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Space as an operational domain

Perspectives from the Slovak Ministry of Defence

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List of Abbreviations

AOS	Armed Forces Academy of General M. R. Štefánika
AU	Analytical Unit
C2	Command and Control
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CapTech	Capability Technology
CARD	Coordinated Annual Review on Defence
CDP	Capability Development Plan
CDT	Cooperative Demonstration of Technology
CoE	Centre of Excellence
CFSP	Common Foreign and Security Policy
CoHGI	Common Hub for Governmental Imagery
COPUOS	Committee on the Peaceful Uses of Outer Space
CSA	Conceptual Framework of Space Activities in the Slovak Republic for 2020+
CU	Comenius University
DIANA	Defence Innovation Accelerator for the North Atlantic
EDA	European Defence Agency
EDF	European Defence Fund
EDIDP	European Defence Industrial Development Programme
EDTs	Emerging and Disruptive Technologies
EGNOS	European Geostationary Navigation Overlay Service
ELINT	Electronic Intelligence
EO	Earth Observation
ESA	European Space Agency
ESPI	European Space Policy Institute
EUMETSAT	European Meteorological Satellite Agency
EUSPA	European Union Agency for the Space Programme
EU SST	EU Space Surveillance and Tracking
EU	European Union
FEI STU	Faculty of Electrical Engineering and Information Technology of the Slovak University of Technology
FNC	Framework Nations Concept
GEO	Geostationary Satellites
GEOINT	Geospatial Intelligence
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GŠ OS SR	General Staff of the Slovak Armed Forces
HEO	High Earth Orbit
HICG	High Impact Capability Goals
ICT	Information and Communication Technology
IMINT	Imagery Intelligence
ISR	Intelligence, Surveillance, Reconnaissance
ISS	International Space Station
JISR	Joint Intelligence, Surveillance and Reconnaissance
LEO	Low Earth Orbit
LoI	Letter of Intent
MEO	Medium Earth Orbit
METOC	Naval Meteorology & Oceanography Command

MoESRS SVK	Ministry of Education, Science, Research and Sport of the Slovak Republic
MS	Member State
NATO	North Atlantic Treaty Organization
NATO STO	NATO Science & Technology Organization
NIF	NATO Innovation Fund
NSIP	NATO Security Investment Programme
NSS6G	NATO SATCOM Services 6th Generation
OdPIaFP	Investment Planning and Project Funding Department of SVK MoD
PCY	Project Completion Year
PECS	The Plan for European Cooperating States
PESCO	Permanent Structured Cooperation
PEY	Project Execution Year
PNT	Positioning, Navigation, and Timing
SAF	Slovak Armed Forces
SAS	Slovak Academy of Sciences
SatCen	Satellite Centre
SATCOM	Satellite Communication
SBEO	Space Based Earth Observation
SCC	Standard Contractual Clauses
SEMOD	Modernization Section of the Ministry of Defence of the Slovak Republic
SEW	Shared Early Warning
SIGINT	Signals Intelligence
SME	Small and Medium-Sized Enterprises
SSA	Space Situational Awareness
SST	Space Surveillance and Tracking
STEM	Science, Technology, Engineering, and Mathematics
SVK MoD	Ministry of Defence of Slovak Republic
TRL	Technology Readiness Level
TUKE	Technical University of Košice
UNOOSA	United Nations Office for Outer Space
UPJŠ	P. J. Šafárik University in Košiciach
VZLÚ	Czech Aerospace Research Centre

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1. Summary

The main aim of this document is to analyse possibilities for development of the space-defence nexus at the Ministry of Defence of the Slovak Republic (SVK MoD) while reflecting the existing level of ambition of the Slovak MoD, as well as the geopolitical, financial and economic realities. The analysis explores possible cooperation of Slovakia within the EU and NATO, but also policies and activities of small countries within the space domain and the options of bi- and multilateral engagement. Besides, it evaluates capacities for Slovak private sector involvement in the space domain and related industries. Based on the collected data, we propose a set of recommendations supported by a cost-benefit analysis with defined objectives, timelines and KPIs to measure effectiveness and feasibility of the recommended steps in a given timeframe at the Slovak Ministry of Defence.

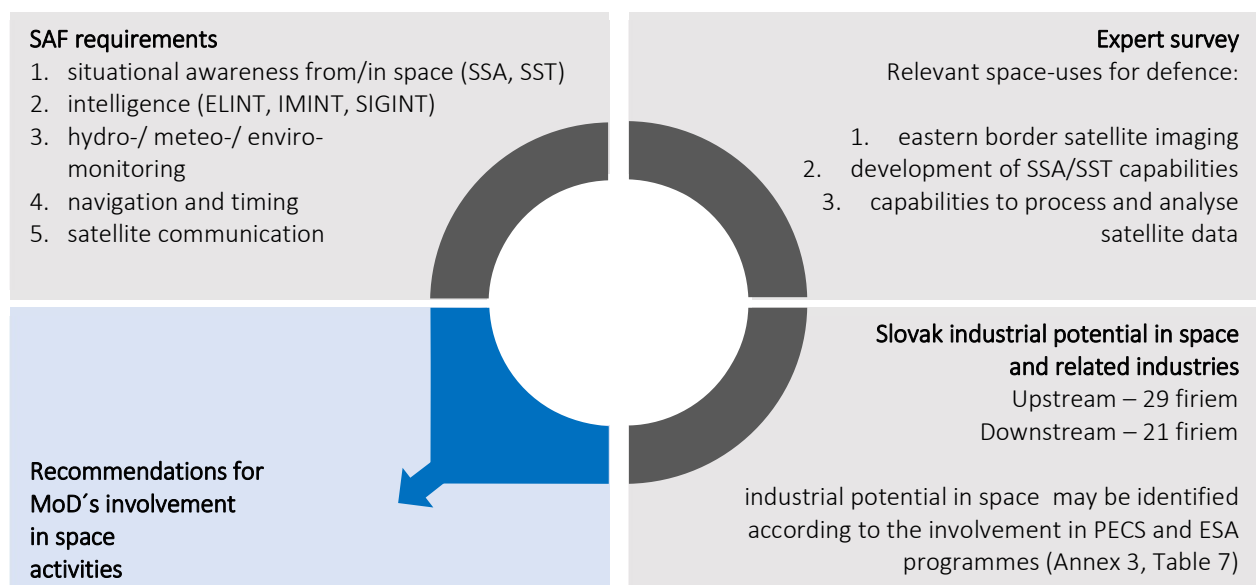
So far, the Slovak Ministry of Defence has not planned to build up capabilities for operating in the space domain on its own. It uses available tools at the international level, but does not actively contribute to their development. *The Long-Term Defence Development Plan with an Outlook to 2035 of the Ministry of Defence* does not foresee any development of independent space capabilities and emphasises that the membership in NATO and in the EU allow Slovakia to build such capabilities jointly with other allies.

A synthesis of three sources was used to define areas of possible involvement of the Slovak Ministry of Defence in the space domain (Chart 1):

1. requirements of the Slovak Armed Forces (SAF)
2. outcomes of an expert survey carried out by the Analytical Unit of the Slovak MoD in 02/2023
3. Slovak industrial potential in the space sector, based on the data provided by the Slovak Space Office and with regard to the Slovak membership in the ESA programmes (possible build-up of specific dual use technologies)

For the purpose of this analysis, the Slovak Armed Forces identified 5 priority requirements for the space domain, which they find relevant regarding their expected tasks in the future operational environment: situational awareness from/in space, intelligence, hydro-/meteo-/enviro- monitoring, navigation and timing, and satellite communication. However, they do not currently have the expertise nor structures for the space domain and therefore any future involvement would require appropriate adaptation of the SAF structure

Chart 1: Variables for defining possibilities of the SVK MoD in the space-defence nexus



Source: own elaboration

50% of the respondents of an expert survey identified satellite imaging of the Slovak eastern border as a specific defence issue that could be positively influenced by the use of space technology. In an open-ended question (no options offered), more than 20% of the respondents identified accession to the EU SST Partnership as important. The outputs were analysed based on data from a survey conducted by the Analytical Unit in February 2023 among experts representing state administration, NGOs, industry and academia in the Slovak Republic.

The eastern border can be monitored via satellite imaging or aerial imaging (drones, aircraft, and helicopters). Experts consider combination of both technologies as appropriate, depending on:

1. requirements for the time and frequency of coverage (24/7; several times/day/week)
2. the size of an area to be monitored

Advantages of satellite monitoring over aerial surveillance are mainly responsiveness, high frequency of coverage, the possibility of monitoring even in bad weather conditions, and minimum legal and regulatory constraints: drones/aircraft may be subject to legal and regulatory constraints such as flight altitude limits or airspace restrictions. **The main disadvantage of satellite monitoring** is higher upfront investment into one's own satellite(s). Smaller satellites in a Low Earth Orbit (LEO) are commonly used for area monitoring because of easier accessibility of the high resolution images from this orbit. However, these satellites orbit the Earth several times a day and thus are not able to monitor the same area continuously. The number of these satellites rises with the higher required frequency of transmission of images per day. Relatively high operational costs (a network of ground stations to control and communicate with the satellites) are also a disadvantage. **The high initial investment is not needed in case of commercially contracted satellite coverage from private suppliers.** Commercial companies currently offer much greater capabilities than national satellite programmes, but they operate for profit, and images are usually only collected when specifically ordered. In 2022, the cost of a new image per 1 km² from commercial providers ranged from USD 14 to USD 100. However, the biggest disadvantage of using commercial satellite imagery is the possibility of commercial companies to fully or partially deny access to their images or sensors.

Slovakia does not have the capability of the satellite monitoring of its eastern border by own means. Bilateral cooperation with countries actively developing these capability could be therefore a viable solution and can be realised in different forms:

1. cooperation with other countries in building satellite systems
2. investment into another country's satellite systems in exchange for a percentage of the operating time

However, both options require building up of the relevant structures and personnel at the MoD SVK.

The cost analysis of any of the abovementioned solutions cannot be determined in detail at this stage due to the different scope of possible involvement. Slovakia needs to declare serious interest in bilateral cooperation in the first phase. Only then it is possible to specify the means of cooperation with particular state and the resulting obligations for Slovakia. Examples of similar activities of selected smaller states in the space domain are provided in Chapter 4 and 6.3.3.

The number of countries with at least one satellite in Earth orbit increased from 50 to 82 between 2008 and 2018. Countries are investing into their national space efforts despite there are joint initiatives at the EU level and projects supported by NATO. The reasons of these individual actions are manifold – from streamlining the decision-making process and enhancing the C2 at the national level, to improving the response time and accuracy of operations or increasing resilience of particular state. The cost of launching satellites on launch vehicles in the 'heavy' category (defined by their 'payload') that can carry more than 20,000 kg to the LEO decreased by more than 95 % over the last 40 years – from USD 65,000 per kg to USD 1,500 per kg (in 2021 prices).

The Czech Republic and Denmark are the most active countries of our reference group in terms of building their own space capabilities with defence overlap. Involvement of defence ministries in building space capabilities has been a decision based either on the **identification of a national need** that cannot be sufficiently covered by existing EU/NATO/commercial capabilities (Denmark); or a **political decision** to specialise the country in the field of space for defence use (the Czech Republic).

The Slovak Ministry of Defence has defined its focus activities related to the R&D in the *Concept for Focusing and Supporting Defence Research and Development with an Outlook to 2025*. Included are projects and calls of the European Defence Agency (EDA), the European Defence Fund (EDF) and the Permanent Structured Cooperation (PESCO), yet only few relate to space:

- **Out of 60 active PESCO projects, five are related to space technologies. Slovakia is not a member of any of them. Considering the military requirements of the Slovak Armed Forces and the results of the expert survey, we recommend involvement of the Ministry of Defence in the PESCO project CoHGI, at least as an observing country.**
- **EDF programme calls for 2023 include two projects focused on space:** "Threat surveillance and protection of space-based assets" (research) and "Initial operational capacity for space situational awareness C2 and sensors" (development). Allocated budget for these projects amounts to EUR 125 million.
- **Slovakia is currently a passive observer in CapTech groups with space overlap within EDA.** More active participation of experts in CapTech groups (governmental but also non-governmental experts, academia, and private sector) should be encouraged. Membership of non-governmental experts is subject to the approval of the National CapTech Coordinator at the SVK MoD. Experts can propose ad-hoc research and technology projects (bottom-up approach, technology push) or respond to existing requirements (top-down approach, capability pull).

An active participation in the NATO STO framework of Cooperative Demonstration of Technology (CDT) and nomination of a Slovak representative to the newly established Centre of Excellence for Space in Toulouse in order to demonstrate Slovakia's interest in cooperation in the field seems to be an appropriate form of engagement at the NATO level at an early stage. NATO neither owns nor directly operates any assets in the Earth orbit. It relies on national (or commercial) capabilities provided by the member states. For this reason, more extensive cooperation beyond financial contribution to the common budget (part of which is allocated to space projects) seems unrealistic for Slovakia for the time being.

We formulate 8 recommendations for the SVK MoD based on the results of this study. However, their implementation would need to reflect the necessary financial and personnel adjustment of particular MoD departments and possibly other organizational changes.

Recommendations

1. **Join the EU SST Partnership.** According to the document *Conceptual Framework of Space Activities in the Slovak Republic*, the SSA/SST is a cross-cutting topic within the agenda of several ministries, including the MoD. The issues of situational awareness in space, reconnaissance and tracking fully correlate with the issues of JISR (Joint Intelligence and Surveillance). Moreover, Slovakia has technological capabilities (in the industrial sector and academia) available for this initiative. Joining the Partnership probably won't be possible before 2026, i.e. before the end of the current grant period.
2. **Become an observer in the PESCO project CoHGI.** Joining the project as an observing country does not entail any financial cost except for the allocation of staff attending project activities and meetings. On the other hand, Slovakia could gain information on other states' activities with regard to the government imagery sharing (including intelligence) and develop a more coordinated approach to space capabilities within this area.
3. **Specify calls in the inter-ministerial sub-programme 06E0I Research and development in support of national defence to the maximum extent possible, within the existing legal framework.** The call should be focused in such a manner as to reflect the MoD's areas of interest in space in a given timeframe.
4. **Nominate non-governmental representatives to the EDA CapTech Space.** This would support more active participation of Slovak entities in proposing ad-hoc projects and studies in the field of space technology research and development and relieve the lacking human capacity at the government level.
5. **Ensure greater involvement in Cooperative Demonstrations of Technology (CDT) within NATO STO** as a platform for presenting of breakthrough technologies (including space) and their applicability in a military environment.
6. **Include a separate chapter on space-defence nexus in the new Slovak Space Strategy.** Currently we do not recommend creation of a separate space strategy for defence. However, the Slovak Space Strategy should reflect both civilian and defence uses of space
7. **Build civilian and military human capacities for space at the MoD.** Stimulate interest in space topics at universities (especially at the Armed Forces Academy of General M. R. Štefánik) and expand cooperation between Slovak universities and research institutions to train specialised personnel for the defence sector in the long term perspective
8. **Specify demand for space capabilities in defence and take over political leadership for their development.** This decision can be based on the defined level of ambition, specification of military requirements, knowledge of the environment (internal and international) and the available analyses, in accordance with the proposed timeline (see page 15).

2. Small countries as a new actors in the space-defence domain

2.1 Importance of space for defence

In the London Summit Declaration (3 – 4 December 2019) NATO declared space its fifth operational domain after land, sea, air and cyberspace¹. At the Brussels Summit in June 2021, NATO leaders agreed that attacks into, from or within space pose a challenge to the security of the Alliance as they could be as damaging as a conventional attack². Such attacks could lead to invocation of Article 5 of the Washington Treaty³. Growing importance of space was confirmed also by establishment of the NATO Space Centre at the Allied Air Command Headquarters in Ramstein, Germany, and foundation of the NATO Centre of Excellence in Toulouse, France.

Box 1: Terms and definitions

Space: The space above the Earth's surface at the height of 90 – 100 km above sea level (the so-called Kármán line). It is no longer possible to perform conventional aeronautical flight (using air lift for level flight) above this line due to decreasing air density. Since the lift depends on various factors (aircraft parameters, meteorological conditions,...), the Kármán line is at different altitudes at different places.

Militarization of space: The use of space assets for command, control, communications, surveillance and reconnaissance to support armies. Unlike the weaponization of space (i.e. the placement of weapons - especially weapons of mass destruction - in space), it is not prohibited by the 1967 Outer Space Treaty (Article 4).

The space-defence nexus refers to 2 complementary aspects:

Defence of Space: tools used by states to defend their space assets against space-based or terrestrial deliberate threats (jamming, spoofing, both cyber and kinetic threats), it emphasizes the need for space surveillance through Space Situational Awareness (SSA).

Space for Defence: use of space and space technologies in support of ground-based military operations, missile defence (early warning), ISR, PNT, satellite communication, etc.

Source: NATO STO, 2020: 75 & ESPI, 2020: 3

The European Defence Agency (EDA) identified space in the CARD Reports (2020⁴, 2022⁵) as one of six next-generation capabilities with the potential to enhance the EU's operational performance. The European Union has underlined importance of space in the Strategic Compass (2022)⁶ and the EU Space Strategy for Security and Defence (2023)⁷.

¹ "London Declaration," NATO, 2019, https://www.nato.int/cps/en/natohq/official_texts_171584.htm

² "Brussels Summit Communiqué," NATO, 14 June 2021, https://www.nato.int/cps/en/natohq/news_185000.htm

³ *The decision on when such attacks would lead to application of the Article 5 would be made by the North Atlantic Council on a case-by-case basis. The above-stated is consistent with the policy of strategic ambiguity, which seeks to deter actors from potentially hostile activities against the Alliance based on uncertainty about the form and scope of NATO's response.*

⁴ "2020 CARD Report," EDA, 2020, p. 1, <https://eda.europa.eu/docs/default-source/reports/card-2020-executive-summary-report.pdf>

⁵ "2022 CARD Report," EDA, 2022, <https://eda.europa.eu/docs/default-source/eda-publications/2022-card-report.pdf>

⁶ "A Strategic Compass for Security and Defence," EEAS, 23 March 2022, p. 12, https://www.eeas.europa.eu/sites/default/files/documents/strategic_compass_en3_web.pdf

⁷ "JOINT COMMUNICATION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL European Union Space Strategy for Security and Defence." EU. Commission documents register, 10 March 2023, [https://ec.europa.eu/transparency/documents-register/detail?ref=JOIN\(2023\)9&lang=en](https://ec.europa.eu/transparency/documents-register/detail?ref=JOIN(2023)9&lang=en)

Space technologies support operational effectiveness and offer a strategic advantage in the implementation of defence policies, including the C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance). (Table 1)

Table 1: Use of space for military activities – C4ISR

Navigation (Positioning, Navigation, and Timing, PNT)	missile guidance, synchronisation of operations, force tracking, search and rescue missions
Support to the Early Warning Systems (Shared Early Warning, SEW)	precise strikes, force tracking
Terrestrial and Space Environmental Monitoring (METOC)	meteorological forecasting and mission planning
Satellite Communication (SATCOM)	consultation, command and control
Intelligence, Surveillance, Reconnaissance (ISR)	situational awareness, planning and decision-making
Space Situational Awareness (SSA)	strategic foresight and resilience

Source: NATO STO, 2020: 76

Countries in the reference group⁸ which are actively using space for military purposes identified many benefits of investing into own national space capabilities:

- streamlining the decision-making process and improving C2
- improving reaction time and accuracy
- enabling the use of more advanced military systems and capabilities
- enabling more efficient coordination in a multi-domain environment
- reducing the dependence on local infrastructure
- eliminating geopolitical constraints
- increasing one's own resilience

2.2 State actors in the space sector

Space exploitation activities are growing. Between 2008 and 2018, the number of countries with at least one satellite in Earth orbit increased from 50 to 82⁹. There are currently more than 5,460 satellites in space, of which 424 are military and 152 are dual-use¹⁰. This number is projected to be five times higher by 2030 (compared to 2019 with about 2,000 satellites in orbit)¹¹. The size of the global space industry will increase from USD 350 million to USD 1 – 2,7 trillion¹² by 2040.

⁸ Space strategies of the reference group countries.

⁹ "Austrian Space Strategy 2030+: People, Climate and Economy: "Space is for everyone", Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (Austria), 2021, p. 11, https://austria-in-space.at/resources/pdf/V4_EN_Austrian-Space-Strategy-2030_0803_taggedv6_PAC2021Approved.pdf

¹⁰ "UCS Satellite Database," Union of Concerned Scientists, 1 May 2022, <https://www.ucsusa.org/resources/satellite-database#.XG6yv3RKiUk>

¹¹ Ryan-Mosley, T. et al., "The number of satellites orbiting Earth could quintuple in the next decade," 26 June 2019, <https://www.technologyreview.com/2019/06/26/755/satellite-constellations-orbiting-earth-quintuple/>

¹² "Science & Technology Trends 2020-2040: Exploring the S&T Edge," NATO STO, March 2020, p.81 https://www.nato.int/nato_static_fl2014/assets/pdf/2020/4/pdf/190422-ST_Tech_Trends_Report_2020-2040.pdf

Chart 2: No. of satellites in orbit by user (2022)

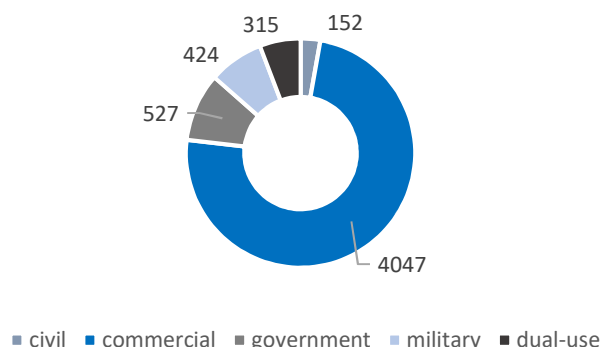
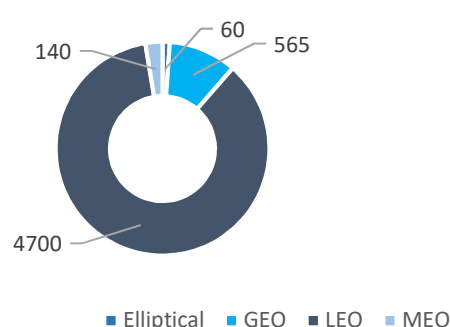


Chart 3: No. of satellites¹³ by class of orbit



Source: Union of Concerned Scientists, 2022

Table 2: Mass-based classification of satellites

Name	Mass (kg)
large satellites	≥1000
medium satellites	500-1000
minisatellites	100-500
microsatellites	10-100
nanosatellites	1-10
picosatellites	0,01-1

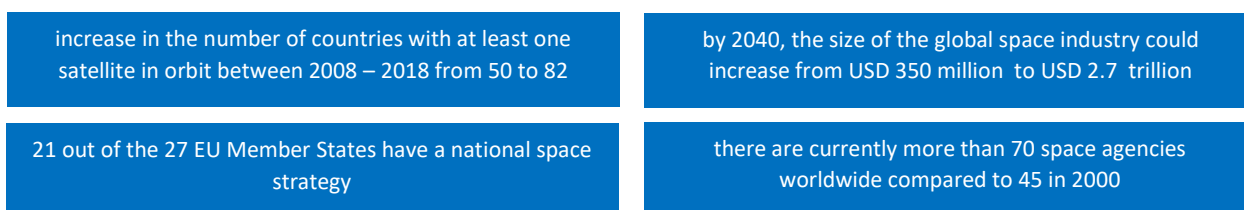
■ cubesat Source: Stevan et al. 2019

Countries are developing their national initiatives and national space strategies despite there are projects both within NATO and in the EU providing states with main space services (Copernicus, Galileo/EGNOS, SSA/SST, GOVSATCOM, Secure Connectivity, IRIS², etc.). There are currently more than 70 space agencies in different parts of the world¹⁴. 21 of the 27 EU Member States have a national space strategy (Annex 1).

Space activities of smaller states were rising rapidly in the last decade. Commercialisation of space, but also reduction of the launching costs have contributed to growing interest in the space domain¹⁵. The cost of launch vehicles in the

'heavy' category (defined by their 'payload') that can carry more than 20,000 kg to the low Earth orbit decreased by more than 95 % over the last 40 years, from USD 65,000 per 1 kg to USD 1,500 per 1 kg (in 2021 prices)¹⁶.

