

National Space Plan 2026–2032

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1. Introduction

The National Space Plan 2026-2032 (NKP 2026+) is the Czech Republic's (CR) strategy for space activities. NKP 2026+ builds on the successes and results of the national space plans approved by the CR government in 2010, 2014 and 2019.

Space activities include all state, industrial, scientific, research and educational programmes, projects and activities aimed at exploiting the possibilities and opportunities offered by space for the development of the state, society, and economy. Space activities broadly cover the areas of satellite navigation, satellite communications, Earth observation, launch vehicles and space transport (especially launch vehicles), monitoring the state of outer space (i.e. protection against space weather or space debris) and planetary defence, space exploration (robotic exploration and human spaceflights), space science (all disciplines of astronomical observations conducted from space, microgravity research, effects of the space environment), as well as a wide range of applications and services related to the use of acquired data in agriculture, transport, energy, banking, crisis management, etc.¹

Space activities have enormous strategic, security, defence, economic and social dimensions and potential, and are increasingly influencing virtually all areas of our lives. Active involvement in these activities also increases the competitiveness of the countries involved and their status as innovative and technologically advanced countries. Space diplomacy is also a proven tool for building solidarity between nations. Space is also the fifth operational domain of the North Atlantic Treaty Organisation (NATO), and satellite data and services are now an integral part of modern warfare.

Analyses and studies by the European Union (EU), the European Space Agency (ESA), the Organisation for Economic Co-operation and Development (OECD) and other entities show that, in terms of space activities:

- **The** global space economy is estimated to be worth USD 1.8 trillion by 2035, almost triple the USD 630 billion in 2023. The expected annual growth rate for this sector is double the projected GDP growth rate for the next decade.²
- In 2022, there were approximately 6,700 operational satellites in orbit, double the number in 2020. More than two-thirds of the satellites came from commercial operators. In 2023, the number of operational satellites in Earth orbit increased by another 35% to 9,115. The increase is associated with a significant reduction in the cost of access to space thanks to reusable launch vehicles, smaller satellites and greater competition.³

In terms of satellite systems in general:

- **Approximately** 10% of the European economy depends on space system services. European companies account for 25% of the downstream market for space activities.⁴

¹ See EUSPA EO and GNSS Market Report euspa.europa.eu/sites/default/files/2024-03/euspa_market_report_2024.pdf#page=8.

² See Acket-Goemaere A., Bruhardt R., Klempner J., Sierra A., Stokes B. (2024), 'Space: The \$1.8 trillion opportunity for global economic growth', McKinsey & Company website [online; accessed on 30 January 2025], https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/space-the-1-point-8-trillion-dollar-opportunity-for-global-economic-growth#.

³ See The Space Economy in Figures: Responding to Global Challenges, OECD Publishing, Paris, <https://doi.org/10.1787/fa5494aa-en>. Statista Research Department (2024). "Number of active satellites from 1957 to 2023" Published by Statista [online; cited 4 February 2025]. <https://www.statista.com/statistics/897719/number-of-active-satellites-by-year/>.

⁴ Europe's economy is increasingly dependent on space - ITRE committee hears [online; cited 30 January 2025]. Available at <https://www.euspa.europa.eu/newsroom-events/news-archive/europes-economy-increasingly-dependent-space-itre-committee-hears>.

In terms of satellite navigation:

- global satellite navigation services and sales of satellite navigation receivers represented a market worth EUR 260 billion in 2023, with the satellite navigation market expected to more than double to an estimated EUR 580 billion by 2033.⁵

In terms of Earth observation:

- The value of the global commercial Earth observation services market is estimated at 5 billion USD, with the potential to grow to USD 8 billion in 2033. North America dominates the market with 44% of global sales, followed by Europe with 22% of global sales in 2023. However, the Asian market for Earth observation is expected to grow in the coming years, reaching 23% of global sales in 2033.⁶
- From 2024 to 2033, more than 5,000 Earth observation satellites are expected to be launched, triple the number launched in the previous decade. Approximately 80% of these are likely to belong to approximately 160 constellation projects, primarily commercial.⁷
- Earth observation satellite manufacturing is expected to generate revenues of \$131 billion, with a significant portion attributable to civil institutional programmes and commercial programmes (\$56 billion of these revenues will come from defence contracts). Civil institutional programmes are expected to grow by 50% to reach \$44 billion. Europe will have a growing 27% share of this value, with USD 6.8 billion expected to finance the Copernicus and EUMETSAT missions. Commercial programmes are expected to more than double to USD 11.3 billion, mainly involving small satellites.⁸
- It is estimated that satellite data used to generate air quality warnings could yield between €8.3 and €21 million in Europe by 2035 by preventing hospitalizations.⁹

As for satellite communications:

