, and a loss of synergy between the civilian and defense sectors.

Therefore, it is recommended to establish an inter-ministerial space policy coordination center with clearly defined competencies, a budget, and performance metrics. It is also essential to develop a defense industry development strategy that integrates cyber and satellite components. This requires strengthening international cooperation, particularly within NATO in the areas of Space Domain Awareness (SDA) and Space Situational Awareness (SSA), and actively involving Poland in the development of the European Defense Technological and Industrial Base (EDTIB), in line with the assumptions of the European Defense Industry Strategy.

Satellite technologies are the foundation of modern defense—they determine the effectiveness of command, crisis response, and early warning systems. Investments in national space capabilities should therefore be treated not as an element of industrial policy, but as an investment in national security and sovereignty. Without a fundamental reform of the space sector's governance system, Poland will not be able to ensure its security in the 21st century.

The use of space determines the outcome of armed conflicts, where advantage is gained not by the number of tanks or missiles, but by the ability to rapidly process and transmit information. For this reason, highly developed countries treat space as a strategic environment for competition. Its importance is evidenced by NATO's decision in November 2019 to designate space as the fifth operational domain.

In the face of current geopolitical tensions and the climate crisis, there is a growing demand for space technologies that enable rapid threat detection, crisis impact assessment, and preventive action planning. Space is becoming the foundation of modern defense – an integral part of combat operations and a guarantee of security in peacetime.

There are approximately 13,000 satellites in orbit. The decreasing cost of launching such payloads has led to nearly one hundred countries operating their own satellites. Poland has two owned by the Space Research Centre of the Polish Academy of Sciences, the rest by private companies. The global space market is estimated at €450 billion. Its annual growth rate is 15-20 percent, and by 2040, the sector could reach \$1.8 trillion, making it one of the fastest-growing sectors of the global economy. The Polish space market is worth over \$2 billion and includes 300-400 companies and research institutions, employing 12,000 people. Polish companies have already developed over one hundred space technologies, and their potential will grow with greater participation in EU and European Space Agency (ESA) programs. Thus, the next stage of the industrial revolution is unfolding before our eyes.

However, existing state support mechanisms for the defense industry, including the space industry, have proven insufficient. The lack of a clear division of responsibilities, duplication of structures, complex procedures, and blurred accountability undermine the system's efficiency and, consequently, the country's defense. The generation gap, low workplace identification, and lack of institutional continuity intensify the need for deregulatory changes.

To meet global challenges, systemic solutions must be implemented. The Polish space sector remains weak due to its lack of a coherent strategy, centralized decision-making, and consistent operations. The Polish Armed Forces should develop a strategy that takes into account the operational space domain, and the Ministry of Development and Technology – in conjunction with the Ministry of National Defense and the Ministry of National Defence – should prepare a defense industry development strategy. Decisions regarding the space sector should be centralized in a single institution with full financial resources for such projects, both civilian and military.

The government's priority, especially in light of Poland's frontline position and the ongoing war in Ukraine, should be to increase defense readiness by leveraging domestic industrial potential. A strong and competitive defense industry, including the space industry—which provides the Polish Armed Forces with access to modern communications and weaponry—is a key element of national security.

The most important government body responsible for defining and implementing Polish space policy is the Ministry of Development and Technology (MRiT). Its responsibilities include shaping and implementing space policy. Within the MRiT, space policy-related tasks were previously handled by the Department of Innovation and Industrial Policy, but since December 2025, they have been taken over by the Department of Defense Industry, responsible for supporting the development of the national defense industry, including the space sector. The Department exercises substantive oversight of the Polish Space Agency (POLSA), handling matters arising from Poland's membership in ESA and concerning the space policy of the EU and the Republic of Poland. The Department supports POLSA in carrying out these tasks, which has been subordinate to the Minister of Development and Technology since July 20, 2019.

A number of other state entities are also involved in the implementation of the Polish Space Strategy, operating both at the strategic level – in the area of planning and coordinating space policy – and at the operational level, including implementing programs, conducting research and supporting industry.

### **Institutional system of the space sector in Poland**

There is currently no single coordinating body with real decision-making authority regarding the space sector. Poland has an extensive system of institutions involved in space activities. This means that responsibilities regarding space matters are dispersed across state institutions. The most important of these are outlined below.