Chart 4: Trends in the space domain (countries)



¹³ GEO (geostationary satellites), altitude 36,000 km, move at the same speed as the Earth. LEO (Low Earth Orbit) satellites, altitude under 1,200 km (about 35 times closer than GEO). MEO (Medium Earth Orbit), altitude between 5,000 and 20,000 km, e.g. GPS. (Sanders, S. "Geo, MEO, and Leo - via Satellite," May 2020. p. 2, <https://www.satellitetoday.com/wp-content/uploads/2021/02/Guide-GEO-MEO-LEO-1.pdf>)

¹⁴ "Countries with Space Programs 2023," World population review, (n.d.) <https://worldpopulationreview.com/country-rankings/countries-with-space-programs>

¹⁵ Brunner, K.H., "Space and Security – NATO's role," 10 October 2021, <https://www.nato-pa.int/download-file?filename=/sites/default/files/2021-12/025%20STC%2021%20E%20rev.%202%20fin%20-%20SPACE%20AND%20SECURITY%20-%20BRUNNER.pdf>

¹⁶ Roberts, T.G. "Space Launch to Low Earth Orbit: How Much Does It Cost?," 1 September 2022, <https://aerospace.csis.org/data/space-launch-to-low-earth-orbit-how-much-does-it-cost/>

3. Space and defence in the Slovak Republic

3.1 Ministry of Defence of the Slovak Republic

According to the strategic documents, the Ministry of Defence of the Slovak Republic does not plan to build its own space capabilities for the moment. The existing level of ambition defines space capability building as a process performed jointly with allies and partners within NATO and the EU. The Defence Strategy of the Slovak Republic promotes the NATO and EU space initiatives in support of military activities¹⁷. According to the Long-Term Defence Development Plan with an Outlook to 2035 (hereinafter referred to as the "Long-Term Plan"): *"Space... creates opportunities to support military activities, particularly in the areas of intelligence, navigation, and communication. The Ministry of Defence does not plan to build capabilities to operate in the space domain independently. However, its membership in NATO and the EU allows the Slovak Republic, together with other allies and partners, to build capabilities that it would not be able to provide alone"*¹⁸.

Table 3: Involvement of the SVK MoD in space domain – state of play

navigation (Positioning, Navigation, and Timing, PNT)	no own capabilities (use of Galileo and EGNOS services)
supporting early warning systems (Shared Early Warning, SEW)	no own capabilities (use of information provided by the NATO partners)
Terrestrial and Space Environmental Monitoring (METOC)	no active involvement (EUMETSAT member, use of Copernicus services)
satellite communication (SATCOM)	does not have its own segment
Intelligence, Surveillance, Reconnaissance (ISR)	limited competence within the Military Intelligence, Cooperation with EU SatCen (generation and provision of IMINT and GEOINT outputs to the EU authorities and EU Member States)
Space Situational Awareness (SSA)	area lead for Slovakia, currently without active involvement

Source: own elaboration, according to publicly available information

The level of ambition is further detailed in the military requirements of the Slovak Armed Forces, which were formulated for this analysis. The SAF propose 5 priority requirements for the space domain, which they find relevant regarding their expected tasks in the future operational environment¹⁹:

1. **Situational awareness from/in space** to identify risks and threats through cooperation with the EU Member States in the framework of existing EU projects (EU Space Surveillance and Tracking (EU SST), PESCO project EU-SSA-N (European Military Space Surveillance Awareness Network),
2. **Intelligence** (ELINT, IMINT, SIGINT) to support situational awareness and decision making, to assess the operational environment,

¹⁷"Obranná Stratégia SR." SVK MoD. 2021. p. 6, https://www.mosr.sk/data/files/4286_obranna-strategia-sr-2021.pdf

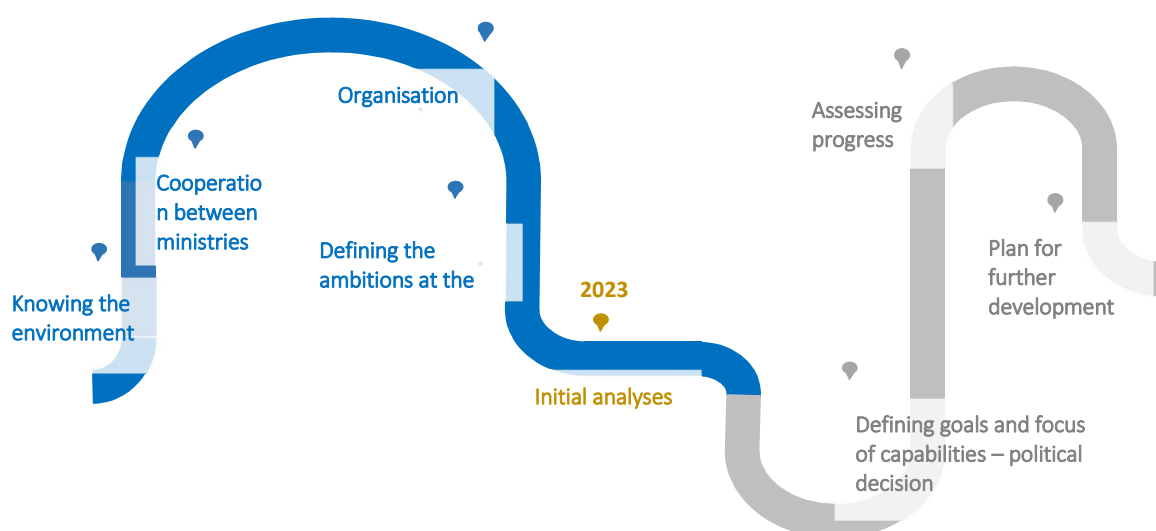
¹⁸ "Dlhodobý plán rozvoja rezortu ministerstva obrany s výhľadom do roku 2035,"SVK MoD, 2022(a), p.12, https://www.mosr.sk/data/files/4767_dlhodoby-plan-rozvoja-rezortu-ministerstva-obrany-s-vyhľadom-do-roku-2035.pdf

¹⁹ Opinion of the Slovak Armed Forces (Strategic Planning Department), 2023

3. **Monitoring of the hydrological and meteorological situation and environment** for planning and executing operations (PESCO project Common Hub for Governmental Imagery (COHGI)),
4. **Navigation and timing** for the potential use of precision guided weapons and fire support (PESCO project EU Radio Navigation Solution (EURAS)),
5. **Satelitná komunikácia** so šírkou pásma schopnou prenášať obrovské objemy dát v reálnom čase do priestorov nasadenia OS SR potrebných pre zabezpečenie velenia a riadenia (napr. projekt STARLINK).

However, the Slovak Armed Forces do not have neither the necessary expertise nor structures for the space domain. Therefore, involvement in any project would require appropriate adaptation of the SAF structures and training of specialised personnel in the long term. This is a necessary step in development of space activities at the MoD according to the schedule proposed in Chart 5, which reflects the experience of the Capabilities and New Trends Department of the Ministry of Defence of the Czech Republic.

Chart 5: Development of space activities at the Ministry of Defence – stages and recommendations



STAGE	STATUS	RECOMMENDATION
Knowing the environment	• participation in EU and NATO activities (pp. 37 – 41) • cooperation with the Slovak Space Office in the space and related industries (pp. 17 – 19) • classification of Slovak private companies (i.a. regarding their involvement in ESA optional programmes - value-added opportunities and dual-use defence applications) (pp. 67 – 72)	• EU SST partnership (pp. 43 – 48) • observer status in PESCO CoHGI (pp. 49 – 53)
Cooperation between ministries	• Conceptual Framework of Space Activities in the Slovak Republic for 2020+ (2019) (pp. 15 – 16 and 21 – 22) • meetings of the Committee for Space Activities in the Slovak Republic (pp. 15 – 16)	• prepare the space-defence chapter to the forthcoming Slovak Space Strategy (p. 35)
Organisation	• limited competence at the Modernization and Military Intelligence Sections (pp. 16 and 49) • absence of a separate unit within the Ministry	• training of civilian and military experts (courses at the Armed Forces Academy of General M. R. Štefánik, international training) (p. 15)
Definovanie rezortných ambícií	• Long-Term Plan 2035 (p. 14) • military requirements of the Slovak Armed Forces (p. 14, to be specified)	• political decision on the next steps based on the initial analyses (p. 10)

Source: own elaboration, based on consultations with MoD CR

Slovakia does not have a strategic document focused specifically on the space-defence nexus. The only space-related document is the Conceptual Framework of Space Activities in the Slovak Republic for 2020+ ("CSA") published by the Ministry of Education, Science, Research and Sport of the Slovak Republic in 2019, which, however, has not been fully put into practice. The document describes division of responsibilities for management of space activities between different ministries²⁰. Defence aspects are mentioned only briefly. Inter-ministerial cooperation takes place primarily through discussions of the Committee for Space Activities²¹.

Table 4: Space activities in Slovakia – division between ministries (CSA for 2020+)

	COPERNICUS	GALILEO/EGNOS	GOVSATCOM	SSA/SST
Ministry of Defence		X	X	X
Ministry of Interior	X		X	X
Ministry of Foreign and European Affairs			X	X
Ministry of Health			X	
Ministry of Environment	X		X	X
Ministry of Construction and Development	X	X	X	
Ministry of Economy	X	X	X	X
Ministry of Finance	X	X	X	X
Office of the Deputy Prime Minister of the Slovak Republic for Investment and Informatization	X	X	X	X
Ministry of Education, Science, Research and Sport	X	X	X	X

Source: Ministry of Education of the Slovak Republic, 2019

At the national level, the Ministry of Defence supports development of the Slovak space and related industry. Based on the Slovak Armed Forces General Staff requirements and taking into account the initiatives within NATO STO and the EU/EDA, MoD has identified 10 R&D areas in support of national defence, including the "operational domain of space and space technologies"²². MoD opened a call in this domain under the inter-ministerial sub-programme *06EOI Research and development in support of national defence*²³, however, no entity applied²⁴. In 2022, MoD financed 14 projects under this sub-programme, with grants ranging from EUR 45,000 to EUR 140,000²⁵.

²⁰ "A conceptual framework of space activities in the Slovak Republic," Ministry of Education of Slovak Republic, June 2019, p.11, <https://slovak.space/wp-content/uploads/2019/07/Koncepcia-FINAL-AJ.pdf>

²¹ "A conceptual framework of space activities in the Slovak Republic," Ministry of Education of Slovak Republic, June 2019, p.11, <https://slovak.space/wp-content/uploads/2019/07/Koncepcia-FINAL-AJ.pdf>

²² "Konceptcia zamerania a podpory výskumu a vývoja v oblasti obrany s výhľadom do roku 2025," SVK MoD, March 2021, p.9, https://www.mosr.sk/data/files/4357_koncepcia-zamerania-a-podpory-vyskumu-a-vyvoja-v-oblasti-obrany-s-vyhľadom-do-roku-2025.pdf

²³ *The announcement of the call is planned in the summer of 2023. If the space domain is again included, the entities interested in applying might have to present a prototype of their product at the end.*

²⁴ "Verejná výzva na predkladanie žiadostí o poskytnutie dotácie na projekty výskumu a vývoja na podporu obrany štátu," SVK MoD, 2022(b), p. 5, https://www.mosr.sk/data/files/4812_vyzva-2022_final.pdf

²⁵ "Schválené žiadosti podľa § 2 písm. e) zákona č. 435/2010 Z. z. o poskytovaní dotácií v pôsobnosti Ministerstva obrany Slovenskej republiky v znení neskorších predpisov k verejnej výzve," SVK MoD, február 2023(b), https://www.mosr.sk/data/files/4955_schvalene-ziadosti-vyzva-1_2022.pdf

Table 5: The SVK MoD support tools to the Slovak space industry

Direct	Indirect	Cooperation
targeted support A call for proposals in the sub-programme <i>06E0I Research and development in support of national defence</i> with the topic "operational domain space and space technologies".	EU level (EDIDP calls 2020) Lols, e.g. for the Comenius University that led project <i>Identification of space objects in Earth orbit</i> – the project was not successful in foreign competition	testing facilities Testing a hybrid rocket engine and special wax fuel in the premises of state owned company Konštrukta Defence for the ESA project.

Source: SVK MoD, 2022(b) & SEMOD MoD SVK

Slovakia is rather a passive user of space technologies in the EU. In particular, the Galileo and Egnos positioning services are fully used. Slovak MoD is also co-financing the European SatCen (EUR 107 380 in 2022)²⁶. The annual contributions are generally made twice a year and the MoD would like to use the SatCen more actively in the future operations.

NATO does not own nor directly operate on-orbit assets and relies on national (or commercial) capabilities provided by the NATO member states. Slovakia has long participated in the NATO's Alliance Ground Surveillance (AGS) project which provides a complete, up-to-date and objective real-time picture of the ground situation on the battlefield or in the monitored territory through HALE (High Altitude, Long Endurance) unmanned aerial vehicles^{27 28}. However, this capability has several disadvantages compared to the satellite imagery, especially with regard to the spatial use limitations. Unmanned aerial vehicles operate at controlled air traffic altitudes. For this reason, they can be deployed only in international airspace or above countries which have authorized use of such assets (treaties of the use of the national airspace etc.) A total of EUR 14.1 million has been allocated to the AGS programme since the inception of the project²⁹. The SVK MoD would also like to participate in the development of the emerging NATO Centre of Excellence for Space in Toulouse (accreditation until 2025) by sending a permanent representative.

3.2 Private sector

Potential of the Slovak industry in development of dual-use capabilities is growing. There are over 40 space companies in Slovakia, focused both on the upstream and downstream segment (from satellite hardware, mission planning, biological research to the use of satellite data on Earth)³⁰. Moreover, there are more than 40 related companies (electronics, Industry 4.0, ICT) with a strong potential to enter the space segment (see Annex 4). Some of them already have their first experience with space projects³¹.

²⁶ MoD SVK Finance Department, email communication, 21 March 2023

²⁷ "Alliance Ground Surveillance (AGS)," NATO, 2022, https://www.nato.int/cps/en/natohq/topics_48892.htm

²⁸ "Konceptia zamerania a podpory výskumu a vývoja v oblasti obrany s výhľadom do roku 2025," SVK MoD, March 2021, p.27, https://www.mosr.sk/data/files/4357_konceptia-zamerania-a-podpory-vyskumu-a-vyvoja-v-oblasti-obrany-s-vyhľadom-do-roku-2025.pdf

²⁹ *Share of the Slovak Republic's contribution to the AGS program is 0.8194 % of the total cost of the system acquisition (the cost allocation among the participating countries was made on the basis of the % share established for the NSIP program), "Zámer rezortu MO SR pri zapájaní sa do projektov a iniciatív NATO a EÚ v oblasti spôsobilostí," SVK MoD, February 2021, p. 13*

³⁰ *Companies directly involved in the space sector in Slovakia generate an annual turnover of more than EUR 120 million. Such companies employ more than 550 workers.* (SARIO email communication, March 2023).

³¹ "Space industry in Slovakia," SARIO, March 2022, <https://www.sario.sk/sites/default/files/sario-space-industry-in-slovakia-2022-03-21-online.pdf>

Box 2: Upstream and downstream segment of the space industry

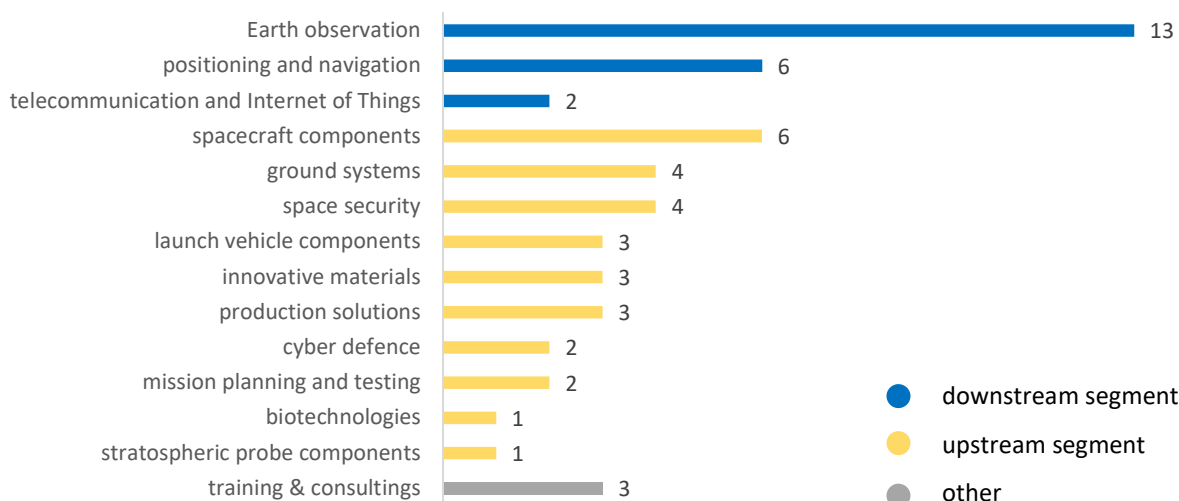
Upstream – includes areas related to satellites and their operations, launch vehicles and the ground segment (research and development of technology, mission planning and execution, basic and applied research activities, scientific and technical support activities, supply of materials and components, production of space systems, subsystems and equipment, telemetry, tracking and control stations)

Downstream – industrial segments which use space infrastructure and data to provide tools and services to the users; including any satellite technology/data dependent products and services (satellite broadcasting, selected GIS, GNSS-enabled equipment)

Source: ESA, 2019

Most space-related revenues come from software applications using Earth observation or positioning data – PNT (positioning, navigation, timing), i.e. the downstream segment³². Slovakia's advantage in the space industry is its strong IT background and the country demonstrated its potential e.g. by successful industry- and academia long-term participation in ESA projects.

Chart 6: Number of Slovak companies actively involved in the space sector



Zdroj: SARIO - an e-mail communication, 2023

On 13 October 2022, Slovakia became an associate member of ESA. Associate membership will bring new possibilities for Slovak entities to conclude contracts in space technology development and research, and will allow for a more intensive international cooperation. The associate membership concluded for 7 years³³ replaced cooperation under the PECS (The Plan for European Cooperating States)

³² "Space industry in Slovakia," SARIO, March 2022, <https://www.sario.sk/sites/default/files/sario-space-industry-in-slovakia-2022-03-21-online.pdf>

³³ The association agreement is concluded for a period of 7 years during which an annual financial contribution of approximately EUR 4.5 million is foreseen. The specific amount will be subject to the economic conditions of the particular year. The related expenditure is approximately EUR 500 thousand per year for the operation of Slovak the space office. ("NRSR odobrila zmluvu o pridružení SR k Európskej vesmírnej agentúre," National Council of the Slovak Republic, 6 October 2022, <https://www.nrsr.sk/web/Default.aspx?sid=udalosti/udalost&MasterID=56179>)

ESA is also bound by the country's economic rate of return (Geo-return), which may not fall below 0.8 under any circumstances. This is therefore another toll how ESA membership supports development of the Slovak industry. ("Návrh na pokračovanie

programme³⁴. From 2015 to 2022, 7 PECS calls were announced for Slovak entities, with 32 different industrial projects³⁵ selected for funding (Annex 3).

Table 6: Slovak space industry potential (ESA assessment 2020)

Key competences	Future potential
• rotary encoders • solar sensors • use of Earth observation data (habitat monitoring, forestry, modelling of soil deformation and gravity field) • cataloguing and tracking LEO objects • monitoring and modelling the ionosphere • meteorite analysis • X-ray astronomy	• electronic mechanisms/instruments • software and ICT • special materials • cubesats • robotics • optical systems for ground-based telescopes

Source: ESA & Ministry of Education, Science, Research and Sport of the Slovak Republic, 2020: 12

Slovakia participates in activities under the ESA's general budget (with the exception of the "Technological Development" line) and in 3 optional programmes.

Table 7: List of expected involvement of Slovak industrial entities in ESA optional programmes

Earth Observation – Future EO	Space Safety Programme	General Support Technology Programme
• Algoritmy:SK • INSAR • YMS • ABMerit • Slovenská technická univerzita • Národné lesnícke centrum	• Orbisys • TILA • ASTROS • Comenius University in Bratislava • Institute of Experimental Physics of the Slovak Academy of Sciences • Institute of Astronomy of the Slovak Academy of Sciences	• CTRL • Needronix • GOSPACE • Touch4IT • M2M Solutions • 3IPK • Slovak Academy of Sciences • Spacemanic • SPINEA Technologies • ATCrystals • Robotech Vision

Source: ESA & Ministry of Education, Science, Research and Sport of the Slovak Republic, 2020: 13

Involvement of Slovak companies in ESA optional programmes can indicate areas for potential cooperation between the Slovak space industry and the Slovak MoD in dual-use space technologies for defence. An overlap between the civilian and defence sectors assumes also greater involvement of Slovak start-ups in the above mentioned 3 priority areas. This selection reflects capabilities of the Slovak space industry and the segments where Slovak companies can bring added value compared to the other countries.

spolupráce SR s Európskou vesmírnou agentúrou (ESA),” Ministry of Education of the Slovak Republic, 2022, pp. 4 – 5, <https://www.slov-lex.sk/legislativne-procesy/-/SK/dokumenty/LP-2020-399>

³⁴ “Spolupráca s ESA,” Slovak Space Portal (a), (n.d.), <https://slovak.space/sr-a-vesmir/spolupraca-s-esa/>

³⁵ “Všeobecné informácie k projektovým výzvam,” Slovak Space Portal (b), (n.d.), <https://slovak.space/vyskum-a-vyvoj/vseobecne-informacie-k-projektovym-vyzvam/>

4. Activities of „small“ states

The following chapter is a short overview of activities of reference group countries (Box 3) as matched against accompanying *definition criteria*. As only open source data were utilised (namely data published in space strategy documents of the respective countries), there are no activities listed that are subject to secrecy. Sums listed with space technology acquisitions are indicative, as most of the contracts and related documentation is not publicly available.

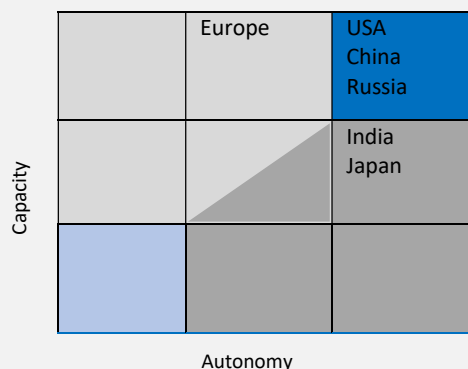
Box 3: Reference group for defence – methodological delineation

This analysis clusters states into four groups according to categories “*capacity*” and “*autonomy*” of space activities:

1. Space power
2. Capable space faring nation
3. Autonomous space faring nation
4. Limited space nation

Capacity: the ability of a state to implement space strategies for achieving it economic, political or social goals.

Autonomy: the ability of a state to independently formulate and realise its interests related to space in areas of technology (accessing and operating in space without relying on others) and policy (the ability to define space policy independently of others).



- 1. space power
- 2. capable space faring nation
- 3. autonomous space faring nation
- 4. limited space nation

For the purposes of this analysis **small states in the area of space activities** are defined as states in categories 2.-4. that also meet at least one of the following **mandatory definition criteria** (Annex 2):

- territory area up to 90 000 km²
- population size up to 11 mil. inhabitants
- real GDP per capita up to EUR 52 000

Mandatory definition criteria were applied to member states of the EU with the goal of identifying a group of states, analogous to Slovakia that could be taken as a reference group for comparing activities in the area of space.

These states should also be undertaking at least one of the following activities (**accompanying definition criteria**):

- the existence of national strategy/concept for space activities, specific strategy for space activities in the area of defence
- establishment of national space agency
- allocation from the national budget for space activities
- development of domestic industry/support industry (IT, cyber...) with space utility
- engagement with international/transnational organisations and institutions aimed at space (ESA – at least at the level of PESK, NATO CoE Toulouse)
- acquisition of space capabilities (governmental or in partnership with the private sector)

Mandatory definition criteria were met by 11 states of the EU: Austria, Cyprus, Croatia, Czech Republic, Denmark, Estonia, Latvia, Lithuania, Malta, Slovakia and Slovenia.

Source: ESPI, 2022: 9-12 & Eurostat, 2022 & Eurostat, 2023

The Czech Republic and Denmark are the most active countries of our reference group in terms of building their own space capabilities with defence overlap. Involvement of defence ministries in building space capabilities has been a decision based either on the **identification of a national need** that cannot be sufficiently covered by existing EU/NATO/commercial capabilities (Denmark); or a **political decision** to specialise the country in the field of space for defence use (the Czech Republic). Denmark invested in building of a satellite Ulloriaq for monitoring of the Arctic and Greenland. Monitoring of these territories by Danish naval and air assets as well as deployment of commercial satellites was insufficient particularly with reference to gaps in the time of observation. Czech Republic is a specific case because of building of indigenous GOLE, STRATOM (stratospheric imaging system) and MODES (system for the evaluation of visual data using aspect of AI), as well as building of a satellite centre suitable for use by the Alliance.