- In the coming period, demand for secure satellite communications within the EU is expected to increase from 19 Gb/s (2025) to 186 Gb/s (2040) for fixed satellite services, and demand for mobile satellite services could be up to three times higher, from 1.2 Gb/s (2025) to 3.9 Gb/s (2040).¹⁰

As for launch vehicles:

- Compared to the previous decade, the global number of rocket launches sharply rose from 2021, from 146 launches in 2021 to 264 launches in 2024. Most rockets in 2024 were aimed at low Earth orbit (61%).¹¹

In terms of space safety:

- Space debris is one of the main threats to satellites in orbit. According to estimates, there are around 1.1 million objects larger than 1 cm orbiting the Earth.¹² Space Surveillance & Tracking (SST) is currently used by more than 200 organisations, with

⁵ See EUSPA EO and GNSS Market Report. 2024 / Issue 2, Publications Office of the European Union, 2024, <https://data.europa.eu/doi/10.2878/73092>.

⁶ Vit Novaspace (2024). "Earth Observation Data and Services Market 17th Edition".

⁷ See Novaspace "Earth Observation Satellite Systems" July 2024 – 17th Edition.

⁸ See Euroconsult: Market Brief: Earth Observation, 21 February 2024.

⁹ See The Space Economy in Figures: Responding to Global Challenges, OECD Publishing, Paris, <https://doi.org/10.1787/fa5494aa-en>.

¹⁰ See EUSPA Secure SATCOM Market and User Technology Report, Issue 1, doi: 0.2878/961897.

¹¹ See RocketLaunch.org: Overview of the Space Age [online; cited 6 February 2025]. <https://rocketlaunch.org/rocket-launch-recap#2022>.

¹² See ESA, Space Environment Statistics. Available from <https://sdup.esoc.esa.int/discosweb/statistics/>.

the SST service protecting over 500 (not only) European satellites¹³ from the risk of collision. The protection of space infrastructure is key to ensuring the continuity of services provided, and its importance is therefore rapidly increasing, as is the importance of satellite systems for modern society.¹⁴

- Similarly, the development of technologies and the provision of services for in-orbit servicing satellites in order to extend their lifespan and ensure their functionality is of fundamental importance. According to the OECD, the market for in-orbit servicing satellites is expected to grow significantly in the coming years¹⁵. The OECD states that advances in robotic technologies and increased commercialisation of space services will be key factors in this growth. The in-orbit satellite servicing market is estimated at USD 2.4 billion in 2023 and is expected to reach USD 5.1 billion by 2030, with an average annual growth rate (CAGR) of 11.5% from 2023 to 2030.¹⁶

A description of the domains of space activities, trends, potential and benefits is provided in **Annex 1**.

¹³ EU SST Partnership. Available from <https://www.eusst.eu/services/>

¹⁴ European Union Agency for the Space Programme copyright © (2023). *EUSPA Secure SATCOM Market and User Technology Report*, Issue 1, doi: 0.2878/961897

¹⁵ OECD (2023), *The Space Economy in Figures: Responding to Global Challenges*, OECD Publishing, Paris, <https://doi.org/10.1787/fa5494aa-en>

¹⁶ On-Orbit Satellite Servicing Market (2023). Available from <https://www.marketsandmarkets.com/Market-Reports/on-orbit-satellite-servicing-market-206789424.html>

2. The Czech Republic's position in the field of space activities

The Czech Republic is very successful in space activities and has achieved a number of significant successes through the long-term and concentrated efforts of the state, industry and academia, coordinated by the Ministry of Transport (MD).

The institutional framework for space activities in the Czech Republic is described in **Annex 2**.

Thanks to the continuous efforts of all Czech governments since 2006, Prague has been home to the European Union Agency for the Space Programme (EUSPA), which ensures the operation, security and protection of certain EU space infrastructures, such as Galileo, EGNOS, Copernicus and Govsatcom, as well as supporting innovation and the development of markets linked to the use of satellite data and services. With the growing importance of space activities, especially for security and defence, EUSPA continues to develop and is entrusted with additional tasks.

Thanks to its membership in the EU, and in particular in the European Space Agency (ESA), the Czech Republic has built on the excellent results achieved by Czech scientists and engineers over decades and, unlike many other countries, has managed to transform space activities from a purely scientific discipline into an economic sector. Over the past 15 years, the Czech Republic has succeeded in building a space industry and integrating it into international supply chains. In 2025, there are approximately 150 established companies, start-ups and academic institutions active and successful in space activities in the Czech Republic, and this number continues to grow. As a result, the Czech Republic has not only become a leader among the "new" EU member states, but is catching up with and even overtaking a number of Western countries. It is also increasingly visible in the international community and, with the help of effective coordination between the state administration led by the Ministry of Transport, academia and industry, it is successfully reaching out to foreign partners at all levels and entering markets not only in Europe, but also in America, Asia and Africa.