- Ministry of Development and Technology (MRiT): Coordination of the state's space policy and, among others, substantive supervision over POLSA, Poland's representation in ESA and on the EU forum, responsibility for the National Space Program, and the Act on Space Activities
- Ministry of National Defence (MON): including defining operational needs in the field of satellite observation, communication and navigation systems, implementing space security projects (e.g. the National Satellite Information System), cooperation with the European Defence Agency (EDA) and the NATO Space Centre, coordination of the military segment of the Copernicus programme
- Ministry of State Assets (MAP): including supervision over state-owned companies implementing space and defense projects (e.g. Creotech Instruments, PIAP Space, PIT-RADWAR, PGZ), investment and consolidation policy in the area of dual-use technologies
- Ministry of Digital Affairs: including participation in the Galileo system, including responsibility for the national PRS (Public Regulated Service) segment, supervision of the national GNSS (Global Navigation Satellite System) infrastructure, cooperation within the GovSatCom program (secure government communications)
- Ministry of Climate and Environment: including Poland's representation in the EU-METSAT organization (meteorological satellites), the use of satellite data in environmental, climate and agricultural policy
- Ministry of the Interior and Administration (MSWiA): Including the use of satellite systems in internal security, rescue and crisis management, coordination of access to the PRS signal
- Ministry of Foreign Affairs (MFA): including international cooperation in the area of space law and technological diplomacy, Poland's representation in the UN COPUOS (Committee on the Peaceful Uses of Outer Space), support for international negotiations on the registration and liability for space objects
- Ministry of Science (MNiSW / formerly MNiSzW): including financing of scientific research in the field of space technologies, cooperation with the National Centre for Research and Development, the National Science Centre and institutes of the Polish Academy of Sciences, coordination of participation in the Copernicus programme and ESA research projects
- Ministry of Finance (MF): including financing of Poland's participation in ESA and EU programs, settlement of membership fees, supervision of technology transfers and export controls (jointly with the Ministry of National Defense)
- Ministry of Infrastructure: responsible for, among others, satellite transport, ground infrastructure (receiving stations, communications) and the integration of space systems with the transport infrastructure
- National Security Bureau (BBN): including assessment of the strategic importance of space technologies for national security, cooperation with the Ministry of National Defense and the Ministry of Energy and Technology on defense projects (e.g. in the field of observation and communication satellites).

#### Government institutions and agencies:

- Polish Space Agency (POLSA) – key executive institution (coordination of national space policy, register of space objects, advice to the government, international cooperation)
- Civil Aviation Authority (ULC) – licensing and safety issues for launching objects and near-space airspace

- Head Office of Geodesy and Cartography (GUGiK) – use of satellite data in Earth observation and geolocation systems
- Central Statistical Office (GUS) – collecting data on the activities of the space sector in Poland.

Advisory bodies and coordination teams:

- Inter-ministerial Team for Space
- Parliamentary Group for Space.

Key scientific and research institutions:

- Space Research Centre of the Polish Academy of Sciences (CBK PAN) – a research center in the field of space technologies and instruments, participating in ESA and NASA missions
- Nicolaus Copernicus Astronomical Center of the Polish Academy of Sciences – research in the field of astrophysics, observational astronomy, and cosmic theory
- Committee for Space and Satellite Research of the Polish Academy of Sciences – an advisory body of the Polish Academy of Sciences in the field of space sciences and international cooperation
- National Centre for Research and Development (NCBR) – finances research and development projects in the field of space technologies and supports cooperation between science and industry.
- Polish Agency for Enterprise Development (PARP) – supports the development of innovative enterprises operating in the space industry.
- Institute of Aviation – Łukasiewicz Research Network (active in ESA projects, e.g. PW-Sat satellites, EagleEye).
- The Institute of Geophysics of the Polish Academy of Sciences, the Institute of Low Temperatures of the Polish Academy of Sciences, the Institute of Nuclear Physics of the Polish Academy of Sciences – conduct research as part of ESA and NASA projects.
- Nicolaus Copernicus University Astronomical Centre in Toruń – participates in radio telescope and observation projects.
- Institute of Geophysics of the Polish Academy of Sciences, Institute of Low Temperatures of the Polish Academy of Sciences, Institute of Nuclear Physics of the Polish Academy of Sciences – participation in ESA and NASA scientific projects.
- Nicolaus Copernicus University Astronomical Centre (Toruń) – participation in radio telescope and observation projects.