4.1 Slovakia³⁶

National Strategy:

- Not available at the time of writing (Conceptual Framework of Space Activities in the Slovak Republic for 2020+, created in 2019)

Space agency/ institution:

- Slovak Space Office

Budget allocation:

- contribution to ESA – approx. EUR 4.5million (data from Oct 2022)
- financing of Slovak Space Office approx. EUR 500 thousand³⁷ (data from Oct 2022)
- contribution to EU SatCen (SVK MoD EUR 107 308 in 2022)³⁸
- the contribution of other state institutions was not investigated

Development of domestic industry and space R&D:

- 2021 launching of project of Slovak space incubator³⁹
- Slovak round of international hackathon ActInSpace
- Slovakia has a potential in the area of space security (its own industry is being created and is backed academically and through scientific research)⁴⁰
- Higher education:
 - o FEI STU: Space Engineering
 - o TUKE: Faculty of Aeronautics
 - o Comenius University: Faculty of Mathematics, Physics and Informatics
 - o AOS: overlap of study programs with the area of space technology at the Department of Electronics⁴¹
 - o Faculty of Science UPJŠ Košice and Comenius University Bratislava
- Research and development:
 - o the Slovak Academy of Sciences⁴²

³⁶“ A conceptual framework of space activities in the Slovak Republic,” Ministry of Education of Slovak Republic, June 2019, p.11, <https://slovak.space/wp-content/uploads/2019/07/Koncepcia-FINAL-AJ.pdf>

³⁷ “NRSR odobrila zmluvu o pridružení SR k Európskej vesmírnej agentúre,” National Council of the Slovak Republic , 6 October 2022, <https://www.nrsr.sk/web/Default.aspx?sid=udalosti/udalost&MasterID=56179>

³⁸ MoD SVK Finance Department, email communication,, 21. marec 2023

³⁹“ Spaceport_SK,” Slovak Space Office, (n.d.) <https://spaceoffice.sk/spaceport-sk/>

⁴⁰ „Astronóm Šilha sleduje vesmírny odpad: Na obežnej dráhe vytvárame novú skládku,” Zelná, R., 27 September 2022, <https://tech.sme.sk/c/23018935/silna-stranka-slovakov-vo-vesmirnom-vyskume-astronom-silha-hovori-co-vieme-ponuknut-esa.html>

⁴¹“ Katedry,” AOS, (n.d.) <https://weblm.aos.sk/menu-kategoria/katedry>

⁴² *Institute of Experimental Physics , Geophysical Institute , Astronomical Institute, Institute of materials and machine mechanics , Institute of Geography*

- Development of scientific tools for space probes as part of international missions or survey of space weather
- Development of applications using space data

International / supranational activities:

- Associated member of ESA (2022)
- Member of COPUOS
- Member of EUMETSAT (2006)
- Slovak AeroSpace Cluster is member of SME4SPACE
- Member of EURISY⁴³

Acquisition of space capabilities:

- 2017 – the first Slovak satellite **skCUBE**
- 2021 – the second Slovak satellite **GRBAAlpha**
- Planned launch of a third satellite **GRBBeta**⁴⁴
- Participation in ESA projects
 - **BepiColombo**: cooperation on construction of ion camera exploring Mercury⁴⁵
 - **JUICE**: cooperation on project via the construction of anti-coincidence detector⁴⁶

4.2 Austria

National Strategy:

- Austrian Space Strategy 2030+⁴⁷

Space agency/institution:

- The Aeronautics and Space Agency
- Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology

Budget allocation⁴⁸:

- Annual budget for ESA and EUMETSAT is EUR 60 million
- Annual investment approx. EUR 30 million into European space programs

Development of domestic industry and space R&D⁴⁹:

- Establishment of BIC ESA in Graz and Wiener Neustadt
- European Space Education Resource Office (ESERO) in Linz

⁴³ EURISY is a non-profit association of European space agencies, government departments and international organisations responsible for space affairs ("About Us," EURISY, (n.d.) <https://www.eurisy.eu/>).

⁴⁴ "Slovensko bude mať ďalšiu vesmírnu družicu. Tentoraz ju zaplatí štát," Hodás, M., 27 September 2022, <https://zive.aktuality.sk/clanok/wKJ4kvv/slovensko-bude-mat-dalsiu-vesmirnu-druzicu-tentoraz-ju-zaplati-stat/>

⁴⁵ "Sonda ESA Bepicolombo úspešná aj na „polceste“ k Merkúru," SAS, 28 March 2023, https://www.sav.sk/?lang=sk&doc=services-news&source_no=20&news_no=11109

⁴⁶ "Vesmírna sonda ESA Juice ponesie k Jupiteru aj detektor zo Slovenska," Gáliková, K., 13 April 2023, https://www.sav.sk/?lang=sk&doc=services-news&source_no=20&news_no=11133

⁴⁷ "Austrian Spae Strategy 2030+: People, Climate and Economy: Space is for Everyone," Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (Austria), 2021, https://austria-in-space.at/resources/pdf/V4_EN_Austrian-Space-Strategy-2030_0803_taggedv6_PAC2021Approved.pdf

⁴⁸ "Space Activities," Austria in Space, (n.d.), <https://austria-in-space.at/en/european-space-activities/>

⁴⁹ "Austrian Spae Strategy 2030+: People, Climate and Economy: Space is for Everyone," Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (Austria), 2021, pp. 16 – 19, https://austria-in-space.at/resources/pdf/V4_EN_Austrian-Space-Strategy-2030_0803_taggedv6_PAC2021Approved.pdf

- Austrian Space Applications Programme (ASAP) established in 2002 facilitates cooperation with ESA and the EU and in the field of trade and is also central element to research and development of space technologies

International / supranational activities⁵⁰:

- Member of ESA
- Member of EUMETSAT (1993)
- Member of COPUOS (1959)
- Austria is a centre of space diplomacy, policy and legal matters (the seat of UNOOSA) and European Space Policy Institute (ESPI)

Acquisition of space capabilities⁵¹:

- 2013 start of the first two Austrian satellites **TUGSAT-1 / UNIBRITE**
- 2014 establishment of the Earth Observation Data Centre (EODC)
- 2017 launch of third satellite **PEGASUS**
- 2019 launch of fourth satellite **OPS-SAT**

4.3 Croatia

National strategy:

- Nacionalna svemirska strategija⁵² (concept from 2018)

Space agency/institution:

- Does not currently have a specific institution (Croatian Space Agency, created in 2002, is currently an inactive institution)

Budget allocation:

- Contribution to ESA EUR 1.9 million in 2021⁵³

Development of domestic industry and space R&D⁵⁴:

- Education aimed at STEM (Science, Technology, Engineering and Maths)
- Space research and education (The Faculty of Electrical Engineering and Computing of the University of Zagreb conducts research in the field of space technologies and cooperates with several international space agencies)
- Research institutions: Institute of Rudjer Boskovic (RBI), Meteorological and Hydrological Service (DHMZ), Croatian Academy of Sciences and Arts (HAZU) and Adriatic Aerospace Association (A3)

International / supranational activities:

- Plan to become associated member of ESA
- Member of EUMETSAT (2006)

⁵⁰ "Austrian Space Strategy 2030+: People, Climate and Economy: Space is for Everyone," Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (Austria), 2021, pp. 16 – 19, https://austria-in-space.at/resources/pdf/V4_EN_Austrian-Space-Strategy-2030_0803_taggedv6_PAC2021Approved.pdf

⁵¹ "Austrian Space Strategy 2030+: People, Climate and Economy: Space is for Everyone," Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (Austria), 2021, p. 19, https://austria-in-space.at/resources/pdf/V4_EN_Austrian-Space-Strategy-2030_0803_taggedv6_PAC2021Approved.pdf

⁵² "Nacionalna svemirska strategija," Bosanac et al., 2018, <https://a3space.org/wp-content/uploads/2020/01/Nacionalna-svemirska-strategija-14-12-18.pdf>

⁵³ "Funding," ESA, (n.d.), https://www.esa.int/About_Us/Corporate_news/Funding

⁵⁴ "Political, Economic and Legal Considerations for Developing Space Nations Republic of Croatia," Sun, G. et al., 2021, <https://a3space.org/wp-content/uploads/2020/10/ISU-space-report-Croatia.pdf>

- Signed The Outer Space Treaty – UNOOSA

Acquisition of space capabilities⁵⁵:

- Construction of the first satellite **PERUN 1**
- Project **SPELL** (open source software package with an integrated environment that helps perform the necessary functions)
- Project **MONICA** (passive satellite ranging)
- Project **BLINK** and **SatScout** (goal is to simplify and make launching and studying of satellites more effective)

4.4 Cyprus

National Strategy:

- Cyprus Space Strategy 2022 – 2027⁵⁶ (approved in 2022)

Space agency/ institution:

- Cyprus Space Office (under the auspices of Deputy Ministry of research, Innovation and Digital Policy)
- Plan to establish Space Policy Advisory Group (representatives of Cypriot academia and industry)

Budget allocation:

- 2023 contribution to ESA – EUR 2.6 million

Development of domestic industry and space R&D:

- Support of space research and education via Cyprus Space Exploration Organisation (CSEO)⁵⁷
- Launch of national incubation centre for space business and a local space cluster
- Hosting of events connected with space (e.g. 2nd Cypriot space conference in 2020)

International / supranational activities:

- Plan to become associated member of ESA by 2025, 2027 at the latest (cooperating state at the moment)
- Member of EURISY
- Member of COPUOS (2018)

Acquisition of space capabilities:

- **HELLASAT** (in cooperation with Greece) satellites for communication services (satellite broadband for markets in Europe and Middle East and in Africa)⁵⁸
- **MEOLUT** (Medium Earth Orbit Local User Terminal) ground segment of MEOSAR system (Medium Earth Orbit Search and Rescue). Space segment of MEOSAR system for Search and Rescue services consists of SAR/Galileo that carries signals of emergency beacons back to Earth. MEOLUT as a ground segment receives these signals. Apart from Cyprus this system is installed in Spain, Greenland and Réunion⁵⁹.

⁵⁵ "Political, Economic and Legal Considerations for Developing Space Nations Republic of Croatia," Sun, g. et al., 2021, pp. 7- 8, <https://a3space.org/wp-content/uploads/2020/10/ISU-space-report-Croatia.pdf>

⁵⁶ "Cyprus Space Strategy 2022- 2027," Deputy Ministry of Research, Innovation and Digital Policy of Cyprus, 2022, [https://dec.dmid.gov.cy/dmid/dec/ws_dec.nsf/All/C976C0C5D58E47C9C225893B0035FE92/\\$file/Cyprus%20Space%20Strategy%202022-2027_APPROVED.pdf](https://dec.dmid.gov.cy/dmid/dec/ws_dec.nsf/All/C976C0C5D58E47C9C225893B0035FE92/$file/Cyprus%20Space%20Strategy%202022-2027_APPROVED.pdf)

⁵⁷ "About Us," CSEO, (n.d.), <https://www.spaceexploration.org.cy/#!/AboutUs>

⁵⁸ "Bridging Worlds," Hellas-sat, (n.d.), <https://www.hellas-sat.net/>

⁵⁹ "La Réunion EU MEOLUT, a cornerstone new infrastructure for SAR Galileo delivery in the Indian Ocean," EUSPA. 5 December 2022, <https://www.euspa.europa.eu/newsroom/news/la-r%C3%A9union-eu-meolut-cornerstone-new-infrastructure-sar-galileo-delivery-indian-ocean>

4.5 Czechia

National strategy:

- Národní kosmický plán na roky 2020 až 2025⁶⁰ (approved in 2019, 3rd in a row)

Space agency/institution:

- Czech Space Office

Budget allocation:

- According to the Ministry of Transport space activities received an investment of CZK 1.2 billion CZK in 2020⁶¹
- In 2023 ESA contribution was EUR 49.2 million⁶²
- Contribution to EUMATSAT in 2019 was EUR 5.1 million⁶³
- Budget of Czech SATCEN is not publicly disclosed

Development of domestic industry and space R&D:

- Establishment of industrial associations (Czech Space Alliance (ČVA); The Association of the Czech AeroSpace Industry (ALV); Czech Intelligent Transport Systems and Services (ITS&S); GNSS Centre of Excellence (GCE))
- Establishment of ESA BIC Prague, ESA BIC Brno
- First advanced educational program of space technologies: European international interdisciplinary program “Space Master” Faculty of Mechanical engineering ČVUT in Prague
- Master’s programs (Aeronautical and space systems and Aeronautics and astronautics at Charles University in Prague and Masaryk University in Brno)
- Institute of International Relations established a „Governance of Emerging Technologies“ focusing on space activities
- The number of patent applications to the European Patent Office rose by 50% since 2012 (i.e. 33.8 applications per million inhabitants in 2017)

International / supranational activities:

- Member of ESA
- EUSPA headquarters in Prague
- Member of EUMETSAT (2010)
- Member of EURISY
- Member of COPUOS
- Participation in NATO Space centre in Rammstein since 2022
- Plan to occupy a position at Centre of Excellence in Toulouse since summer of 2023⁶⁴
- Bilateral agreement with France on cooperation in the field of exploration and use of space for peaceful purposes
- Lol with the Brazilian Space Agency to explore possibilities for cooperation
- Memorandum of understanding with Luxembourg on cooperation in the field of space exploration and the use of space resources

⁶⁰ “Národní kosmický plán na roky 2020 až 2025,” Czech Space Portal, 2020, <https://www.czechspaceportal.cz/narodni-strategie/narodni-kosmicky-plan/>

⁶¹ “Média a tiskové zprávy.” Ministry of Transport of the Czech Republic. 10 December 2019, <https://www.mdcz.cz/Media/Media-a-tiskove-zpravy/Kosmicke-aktivity-se-CR-vyplati,-prinasi-pracovni>

⁶² “Funding,” ESA, (n.d.), https://www.esa.int/About_Us/Corporate_news/Funding

⁶³ “Národní kosmický plán na roky 2020 až 2025,” Czech Space Portal, 2020, p. 15, <https://www.czechspaceportal.cz/narodni-strategie/narodni-kosmicky-plan/>

⁶⁴ Communication with MoD CR, March 2023

Acquisition of space capabilities:

- Cooperation on the development of satellite navigation system Galileo and participation on various ESA missions
- The establishment of Czech Satellite centre ⁶⁵
- 2017 satellite **VZLUSat-1**
- 2021 satellite **VZLUSat-2** (including an experimental camera for Earth observation)
- Participation in ESA project **ePLATO** (Planetary Transits and Oscillations of Stars) that is aimed at space exploration and the search for planets similar to Earth (in space around 2026) ⁶⁶
- Constellation of Czech satellites **Hyperion** as part of the SPACE 2030 program (The Czech Aerospace Research Centre)
- command and data station SOLUM
- Projects of the Czech **SATCEN** (the information is publicly available) ⁶⁷
 - o **GOLEM** constellation (in space 2024/2025)
 - o **STRATOM** (stratospheric imaging system)
 - o **MODES** (system for evaluating image information using elements of AI)

4.6 Denmark

National strategy:

- Denmark's National Space Strategy ⁶⁸ (published 2016, supplemented with new goals in 2021 ⁶⁹)

Space agency/institution:

- The Danish Agency for Science, Technology and Innovation
- The Interministerial Space Committee

Budget allocation ⁷⁰:

- Annual fund in the amount of DKK 10 million (EUR 1.3 million) for the development of Danish space industry and space research with the goal of developing national competencies
- Contribution to ESA EUR 35.1 million in 2023
- Contribution to EUMETSAT approx. EUR 8.5 million (DKK 63.5 million)

Development of domestic industry and space R&D ⁷¹:

- Support of innovations, start-ups and digitization
- Support of research and innovations in the use and implementation of space systems particularly earth observation and positioning within the EU and ESA
- Innovation centres in USA, India, Brazil, South Korea, China, Germany and Israel (support of relationships between Danish and universities and companies in respective countries)
- Space research carried out at universities (DTU Space Danish Technical University, University in Aalborg) and public research institutes such as Geological Survey of Denmark and

⁶⁵ "Česká vojenská družice GOLEM," Grohman, J., 16 January 2020, <https://www.armadninoviny.cz/cesky-satelit-golem.html>

⁶⁶ "PLATO," OHB Czech Space, (n.d.), <https://www.ohb-czech.cz/our-projects/plato>

⁶⁷ "Šéf Satelitního centra: Cílem je kontinuálně snímat Česko. Vlastní družice bychom mohli mít do pěti let," Magdoňová, J., 20 January 2020, https://www.irozhlas.cz/zpravy-domov/satelitni-snimky-satelit-satcen-armada-cesko-nato-ladislav-stahl_2001200701_dok

⁶⁸ "Denmark's national space strategy," The Danish Government, June 2016, <https://ufm.dk/en/publications/2016/files/space-strategy-2016.pdf>

⁶⁹ "Denmark's national space strategy: Update of strategic objectives," The Danish Government, June 2021, <https://ufm.dk/en/publications/2021/files/denmarks-national-space-strategy.pdf>

⁷⁰ "Denmark's national space strategy: Update of strategic objectives," The Danish Government, June 2021, <https://ufm.dk/en/publications/2021/files/denmarks-national-space-strategy.pdf>

⁷¹ "Denmark's national space strategy," The Danish Government, June 2016, <https://ufm.dk/en/publications/2016/files/space-strategy-2016.pdf>

Greenland (GEUS) and Danish Meteorological Institute (DMI) and public bodies, e.g. Danish Defence Command

- Bilateral cooperation of public bodies and universities with NASA

International / supranational activities:

- Member of ESA
- Member of EUMETSAT (1986)
- Member of COPUOS (2017)

Acquisition of space capabilities:

- 2018 satellite **Ulloriat** (cooperation with Danish Technical University (DTU). Ministry of Defence and Gomspace (private company)⁷² for the observation of Arctic 16 times a day, once every hour and a half, from orbit, from a distance of approximately 540 km from Earth's surface. The satellite will be a part of civilian missions performed by the armed forces, including rescue at sea⁷³. Before launching of this satellite the area was observed by using Danish air and naval forces, as well as using commercial satellite. Data gathered this way was not sufficient, due to the fact that the satellites used were not specialised in observation of the arctic region (Greenland). Meaning there were gaps in observation between different images sent to Earth sometime as long as entire days. This has proven to be a problem during and attempt to track down the originator of an oil spill near the east coast of the island.
- The Danish Ministry of Defence Acquisition and Logistics Organisation is establishing the necessary contact point for Denmark to get access to the encrypted and specially robust service of the Galileo programme, the Public Regulated Service (PRS)⁷⁴
- Plan for the establishment of a satellite as part of multinational satellite program and the establishment of ground segment with the package of capabilities for the Arctic region
- Research project **MARIOT** (the provision of cheap and effective data connectivity for nautical safety and navigational services via small satellites in LEO)⁷⁵

4.7 Estonia

National strategy:

- Not available at the time of writing

Space agency/institution:

- Competencies under the auspices of Ministry of Economic Affairs and Communications (Estonian Space Office)
- Plan to establish National Space Agency

Budget allocation:

- Contribution to ESA EUR 6.9 million in 2023⁷⁶

⁷² "Unique Danish satellite in orbit around the Arctic," Andersen, M.G., February 2018, <https://www.dtu.dk/english/news/all-news/nyhed?id=b6b1e469-9c27-44bf-80a5-08ac9c9e8382>

⁷³ "Unique Danish satellite in orbit around the Arctic," Andersen, M.G., February 2018, <https://www.dtu.dk/english/news/all-news/nyhed?id=b6b1e469-9c27-44bf-80a5-08ac9c9e8382>

⁷⁴ "Denmark's national space strategy: Update of strategic objectives," The Danish Government, June 2021, p. 42, <https://ufm.dk/en/publications/2021/files/denmarks-national-space-strategy.pdf>

⁷⁵ "Denmark's national space strategy: Update of strategic objectives," The Danish Government, June 2021, <https://ufm.dk/en/publications/2021/files/denmarks-national-space-strategy.pdf>

⁷⁶ "Funding," ESA, (n.d.), https://www.esa.int/About_Us/Corporate_news/Funding

- Estonia increased the investment into space sector by 2.5 times in 2021 (compared to 2020)⁷⁷

Development of domestic industry and space R&D⁷⁸:

- Plan to increase investment in research and development in the field of space and develop new commercial opportunities
- Estonia wants to contribute to the development of the space sector by know –how sharing in the field of electronic public administration and cyber security
- Estonian policy in the field of space industry is divided into three main categories: cyber security, artificial intelligence and innovations
 - o Focusing on aeronautical software as well as independent verification and validation of software, blockchain, cyber security exercises, development of applications for electronic public administration for management in space
- Priorities of research: scientific ESA missions, program of small satellites and national internship programs for students and experts

International / supranational activities:

- Member of ESA (2015)
- Member of EUMETSAT (2013)

Acquisition of space capabilities⁷⁹:

- **ESTHub** (national centre of satellite data, that enables users to search and download data of the Copernicus program, in addition it participates in data processing for government institutions)⁸⁰
- Foundation Space for Earth also develops platform for Earth observation, using AI for the analysis of satellite data
- 2013 satellite **ESTCube-1** (developed by Tartu University in cooperation with a host of Estonian companies and research organisations, it was financed by public and private funds as well as crowdfunding campaigns)

4.8 Latvia

National Strategy:

- The Space Strategy of Latvia 2021-2027⁸¹ (published in 2020)

Space agency/institution:

- Ministry of Education and Science (virtual Latvian Space Office established in 2020)
- Latvian Space Policy Working Group

Budget allocation:

- Contribution to ESA EUR 1.1 million in 2023⁸²

⁷⁷ “Estonian contribution to Space Traffic Management,” Ministry of Economic Affairs and Communication, (n.d.), https://www.unoosa.org/documents/pdf/PromotingSpaceSustainability/PresentationsCaseStudies/3_Regulators_SpacePolicyMakers/Estonian_contribution_to_Space_Traffic_Management.pdf

⁷⁸ “Estonia’s space policy – prioritizing e-gov, cybersecurity and AI,” Liias, P., (n.d.), <https://spacewatch.global/2020/07/spacewatchgl-opinion-estonias-space-policy-prioritizing-e-gov-cybersecurity-and-ai/>

⁷⁹ “Estonia’s space policy – prioritizing e-gov, cybersecurity and AI,” Liias, P., (n.d.), <https://spacewatch.global/2020/07/spacewatchgl-opinion-estonias-space-policy-prioritizing-e-gov-cybersecurity-and-ai/>

⁸⁰ “National Satellite Data Centre ESTHub,” Geoportaal, October 2022, <https://geoportaal.maaamet.ee/eng/Spatial-Data/National-Satellite-Data-Centre-ESTHub-p654.html>

⁸¹ “The Space Strategy of Latvia 2021-2027,” Ministry of Education and Science of the Republic of Latvia, 2020, https://www.em.gov.lv/sites/em/files/media_file/the-space-strategy-of-latvia-2021-2027.pdf

⁸² “Funding,” ESA, (n.d.), https://www.esa.int/About_Us/Corporate_news/Funding

Development of domestic industry and space R&D⁸³:

- Space research and education (e.g. University of Latvia, Riga Technical University, Institute for Environmental Solutions, The Institute of Electronics and Computer Sciences and Ventspils International Radio Astronomy Center)
- High level research (radio astronomy, detection of small planter bodies, comets and meteors), remote Earth exploration, indicators of critical climate change points, data processing, high-performance computing, low density thermal insulation, assessment of structural safety and composite structures)

International / supranational activities:

- Associated member of ESA
- Participation on EUMETSAT (2009), JIVE (Joint Institute for VLBI, a European Research Infrastructure Consortium), ILT (International LOFAR Telescope network)⁸⁴

Acquisition of space capabilities:

- 2017 launching of first nanosatellite **Venta-1**⁸⁵
- System ForestRadar (change detection: logging, wind disasters, services of flood detection and fires will soon be a part of the portfolio)
- Plan to develop space infrastructure including ground segment and satellite receiving stations

4.9 Lithuania

National strategy:

- Not available at the time of writing

Space agency/institution:

- Space activities fall under the auspices of Ministry of Economy and Innovation
- Lithuanian space association

Budget allocation:

- Contribution to ESA EUR 1.8 million in 2023⁸⁶

Development of domestic industry and space R&D⁸⁷:

- Research particularly in the field of generating, transfer and detection of electromagnetic emissions in microwave and infrared bands (nano-structural photonics)
- Development of capacities in the field of space technologies, especially in connection with small satellites
- Space research and education (Vilnius University is active in the field of space technologies, Kaunas University of Technology has a research group focused on the development of micro satellites)

⁸³ "The Space Strategy of Latvia 2021-2027," Ministry of Education and Science of the Republic of Latvia, 2020, https://www.em.gov.lv/sites/em/files/media_file/the-space-strategy-of-latvia-2021-2027.pdf

⁸⁴ "The Space Strategy of Latvia 2021-2027," Ministry of Education and Science of the Republic of Latvia, 2020, https://www.em.gov.lv/sites/em/files/media_file/the-space-strategy-of-latvia-2021-2027.pdf

⁸⁵ "Venta-1 Nanosatellite," ESA, 2017, <https://www.eoportal.org/satellite-missions/venta-1>

⁸⁶ "Funding," ESA, (n.d.), https://www.esa.int/About_Us/Corporate_news/Funding

⁸⁷ "Space Policy," Ministry of the Economy and Innovation of Lithuania, September 2020, <https://eimin.lrv.lt/en/sector-activities/innovation/space-policy>

- Development of technologies (sensors and tools for remote Earth exploration, satellite communications and monitoring of space debris)

International / supranational activities:

- Associated member of ESA
- Member of EUMETSAT (2013)

Acquisition of space capabilities⁸⁸:

- Astronomers participated in the development of **GAIA** and provided an analysis of photometric systems, peculiar stars and interstellar extinction
- 2014 satellite **Lituanica SAT-1** (approximate cost, based on components used, could be several thousand EUR) and **LitSat-1**
- 2017 satellite **LituanicaSAT-2**
- 2016 – 2018 project **ESPRESSO** (Lithuanian company Lidaris in cooperation with ESA in obtaining experimental data on the prediction of the lifetime of optics, as required by various space programs)
- more than 90% of Lithuanian satellite telecommunication services are exported