Academic centers conducting research and education in the field of space engineering:

- Military University of Technology (WAT)
- AGH University of Science and Technology (AGH)
- Warsaw University of Technology (WUT)
- Wrocław University of Science and Technology (WUT)
- Gdańsk University of Technology (PG)
- Lodz University of Technology (TUL)
- Rzeszów University of Technology
- University of Zielona Góra
- Wrocław University of Environmental and Life Sciences

Industry organizations and networks:

- Association of Space Sector Employers (ZPSK)

- Space and Satellite Engineering Cluster at the Military University of Technology (WAT)
- Polish Space Technology Platform
- National Committee for Space Technologies (SITK/NOT)

### **Satellite technologies in the defense system of the republic of Poland**

Satellite technologies play a key role in the areas of reconnaissance, communications and missile defense systems.

In terms of reconnaissance, they enable real-time intelligence gathering, enabling, among other things, monitoring troop movements, detecting military installations, and analyzing changes in enemy infrastructure. Modern observation satellites offer high-resolution imagery and the ability to operate in diverse weather conditions.

In the area of communications, satellites provide stable, secure connections between military units deployed in different parts of the world. They guarantee transmission independent of terrestrial infrastructure, which is crucial for military operations conducted in difficult terrain.

In missile defense, satellites act as early warning systems against missile attacks. An example is the American SBIRS (Space-Based Infrared System), which detects ballistic missile launches, tracks their trajectory, and transmits data to missile defense systems, enabling their coordination.

### **Conclusions and recommendations regarding the priorities of the development of satellite technologies in the republic of Poland**

In the area of satellite observation and communications, Poland remains largely dependent on external entities. The Polish Armed Forces alone spend more than PLN 100 million annually on Earth observation and satellite communications (this amount does not include the costs of leasing satellite spectrum and equipment).

Poland should develop its own high-resolution observation satellites – both optical (for imaging in visible light) and radar, enabling observations regardless of weather conditions. Synthetic radar (SAR) capabilities will enable effective tracking of military movements, detection of infrastructure changes, and monitoring of large areas.

To effectively utilize space for defense purposes, Poland should develop its own technologies in the areas of reconnaissance and communications satellites, missile defense systems, and space monitoring, while simultaneously deepening cooperation within NATO and the EU. Active participation in international projects that provide access to the latest technologies and systems is also crucial. The focus should be on satellites that meet both civilian and military needs.

In May 2024, Prime Minister Donald Tusk announced the approval of a €300 million loan for the development of the Polish satellite component of the European Missile Defense Shield program. These funds could not only provide an impetus but also a real lever for the development of the domestic space industry. However, participation in the European Missile Defense Shield initiative is not an alternative to Polish defense programs, but a significant complement.

Acquiring and developing capabilities to observe and track space objects are crucial for the Polish Armed Forces due to:

- the growing activity of states in space, including the launch of objects of unknown purpose,
- the need to plan missions to launch our own satellites, especially in connection with the construction of a national optoelectronic Earth observation system,

- the need to maintain situational awareness of objects entering the Earth's atmosphere in an uncontrolled manner.

The Polish Armed Forces must have the capability to detect and track threats in airspace and space. This requires satellites equipped with infrared detectors and radar systems, enabling space monitoring and ballistic missile detection. These technologies form the basis of early warning and missile defense systems.

Collaboration with countries developing SSA technologies and possessing advanced space monitoring systems and experience in missile defense systems, such as the United States (SBIRS program), is crucial. Collaboration with NATO allies developing similar capabilities is also crucial. Collaboration with space monitoring companies, such as Lockheed Martin and Northrop Grumman, is also essential.

It is also important to deepen cooperation with European partners – France (observation satellite programs), Italy (COSMO-SkyMed), and Germany (radar systems). A good example of cooperation with European partners is Poland's participation in the Copernicus and Galileo programs, which support Earth observation and satellite navigation. Poland should invest in space monitoring technologies, including developing its own satellites for early detection of space threats, space debris surveillance, collision risk management, and satellite infrastructure protection. Such solutions will enhance national security by protecting both military and civilian systems.

### **Priority recommendations for the polish defense industry**

Effective transformation of the Polish defense industry requires a coherent development strategy integrating military, economic, and political aspects, based on sustainable international cooperation and leveraging domestic technological potential. Achieving these goals should include:

- Linking modernization with international military-economic cooperation (EU, USA, South Korea), taking into account both the country's economic capabilities and defense needs over the next few decades.
- Ensuring a network-centric command and control system, enabling the performance of tasks in the national and allied systems.
- The purchase and operation of weapons should guarantee their unification and be linked to the right to modernization, servicing and development of the domestic defense industry.
- Building a political, economic, and social consensus based on substantive debate and understanding between the Armed Forces, the ruling elite, and the opposition. This consensus should be reinforced by appropriate legal regulations.
- Strengthening national industrial and institutional structures, including the Polish Armaments Group, the Armaments Agency, and the International Defense Industry Exhibition (MSPO). Acquiring and transferring the latest technologies to the Polish defense industry is also crucial.
- Stabilization of structures and modernization plans and the selection of competent leaders capable of effectively managing the transformation.

The post-Soviet combat equipment still present in the Polish Armed Forces is ill-suited to modern threats, and the domestic arms industry has limited modernization capabilities. Therefore, consistency in implementing these actions is essential. The Polish Armed Forces possess a solid base and human potential, built over years, and their development should be non-partisan. This requires the introduction of stable, long-term legal solutions to ensure the continuity of the country's defense policy.

The world is in an intense race to develop space technologies and explore space, which is becoming a key element of technological, economic, and military competition between

nations. By 2024, the global space economy had already reached \$546 billion, and forecasts indicate that its revenues will exceed \$1 trillion by 2030.

Currently, the United States and China are competing for the top spot in this sector's technology, but rivalry also rages between Russia, Japan, and India. A key area of exploration is the exploration of the Moon and Mars, where helium-3 and rare-earth metals, crucial for modern energy and electronic technologies, are located. Countries with developed research and development potential and the ability to launch objects into space gain a strategic advantage. The ability to design and manufacture satellites, launch vehicles, and Earth observation systems is a key determinant of technological power.

Much of the contemporary space sector remains closely linked to the military, embracing dual-use technologies. Major military powers also possess ASAT (Anti-Satellite Weapons) ballistic missiles, which can carry nuclear payloads and destroy objects in space, including enemy satellites. The ability to neutralize space infrastructure is becoming one of the pillars of strategic deterrence. Superiority in space directly translates into military advantage, enabling more effective reconnaissance, communications, and precision targeting. We are currently witnessing the next phase of the technological revolution, of which the militarization of space is a crucial element.

On June 9, 2025, the NATO Secretary General called on member states to quadruple their air defence spending, emphasizing that space capabilities, missile and satellite defence systems are a key element of the Alliance's modern security architecture.

### **Directions of transformation of the world's armed forces**

History shows that those who rely on systems proven in past conflicts will not succeed in future wars. Those who prepare for a war that has already occurred are doomed to failure. The examples of France, Egypt, Iran, Armenia, and most recently, Russia demonstrate that outdated doctrines and equipment, even if impressive on paper, cannot provide an advantage in a modern combat environment.

True military and technological sovereignty requires developing our own capabilities, not becoming dependent on imports. As French President Emmanuel Macron noted during the 2022 arms fair in Paris, "spending a lot of money to buy elsewhere is not a good idea." As early as 1991, Professor Paweł Bożyk, in his book "The Road to Nowhere," wrote that a country that buys weapons is a backward country. Michèle Flournoy, former US Deputy Secretary of Defense, briefly summarized the current trends in armed forces modernization during her testimony before Congress: "megabits instead of megatons." The future belongs to digital technologies, autonomous and unmanned systems capable of interoperating with satellites, piloted aircraft, manned ships, and artificial intelligence.

Flournoy identified three pillars of a modern armed forces:

A network-centric command and control system—connecting all elements of the battlefield into a single, coherent information network. The idea of "connecting everything to everything" is already being implemented in the United States, which has made its own armed forces a testing ground for this type of solution.