4.10 Malta

National Strategy:

- Malta National Space Strategy⁸⁹ (consultation document 2022)

Space agency/institution:

- The Malta Council for Science and Technology, under the auspices of Ministry for Equality, Research and Innovation

Budget allocation⁹⁰:

- No budget allocation specifically for space
- Provision of funds for research (GBARD - Government Budget Allocation for R&D) further investment in infrastructure (e.g. establishment of Malta Space Task Force)
- Creation of a Fund for Space exploration

Development of domestic industry and space R&D:

- 2014 establishment of Institute of Space Sciences and Astronomy (ISSA) at Maltese University (research from software development to radio telescopes and concept for the optimisation of antenna placement)

International / supranational activities⁹¹:

- Cooperation with ESA (Cooperation agreement signed)
- Member of EURISY
- Field of interest SCO (Space Climate Observatory) - The Malta Council for Science and Technology
- Plan to cooperate within the framework of Network of European regions using space technologies (NEREUS)

⁸⁸ "Space Policy," Ministry of the Economy and Innovation of Lithuania, September 2020, <https://eimin.lrv.lt/en/sector-activities/innovation/space-policy>

⁸⁹ "Malta National Space Strategy," Ministry For Equality, Research And Innovation (Malta), March 2022, https://meae.gov.mt/en/Public_Consultations/MRIC/Pages/Consultations/MaltaNationalSpaceStrategy.aspx

⁹⁰ "Malta National Space Strategy," Ministry For Equality, Research And Innovation (Malta), March 2022, p. 17, https://meae.gov.mt/en/Public_Consultations/MRIC/Pages/Consultations/MaltaNationalSpaceStrategy.aspx

⁹¹ "Malta National Space Strategy," Ministry For Equality, Research And Innovation (Malta), March 2022, p. 23, https://meae.gov.mt/en/Public_Consultations/MRIC/Pages/Consultations/MaltaNationalSpaceStrategy.aspx

Acquisition of space capabilities:

- ASTREA (Research group Astrionics at Maltese University) develops its own satellite **UoMSat** and a ground station)⁹²

4.11 Slovenia**National Strategy:**

- Not available at the time of writing

Space agency/institution:

- Industry, Entrepreneurship and Internationalisation Directorate (Ministry of the Economy, Tourism and Sport)⁹³

Budget allocation:

- Contribution to ESA EUR 3.4 million in 2023⁹⁴

Development of domestic industry and space R&D⁹⁵:

- Creation of Space Objects registry in 2022
- Space activity Act which will regulate space activities in the country, adopted in 2022
- SPACE-SI (Slovenian centre of excellence for space sciences and technologies: academic institutions, high-tech SME and large industrial firms)⁹⁶

International / supranational activities:

- Associated member of ESA
- Member of EUMETSAT (2008)
- Member of COPUOS (2021)

Acquisition of space capabilities:

- **CubeSat NEMO-HD** (Slovenia's cooperation with the Institute of Aeronautical Studies at the University of Toronto Institute for Aerospace Studies/Space Flight Laboratory)⁹⁷ Slovenia provided EUR 2.1 MILLION for the purpose of launching the satellite.⁹⁸
- **CubeSat TRISAT** (financed by PECS program)⁹⁹

⁹² "Maltese Innovation Promises New Era in Accessing Space," Ridgeway, S., August 2022, <https://thinkmagazine.mt/maltese-innovation-promises-new-era-in-accessing-space/>

⁹³ "Cooperation with the European Space Agency," Ministry of the Economy, Tourism and Sport (Slovenia), March 2023, <https://www.gov.si/en/topics/sodelovanje-z-esa/>

⁹⁴ "Funding," ESA, (n.d.), https://www.esa.int/About_Us/Corporate_news/Funding

⁹⁵ "Parliament confirms space activities legislation," The Slovenia Times, 16 March 2022, <https://sloveniatimes.com/parliament-confirms-space-activities-legislation>

⁹⁶ "Slovenian Centre of Excellence for Space Sciences and Technologies Space-SI," SPACE-SI, (n.d.), <http://www.space.si/en/>

⁹⁷ "NEMO-HD (Nanosatellite for Earth Monitoring and Observation – High Definition) ", ESA, 8 March 2021, <https://www.eoportal.org/satellite-missions/nemo-hd#eop-quick-facts-section>

⁹⁸ "Cooperation with the European Space Agency," Ministry of the Economy, Tourism and Sport (Slovenia), March 2023, <https://www.gov.si/en/topics/sodelovanje-z-esa/>

⁹⁹ "Cooperation with the European Space Agency," Ministry of the Economy, Tourism and Sport (Slovenia), March 2023, <https://www.gov.si/en/topics/sodelovanje-z-esa/>

5. Expert survey

Between February 1st and 13th 2023, the Analytical Unit of the Ministry of Defence of the Slovak Republic conducted a survey among selected experts from state service, academia and industry on the topic of „*Potential of space technologies for enhancing the defence of the Slovak Republic*“. The survey was done using an anonymized questionnaire containing 4 closed and 4 open questions (Annex 6). The closed questions allowed for responses on a 5-point scale and were evaluated using a variation of the Likert scale¹⁰⁰. The results of the survey contain 26 responses from experts of all backgrounds in roughly equal proportions (industry: 10 respondents, state service: 9 respondents, academia: 6 respondents, think-tank/NGOs: 1 respondent).

The interpretation of the results was mindful of several factors that could potentially distort the outcome, such as the individual professional expertise of the respondents (experts from the public sector may lack a detailed awareness of the state of the Slovak space industry) and their personal interests (the answers of the industry representatives may have been distorted by their business interests or their specialization towards a specific segment of the space economy).

Box 4: Interpretation of the results

The responses to the closed questions were evaluated using a variation of the Likert scale, which is used to measure stances and opinions with a greater level of distinction than a simple yes/no answer. The assessments are structured in a way to provide quantifiable answer options, which subsequently facilitate the analysis of the collected data. Once the responses are collected, every point can be either analysed on its own or, in some cases, a set of responses on the Likert scale can be aggregated to get a total sum (the most valuable space technology in general, for example).

Advantages:

- Easy to use and comprehend
- Does not expect a yes/no response from the respondents but allows them to express their opinion or decline an answer (gives a deeper insight into people's thoughts)
- Less prone to errors (response scales without a neutral option may distort the results and jeopardize the validity of the conclusions)

Disadvantages:

- Validity of the results may be affected if respondents choose more socially acceptable answers (individuals may provide answers that show them in a favourable light, *for example, if the Likert scale measured discrimination, few people would admit to being racist*)
- 5-point scale cannot measure all opinions (this is offset by the option to provide an open comment)
- Proclivity towards neutral opinion or evaluation (makes the analysis of the responses more difficult)
- Inclination to agree with the provided statements (acquiescence bias)

Source: Joshi et al., 2015

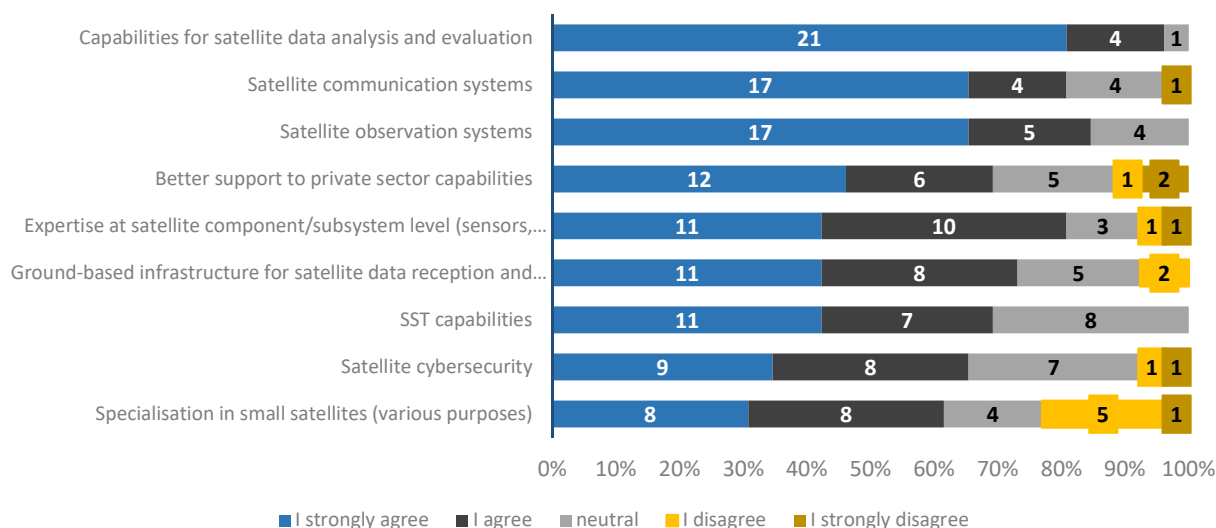
¹⁰⁰ Joshi, A. et al., "Likert Scale: Explored and Explained," 2015, pp.396 – 403, doi: 10.9734/BJAST/2015/14975

5.1 Space technology for security and defence in Slovakia

Capabilities for analysing and evaluating satellite data were considered as the most perspective for practical application in the defence of Slovakia (Chart 7.) According to the experts, it would be best to develop these capabilities as stand-alone, either within the state sector or in cooperation with the private sector. However, the conclusion of the experts may have been affected by their lack of awareness of the classified capacities of the Ministry of Defence. Capabilities for satellite image analysis are already partially handled by the Military Intelligence.

Small satellite specialization received the lowest score. At the moment, Slovakia should avoid setting up large projects on its own due to its limited experience with the application of space technology for defence as it would not be effective. In general, nanosatellites and small satellites are the domain of the private sector but as they are a dual-use technology, there is an untapped potential for their application in defence as well. These systems have broad applications, for example in encrypted communication.

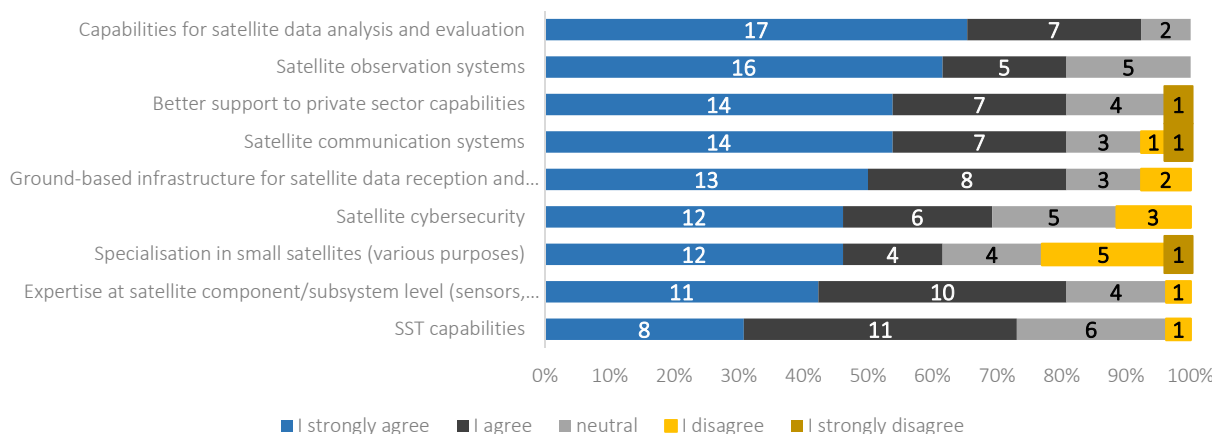
Chart 7: Areas of interest that the Ministry of Defence should pursue in the next 5 to 10 years according to their potential application for the security and defence of the Slovak Republic



Source: survey by the Analytical Unit

The survey question on the possible involvement of the Slovak Ministry of Defence in space activities from the point of view of exploiting the potential of the Slovak space and related industries also suggested similar conclusions (Chart 8). The fact that the SST capabilities occupy the very last place in the evaluation is curious, as the Ministry of Defence is responsible for the area of SSA/SST capabilities according to the *Conceptual Framework of Space Activities in the Slovak Republic for 2020+* and at the same time Slovakia has the necessary technical capabilities for this segment within its academic sphere. However, experts consider the industrial applications of this area to be limited.

Chart 8: Areas of interest that the Ministry of Defence should pursue in the next 5 to 10 years to take advantage of the existing Slovak space (upstream/downstream segment) and related (IT, computing etc.) industry.

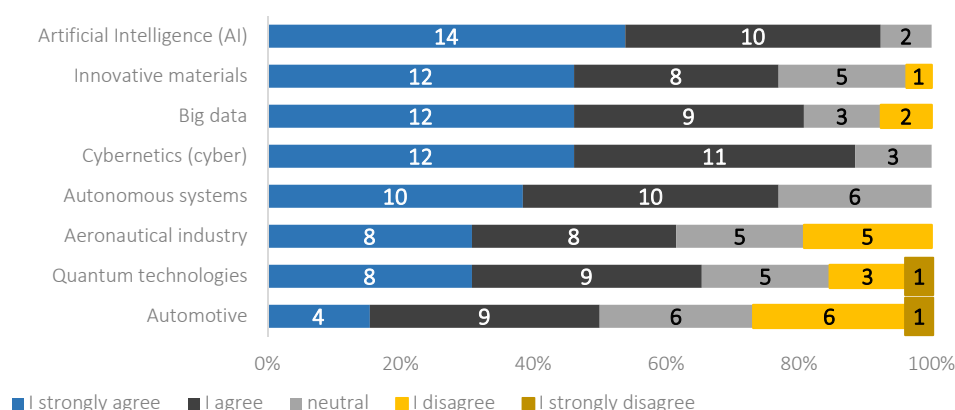


Source: survey by the Analytical Unit

5.2 Private sector and the space activities

According to the experts, artificial intelligence, cybernetics, big data processing and innovative materials are the areas with the greatest potential for the involvement of Slovakia in the ESA, EU and NATO space activities. In general, the respondents appealed for a greater support towards the private sector capabilities and a proactive approach of the Ministry of Defence in helping increase the TRL of the Slovak companies, which could boost their success rate when applying for grants with the ESA or the EU in the area of space and in the end lead to the development of dual-use products in Slovakia.

Chart 9: Areas of the Slovak industry that have the greatest potential for the involvement of Slovakia in the space activities of ESA, EU and NATO, excluding companies that are directly involved with space



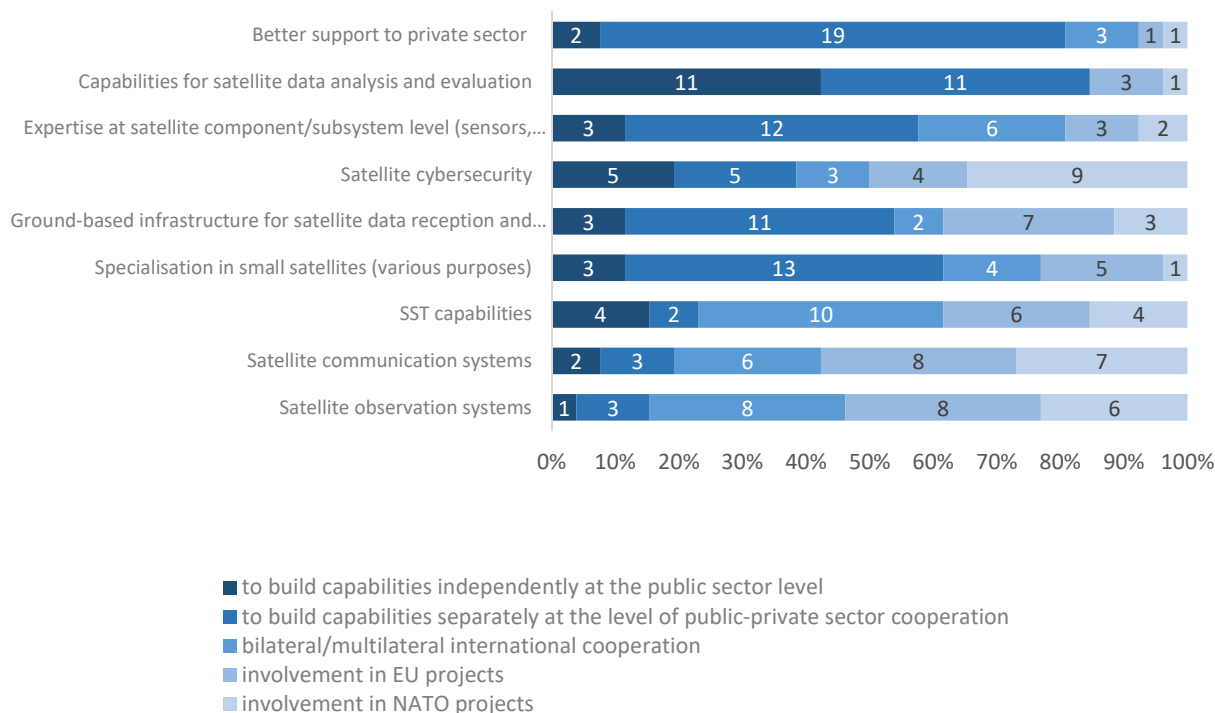
Source: survey by the Analytical Unit

5.3 Slovak involvement within the space-defence nexus

Satellite communication and surveillance systems, SST capabilities, or cybersecurity of satellites should be pursued by the active involvement of the Ministry of Defence in the activities of EU and NATO. These areas require significant investments into research and development as well as

procurement and deployment of space assets such as satellites or ground support systems. Smaller countries with limited budgets and resources may utilise bilateral or multilateral cooperation as an alternative. **The only capability that the expert survey recommended to be developed individually is satellite data analysis and evaluation.**

Chart 10: Optimal modality of the Slovak involvement in the area of space and defence after considering the existing security needs and resources of Slovakia



Source: survey by the Analytical Unit

5.4 Space activities and specific Slovak defence interests

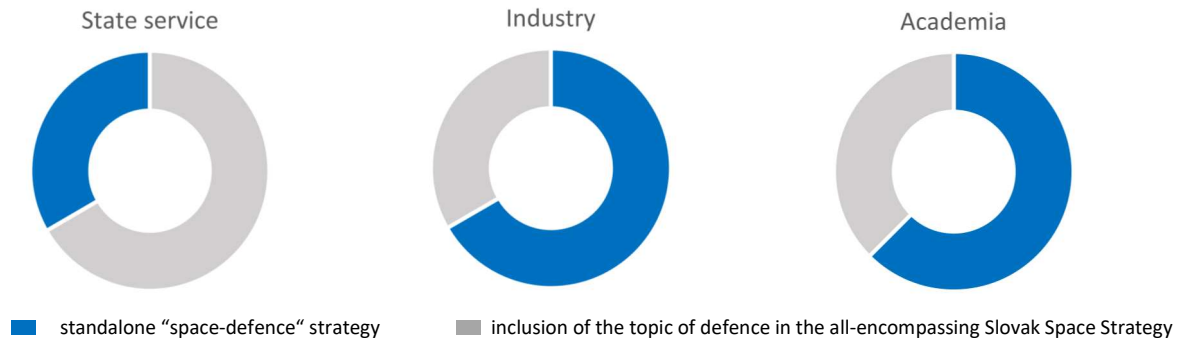
50% of the respondents of an expert survey identified satellite imaging of the Slovak eastern border as a specific defence issue that could be positively influenced by the use of space technology. In an open-ended question (no options offered), more than 20% of the respondents identified accession to the EU SST Partnership as important. Other areas that were mentioned:

- Development of domestic capacities in the ground segment and data processing
- Monitoring of the frequency spectrum related to satellite communication
- Strategic placement of a satellite ground station that can utilize the advantageous position of Slovakia as a communication node on the eastern border of NATO
- Monitoring of climate change aspects that can cause massive migration (wildfires, floods)
- Take-off stations for autonomous air and orbital drones

5.5 Space-Defence Strategy of the Slovak Republic and others

The expert opinions were divided on the question of developing a standalone strategy for the area of space and defence. The representatives of academia and industry were inclined towards a creation of a standalone document. On the other hand, the representatives within the state service recommended the inclusion of the topic as a chapter in the all-encompassing *Slovak Space Strategy* that is being prepared, which would prevent the creation of duplicate documents.

Chart 11: Creation of a specific space strategy for the area of defence vs. inclusion of the space and defence topic in the *Strategy for the space activities of the Slovak Republic* (divided according to the respondent's profession)



Source: survey by the Analytical Unit

According to the survey, the accelerated development of the space and defence topics in Slovakia could be assisted by a more proactive approach of the Ministry of Defence, for example with a creation of a specialised department for the coordination of space activities and preparation of projects. The same applies for the public communication on the relevance of the topic for the security interests of Slovakia and for consultation and information support to the academia and industry.

The experts agree that Slovakia should start planning new projects to be presented within the EU and NATO with the goal of transitioning from a passive observer to an active participant. The participation of Slovakia in the activities of EU, ESA and NATO needs to be broader and more proactive. New project proposals should especially take advantage of the geographical position of the country.

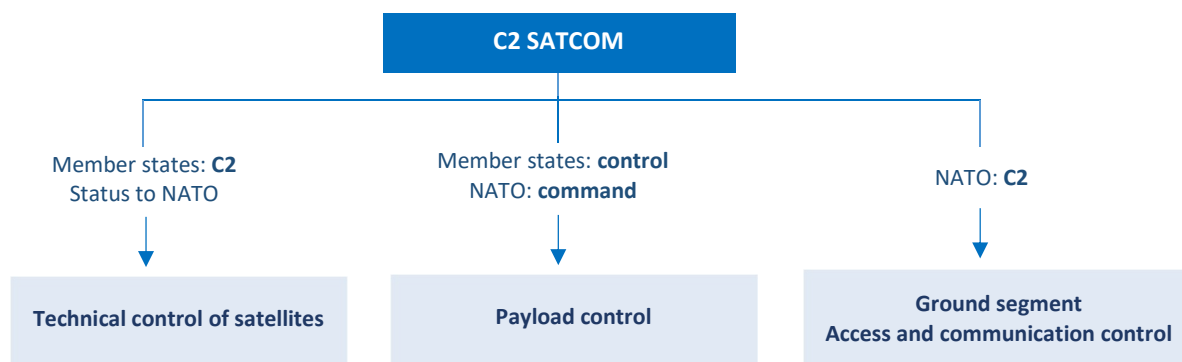
The attention should be focused on the creation of synergies between the state sector and technology companies in areas that can enhance the competitive advantage of Slovakia by utilizing space technologies, determined in advance. The Ministry of Defence should support the development of defence research and defence industry capacities in line with the Law no. 172/2005 on the organization of the state support for research and development and at the same time cooperate with the other ministries (especially the Ministry of Education) on the creation of mechanisms to attract brains and talents.

6. Opportunities for the Slovak MoD

6.1. NATO activities

Since 2010 NATO neither owns nor directly operates any assets in the Earth orbit. It relies on national (or commercial) capabilities provided by the member states. The cooperation between NATO and its member states is structured through a Memorandum of Understanding supported by a Service Level Agreement¹⁰¹. Alliance relies on member states to provide space assets, data or products on voluntary basis and in accordance with the national laws, regulations and policies. NATO Owns and operates ground segments (e.g. anchor stations or terminals that receive SATCOM information)¹⁰².

Chart 12: Cooperation between NATO and its member states regarding SATCOM system control (according to the Service Level Agreement)



Source: ESPI, 2020: 24

An active participation in the NATO STO framework of Cooperative Demonstration of Technology (CDT) should be Slovakia's main intention. Moreover, membership in NATO obliges Slovakia to support NATO STO activities. Slovakia, as a new member state, is currently participating in so called Support program which provides assistance or financial support for the participation of Slovak representatives. These representatives are delegated by The General M. R. Štefánik Armed Forces Academy (AOS) on the basis of approval of the National Director for Science and Technology. Cooperative Demonstration of Technology, considered to be the most noteworthy activity, provides a platform where the disruptive technologies and possible utilization of civil technology for military are presented¹⁰³.

6.1.1 Defence Innovation Accelerator for the North Atlantic (DIANA) and NATO Innovation Fund (NIF)

DIANA and NIF are designed to elevate early-stage start-ups or small and medium-sized enterprises with minimal experience in defence and security. SVK MoD delegates can present their needs and requirements at the Board meetings and thus influence the topics of the Accelerator's programme calls. The mentioned initiatives have significant impact on SVK MoD and Slovak space segment, as they support the industry mainly through newly establish test centres in Slovakia.