Autonomous systems cooperating with humans – implemented in all branches of the armed forces on an increasingly large scale.

Artificial intelligence – the key to analyzing data, which has become one of the main battlefields today.

Contemporary defense discussions are increasingly less concerned with individual platforms—tanks, aircraft, missiles, or even satellites. The focus is shifting to integrated networks, communications, data, and the potential of AI technologies that automate decision-making, predict events, assess risks, and support operations. It's worth emphasizing, however, that no modern battlefield asset, even the most advanced one, is significant unless it's

connected to a disruption-resistant, secure, and high-capacity IT network. It's this network—not a single weapon system—that determines military advantage in the 21st century.

### **General principles of the process of building the polish space sector**

#### Strategic aspects

- The process of building the Polish space sector should be determined by international military and economic cooperation, while taking into account national technological and financial capabilities and defense needs over the next few decades.
- However, excessive dependence on foreign partners should be avoided – a cooperation model in which Polish entities act solely as subcontractors leads to a loss of technological independence and the outflow of specialists abroad.
- Poland should maintain the ability to operate in parallel within the national and allied systems, while striving for equipment unification and interoperability.
  - Defense and technological aspects
  - National defense and security needs should be met through the use of the latest available satellite technologies.
  - The operation of equipment should be combined with the right to its servicing, modernization and further development, which strengthens the competences of the domestic industry.
  - It is a mistake to focus on one technology – several domains should be developed in parallel, including space technologies, network-centric command systems and autonomous means of action.
  - It is necessary to promote the development of new space technologies and raise public awareness of the importance of space as a new operational domain.
  - Institutional and organizational directions
  - It is necessary to establish a coherent organizational structure to coordinate national space activities.
  - Space activities should be treated as a tool for supporting innovation, economic development and improving the efficiency of state institutions.
  - Cooperation between public administration, science and industry is of key importance, as is increasing the innovation and competitiveness of enterprises through the development of satellite and space technologies.
  - Stable financing and increased spending on space research, treated as a strategic investment, are required.

#### Social and educational aspects

- It is necessary to ensure a broad political, economic and social consensus around the development of the space sector.
- What is needed is a substantive public debate and a lasting understanding between the armed forces, the ruling elites and the opposition – preferably in the form of a legally binding commitment.
- A system for identifying and supporting talents in the field of space technologies should be created – Poland has the potential to become a leader in this area, but currently it is too weak in this direction.

The overarching goal of Polish space policy should be achieving autonomy across the full scope of space exploration. The ability to independently design, build, and manage satellites provides not only greater security but also real influence over national interests in the new global geopolitical order. The lack of strategic planning, the fragmented structure of the Polish space sector, and its management methods prevent real success. Strong organizational, task-oriented, and financial support from the state is required.

Comprehensive consideration of the presented solutions will ensure the restoration of strategic continuity and a return to a state-based strategic approach to defense and national security, including the crucial role and place of the Polish space sector. Greater focus should be placed on achieving autonomous capabilities, production readiness, and national capacity to meet needs.

Given the difficult geopolitical situation, with Poland threatened by aggression from Russia, a separate ministry should be established to encompass the entire country's military potential. Consolidation of management and leadership efforts is essential. This ministry's policy, developed in cooperation with the Ministry of Energy and Technology, the Ministry of National Defense, the National Defense Ministry, and other ministries based on the national security strategy and the Political-Strategic Defense Directive (currently outdated), would determine requirements for industry regarding innovation, its implementation, and production. Public and private companies should cooperate. The General Staff of the Polish Army, which develops plans for the development of the Polish Armed Forces, should be the driving force behind solutions serving the military. Based on this, industry should refine programs to meet specific requirements.

The Armed Forces should define needs. Projects and industrial capabilities should be compatible with long-term programs and plans for the development of the Armed Forces. The promotion of the Polish defense industry should also change. Currently, it is highly fragmented and divided among numerous institutions, for which no one takes responsibility. Promotion should be managed by the state through a newly established ministry. The new proposed system will ensure there's no competition for who's more important – this transcends divisions. Ensuring national security is paramount. Therefore, crucial decisions should be made at the national level, not at the ministry level.

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