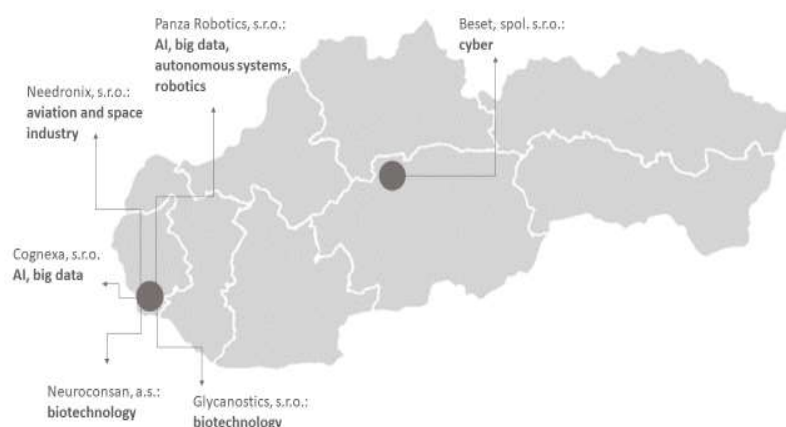
¹⁰¹ "Europe, Space and Defence: From "Space for Defence" to "Defence of Space," ESPI, February 2020, pp.23 – 25, <https://www.espi.or.at/wp-content/uploads/2022/06/ESPI-Public-Report-72-Europe-Space-and-Defence-Full-Report.pdf>

¹⁰² "Europe, Space and Defence: From "Space for Defence" to "Defence of Space," ESPI, February 2020, pp.23 – 25, <https://www.espi.or.at/wp-content/uploads/2022/06/ESPI-Public-Report-72-Europe-Space-and-Defence-Full-Report.pdf>

¹⁰³ "Konceptcia zamerania a podpory výskumu vývoja v oblasti obrany s výhľadom do roku 2025," SVK MoD, March 2021, s.10, https://www.mosr.sk/data/files/4357_koncepcia-zamerania-a-podpory-vyskumu-a-vyvoja-v-oblasti-obrany-s-vyhľadom-do-roku-2025.pdf

DIANA could potentially speed up the adoption process of dual-use disruptive technologies (including space technologies) in defence sector and help promote education in security-related topics¹⁰⁴. DIANA will be supported by NIF through EUR 1 billion venture capital fund with a 15-year timeframe. With a long-term view, the NIF enables disruptive technologies with the potential to shape our security for decades to come¹⁰⁵.

Chart 13: List of DIANA test centres* in Slovakia



* The list of companies is expected to be expanded in the future by the company focusing on AI, big data

Source: own elaboration

Financial support for DIANA projects is comprised of member states contributions. SVK MoD plans to increase its contribution in the future fiscal years.¹⁰⁶ DIANA aims to establish a technology and innovation ecosystem by means of connecting end-users (e.g. Armed Forces), scientists, and system integrators with the best performing start-ups to advance compelling deep tech with dual-use solutions for the Alliance **DIANA and NIF funding is also part of the defence planning for 2024 – 2026**¹⁰⁷.

Box 5: Space technology focused entities within DIANA

Accelerators

1. **Belgium:** WSL Wallonia & Brussels
2. **Czech Republic:** CzechInvest Praha - (focus: artificial intelligence, space and green technologies)
3. **Estonia:** Tallinn Science Park Tehnopol Startup Wise Guys / Tartu Science Park - (focus: artificial intelligence, cyber, space and green technologies)
4. **Italy:** OGR / Plug and Play Turin

Test centres

1. **Estonia** (Tartu and Tallin): Tartu University and Tallinn University of Technology (UNI)
2. **France**
3. **Greece** (Athens): National Centre for Scientific Research Demokritos (NCSR) – Giga Test Centre
4. **Greece** (Heraklion): Institutes of Computer Science, Electronic Structure and Laser, Molecular Biology and Biotechnology y - ICS, IESL, IMBB, IACM
5. **Lithuania:** (Kaunas): Kaunas Science and Technology Park
6. **Germany:** Resilient Space Test Centre Network (RESTEC)
7. **Slovakia** (Bratislava): Needronix, s.r.o.
8. **Italy**
9. **Turkey** (Ankara and other): Tübitak Sage
10. **Turkey** (Ankara and other): Tübitak Bilgem

*data valid as of March 2023

Source: DIANA, 2023 & communication with OdPlaFP SVK MoD

¹⁰⁴ "Severoatlantický akcelérátor pre obranné inovácie – DIANA," SVK MoD, (n.d.), <https://www.mosr.sk/severoatlanticky-akcelerator-pre-obranne-inovacie-diana/>

¹⁰⁵ "NATO launches Innovation Fund," NATO, 30 June 2022, https://www.nato.int/cps/en/natohq/news_197494.htm

¹⁰⁶ Investment Planning and Project Funding Department of SVK MoD, e-mail communication, 24 March 2023

¹⁰⁷ Investment Planning and Project Funding Department of SVK MoD, e-mail communication, 24 March 2023

6.2 EU activities

The EU Space Programme consists of several flagship dual-use components: Galileo, Copernicus, EGNOS, GOVSATCOM, EU SST and IRIS². The EU Space Programme (*2021¹⁰⁸) brings together all existing and new EU activities and initiatives in the field of space policy and at the same time covers the activities of the European Union Space Programme Agency (EUSPA)¹⁰⁹.

The relevance of synergies between the civil, defence and space industries is particularly emphasized within the framework of the Union's space policy. Despite the fact that the technologies are owned and managed by civil institutions, their use for the purpose of security and defence has been considered since the beginning of their operation¹¹⁰. In particular, domains such as intelligence, surveillance and reconnaissance, satellite communication or space situational awareness fit this definition.

The SVK MoD has defined priority programs at the EU level in the document: *Concept for Focusing and Supporting Defence Research and Development with an Outlook to 2025*. Included are projects and calls of the European Defence Agency (EDA), European Defence Fund (EDF) and Permanent Structured Cooperation (PESCO)¹¹¹. At the EU level, there are other support instruments for the space domain that complement the mentioned priority areas. The most relevant ones are listed in Annex 5.

6.2.1 Permanent Structured Cooperation (PESCO)

Out of 60 active PESCO projects, five are related to space technologies. Slovakia is not a member, nor an observer on any of them¹¹². „National Implementation Plan“ is prepared annually by the SVK MoD. According to the current plan, Slovakia is a coordinator on one project¹¹³, a member on another five projects and an observer on four PESCO projects¹¹⁴ (February 2023).

Considering the military requirements of the SAF (p. 14) and the results of the expert survey (Chapter 5), we recommend the involvement of the SVK MoD in the PESCO CoHGI project as an observer. Slovakia has the possibility to join PESCO projects as a member or an observer. Observers shall have no obligation to contribute to a project with their own resources and expertise, however, at the same time, they do not participate in the decision-making process within the project¹¹⁵. Participating in the project as an observer provides benefits such as gaining experience and know-how in a certain area and also declaring an active interest in the development of the particular domain. The project members may agree among themselves upon specific arrangements on the status of observer, reflecting the particularities of the project and its different stages of development. Additionally,

¹⁰⁸ “ Regulation (EU) 2021/696 of the European Parliament and of the Council ,” European Parliament, 2021, <https://eur-lex.europa.eu/legal-content/SK/TXT/?uri=CELEX:32021R0696>

¹⁰⁹ “The EU Space Programme,” EUSPA, 21 November 2022, <https://www.euspa.europa.eu/european-space/eu-space-programme>

¹¹⁰ “Europe, Space and Defence: From “Space for Defence” to “Defence of Space,” ESPI, February 2020, pp.34 – 39, <https://www.espi.or.at/wp-content/uploads/2022/06/ESPI-Public-Report-72-Europe-Space-and-Defence-Full-Report.pdf>

¹¹¹ “Konceptcia zamerania a podpory výskumu a vývoja v oblasti obrany s výhľadom do roku 2025,” SVK MoD, March 2021, pp.10 - 14, https://www.mosr.sk/data/files/4357_konceptcia-zamerania-a-podpory-vyskumu-a-vyvoja-v-oblasti-obrany-s-vyhľadom-do-roku-2025.pdf

¹¹² “The Strategic Compass and EU space-based defence capabilities,” Fiott, D., November 2022, [https://www.europarl.europa.eu/RegData/etudes/IDAN/2022/702569/EXPO_IDA\(2022\)702569_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/IDAN/2022/702569/EXPO_IDA(2022)702569_EN.pdf)

¹¹³ *The project ended in 2022. The project will be formally terminated during 2023.* (“Národný plán vykonávania účasti Slovenskej republiky v Stálej štruktúrovanej spolupráci Európskej únie 2023”, SVK MoD, February 2023, p.4, <https://rokovania.gov.sk/RVL/Material/28073/1>)

¹¹⁴ “Národný plán vykonávania účasti Slovenskej republiky v Stálej štruktúrovanej spolupráci Európskej únie 2023,” SVK MoD, February 2023, p.4, <https://rokovania.gov.sk/RVL/Material/28073/1>

¹¹⁵ Permanent Representation of the Slovak Republic to the EU in Brussels, email communication, 10 March 2023

project members may agree among themselves to allow other participating Member States to become observers on the project, as it is stated in *Council Decision (CFSP) 2018/909*¹¹⁶.

Box 6: Space-defence nexus PESCO projects (in 2023)

CoHGI (Common Hub for Governmental Imagery)

- the objective is to establish a common hub to facilitate the exchange of classified governmental imagery at European level between MS

DOSA (Defence of Space Assets)

- the objective is to increase the EU's operational efficiency in the space domain by making the best use of current and future space assets

EU-SSA-N (European Military Space Surveillance Awareness Network)

- the main objective is to develop an autonomous, sovereign EU military SSA capability that is interoperable, integrated and harmonized with the EU-SST Framework initiative

EURAS (EU Radio Navigation Solution)

- the project is to promote development of EU military PNT (positioning, navigation and timing) capabilities and future cooperation taking advantage of Galileo and the public regulated service

TWISTER (Timely Warning and Interception with Space-Based Theater Surveillance)

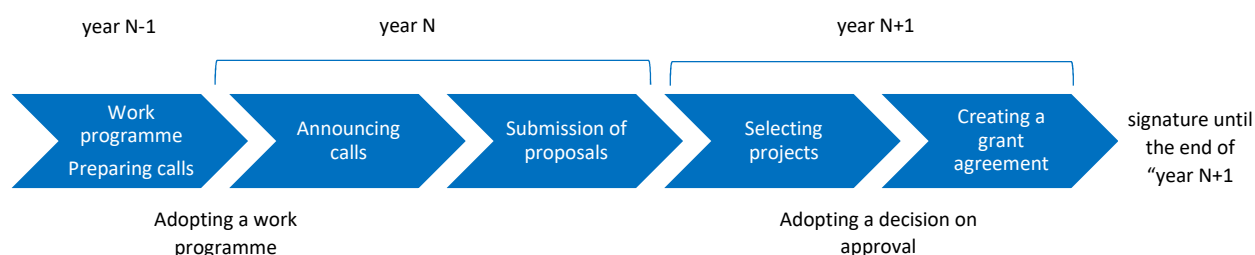
- the project aims at strengthening the ability of Europeans to better detect, track and counter threats through a combination of enhanced capabilities for space-based early warning and endo atmospheric interceptors

Source: *Permanent Structured Cooperation (PESCO)*, (n.d.)

6.2.2 European Defence Fund (EDF)

The European Defense Fund plans to allocate a total of approximately EUR 8 billion to successful projects, during the period 2021-2027. Space domain is also part of the program's calls, for which EUR 125 million will be allocated in 2023. Calls for Proposals are divided into research area „*Threat surveillance and protection of space-based assets*“ and development area „*Initial operational capacity for Space situational awareness C2 and sensors*“¹¹⁷. The calls will be open from 15 June to 22 November 2023. Legal entities based in the EU from several member states may apply for grants from the fund, with the requirement that minimum of three entities from three different member states must participate¹¹⁸.

Chart 14: Life cycle of EDF



Source: *European Commission*, 2022

¹¹⁶ "Council Decision (CFSP) 2018/909," Council of the European Union, 25 June 2018, p. L 161/39, <https://eur-lex.europa.eu/eli/dec/2018/909/oj>

¹¹⁷ "EDF Calls for Proposal", European Commission, 30 March 2023, s. 1, https://defence-industry-space.ec.europa.eu/european-defence-fund-eu12-billion-boost-eu-defence-capabilities-and-new-measures-defence-innovation-2023-03-30_en

¹¹⁸ "Regulation (EU) 2021/697 of the European Parliament and of the Council," European Parliament, 12 May 2021, para. 13, <https://eur-lex.europa.eu/legal-content/SK/TXT/?uri=CELEX:32021R0697>

A total of 60 projects were successful in the 2021 call, 8 of which were partially devoted to the field of space technologies¹¹⁹. Slovakia is not a consortium member in any of them. Approximately EUR 167.4 million was allocated for projects related to the space domain¹²⁰. The results of the 2022 calls will be announced in Q2 2023¹²¹.

In the call of the European Defence Industrial Development Program (which preceded the European Defence Fund) from 2020, Slovakia participated in a joint project to avoid space debris and prevent collisions in orbit.¹²² The SVK MoD formally supported the project through a Letter of Intent, although the proposal was not among the successful projects that received a grant¹²³.

6.2.3 European Defence Agency (EDA)

Searching for common areas of cooperation through Capability Technology (CapTech) groups is one of the possibilities of strengthening mutual cooperation between states within the EDA. In total there are currently 14 CapTechs, some of which also extend into space domain and one (ad hoc) working group dedicated exclusively to the nexus space-defence¹²⁴.

Slovakia is currently a passive observer in CapTech groups with space overlap within EDA. More active participation of experts in CapTech groups (governmental but also non-governmental experts, academia, and private sector) should be encouraged. In addition to the CapTech National Coordinator, non-Governmental Experts who are appointed from Industry, Small and Medium-Sized Enterprises, Research Organisations, scientific institutes and academia can also become members¹²⁵. CapTech non-Governmental Experts membership is subject to the approval of the CapTech National Coordinator at the SVK MoD¹²⁶. The non-Governmental Experts may propose R&T ad-hoc projects and studies (bottom-up approach, technology push) and respond to existing requirements (top-down approach, capability pull). The non-Governmental Experts participate in regular meetings, usually three times a year¹²⁷.

R&D collaborative projects and initiatives within the EDA framework can be divided into two categories: Category A programmes and Category B projects. Slovakia is a member of three Category B projects¹²⁸, none of which deals with space technologies. Category A (opt out) ad hoc projects or

¹¹⁹ "The Strategic Compass and EU space-based defence capabilities," Fiott, D., November 2022, p. 22, [https://www.europarl.europa.eu/RegData/etudes/IDAN/2022/702569/EXPO_IDA\(2022\)702569_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/IDAN/2022/702569/EXPO_IDA(2022)702569_EN.pdf)

¹²⁰ *These are projects announced directly in the field of "space" and projects that were part of the open call for SMEs - Innovative and future-oriented defense solutions.*

¹²¹ "European Defence Industry submits 134 joint defence R&D proposals under the European Defence Fund 2022 calls for proposals," European Commission, 1 December 2022, https://defence-industry-space.ec.europa.eu/european-defence-industry-submits-134-joint-defence-rd-proposals-under-european-defence-fund-2022-2022-12-01_en

¹²² *The consortium of countries NL, FI, PL, DE, AT, IT and ES was completed by Slovakia through Comenius University, Faculty of Mathematics, Physics and Informatics (UK FMFI).*

¹²³ Communication with SMOD SVK MoD, 2023

¹²⁴ "Capability Technology Areas, (CAPTECHS)," EDA, (n.d.), [https://eda.europa.eu/what-we-do/research-technology/capability-technology-areas-\(captechs\)](https://eda.europa.eu/what-we-do/research-technology/capability-technology-areas-(captechs))

¹²⁵ "Konceptcia zamerania a podpory výskumu a vývoja v oblasti obrany s výhľadom do roku 2025," SVK MoD, March 2021, pp.11 - 14, https://www.mosr.sk/data/files/4357_koncepcia-zamerania-a-podpory-vyskumu-a-vyvoja-v-oblasti-obrany-s-vyhľadom-do-roku-2025.pdf

¹²⁶ "Capability Technology Areas, (CAPTECHS)," EDA, (n.d.), [https://eda.europa.eu/what-we-do/research-technology/capability-technology-areas-\(captechs\)](https://eda.europa.eu/what-we-do/research-technology/capability-technology-areas-(captechs))

¹²⁷ "Capability Technology Areas, (CAPTECHS)," EDA, (n.d.), [https://eda.europa.eu/what-we-do/research-technology/capability-technology-areas-\(captechs\)](https://eda.europa.eu/what-we-do/research-technology/capability-technology-areas-(captechs))

¹²⁸ *Category B projects which Slovakia currently participates in: 1. Cooperation in the use of C27J Spartan aircraft; 2. Optimised solutions for corrosion repair and prediction with an efficient network of environmental sensors – SCORPENES (The costs of the Slovak Republic for the SCORPENES project amount to EUR 50,000 and are distributed over a period of 4 years); 3. Joint procurement of ammunition. ("Národný plán vykonávania účasti Slovenskej republiky v Stálej štruktúrovanej spolupráci Európskej únie 2023", SVK MoD, February 2023, p.4, <https://rokovania.gov.sk/RVL/Material/28073/1>)*

programmes assume general participation and contributions from all participating Member States (the option not to participate was imposed by the Council Decision (CFSP) 2015/1835). Category B (opt in) ad hoc projects or programmes are initiated by Member States, while any participating Member State may express a wish to join¹²⁹.

6.3 Proposals for involvement of the Slovak MoD in space activities

With regard to the defined ambition in the Long-Term Plan 2035 of the Ministry of Defence of the Slovak Republic, with an emphasis on the results of the expert survey, with regard to the recommendations of the representatives of Slovakia at the Permanent Representation to the EU in Brussels, taking into account the military requirements articulated by the Armed Forces of the Slovak Republic and the existing industrial potential in Slovakia, the initiatives relevant to the Ministry of Defence relate mainly to areas:

1. Space situational awareness

- joining the EU SST Partnership

2. Satellite imagery and subsequent sharing of images through a digital platform

- joining the PESCO project (CoHGI)
- eastern border satellite imaging carried out on the basis of bilateral cooperation

The document, named *The intention of the Slovak Ministry of Defence in participating in NATO and EU projects and initiatives related to the development of capabilities (Intention of the SVK MoD)*, defines the procedure to be followed when engaging in international initiatives and projects¹³⁰. At the same time, it is necessary to take into account and apply the criteria for assessing the benefit of involvement in the project/initiative, according to the *Template for Assessing the Contributions of NATO and EU Projects and Initiatives*, which this study also considers.

Box 7: Mechanism of Slovakia's involvement in NATO and EU capability projects and initiatives

A bottom-up proposal (the relevant organizational unit of the SVK MoD will express interest in participating in the project/initiative) to join an EU or NATO project/initiative must include the following:

1. the main reason for joining the project/initiative,
2. compliance with the defence priorities of the SVK MoD defined in the long-term and medium-term strategic documents,
3. evaluation of the benefit of involvement based on established criteria (according to section 2.2.),
4. comprehensive technical (operational dimension and capability development dimension) and cost-benefit analysis of involvement in the project/initiative; the analysis must include all foreseeable political, political-military, and resource implications (personnel, material, financial),
5. time horizon of involvement in the project/initiative,
6. definition of the method of measuring the success of involvement in the project/initiative (measurability),
7. the possibility of accessing funds from sources (bilateral or international financial mechanisms) outside the state budget (e.g. American funds, EDF, NSIP),
8. the statement of state administration authorities, if a new initiative or project is in their interest
9. the statement of all relevant organizational units of the Ministry of the SVK MoD

Source: *Intention of the SVK MoD, 2021*

¹²⁹ "Council Decision (CFSP) 2015/1835," Council of the European Union, 13. October 2015, <https://eur-lex.europa.eu/legal-content/SK/TXT/PDF/?uri=CELEX:32015D1835&from=SK>

¹³⁰ "Zámer rezortu MO SR pri zapájaní sa do projektov a iniciatív NATO a EÚ v oblasti spôsobilostí," Intention of the SVK MoD, February 2021

6.3.1 The EU SST Partnership

The EU SST Partnership aims to offer publicly available SST services (space surveillance and monitoring). The EU SST Partnership was established on 31 August 2022 based on the approval of the European Commission. It will start providing services on 1 July 2023¹³¹.

The number of debris objects is steadily increasing¹³², resulting in a greater degree of threat to space technologies due to a possible collision. There are currently approximately 46,500 bodies larger than 10 cm listed in the public catalogue of artificial objects¹³³ (there were approximately 34,000 of them in 2020¹³⁴) - mostly in LEO orbits¹³⁵. Even particles larger than 5 cm can significantly damage satellites or the ISS or re-enter the atmosphere and cause damage on Earth¹³⁶.

Table 8: Contribution Assessment of involvement in the EU SST Partnership (according to *Template for Assessing the Contributions of NATO and EU Projects and Initiatives*)

Project/ Initiative	SK title	Rámec na podporu dohľadu nad kozmickým priestorom a sledovania tohto priestoru					
	EN title (acronym and the full name)	EU Space Surveillance and Tracking (EU SST)					
	numeric code						
The main purpose of the project/initiative		The SST services assess the risk of in-orbit collisions and uncontrolled re-entry of space debris into the Earth's atmosphere, and detect and characterise in-orbit fragmentations ¹³⁷					
Umbrella organisation/Initiator		EUSPA					
Involvement of countries	lead nation (LN)						
	participating nations	FR,DE, IT, PL, PT, RO, ES, AT, CZ,DK, FI, GR, LV, NL, SE					
	observers						
Form of participation of SR (x)		member		observer		none	
Date of accession	Founding document	2026 ¹³⁸					
Project status		active			non-active		
Project coordinator – organisational unit							
POC and phone number							
2.4 a) Form of participation of the relevant organizational unit in the project / initiative (brief overview of activities)		The level of participation and involvement in a given project depends on the specific agreement between Member States and the ownership of the type of capabilities required: 1. Ownership of, or access to, an adequate SST sensor available for the SST sub-component and human resources to operate it (radars, telescopes, lasers) 2. Ownership of, or access to, an adequate operational analysis capability and data processing capability specifically designed for SST purposes and available for SST (this mainly					

¹³¹ Section of Modernisation (SVK MoD), e-mail communication, 23 March 2023

¹³² Space debris consists of man-made objects that are located in the near vicinity of the Earth and no longer serve any purpose. Their dimensions range from micrometers to several meters. ("Kozmický odpad," UNIBA, (n.d.), <https://fmph.uniba.sk/microsites/daa/daa/veda-a-vyskum/kozicky-odpad/>)

¹³³ "Space-Track", (n.d.), <https://www.space-track.org/auth/login>

¹³⁴ "Kozmický odpad," UNIBA, (n.d.), <https://fmph.uniba.sk/microsites/daa/daa/veda-a-vyskum/kozicky-odpad/>

¹³⁵ "Kozmický odpad," UNIBA, (n.d.), <https://fmph.uniba.sk/microsites/daa/daa/veda-a-vyskum/kozicky-odpad/>

¹³⁶ "Astronóm Šilha sleduje vesmírny odpad: Na obežnej dráhe vytvárame novú skládku," Zelná, R., 27 September 2022, <https://tech.sme.sk/c/23018935/silna-stranka-slovakov-vo-vesmirnom-vyskume-astronom-silha-hovori-co-vieme-ponuknut-esa.html>

¹³⁷ "What is EU SST?," EU SST, (n.d.), <https://www.eusst.eu/>

¹³⁸ Section of Modernisation (SVK MoD), e-mail communication, 23 March 2023

		concerns the provision of three SST services – collision avoidance, re-entry analysis and fragmentation analysis) ¹³⁹
		yes (in what way) / no
2.4 b) Benefits assessment according to the section 2.2:	a) fulfilment of the political and military ambitions of the Slovak Republic	YES <i>...effectively guarantee the defence of the Slovak Republic with all available and mobilized forces and assets using the help of other NATO member states or other EU member states¹⁴⁰... is one of the most important political-military ambitions</i> • EU SST assesses the risk of in-orbit collisions and uncontrolled re-entry of space debris into the Earth's atmosphere and detect and characterize in-orbit fragmentations¹⁴¹. ○ Slovakia's active participation could help develop the capabilities of intelligence services, state administration bodies and the space segment to ensure real time analysis of threats
	b) development of the required capabilities defined in the long-term and medium-term strategic documents of the Slovak Republic	YES • The aim of the EU SST Partnership is to create a comprehensive structure of space situational awareness at the EU level ○ The project consists of three main areas: sensors, data processing and service provision. The sensors of the Member States contribute to the acquisition of data, which are analysed and processed into a mutual database. This information would be then accessible to member states, ○ fulfilling the ambition of developing capabilities through cooperation with NATO/EU member states¹⁴²
	c) fulfilment of capability goals for Slovakia (emphasis on mechanized brigade), compliance with NATO standards	PARTIALLY YES The project includes activities that SK participates in: ○ reconnaissance and tracking fully correlate with the issues of JISR
	d) fulfilment of CDP and obligations under the PESCO program	YES • EU CDP : the project directly strengthens the capabilities of the EU " <i>Space-based information and communication services</i> ", and in particular the "<i>Space Situational Awareness (SSA)</i>" by reducing the threat from space debris for technologies in orbit¹⁴³ • The project directly addresses the domain "Defence in space"¹⁴⁴ defined in the CARD report
	e) foreign policy context - perception of the Slovak Republic as a reliable ally and trustworthy partners in regards to fulfilment of international obligations	YES • Cooperative protection of European space assets and infrastructure, achieving a higher level of Europe's strategic autonomy in the SSA domain, and thus contributing to global burden sharing with key partners

¹³⁹ " Commission Implementing Decision (EU) 2022/1245 " European Commission. 15 July 2022, <https://eur-lex.europa.eu/legal-content/SK/TXT/PDF/?uri=CELEX:32022D1245&from=EN>

¹⁴⁰ "Obranná Stratégia SR," SVK MoD, 2021, s.17, https://www.mosr.sk/data/files/4286_obranna-strategia-sr-2021.pdf

¹⁴¹ "EU Space Surveillance and Tracking Service Portfolio," EU SST, 2021, <https://www.eusst.eu/services/>

¹⁴² "EU Space Surveillance and Tracking Service Portfolio," EU SST, 2021, <https://www.eusst.eu/services/>

¹⁴³ "The EU Capability Development Priorities," EDA, 2018, p.9, <https://eda.europa.eu/docs/default-source/eda-publications/eda-brochure-cdp>

¹⁴⁴ "2022 Coordinated Annual Review on Defence Report," EDA, 2022, p.10, <https://eda.europa.eu/docs/default-source/eda-publications/2022-card-report.pdf>

	f) economic context - development of national industrial and scientific research institutions using the possibility of financing projects from other sources as well (e.g. EDF, NSIP)	YES • Slovakia's strengths are precisely the areas of space security, space debris and space weather, while the focus is mainly on prevention ○ industry: <i>Space scAvengers, Astros Solutions</i> ○ academia: <i>Faculty of Mathematics, Physics and Informatics, Comenius University</i> ¹⁴⁵ • financial support from EDF could be considered • EU funding for the modernisation and operation of assets
	g) coherence and synergy among initiatives and avoiding duplication	YES Coherence with NATO • project correlates with JISR • activities could be linked to the planned NATO 3SAS project¹⁴⁶ Coherence with other activities • EDA PT Early space situational awareness (SSA) • synergies with ongoing PESCO projects, such as DOSA and TWISTER • EDF calls for 2023 (<i>EDF-2023-RA-SPACE-PSA</i>: „Threat surveillance and protection of space-based assets“ and <i>EDF-2023-DA-SPACE-SSA</i>: „Initial operational capacity for Space situational awareness C2 and sensors“ ¹⁴⁷)

¹⁴⁵ „Astronóm Šilha sleduje vesmírny odpad: Na obežnej dráhe vytvárame novú skládku,“ Zelná, R., 27 September 2022, <https://tech.sme.sk/c/23018935/silna-stranka-slovakov-vo-vesmirnom-vyskume-astronom-silha-hovori-co-vieme-ponuknut-esa.html>

¹⁴⁶ *Space Situational Awareness System (3SAS) will allow the Alliance to better understand space objects and space events, and their effects across all domains. The project will support the NATO's Space Centre established in Germany in 2020.* (“NATO and Luxembourg boost Alliance Space Situational Awareness,” NATO, 14 June 2021, https://www.nato.int/cps/en/natohq/news_185365.htm)

¹⁴⁷ “Commission Implementing Decision (EU) 2023/2296,” European Commission. 29 March 2023, <https://defence-industry-space.ec.europa.eu>

Box 8: Intention of the SVK MoD's participation in the EU SST Partnership

1. The main reason for joining the project/initiative

One of the main reasons is the affiliation to the CSA (2019) and agenda adjacency. Space situational awareness, exploration and tracking is fully correlated with the JISR (Joint intelligence and surveillance), which is one of the priority areas in defence in recent years.

Participation brings the benefit of reinvesting the funds of these projects provided by the member states in the domestic economy. In addition, Slovakia provides technological capacities in the industrial and academic spheres (e.g. the Faculty of Mathematics, Physics and Informatics of the Comenius University of Bratislava¹⁴⁸, Astros Solutions, Space scAvengers and others). The focus is mainly on prevention (supplement observation and providing of services)¹⁴⁹.

The SVK MoD has accepted the role of a co-coordinator for the SSA domain (together with the Ministry of Education)¹⁵⁰. Currently, it is not possible to create these particular capabilities independently, therefore the participation in the EU SST Partnership is crucial for the SVK MoD.

2. Compliance with the defence priorities of the SVK MoD defined in the long-term and medium-term strategic documents

- mentioned in Table 8

3. Evaluation of the benefit of involvement based on established criteria (according to section 2.2)

- mentioned in Table 8

4. Comprehensive technical (operational dimension and capability development dimension) and cost-benefit analysis of involvement in the project/initiative; the analysis must include all foreseeable political, political-military, and resource implications (personnel, material, financial)

Operational dimension: N/A

Capability development dimension:

- the project should lead to the acquisition of capabilities for faster and more effective identification of risks and threats in/from space
- the involvement of several member states will ensure increasing interoperability of national capabilities
- more effective protection of EU space assets will be ensured

Cost-benefit analysis:

- it is not possible to perform the cost-benefit analysis in more detail at this stage, as accession criteria must be agreed upon first
 - assumed are minimum costs created on part of sensors operators tied to the observation intervals (time when the telescope is blocked and unavailable for different use) and capacities used to organize EU SST validation campaign
 - also assumed are costs resulting from the delegation of Slovak representative to EU SST meetings
- it is expected that Slovakia, as a potential member, must satisfy its individual requirements which include:
 - compliant SST sensor (radars, telescopes, lasers) ownership and human resources for its operation

¹⁴⁸ The main instrument currently used to observe space debris is a 70-cm AGO 70 telescope which was installed at the AGO Observatory in Modra in 2016.

¹⁴⁹ „Astronóm Šilha sleduje vesmírny odpad: Na obežnej dráhe vytvárame novú skládku,“ Zelná, R., 27 September 2022, <https://tech.sme.sk/c/23018935/silha-stranka-slovakov-vo-vesmirnom-vyskume-astronom-silha-hovori-co-vieme-ponuknut-esa.html>

¹⁵⁰ Ministry of Education of the Slovak Republic. “A conceptual framework of space activities in the Slovak Republic.” June 2019. <https://slovak.space/wp-content/uploads/2019/07/Koncepcia-FINAL-AJ.pdf>

- ownership of adequate SST operational analysis and data processing capability (Data processing capability shall be considered 'adequate' if it includes the necessary hardware and software solutions to process SST data and produce the relevant SST information and/or deliver SST services. Operational analysis capability should also contain trained analysts in order to generate SST information and deliver SST services¹⁵¹)
- the SVK MoD does not currently possess any type of adequate capability, for that reason it would be necessary to establish cooperation with industry and academia as they are developing these capabilities
- Slovakia owns several types of sensors from the category of optical telescopes, this category of sensors could be a part of the existing EU SST network
 - AGO70 has almost been connected; it generates the so-called Consultative Committee for Space Data Systems (CCSDS) Tracking Data Message (TDM) data format, (data format required by EU SST Partnership)
 - Astros sensors are being developed in a way that they can be connected to any partner, including EU SST
 - AMOS would eventually be able to connect to EU SST even though it is still a highly experimental system
- It could be beneficial to specify calls for national sub-programme *6EOI Research and development in support of national defence* as much as legally possible, reflecting on the SVK MoD's areas of interest in space the current period

Table 9: Sensors suitable for connection to EU SST

	AGO70 ¹⁵²	ASTROS SENSORS NETWORK ¹⁵³	AMOS SENSORS NETWORK ¹⁵⁴
OWNER/OPERATOR	Comenius University, Bratislava	Astros Solutions s.r.o.	Comenius University, Bratislava
COUNT	1	3	16
LOCATION	Slovakia: Modra (Astronomical and Geophysical Observatory, AGO)	Slovakia: Bratislava, Modra (AGO) + plan to expand to the Eastern Slovakia, South Africa and Kazakhstan (during 2023)	Slovakia: 5 Spain: 2 South Africa: 2 Australia: 3 Chile: 2 USA: 2
CATEGORY ¹⁵⁵	may be considered as category C ¹⁵⁶	C (sensors are under development)	may be considered as category C ¹⁵⁷

¹⁵¹“ Commission Implementing Decision (EU) 2022/1245 “ European Commission. 15 July 2022, <https://eur-lex.europa.eu/legal-content/SK/TXT/PDF/?uri=CELEX:32022D1245&from=EN>

¹⁵² “Space debris observations with the Slovak AGO70 telescope: Astrometry and light curves,” Šilha et al., 15 April 2020, <https://www.sciencedirect.com/science/article/pii/S0273117720300727>

¹⁵³ “Dedicated to Space Safety and Long-Term Sustainability“ ASTROS Solutions, (n.d.), <http://www.astros.eu/>

¹⁵⁴ “AMOS video meteor network,” UNIBA, (n.d.) <https://fmph.uniba.sk/en/microsites/daa/division-of-astronomy-and-astrophysics/veda-a-vyskum/meteors/amos/amos-video-meteor-network>

¹⁵⁵ *Category C: sensors under development: Member States’ sensors that are suitable for non-operational purposes and that could be used in the future to provide SST services once they are completed, operational, and have passed the assessment phase. Sensors included in the category C do not receive funding for operational activities, but could receive funding for research and development activities based on the rationale provided in the architecture studies.* (“ Commission Implementing Decision (EU) 2022/1245 “ European Commission. 15 July 2022, <https://eur-lex.europa.eu/legal-content/SK/TXT/PDF/?uri=CELEX:32022D1245&from=EN>)

¹⁵⁶ The sensor was supposed to undergo the EUSST validation process in 2021, the sensor was also registered in the EUSST database for interface testing. The sensor was almost category B, but the validation process never took place and so it can be considered category C.

¹⁵⁷ The sensors are highly experimental, mainly suitable for atmospheric inputs. From a SST point of view, they can be considered as under development and can be considered as category C.

NOTES	• has been validated by the ESA • currently is providing data to ESA, domestic and foreign partners	• undergoing a validation process • currently is providing data to EU partners	• Comenius University together with the industry are exploring the possibilities of using AMOS cameras also for determining the position of space objects
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Source: Comenius University – an e-mail communication (11th of April 2023)

5. Time horizon of involvement in the project/initiative

- **2026: year of Slovakia's potential access to the project** (the process to join the EU SST Partnership will normally not materialise before the end of the current Grant – 2026: the new member will not be able to benefit from the current grant because the grant has been awarded taking into account the activities planned by the 15 Member States composing the current EU SST Partnership)

The process for a Member State to join the EU SST Partnership is the following ¹⁵⁸:

1. a procedure has to be adopted through an implementing act describing how further Member States can join the existing EU SST Partnership
2. the candidate Member State will need to go through the same evaluation as the current members of the EU SST Partnership (the compliance with the individual conditions)
3. a procedure needs to be launched at the level of the EU SST Partnership in order to modify the current Partnership agreement to include a new signatory

6. Definition of the method of the success measurement methodology (measurability)

- participating Member States shall develop the necessary mechanisms in order to establish and monitor the key performance indicators listed in Annex II of *Commission Implementing Decision (EU) 2022/1245*
- the SST Partnership shall report to the Commission every year during the Yearly Operational Review on the results of the key performance indicators

7. The possibility of accessing funds from sources (bilateral or international financial mechanisms) outside the state budget (e.g. American funds, EDF, NSIP),

- mentioned in Table 8

8. The statement of state administration authorities, if a new initiative or project is in their interest

- opinion of the Ministry of Education, Science, Research and Sport of the Slovak Republic that is a co-coordinator of the SSA project is necessary

¹⁵⁸ Section of Modernisation (SVK MoD), e-mail communication, 23 March 2023

6.3.2. CoHGI project

The project has potential to overcome obstacles in the IT connection of EU institutions, agencies and member states. At present, only 4 member states can share images belonging to governments, but they are still negotiating the possibility of sharing them with SatCen as well. According to Germany, there is currently no consensus of all EU Member States within the SatCen to establish this platform. Therefore, it approached like-minded states with the aim of creating a group of Member States that would build this capability through the PESCO project¹⁵⁹.

Slovakia should be interested in this project mainly due to the development of certain capabilities which are already operated to a certain extent by military intelligence. Military intelligence is the national authority of the BICES system (Battlefield Information Collection and Exploitation Systems) and operates SIGINT COINS (Communications and Information System)¹⁶⁰. A more detailed description of the activities of the Military Intelligence is not possible, as this is highly classified information which cannot be the subject of this analysis.

Table 10: Contribution Assessment of involvement in the CoHGI Project (according to *Template for Assessing the Contributions of NATO and EU Projects and Initiatives*)

Project/ Initiative	SK name	Spoločné centrum pre vládne snímky					
	EN name (acronym and the full name)	Common Hub for Governmental Imagery (CoHGI)					
	numeric code						
The main purpose of the project/initiative		The project aims to increase the provision of classified governmental imagery (IMINT products and geo-intell analysis) enabling the exchange of information for decision-making and contributing to the intelligence picture at political, strategic, operational and tactical levels.					
Umbrella organisation/Initiator		EU (PESCO)					
Involvement of countries	Lead nation (LN)	Germany					
	Participating nations	DE, AT, FR, LT, LU, NL, RO, ES					
	observers	BG, CZ, FI, HU, IT, PL, PT, SE					
Form of participation of SR (x)		member		observer			none
Date of accession	Founding document						
Project status		active			Non-active		
Project coordinator – organisational unit							
POC and phone number							
2.4 a) Form of participation of the relevant organizational unit in the project / initiative (brief overview of activities)		- participation of the Military Intelligence representative in the meetings and consultations of the group - the form of participation in a given project as an observer depends on the specific agreement between the potential observer and the project members - unlike regular members, observer countries can decide with more flexibility about the extent of their participation					
		yes (in what way) / no					
2.4 b) Benefits assessment according to the section 2.2:	a) fulfilment of the political and military ambitions of the Slovak Republic	YES - The project is intended to provide secure, accurate and timely information for national or multinational security and defence activities. - The aim is to improve and increase the exchange and provision/sharing/storage of classified national satellite images					

¹⁵⁹ Permanent Representation of the Slovak Republic to the EU in Brussels, email communication, December 2022 & EUCLID database

¹⁶⁰ "Zámer rezortu MO SR pri zapájani sa do projektov a iniciatív NATO a EÚ v oblasti spôsobilostí," Intention of the SVK MoD, February 2021, p. 16

		through EU SatCen and thus contribute to improving the IMINT capability of SatCen and member states. ○ The aforementioned aim is in line with the political and military ambition of the Slovak Republic - to effectively guarantee the defence of the Slovak Republic. In addition, it can help in achieving the ambition of developing the capability of intelligence services and state administration bodies to ensure real-time analysis of threats¹⁶¹
	b) development of the required capabilities defined in the long-term and medium-term strategic documents of the Slovak Republic	YES ○ The project allows member states without their own SBEO assets to participate in these activities and build their own expertise and capability in IMINT/GEOINT analysis. ○ The project provides the basis for the exchange of intelligence information at the international level (so far there has been no agreement on the provision of SatCen satellite images from national sensors, and in the future an exchange on a voluntary basis is expected). ○ SBEO activities enhance political, strategic, operational and tactical levels, support early warning, strategic surveillance, military planning phases, as well as geospatial and meteorological capabilities. ○ The project thus meets the ambition defined in the Long-Term Plan and also relates to the objective of the Directive for Defence Planning of the Slovak Republic for 2023 – 2028: „<i>To analyse the current capabilities of the Slovak Republic and to identify scientific and technological areas that are in line with NATO and EU/EDA priorities. Participate in international activities within the framework of NATO STO and the EU/EDA, taking into account the funding possibilities via the European Defence Fund (EDF) and the Permanent Structured Cooperation of the EU (PESCO)</i>“¹⁶².
	c) fulfilment of capability goals for Slovakia (emphasis on mechanized brigade), compliance with NATO standards	PARTIALLY YES The project partially overlaps with activities that SK participates in: • development of GEOMETOC capabilities in the framework of the "Framework Nations Concept (FNC)" initiative • Joint Intelligence, Surveillance and Reconnaissance (JISR)
	d) fulfilment of CDP and obligations under the PESCO program	YES CDP/SCC/CARD obligations were used in creating the project and characterizing its objectives • EU CDP: The project proposal is directly addressing the EU CDP "Space-based Information and Communication Services" and more particularly the module "Earth Observation" by improving Space Based Earth Observation (SBEO) data access and analysis, processing and exploitation¹⁶³ • The project proposal is directly addressing the Focus Area "Defence in Space" at sub-system level as well as the collaborative opportunity "Earth Observation" mentioned in the 2022 CARD Aggregated Analysis¹⁶⁴. PESCO Binding Commitments

¹⁶¹ "Obranná Stratégia SR," SVK MoD, 2021, pp.8-15, https://www.mosr.sk/data/files/4286_obranna-strategia-sr-2021.pdf

¹⁶² "Smernica pre Obranné plánovanie Slovenskej republiky na roky 2023 až 2028," SVK MoD, 2021, <https://www.slov-lex.sk/legislativne-procesy/-/SK/dokumenty/LP-2021-457>

¹⁶³ "The EU Capability Development Priorities," EDA, 2018, p.9, <https://eda.europa.eu/docs/default-source/eda-publications/eda-brochure-cdp>

¹⁶⁴ "2022 Coordinated Annual Review on Defence Report," EDA, 2022, p.8, <https://eda.europa.eu/docs/default-source/eda-publications/2022-card-report.pdf>

		- BINDING COMMITMENT 6 (Playing a substantial role in capability development within the EU and within the framework of CARD, in order to ensure the availability of the necessary capabilities for achieving the level of ambition in Europe) - BINDING COMMITMENT 16 (Consider, as a priority, a European collaborative approach in order to fill capability shortcomings identified at national level and, as a general rule, only use an exclusively national approach if such a consideration has been already carried out)
e) foreign policy context - perception of the Slovak Republic as a reliable ally and trustworthy partners in regards to fulfilment of international obligations	YES	It may contribute to strengthening the Union's operational effectiveness, enhancing the availability and interoperability of forces and capabilities for CSDP missions, while contributing to the EU's competitiveness in that field
f) economic context - development of national industrial and scientific research institutions using the possibility of financing projects from other sources as well (e.g. EDF, NSIP)	PARTIALLY YES	- The development of Slovak defence industry and research capabilities cannot be assessed at this stage: no information is available on the potentially involved industries and academic entities, - financial support from the European Peace Facility and EDF could be considered
g) coherence and synergy among initiatives and avoiding duplication	YES	Coherence with NATO - The project could support the implementation of the NATO Capability Target E-7102 (JISR) - In the FNC context, the project could be linked to the cluster GeoMETOC Support; Coherence with other activities - EDA - Space-Based Earth Observation (SBEO) Capability - EDA - military Positioning, Navigation and Timing (PNT) equipment - Synergies with ongoing PESCO projects such as Geometeorological and Oceanographic Projects (GeoMETOC) (GMSCE) and (TWISTER) - meeting the CARD recommendations for the "Earth Observation" module

Source: EEAS, 2021 & EUCLID database, 2023

Box 9: Intention behind participation of SVK MoD in CoHGI PESCO¹⁶⁵

1. The main reason for joining the project/initiative

Slovakia's main intention should be to expand its know-how regarding the practices of other states in the process of sharing government images. Participation will improve the perception of Slovakia as an active member country in the EU with an interest in strengthening EU activities and its competitiveness. Observer status in a given PESCO project can be a suitable activity to begin with, as Military Intelligence is currently active in the field of ISR and it would not be a completely unknown area. Since all neighbouring countries of Slovakia are currently members or observers in the project, it would also be about strengthening regional cooperation and expanding capabilities. Moreover, in the 5th wave of PESCO projects, there will probably not be any project dedicated to the space domain.

2. Compliance with the defence priorities of the SVK MoD defined in the long-term and medium-term strategic documents

- mentioned in Table 10

3. Evaluation of the benefit of involvement based on established criteria (according to section 2.2)

- mentioned in Table 10

4. Comprehensive technical (operational dimension and capability development dimension) and cost-benefit analysis of involvement in the project/initiative; the analysis must include all foreseeable political, political-military, and resource implications (personnel, material, financial)

Operational dimension:

- Ability to deploy Capabilities and Forces: the project will not provide any deployable capabilities but will increase efficiency of existing assets
- Availability of Capabilities and Forces: the project will not provide any new deployable capability but should make intelligence product easily available to CSDP missions and operations in the short to medium term
- Interoperability of Capabilities and Forces: the project could indirectly support interoperability by providing a new framework in which to exchange intelligence products
- Addresses MS' Lessons Identified and Learned: the project addresses some shortfalls identified among Lessons Learned from missions
- Impact on the Fulfilment of the Level of Ambition: the proposal may be assessed as having an indirect high impact on the achievement of EU CSDP and is likely to provide increased efficiency to capabilities related to the HICG Joint ISR

Capability development dimension:

- The project should contribute to three EU strategic objectives: 1. Respond to external conflicts and crises, 2. Capacity building of partners 3. Protecting the Union and its citizens
- An increase in the exchange of classified governmental imagery and develop guaranteed access to classified products (up to EU Secret) of SBOP systems, while creating an EU shared catalogue (archive of classified governmental imagery)
- The project would contribute to the intelligence picture at political, strategic, operational and tactical levels, but also to a more coordinated approach in the space
- the project could reinforce the important role of the SATCEN as an EU Agency in support of CSDP actions and could thus prevent the duplication of efforts

¹⁶⁵ "PESCO project proposals: Assessment report," EEAS, 17 September 2021, <https://www.statewatch.org/media/2806/eu-eeas-pesco-projects-recommendation-hr-2021-136-annex-b.pdf> & EUCLID databáza, 2023

Cost-benefit analysis:

- there are no financial obligations for the observer country which is compensated by not granting the right to vote in project matters
- personnel implications: authorizing the representation to participate in project meetings
 - financial costs would be associated with seconding a representative to project meetings
- Total project cost:
 - Initial Business Case has identified initial costs EUR 2,5 million for acquisition, EUR 0.5 million/year for in-service support (a limited set of implemented requirements)
 - No planned or estimated budget allocation of the project is provided, no related timelines, and no estimation of contributions from pMS
 - An in-kind contributions to the 2022 budget¹⁶⁶

5. Time horizon of involvement in the project/initiative

- 2022 (Project Execution Year– PEY)
 - collection and harmonisation of requirements (member states, EU SatCen, EU entities);
 - EDA assessment
- **2023 – 2024 (potential accession of Slovakia)**
 - EU SSI implementation decision or supplementary initial operational capability study (if decision on implementation has been made)
 - signing relevant national agreements
 - implementation
- 2025
 - fully operational under the condition that international agreements are signed and technical conditions are valid
- 2026
 - Project Completion Year (PCY)

6. Definition of the method of the success measurement methodology (measurability)

- the main purpose should be to acquire know-how and to demonstrate Slovak interest in the particular area and cooperation in acquiring EU space capabilities
- as Slovakia would only participate in the project as an observer, no other measurable results are foreseen

Measuring the overall success of the project:

- secure IT platform in operation
 - secure communication between EU SatCen and member states
 - EU shared catalogue (archive of classified governmental imagery)
- Agreements/Memorandum of Understanding signed between member states and EU SatCen on the provision of government imagery

7. The possibility of accessing funds from sources (bilateral or international financial mechanisms) outside the state budget (e.g. American funds, EDF, NSIP),

- mentioned in Table 10

¹⁶⁶ In-kind contributions: The goods or services are offered free of charge or at a price below their normal value

6.3.3. Monitoring of Eastern Border with Satellite Imagery

Monitoring of Slovakia's eastern border has been identified as a specific security and defense interest that could be positively influenced by higher involvement of the Slovak Ministry of Defense in space activities. There are 3 areas of interest in connection with ensuring the defence and security of the state:

1. monitoring of persons – illegal border-crossing – illegal and irregular migration
2. monitoring of illegal activities at the border – smuggling, etc.
3. monitoring of potential border disputes – military mobilisation, construction of infrastructure, damage to civilian structures

Box 10: IMINT vs. GEOINT

IMINT a GEOINT represent the types of basic intelligence sources related to the imaging of a specific area.

IMINT (Imagery Intelligence)

- Intelligence derived from imagery acquired from sensors that can be ground-based, seaborne or carried by air or space platforms

GEOINT (Geospatial Intelligence)

- Intelligence derived from the combination of geospatial information, including imagery, with other intelligence data to describe, assess and visually depict geographically referenced activities and features on the earth.

Source: NATO Glossary of Terms and Definitions, 2021

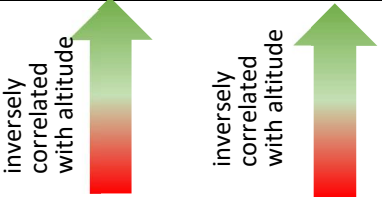
Two alternatives have been considered for monitoring of the eastern border – satellite imaging and aerial monitoring (aircraft and drones). The most significant advantages of satellite monitoring over aerial surveillance include:

- **responsiveness:** if the satellite sensors are configured and accessed appropriately, it is possible to obtain an image from **any location** on Earth within a few hours, which is not possible with drones or aircraft
- **large-scale monitoring:** satellites are able to fly over the territory of the Slovak Republic in a few seconds and, in the case of a sufficient number and a suitable location in the orbit, they can monitor a selected place with a higher frequency of coverage than drones¹⁶⁷ and airplanes, which are capable of providing continuous coverage of the monitored territory for a certain time, but have limited endurance and need to return to base for refuelling or maintenance
- **coverage of remote areas:** satellites can monitor vast and remote areas (mountains, deserts, forests)
- **data continuity:** monitoring even during adverse weather conditions
- **legal and regulatory constraints:** drones/aircraft may be subject to legal and regulatory constraints such as flight altitude limits or airspace restrictions
- **environmental impact:** satellites require no fuel for propulsion and emit no pollutants or greenhouse gases, making them a greener alternative to drones or aircraft during operation. On the other hand, the mere act of putting a satellite into orbit leaves a significant carbon footprint incomparable to the use of e.g. a MALE drone and another problem is space debris in orbit

¹⁶⁷ Although some drones (e.g. Heron 1) already have an endurance of up to 50 hours.

Two main factors need to be considered when deciding on the satellite or aerial monitoring. 1) a required frequency and coverage (24/7; several times a day; several times a week; irregularly) and 2) a size of the monitored area. Drones and aircraft are used to monitor the area, especially in cases where continuous monitoring is not required. For example, Frontex has used drones in the Mediterranean to detect migrants' vessels. Similarly, the UK uses contracted commercial providers of UAVs to monitor the English Channel¹⁶⁸.

Table 11: Overview of the satellite monitoring based on the positioning on the Earth's orbit

TYPE OF EARTH ORBIT	ALTITUDE (km above the sea level)	ORBITAL SPEED /Frequency & Coverage	SPATIAL RESOLUTION (using the same technology)
LEO	up to 2000	several times per day	
MEO	2 000 – 35 786	several times per day	
GEO	35 786	the same as the speed of rotation of the Earth around its axis	
HEO	above 35 786	one orbit takes longer than one day	

Source: own elaboration, according to Privacy International, 2021

Chart 15: Spatial Resolution



Source: EUSI, n.d.

The performance and accuracy of an Earth observation satellites depends on several variables. High-resolution imaging with a pixel size of 0.5 meters or less is most suitable for border monitoring in accordance with a defined area of interest. The higher-resolution satellites are able to identify even smaller

elements, e.g. a specific model of aircraft, battle tank, transport of people, etc. However, the higher the spatial resolution, the smaller the potentially monitored zone. Due to the very high resolution of the captured images (tens of thousands of pixels) and other metadata collected, satellites may be limited by their on-board computing power, which consequently limits the number of images that can be captured¹⁶⁹. The majority of Earth observation satellites are placed in low Earth's orbit. Satellites in LEO move faster, which allows them to orbit the Earth several times (one orbit takes about 90 minutes), but due to the rotation of the Earth during the second orbit, they already fly over another territory. Therefore, by default, one satellite is able to capture a specific area usually only once, at most twice a day (sometimes it is able to capture the same territory a second time thanks to axial tilt).

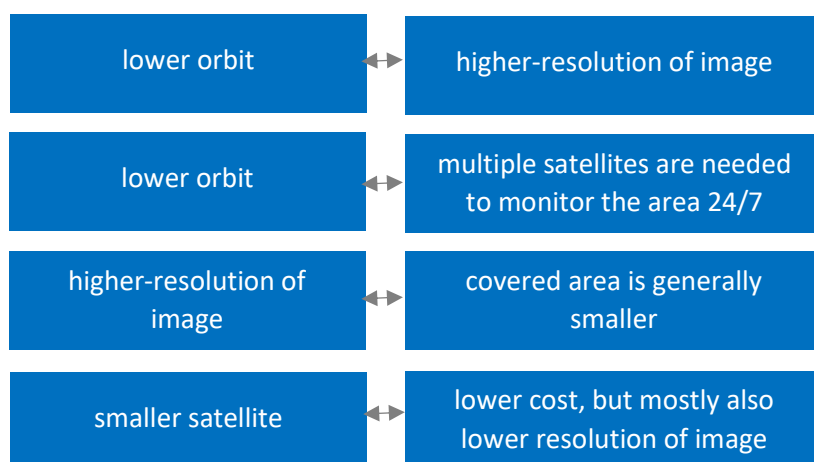
Satellite images offered by private companies are not collected continuously and there are significant gaps in coverage. Companies operate for-profit, so images are usually only collected when

¹⁶⁸ "Satellite and aerial surveillance for migration: a tech primer," Privacy International, 21 July 2021, <https://privacyinternational.org/explainer/4595/satellite-and-aerial-surveillance-migration-tech-primer>

¹⁶⁹ "Monitoring Border Conflicts with Satellite Imagery: A Handbook for Practitioners," AAAS, 2015, <https://www.aaas.org/sites/default/files/s3fs-public/reports/Handbook.pdf>

they are specially commissioned or contracted¹⁷⁰. **The main disadvantage of commercial satellite imagery** is the possibility of private companies to fully or partially deny access to images or sensors.

Chart 16: Pairs of logical statements about satellites



The price of commercially provided images may vary depending on the provider, the type of images (accuracy, spatial resolution, number, age – new vs. old) and other terms of the contract. According to AAAS (American Association for the Advancement of Science) estimations from 2015, the price ranges from USD 10 to 30 per 1 km² for the so called “archived images”, while the

price for new images ranged between USD 20 and USD 40 per 1 km². In 2022, the price per 1 km² of a new image from commercial provider ranged from USD 14 to USD 100, depending on the type of sensor and the data latency¹⁷¹. Providers often set a minimum amount of order (e.g. 25 km²), so costs can range from USD 250 for a small area to several thousand dollars for a larger area. Specialized software is also required to analyse satellite imagery, whereas licenses can cost from hundreds to thousands of dollars per year. Besides that, a trained analyst who knows how to operate this kind of software is needed¹⁷². Otherwise, the imagery must be contracted in an already analytically processed form, which again increases the price.

Slovakia does not have the capability of the satellite monitoring of its eastern border by own means. Bilateral cooperation with countries actively developing these capability could be therefore a viable solution and can be realised in different forms:

1. cooperation with other countries in building satellite systems
2. investment into another country's satellite systems in exchange for a percentage of the operating time

The cost analysis of any of the abovementioned solutions cannot be determined in detail at this stage due to the different scope of possible involvement. Slovakia needs to declare serious interest in bilateral cooperation in the first phase. Only then it is possible to specify the means of cooperation with particular state and the resulting obligations for Slovakia. This study provides activities of two neighbouring states that could be relevant due to their focus and geographical proximity to the eastern border of Slovakia, although from a technological point of view they have not reached the same level of satellite imaging as other countries (ITA, FRA,...) yet¹⁷³:

¹⁷⁰ “Monitoring Border Conflicts with Satellite Imagery: A Handbook for Practitioners,” AAAS, 2015, <https://www.aaas.org/sites/default/files/s3fs-public/reports/Handbook.pdf>

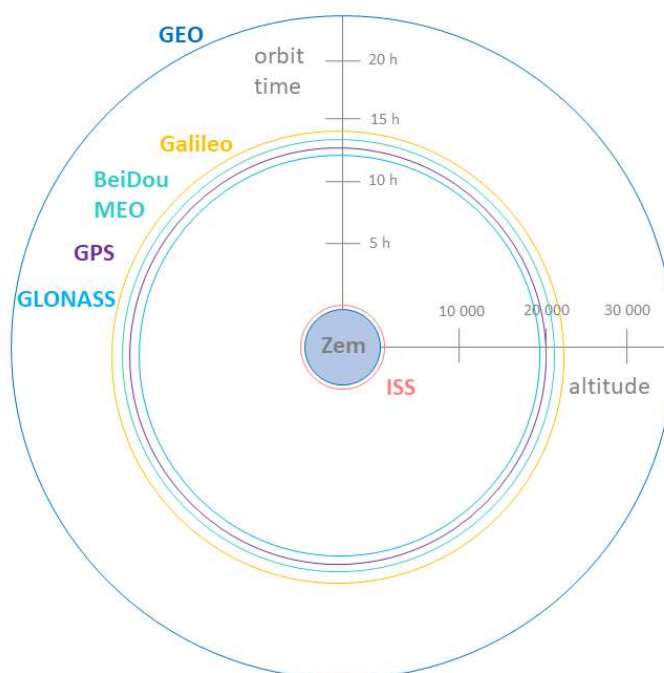
¹⁷¹ “Commercially available satellite imagery worldwide in 2022, by cost per square kilometer,” STATISTA, March 2022, <https://www.statista.com/statistics/1293877/commercial-satellite-imagery-cost-worldwide/>

¹⁷² “Monitoring Border Conflicts with Satellite Imagery: A Handbook for Practitioners,” AAAS, 2015, <https://www.aaas.org/sites/default/files/s3fs-public/reports/Handbook.pdf>

¹⁷³ So far, the PIAST project includes 3 electro-optical nanosatellites, and is likely to be able to acquire a maximum of 6 images per day (in daylight) from the eastern border area at a resolution of 5m, which is insufficient for border monitoring. Both countries are working to develop higher resolution sensors.

1. **Poland and its "Nanosatellite constellation of optoelectronic image recognition PIAST (Polish Imaging SaTellites)" project.** Satellites will be developed in Poland and their critical subsystems will be made on the basis of Polish technologies. Therefore, the process of collecting images for defence purposes will be able to be fully controlled by Poland. Platform, propulsion, AOCS satellite control system, telescopes and laser devices will be developed. Project fulfils an ambition to develop a key component of the national satellite system for the needs of the battlefield reconnaissance and the provision of up-to-date strategic and operational information¹⁷⁴.
2. **The Czech Republic is currently developing Global Orbital Electro-Optical System (a.k.a. GOLEM) and has launched so called „Ambitious Projects for the Czech Republic“¹⁷⁵.** One of the chosen „ambitious projects“ is AMBIC (Ambitious Czech Satellites) with goal to provide image data of the territory of the Czech Republic from space and thus ensure the independence of the Czech Republic from information from commercial satellites. The project takes into account the broad involvement of Czech industry up to the degree „full mission“¹⁷⁶. VZLUSAT-2 nanosatellite that has been already placed in orbit successfully demonstrated orientation and stabilization system, which allows it to take an image¹⁷⁷ in any direction¹⁷⁸.

Chart 17: Trajectories of the selected satellites – orbital period and altitude



Source: own elaboration, according to
Comparison satellite navigation orbits,
n.d.

¹⁷⁴ "PIAST nanosatellites for the Polish Army," Military University of Technology, (n.d.), <https://www.wojsko-polskie.pl/wat/en/articles/muts-news/piast-nanosatellites-polish-army/>

¹⁷⁵ The aim of the projects is to be able to carry out all phases of the mission, including ensuring system design, launch and on-orbit operations. The four submitters of the most promising proposals will be awarded a contract to develop their design. A total of CZK 10 million (EUR 400,000) is earmarked for each submitter, what represents 90 % of the cost („Ambiciózní projekty – Výzvy k podání návrhu mise," (n.d.), <https://www.czechspaceportal.cz/narodni-strategie/narodni-programy-a-aktivita/ambiciozni-projekty-vyzvy-k-podani-navrhu-mise/>)

¹⁷⁶ „AMBIC – Ambitious Czech Satellites – Kick off," VZLU, 13 March 2022, <https://www.vzlu.cz/ambic-ambitious-czech-satellites-kick-off/>

¹⁷⁷ For example, it has sent images of Prague, the border areas of the Czech Republic, Slovakia and Austria.

¹⁷⁸ „VZLUSAT-2 česká technologická nanodružica," 13 January 2023, <https://www.vzlsat2.cz/2023/01/13/vzlsat-2-poridil-i-snimky-cr/>

References

- AAAS. "Monitoring Border Conflicts with Satellite Imagery: A Handbook for Practitioners." 2015. <https://www.aaas.org/sites/default/files/s3fs-public/reports/Handbook.pdf>
- Andersen, M.G. "Unique Danish satellite in orbit around the Arctic." 5 February 2018. <https://www.dtu.dk/english/news/all-news/nyhed?id=b6b1e469-9c27-44bf-80a5-08ac9c9e8382>
- AOS. "Katedry." (n.d.). <https://webim.aos.sk/menu-kategoria/katedry>
- ASTROS Solutions. "Dedicated to Space Safety and Long-Term Sustainability." (n.d.). <http://www.astros.eu/>
- Austria in Space. "Space Activities." (n.d.). <https://austria-in-space.at/en/european-space-activities/>
- Bosanac et al. "Nacionalna svemirska strategija." 2018. <https://a3space.org/wp-content/uploads/2020/01/Nacionalna-svemirska-strategija-14-12-18.pdf>
- Brunner, K.H. "Space and Security – NATO's role." 10 October 2021. <https://www.nato-pa.int/download-file?filename=/sites/default/files/2021-12/025%20STC%2021%20E%20rev.%202%20fin%20-%20SPACE%20AND%20SECURITY%20-%20BRUNNER.pdf>
- "Comparison satellite navigation orbits." Wikimedia. (n.d.). https://upload.wikimedia.org/wikipedia/commons/b/b4/Comparison_satellite_navigation_orbits.svg
- Council of the European Union. "Council Decision (CFSP) 2015/1835," 13 October 2015, <https://eur-lex.europa.eu/legal-content/SK/TXT/PDF/?uri=CELEX:32015D1835&from=SK> Council of the European Union. "Council Decision (CFSP) 2018/909." 25 June 2018, p. L 161/39, <https://eur-lex.europa.eu/eli/dec/2018/909/oj>
- CSEO. "About Us." (n.d.). <https://www.spaceexploration.org.cy/#!/AboutUs>
- Czech Space Portal. "Národní kosmický plán na roky 2020 až 2025." 2020. <https://www.czechspaceportal.cz/narodni-strategie/narodni-kosmicky-plan/>
- Czech Space Portal. "Ambiciózní projekty – Výzvy k podání návrhu mise." (n.d.). <https://www.czechspaceportal.cz/narodni-strategie/narodni-programy-a-aktivity/ambiciozni-projekty-vyzvy-k-podani-navrhu-mise/>
- Deputy Ministry of Research, Innovation and Digital Policy of Cyprus. "Cyprus Space Strategy 2022- 2027." 2022. [https://dec.dmid.gov.cy/dmid/dec/ws_dec.nsf/All/C976C0C5D58E47C9C225893B0035FE92/\\$file/Cyprus%20Space%20Strategy%202022-2027_APROVED.pdf](https://dec.dmid.gov.cy/dmid/dec/ws_dec.nsf/All/C976C0C5D58E47C9C225893B0035FE92/$file/Cyprus%20Space%20Strategy%202022-2027_APROVED.pdf)
- DIANA. "Locations." 2023. <https://diana.nato.int/who-we-are.html>
- EDA. "The EU Capability Development Priorities." 2018. <https://eda.europa.eu/docs/default-source/eda-publications/eda-brochure-cdp>
- EDA. "2020 Card Report - European Defence Agency." 2020. <https://eda.europa.eu/docs/default-source/reports/card-2020-executive-summary-report.pdf>
- EDA. "2022 Coordinated Annual Review on Defence Report - Eda.europa.eu." 2022. <https://eda.europa.eu/docs/default-source/eda-publications/2022-card-report.pdf>

EDA "Capability Technology Areas, (CAPTECHS)." (n.d.) [https://eda.europa.eu/what-we-do/research-technology/capability-technology-areas-\(captechs\)](https://eda.europa.eu/what-we-do/research-technology/capability-technology-areas-(captechs))

EEAS. "PESCO project proposals: Assessment report." 17 September 2021. <https://www.statewatch.org/media/2806/eu-eeas-pesco-projects-recommendation-hr-2021-136-annex-b.pdf>

EEAS. "A Strategic Compass for Security and Defence." 23 March 2022. https://www.eeas.europa.eu/sites/default/files/documents/strategic_compass_en3_web.pdf

ESA. "Funding." (n.d.). https://www.esa.int/About_Us/Corporate_news/Funding

ESA. "Measuring the Space Economy." 2019. <https://space-economy.esa.int/article/34/measuring-the-space-economy>.

ESA. "Venta-1 Nanosatellite." 2017. <https://www.eoportal.org/satellite-missions/venta-1>

ESA. "NEMO-HD (Nanosatellite for Earth Monitoring and Observation – High Definition)." 8 March 2021. <https://www.eoportal.org/satellite-missions/nemo-hd#eop-quick-facts-section>

ESA & Ministry of Education of the Slovak Republic. "Slovakia PECS end of period – Executive Summary Report." 24 April 2020. https://www.slov-lex.sk/legislativne-procesy?p_p_id=processDetail_WAR_portlet&p_p_lifecycle=2&p_p_state=normal&p_p_mode=view&p_p_cacheability=cacheLevelPage&p_p_col_id=column-2&p_p_col_count=1&processDetail_WAR_portlet&fileCooaddr=COO.2145.1000.3.4015755&processDetail_WAR_portlet&file=Slovakia-PECS-End-of-Period---Executive-Summary-Report.pdf&processDetail_WAR_portlet&action=getFile

ESPI. "Emerging Spacefaring Nations." 23 June 2022. <https://www.espi.or.at/reports/emerging-spacefaring-nations/>.

ESPI. "Europe, Space and Defence: From "Space for Defence" to "Defence of Space." February 2020. <https://www.espi.or.at/wp-content/uploads/2022/06/ESPI-Public-Report-72-Europe-Space-and-Defence-Full-Report.pdf>

EU. "JOINT COMMUNICATION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL European Union Space Strategy for Security and Defence." Commission documents register. 10 March 2023. <https://ec.europa.eu/transparency/documents-register/detail?ref=JOIN%282023%299&lang=en>.

EURISY. "About Us." <https://www.eurisy.eu/>

European Commission. "Financing of the European Defence Fund." 25 May 2022. https://defence-industry-space.ec.europa.eu/system/files/2022-05/C_2022_3403_1_EN_ACT%20and%20Annex%201.pdf

European Commission. "European Defence Industry submits 134 joint defence R&D proposals under the European Defence Fund 2022 calls for proposals." 1 December 2022. https://defence-industry-space.ec.europa.eu/european-defence-industry-submits-134-joint-defence-rd-proposals-under-european-defence-fund-2022-2022-12-01_en

European Commission. "Commission Implementing Decision (EU) 2022/." 15 July 2022. <https://eur-lex.europa.eu/legal-content/SK/TXT/PDF/?uri=CELEX:32022D1245&from=EN>

European Commission. "Commission Implementing Decision (EU) 2023/2296." 29 March 2023. <https://defence-industry-space.ec.europa.eu>

European Commission. "EDF Calls for Proposal". 30 March 2023. https://defence-industry-space.ec.europa.eu/european-defence-fund-eu12-billion-boost-eu-defence-capabilities-and-new-measures-defence-innovation-2023-03-30_en

European Parliament " Regulation (EU) 2021/697 of the European Parliament and of the Council ." 12 May 2021. <https://eur-lex.europa.eu/legal-content/SK/TXT/?uri=CELEX:32021R0697>

European Parliament. " Regulation (EU) 2021/696 of the European Parliament and of the Council " 2021. <https://eur-lex.europa.eu/legal-content/SK/TXT/?uri=CELEX:32021R0696>

EUROSTAT. "Fakty a čísla o živote v Európskej únii." 2022. https://european-union.europa.eu/principles-countries-history/key-facts-and-figures/life-eu_sk

EUROSTAT. " Real GDP per capita." 2023. https://ec.europa.eu/eurostat/databrowser/view/sdg_08_10/default/table

EUSI. "INCITE reports." (n.d.) <https://www.euspaceimaging.com/resources/incite/>

EUSPA. "The EU Space Programme." 21 November 2022. <https://www.euspa.europa.eu/european-space/eu-space-programme>

EUSPA. " La Réunion EU MEOLUT, a cornerstone new infrastructure for SAR Galileo delivery in the Indian Ocean." 5 December 2022. <https://www.euspa.europa.eu/newsroom/news/la-r%C3%A9union-eu-meolut-cornerstone-new-infrastructure-sar-galileo-delivery-indian-ocean>

EU SST. "What is EU SST?" (n.d.). <https://www.eusst.eu/>

EU SST. "EU Space Surveillance and Tracking Service Portfolio." 2021. <https://www.eusst.eu/services/>

Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (Austria). "Austrian Space Strategy 2030+: People, Climate and Economy: Space is for everyone." 2021. https://austria-in-space.at/resources/pdf/V4_EN_Austrian-Space-Strategy-2030_0803_taggedv6_PAC2021Approved.pdf

Fiott, D. "The Strategic Compass and EU space-based defence capabilities." November 2022. [https://www.europarl.europa.eu/RegData/etudes/IDAN/2022/702569/EXPO_IDA\(2022\)702569_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/IDAN/2022/702569/EXPO_IDA(2022)702569_EN.pdf)

Gáliková, K. "Vesmírna sonda ESA Juice ponesie k Jupiteru aj detektor zo Slovenska." 13 April 2023, https://www.sav.sk/?lang=sk&doc=services-news&source_no=20&news_no=11133

Geoportaal. "National Satellite Data Centre ESTHub." October 2022. <https://geoportaal.maaamet.ee/eng/Spatial-Data/National-Satellite-Data-Centre-ESTHub-p654.html>

Grohman, J. "Česká vojenská družice GOLEM." 16 January 2020. <https://www.armadninoviny.cz/cesky-satelit-golem.html>

Hellas-sat. "Bridging worlds." (n.d.). <https://www.hellas-sat.net/>

Hodás, M. "Slovensko bude mať ďalšiu vesmírnu družicu. Tentoraz ju zaplatí štát." 27 September 2022. <https://zive.aktuality.sk/clanok/wKJ4kvv/slovensko-bude-mat-dalsiu-vesmirnu-druzicu-tentoraz-ju-zaplati-stat/>

Intention of the SVK MoD. "Zámer rezortu MO SR pri zapájaní sa do projektov a iniciatív NATO a EÚ v oblasti spôsobilostí." February 2021

Joshi, A. et al. "Likert Scale: Explored and Explained." 2015. doi: 10.9734/BJAST/2015/14975

Latvia Space. "Latvian technology in Space." (n.d.). <https://latviaspace.gov.lv/en/directory/baltic-satellite-service/>

Liias, P. "Estonia's space policy – prioritizing e-gov, cybersecurity and AI." (n.d.), <https://spacewatch.global/2020/07/spacewatchgl-opinion-estonias-space-policy-prioritizing-e-gov-cybersecurity-and-ai/>

Magdoňová, J. "Šéf Satelitního centra: Cílem je kontinuálně snímat Česko. Vlastní družice bychom mohli mít do pěti let." 20 January 2020. https://www.irozhlas.cz/zpravy-domov/satelitni-snimky-satelit-satcen-armada-cesko-nato-ladislav-stahl_2001200701_dok

Military University of Technology. "PIAST nanosatellites for the Polish Army." (n.d.) <https://www.wojsko-polskie.pl/wat/en/articles/muts-news/piast-nanosatellites-polish-army/>

Ministry of the Economy and Innovation of Lithuania. "Space Policy." September 2020. <https://eimin.lrv.lt/en/sector-activities/innovation/space-policy>

Ministry of the Economy, Tourism and Sport (Slovenia). "Cooperation with the European Space Agency." March 2023. <https://www.gov.si/en/topics/sodelovanje-z-esa/>

Ministry of Transport of the Czech Republic . "Média a tiskové zprávy." 10 December 2019. <https://www.mdcz.cz/Media/Media-a-tiskove-zpravy/Kosmicke-aktivity-se-CR-vyplati,-prinasi-pracovni>

Ministry For Equality, Research And Innovation (Malta). "Malta National Space Strategy." March 2022. https://meae.gov.mt/en/Public_Consultations/MRIC/Pages/Consultations/MaltaNationalSpaceStrategy.aspx

Ministry of Education and Science of the Republic of Latvia. "The Space Strategy of Latvia 2021-2027." 2020. https://www.em.gov.lv/sites/em/files/media_file/the-space-strategy-of-latvia-2021-2027.pdf

Ministry of Economic Affairs and Communication. "Estonian contribution to Space Traffic Management." (n.d.) https://www.unoosa.org/documents/pdf/PromotingSpaceSustainability/PresentationsCaseStudies/3_Regulators_SpacePolicyMakers/Estonian_contribution_to_Space_Traffic_Management.pdf

Ministry of Education of the Slovak Republic. "A conceptual framework of space activities in the Slovak Republic." June 2019. <https://slovak.space/wp-content/uploads/2019/07/Koncepcia-FINAL-AJ.pdf>

Ministry of Education of the Slovak Republic. "Návrh na pokračovanie spolupráce SR s Európskou vesmírnou agentúrou (ESA)." 2022. <https://www.slov-lex.sk/legislativne-procesy/-/SK/dokumenty/LP-2020-399>

National Council of the Slovak Republic. "NRSR odobrila zmluvu o pridružení SR k Európskej vesmírnej agentúre." 6 October 2022. <https://www.nrsr.sk/web/Default.aspx?sid=udalosti/udalost&MasterID=56179>

NATO STO. "Science & Technology Trends 2020-2040: Exploring the S&T Edge." March 2020. https://www.nato.int/nato_static_fl2014/assets/pdf/2020/4/pdf/190422-ST_Tech_Trends_Report_2020-2040.pdf

NATO. "Brussels Summit Communiqué Issued by NATO Heads of State and Government (2021)." 14 June 2021. https://www.nato.int/cps/en/natohq/news_185000.htm.

NATO. "London Declaration Issued by NATO Heads of State and Government (2019)." 2019.

https://www.nato.int/cps/en/natohq/official_texts_171584.htm.

NATO. "NATO Glossary of Terms and Definitions (AAP-06)." 2021.

https://standard.di.mod.bg/pls/mstd/MSTD.blob_upload_download_routines.download_blob?p_id=281&p_table_name=d_ref_documents&p_file_name_column_name=file_name&p_mime_type_column_name=mime_type&p_blob_column_name=contents&p_app_id=600

NATO. „NATO and Luxembourg boost Alliance Space Situational Awareness.“ 14 June 2021.

https://www.nato.int/cps/en/natohq/news_185365.htm)

NATO. "NATO launches Innovation Fund." 30 June 2022.

https://www.nato.int/cps/en/natohq/news_197494.htm

NATO. "Alliance Ground Surveillance (AGS)," 2022.

https://www.nato.int/cps/en/natohq/topics_48892.htm

OHB Czech Space. "PLATO." (n.d.), <https://www.ohb-czech.cz/our-projects/plato>

Permanent Structured Cooperation (PESCO). "Projects." (n.d.) <https://www.pesco.europa.eu/>

Privacy International. "Satellite and aerial surveillance for migration: a tech primer." 21 June 2021.

<https://privacyinternational.org/explainer/4595/satellite-and-aerial-surveillance-migration-tech-primer>

Ridgeway, S. "Maltese Innovation Promises New Era in Accessing Space." August 2022.

<https://thinkmagazine.mt/maltese-innovation-promises-new-era-in-accessing-space/>

Roberts, T.G. "Space Launch to Low Earth Orbit: How Much Does It Cost?" 1 September 2022.

<https://aerospace.csis.org/data/space-launch-to-low-earth-orbit-how-much-does-it-cost/>

Ryan-Mosley, T. et al., "The number of satellites orbiting Earth could quintuple in the next decade," 26 June 2019,

<https://www.technologyreview.com/2019/06/26/755/satellite-constellations-orbiting-earth-quintuple/>

Sanders, S. "Geo, MEO, and Leo - via Satellite." May 2020. <https://www.satellitetoday.com/wp-content/uploads/2021/02/Guide-GEO-MEO-LEO-1.pdf>.

SARIO. "Space industry in Slovakia." March 2022. <https://www.sario.sk/sites/default/files/sario-space-industry-in-slovakia-2022-03-21-online.pdf>

SAS. "Sonda ESA Bepicolombo úspešná aj na „polceste“ k Merkúru." 28 March 2023.

https://www.sav.sk/?lang=sk&doc=services-news&source_no=20&news_no=11109

Slovak Space Office. "Spaceport_SK." (n.d.) <https://spaceoffice.sk/spaceport-sk/>

Slovak Space Portal (a). "Spolupráca s ESA." (n.d.) <https://slovak.space/sr-a-vesmir/spolupraca-s-esa/>

Slovak Space Portal (b). "Všeobecné informácie k projektovým výzvam." (n.d.),

<https://slovak.space/vyskum-a-vyvoj/vseobecne-informacie-k-projektovym-vyzvam/>

Slovak Space Portal (c). "Program PECS." (n.d.). <https://slovak.space/vyskum-a-vyvoj/vseobecne-informacie-k-projektovym-vyzvam/>

SPACE-SI. "Slovenian Centre of Excellence for Space Sciences and Technologies Space-SI." (n.d.)

<http://www.space.si/en/>

"Space-Track", (n.d.), <https://www.space-track.org/auth/login>

STATISTA. "Commercially available satellite imagery worldwide in 2022, by cost per square kilometer." March 2022. <https://www.statista.com/statistics/1293877/commercial-satellite-imagery-cost-worldwide/>

Stevan et al., "Small Spacecraft Overview," 2019, <https://ntrs.nasa.gov/api/citations/20190031730/downloads/20190031730.pdf>

SVK MoD. "Konceptia zamerania a podpory výskumu a vývoja v oblasti obrany s výhľadom do roku 2025." March 2021. https://www.mosr.sk/data/files/4357_koncepcia-zamerania-a-podpory-vyskumu-a-vyvoja-v-oblasti-obrany-s-vyhľadom-do-roku-2025.pdf

SVK MoD. "Obranná Stratégia SR." 2021. https://www.mosr.sk/data/files/4286_obranna-strategia-sr-2021.pdf

SVK MoD. "Smernica pre Obranné plánovanie Slovenskej republiky na roky 2023 až 2028." 2021. <https://www.slov-lex.sk/legislativne-procesy/-/SK/dokumenty/LP-2021-457>

SVK MoD(a). "Dlhodobý plán rozvoja rezortu ministerstva obrany s výhľadom do roku 2035." 2022. https://www.mosr.sk/data/files/4767_dlhodoby-plan-rozvoja-rezortu-ministerstva-obrany-s-vyhľadom-do-roku-2035.pdf

SVK MoD (b). "Verejná výzva na predkladanie žiadostí o poskytnutie dotácie na projekty výskumu a vývoja na podporu obrany štátu." 2022. https://www.mosr.sk/data/files/4812_vyzva-2022_final.pdf

SVK MoD. "Národný plán vykonávania účasti Slovenskej republiky v Stálej štruktúrovanej spolupráci Európskej únie 2023." February 2023 (a). <https://rokovania.gov.sk/RVL/Material/28073/1>

SVK MoD. "Schválené žiadosti podľa § 2 písm. e) zákona č. 435/2010 Z. z. o poskytovaní dotácií v pôsobnosti Ministerstva obrany Slovenskej republiky v znení neskorších predpisov k verejnej výzve." február 2023 (b). https://www.mosr.sk/data/files/4955_schvalene-ziadosti-vyzva-1_2022.pdf

SVK MoD. "Severoatlantický akceleračtor pre obranné inovácie – DIANA." (n.d.) <https://www.mosr.sk/severoatlanticky-akcelerator-pre-obranne-inovacie-diana/>

Sun, G. et al. "Political, Economic and Legal Considerations for Developing Space Nations Republic of Croatia." 2021. <https://a3space.org/wp-content/uploads/2020/10/ISU-space-report-Croatia.pdf>

Šilha et al. "Space debris observations with the Slovak AGO70 telescope: Astrometry and light curves." 15 April 2020. <https://www.sciencedirect.com/science/article/pii/S0273117720300727>

The Danish Government. "Denmark's national space strategy." June 2016. <https://ufm.dk/en/publications/2016/files/space-strategy-2016.pdf>

The Danish Government. "Denmark's national space strategy: Update of strategic objectives." June 2021. <https://ufm.dk/en/publications/2021/files/denmarks-national-space-strategy.pdf>

The Slovenia Times. "Parliament confirms space activities legislation." 16 March 2022. <https://sloveniatimes.com/parliament-confirms-space-activities-legislation/>

UNIBA. "AMOS video meteor network." (n.d.). <https://fmph.uniba.sk/en/microsites/daa/division-of-astronomy-and-astrophysics/veda-a-vyskum/meteors/amos/amos-video-meteor-network>

UNIBA. "Kozmický odpad." (n.d.). <https://fmph.uniba.sk/microsites/daa/daa/veda-a-vyskum/kozmiccky-odpad/>

Union of Concerned Scientists. "UCS Satellite Database." 1 May 2022. <https://www.ucsusa.org/resources/satellite-database#.XG6yv3RKiUk>

VZLU. "AMBIC – Ambitious Czech Satellites – Kick off." 13. March 2022. <https://www.vzlu.cz/ambic-ambitious-czech-satellites-kick-off/>

“VZLUSAT-2 česká technologická nanodružica.” 13 January 2023.

<https://www.vzlsat2.cz/2023/01/13/vzlsat-2-poridil-i-snimky-cr/>

World population review. “Countries with Space Programs 2023.” (n.d.)

<https://worldpopulationreview.com/country-rankings/countries-with-space-programs>

Zelná, R. “Astronóm Šilha sleduje vesmírny odpad: Na obežnej dráhe vytvárame novú skládku.” 27 September 2022. <https://tech.sme.sk/c/23018935/silha-stranka-slovakov-vo-vesmirnom-vyskume-astronom-silha-hovori-co-vieme-ponuknut-esa.html>

Annexes

Annex 1: Space strategies in EU countries (in April 2023)

Country	Comprehensive space strategy	Specific space strategy Nexus space – defence	Year of adoption
Belgium	✓	✓	2019
Bulgaria	✓	part of a comprehensive strategy	2021
Cyprus	✓	x	2022 draft
Czechia	✓	x	2020
Denmark	✓	part of a comprehensive strategy	2021
Estonia	x	x	x
Finland	✓	x	2018
France	✓	✓	2019
Greece	x	x	x
Netherlands	✓	✓	2022
Croatia	x *	x	x
Ireland	✓	x	2019
Lithuania	x	x	x
Latvia	✓	part of a comprehensive strategy	2020
Luxembourg	✓	✓	2022
Hungary	✓	x	2021
Malta	✓	x	2022
Germany	✓	x	2019
Poland	✓	x	2017
Portugal	✓	x	2018
Austria	✓	x	2021
Romania	✓	x	2020
Slovakia	x *	x	x
Slovenia	x	x	x
Spain	✓	part of a comprehensive strategy	2019
Sweden	✓	x	2019
Italy	✓	part of a comprehensive strategy	2019

* Nacionalna svemirska strategija (draft of Croatian strategy from 2018)

* Conceptual Framework of Space Activities in the Slovak Republic for 2020+ published by the Ministry of Education in 2019

Source: space strategies of EU countries

Annex 2: Space-defence reference group of states

Country	Area (in thous. km ²)	Population (v mil.)	Real GDP per capita
Czech Republic	78,868	10.5	18,470
Cyprus	9,251	0.9	26,550
Denmark	42,924	5.8	51,460
Estonia	45,227	1.3	16,250
Croatia	56,594	3.8	14,540
Lithuania	65,286	2.8	14,970
Latvia	64,573	1.8	13,320
Malta	315.4	0.5	23,770
Austria	83,879	8.9	38,360
Slovakia	49,035	5.4	16,300
Slovenia	20,273	2.1	22,450

Source: Eurostat, 2022 & Eurostat, 2023

Annex 3: Companies involved in the PECS calls

Industrial actors involved in PECS calls					
	Number	Project name	Company	Activity type	Duration
PECS 1	1	Development and preparation of a novel capacitive multiturn absolute rotary encoder for space applications (CAPMARE)	CTRL, s.r.o.	R&D activities	24 months
	2	Retrieval of Motions and Potential Deformation Threats using Sentinel-1 (remotIO)	insar.sk s.r.o.	R&D activities	24 months
PECS 2	3	Distributed European Network of Ground Stations (DENGs)	Orbisys s.r.o.	R&D activities	12 months
	4	Software tools for monitoring NATURA 2000 habitats by satellite images (NATURAsat)	Algoritmy : SK, s.r.o.	preparatory activities	24 months
	5	Stratospheric Autonomous Landing System Application (SALSA)	GOSPACE s.r.o.	R&D activities	16 months
PECS 3	6	Sun sensor feasibility study - recap	NEEDRONIX s.r.o.	preparatory activities	19 months
	7	Sentinel 2 based support of forest disturbance mapping and monitoring (Sen2ForMaM)	YMS, a.s.	space applications	24 months
PECS 4	8	Arthrospira: Biomass Recovery	Biox Technologies s.r.o.	R&D activities	20 months
	9	SBAS Geometry Analysis Tool	Touch4IT s.r.o.	R&D activities	15+6 months
	10	Adjustment of a Novel Capacitive Multiturn Absolute Rotary Encoder for Space Application – Beam Pointing System (CAPMARE2)	CTRL s.r.o.	flight hardware	18 months
	11	Wax Fuel Embedded Structure (WAFER) for Hybrid Rocket Motor	BOROSPACE s.r.o.	R&D activities	18 months
	12	ESA-Sen2Agri connection with ESTE	ABmerit s.r.o.	R&D activities	15 months
PECS 5	13	Blockchain Software Tool for Spacecraft Components Incoming and Outgoing Inspection	3IPK, a.s.	R&D activities	12 months
	14	Capacitive Absolute Sensor for Space Applications-CAPSE	CTRL s.r.o.	R&D activities	16 months
	15	Sky Simulator for Fine Guidance Sensors	Trifid Automation, s.r.o.	R&D activities	18 months
	16	Slovak Automated SST Optical System	Astros Solutions s.r.o.	R&D activities	18 months

	17	NaturaSat-software for exploring Natura 2000 habitats by satellite data	Algoritmy SK, s.r.o.	R&D activities	24 months
	18	Ground Station Scheduling Broker	M2M Solutions, s.r.o.	space applications	24 months
PECS 6	19	Design and qualification of a Capacitive Absolute sensor – EQM (CAPSE2)	CTRL s.r.o.	flight hardware	18 months
	20	Blockchain-augmented configuration management for spacecraft engineering	3IPK, a.s.	R&D activities	14 months
	21	Preparatory activity for an ASIC development applicable for space sensors (CAPASIC)	CTRL s.r.o.	preparatory activities	14 months
	22	Ultra-high temperature thin coatings for aerospace industry	STATON, s.r.o.	preparatory activities	20 months
	23	Enhanced solar radiation nowcasting based on geostationary satellite data (NOWCASTSAT)	Solargis s.r.o.	space applications (downstream)	18 months
	24	Retrieval of Motions and Potential Deformation Threats using InSAR Geodesy (remotIO)	insar.sk s.r.o.	R&D activities	24 months
	25	Satellite-based delineation of yield productivity zones for Slovak crop fields (SatZones)	YMS, a.s.	space applications (downstream)	18 months
	26	Validation of reentry models by using real optical measurements obtained by AMOS global network (AMOS-Reentry)	Astros Solutions s.r.o.	R&D activities	24 months
	27	Space CARTOGRAPHER	GEODETICCA VISION, s.r.o.	preparatory activities	18 months
	28	Formulation and Assessment of Multi-agent Active Debris Removal Application	Strýco Berco s.r.o.	preparatory activities	19 months
	29	MELISSA Feeder	BioX Technologies s.r.o.	R&D activities	18 months
	30	Limnospira – Lipidom and Pathways	BioX Technologies s.r.o.	R&D activities	23 months
PECS 7	31	dCorePQfabric	DECENT Group, a.s.	preparatory activities	9 months
	32	Roadmap for EuroQCI optical ground station deployment in Slovakia – Study	Astros Solutions s.r.o.	preparatory activities	15 months

Source: Slovak Space Portal(c), (n.d.)

Annex 4: Space industry in Slovakia - list of companies

The list below does not cover all the companies that work in the space sector in Slovakia. Only companies and start-ups that are marked as the most successful in the SARIO publication "*Slovak Space Industry*" and those that had several successful projects within the ESA PECS program were selected. In addition, companies whose activities could be used in the defence sector were taken into account.

UPSTREAM segment

NÁZOV SPOLOČNOSTI	OBLASŤ PÔSO BENIA
3IPK	- blockchain-based system for spacecraft components quality inspection - Maintenance, Repair and Overhaul (Tracking the whole lifecycle of aerospace components facilitating the continuous airworthiness management, improving safety and reducing costs)
ASTROS Solutions	- provision of expertise in Space Situation Awareness (SSA) and Space Traffic Management (STM), ground-based data acquisition of space debris and near-earth asteroids - development of new technologies, methods and products related to Space Safety 3 successful ESA PECS projects (Roadmap for EuroQCI optical ground station deployment in Slovakia – Study, Validation of re-entry models by using real optical measurements obtained by AMOS global network (AMOS-Reentry), Slovak Automated SST Optical System)
BioX Technologies	- life support systems within the aerospace industry are one of the main research and development agendas 3 successful ESA PECS projects (Arthrospira - Biomass Recovery, MELISSA Feeder, Limnospira Lipidom and Pathways)
BOROSPACE	- development of suborbital rocket Ardea with hybrid propulsion and multifunctional lithium-ion batteries - successful ESA PECS project - Wax Fuel Embedded Structure (WAFER)
CTRL	- R&D and manufacturing of electromechanical components (cybernetics, AI, robotics, measurement and control) - successful Slovak company in ESA PECS calls (3 successful projects)
M2M Solutions	1 successful ESA PECS project - development of comprehensive solutions for efficient management of production, autonomous mobile robots, visual object detection, etc.
MASAM	metallic component production for global aviation and space companies (e.g. Airbus Defence & Space or Ariane Group)

MYSPECTRAL	• development of spectrometers, spectrophotometers and spectrometric cameras (use in food industry, optical metrology systems or space and stratospheric missions) • the spectrometers have been successfully used in the ArduSat microsattellites
NEEDRONIX	• development of smart sun sensors, telemetry, tracking and command systems and ground segments or Nanosatellite Secure Transfer Boxes • 1 successful ESA PECS project • participated in skCube project (manufacturing of the satellite and its ground station)
Slovenská organizácia pre vesmírne aktivity (SOSA)	• development of complex systems (Stratospheric Balloon, nanosats, ground segment) • ability to provide a complete service from the preparation of the probe, through its launch and tracking, including delivery of the payload back to the customer • complex design of mechanics, electronics, sensors and firmware • automated ground radio stations that enable to receive and transmit signals from nanosatellites • technology and equipment for testing and development of space components
SPACEMANIC	• development and testing of small satellite components (on-board computers, solar panels) • delivering end-to-end solutions - design, subsystem manufacturing and testing, spacecraft integration and testing, launch and deployment and on orbit operations • operation of ground segment in Central Europe • participated in skCube project
STATON	• development and construction of PVD coating machines (Physical Vapor Deposition) • 1 successful ESA PECS project (Ultra-high temperature thin coatings for aerospace industry)

DOWNSTREAM segment

NÁZOV SPOLOČNOSTI	OBLASŤ PÔSOBNIA
ABmerit	• use of space imagery to assess environmental impacts and nuclear accident probabilities (based on ESTE software solutions)
Algoritmy:SK	• software solutions in image processing, remote Earth sensing and deep learning classification of high-dimensional data • computer simulation of complex natural, technical and social processes • NaturaSat programme: satellite imagery, semi-automatic segmentation, automatic segmentation and habitat monitoring
GEODETTICA VISION	• Geodata: remote sensing, 3D laser scanning, geoinformation systems • R&D: AI, computer vision, IoT, big data • 1 successful ESA PECS project (Space Cartographer)
GOSPACE	• expertise in miniaturization, long-distance communication, space-qualified electronics, • profound partnership with the ESA • pioneer the Internet of Things (IoT) • Fleximodo (Digital parking) project earned the European Commission's "Seal of Excellence," • winner of the Challenger Accelerator Green and Digital 2022
IBL SOFTWARE ENGINEERING	• providing of meteorological information • comprehensive and automated weather software solutions (meteorological services, aviation sector etc.)
INSAR.SK	• monitoring of infrastructure stability and advanced situation awareness during evolving and complex deformation processes • winner of Copernicus Masters Airbus & Sobloo Multi-Data Challenge 2019 • 1 successful ESA PECS project
ORBISYS	• developing embedded HW and SW solutions for both commercial and academic markets (experience with LEON, ARM, PIC and PowerPC based designs) • providing of FPGA/CPLD development services with focus on telecommunication industry and radio astronomy
Robotech Vision	• the development of autonomous navigation and location algorithms for different types of platforms that plan a route and avoid obstacles
SOLARGIS	• data products and apps for energy assessment needs from pre-feasibility to day-ahead solar power forecasting
SPACE:SCIENCE	• platform providing access to Earth observation data (integration with internal data, instant data analytics, predictions and visualizations) • facilitating data monetization

SYGIC

- winner of the Copernicus Masters EC EU Space Data for New Business Applications Challenge 2020
- developer of GPS navigation software (used by 200 million people)
- top #2 app in the navigation category worldwide
- development of hybrid navigation for smart devices such as Google Glass and Apple Watch

Touch4IT

- development of software

YMS

- development of technical and geospatial information systems
 - strategic decision-making analytics
 - 1 successful ESA PECS project
-

Source: SARIO, 2022 & Slovak Space Portal(c), (n.d.) & official websites of the companies concerned

Annex 5: Financial support options for the space industry at the EU level (except EDA and EDF)

Programme	Focus areas	Topic	Call code	Period	Total Budget	Expected EU contribution/project
Horizon Europe	development of European space downstream applications	development of Copernicus services	HORIZON-CL4-2024-SPACE-01-35: Copernicus for Land and Water	2024	EUR 4 million	EUR 1.5 – 2.0 million
			HORIZON-CL4-2024-SPACE-01-36: Copernicus for Security	2024	EUR 8 million	EUR ~ 4 million
		innovative space capabilities (SSA, GOVSATCOM, quantum)	HORIZON-CL4-2024-SPACE-01-64: Quantum Space Gravimetry Phase-B study & Technology Maturation	2024	EUR 14.2 million	EUR ~ 14 million
		strategic support to the European space sector	HORIZON-CL4-2024-SPACE-01-73: Space technologies for European non-dependence and competitiveness	2024	EUR 20.1 million	EUR 2 – 3 million
EU Cassini	supporting innovative entrepreneurs, start-ups and SMEs in the space industry (upstream and downstream segment)	5. Hackathon (Space for Defence and Security)	Cross-Terrain mobility	2023		
			Making the seas more secure	2023		
			Protecting our critical infrastructure	2023		
		Matchmaking				
		Business accelerator				
European Innovation Council (EIC)	support game changing innovation (start-ups and SMEs)	next generation technologies in strategic areas for Europe, including space technologies and services	EIC Accelerator	2023	EUR 525 million	
Fundamental Elements	funding mechanism supporting the development of EGNSS-enabled chipsets, receivers and antennas (GNSS strategy)		no new call has been launched as of March 2023	2021-2027	EUR 43 million	funding of 60-70 % of the total value

Source: web EU

Annex 6: Survey on " *Potential of space technologies for enhancing the defence of the Slovak Republic* "

1. Which of the following best describes your professional background?

- a. state administration
- b. think-tank
- c. academia
- d. industry
- e. other

2. Which areas of interest should the SVK MoD pursue in the next 5 to 10 years according to their potential application for the security and defence of the Slovak Republic?

	I strongly agree	I agree	neutral	I disagree	I strongly disagree
Earth observation satellite systems					
Satellite communication systems					
SST capabilities					
Specialisation in small satellites (various purposes)					
Ground-based segment for satellite data reception and processing					
Satellite cybersecurity					
Expertise at satellite component/subsystem level (sensors, computers...)					
Capabilities for satellite data analysis and evaluation					
Better support to private sector capabilities					

3. Which areas of interest should the SVK MoD pursue in the next 5 to 10 to take advantage of the existing Slovak space (upstream/downstream segment) and related (IT, computing etc.) industry?

	I strongly agree	I agree	neutral	I disagree	I strongly disagree
Earth observation satellite systems					
Satellite communication systems					
SST capabilities					
Specialisation in small satellites (various purposes)					
Ground-based segment for satellite data reception and processing					
Satellite cybersecurity					
Expertise at satellite component/subsystem level (sensors, computers...)					
Capabilities for satellite data analysis and evaluation					
Better support to private sector capabilities					

4. In your opinion, what would be the most appropriate format for Slovakia's involvement in the field of space-defence, taking into account the existing security needs and economic possibilities of the Slovak Republic?

build capabilities
independently at
the public sector
level

build capabilities
separately at the
level of public-
private sector
cooperation

bilateral/multilateral
cooperation

involvement
in EU
projects

involvement
in NATO
projects

Earth observation satellite
systems
Satellite communication
systems
SST capabilities
Specialisation in small
satellites (various purposes)
Ground-based segment for
satellite data reception and
processing
Satellite cybersecurity
Expertise at satellite
component/subsystem level
(sensors, computers...)
Capabilities for satellite data
analysis and evaluation
Better support to private
sector capabilities

5. Which areas of Slovak industry, excluding companies focused directly on space technologies, do you think currently have the greatest potential for Slovakia's involvement in EU/NATO space activities?

I strongly agree

I agree

neutral

I disagree

I strongly disagree

Artificial Intelligence (AI)
Cyber
Big data
Quantum Technologies
Autonomous systems
Innovative materials
Automotive
Aeronautical industry

6. What do you consider to be the specific security and defence interests of Slovakia, which could be positively affected by the more extensive involvement of the SVK MoD in space activities? (e.g. Denmark – satellite imagery of Greenland, Slovakia - eastern border)

7. In your opinion, in what way could the more extensive involvement of the SVK MoD in space be beneficial compared to the current situation?

8. Do you consider it necessary to create a Space Strategy of the Slovak Republic for defence purposes? Why yes/no?

9. Your comments and suggestions on the use of space technologies in defence in Slovak conditions, "best practice"/ inspiration from abroad.