In addition to the ESA and the EU, the Czech Republic is a member of a number of other international organisations that are directly involved in space activities or have interests in this area. These include the UN, EUMETSAT, NATO, IMSO, ITU, ITSO, EUTELSAT IGO, GEO, ESO, CEN/CENELEC, EUROCONTROL, WMO, IMO, ICAO and CERN.

In addition to its membership in international organisations, the Czech Republic is developing bilateral cooperation with a number of European and non-European countries.

The Czech Republic has a wide range of industrial and academic expertise in the space sector, covering upstream, midstream and downstream areas. In the upstream area, the national technology base covers the development and production of satellite systems and subsystems, including mechanical structures, thermal systems, radiation-resistant electronics, communication and navigation components, advanced propulsion systems and power electronics for high-frequency applications. Furthermore, the Czech Republic contributes to the construction and testing of critical components of launch vehicles and spacecraft, such as avionics systems, propulsion elements and structural parts. A specific part of the upstream sector is the development of scientific instruments, on which Czech industry cooperates closely with academia. In the midstream sector, it has capacities for space mission control, uplink and downlink station operation, GNSS reference network construction and management, development of computing and dissemination platforms for big data analysis, use of cloud computing, artificial intelligence (AI) and advanced algorithms for processing Earth observation data. Downstream competencies include the processing of multispectral, hyperspectral and SAR data, integration into GIS and customer systems, autonomous mobility, and the development of cyber-secure GNSS services for critical infrastructure, the financial sector and crisis management. The Czech Republic is also

involved in satellite telecommunications, blockchain applications for space technologies, gravimetry, spectrometry, radar interferometry and atmospheric modelling.

A detailed list of the Czech Republic's current technical competencies is provided in **Annex 3**.

In June 2024, space activities were elevated to a national project called Czech Space Journey, which aims to make a significant contribution to the transformation of the Czech economy into one based on high value-added activities through space-related initiatives.

3. Motto, vision of the Czech Republic, strategic objectives of NKP 2026+ and prerequisites for their fulfilment

The Czech Republic's motto is: "The Czech Republic is an active and internationally recognised player in the field of space activities, an internationally successful manufacturer, supplier and user of space technologies, applications and systems capable of fully exploiting their potential for the development of the Czech economy, society, security and defence."

The Czech Republic's vision for space activities is based on previous national space plans. Thanks to the Czech Republic's achievements to date, it is possible to further refine the Czech Republic's vision as follows:

- 1) to have an excellent international political, industrial and scientific reputation in the field of space activities;
- 2) to have an economy capable of generating high added value;
- 3) to be competitive and innovative;
- 4) to be an example of perfect complementarity and cooperation between industry and academia;
- 5) to have sufficient skilled experts in the field of space activities and to be able to absorb and retain the intellectual capital it creates;
- 6) to make practical use of space infrastructure, including the data and services it provides (Earth observation, satellite navigation, satellite communications, etc.) for the development of the Czech Republic's economy, society, security and defence, and environmental and climate protection.

In terms of strategic objectives, NKP 2026+, through the priority areas for intervention and the sub-objectives, measures and performance indicators defined in Chapter 4, aims to contribute to the Czech Republic as follows:

- having a comprehensive and robust chain for the design, construction, operation and use of small satellites and, in line with the technological profile of Czech industry, develops highly advanced products at the level of large subsystems or instruments and also applications, including end-to-end solutions, and maximises technology transfer from space activities to other sectors and vice versa;
- benefiting from the use of satellite system data and services in a number of economic sectors for the needs of society, security and defence;
- establishing and further developing strategic partnerships with international partners with the aim of creating comprehensive advanced technologies and solutions for commercial, scientific and government use;
- having an educational and popularisation ecosystem that systematically develops human potential for the space sector, inspires a new generation and ensures the continuity of professional capacities;
- strengthening excellent scientific teams capable of participating as Principal Investigators in the instrumentation of national and international scientific missions;
- by means of Czech state institutions, acting as a key customer for Czech space technologies and applications, thereby actively supporting the development of new technologies and the implementation of innovations in practice, and have its own space and related ground infrastructure, capacities and capabilities to ensure the self-sufficiency, security and defence capabilities of the Czech Republic and its foreign partners and allies;

- having adequate financial resources for the development of space activities; the necessary institutional framework and human resources for the management of space activities in the Czech Republic.

The key prerequisites for the fulfilment of NKP 2026+ include:

- 1) broad support for space activities, understanding of their benefits and interest in exploiting their potential for the economy, society and ensuring the security and defence capabilities of the Czech Republic;
- 2) active cooperation and coordination between the state, industry, scientific research and education sectors, including further activation of the so-called Czech space community;
- 3) material support for the development of space technologies and applications and the implementation of demanding and ambitious national and international projects, including a mission by a Czech astronaut into space, with the objective of contributing to:
 - o further development of the capacities, capabilities and international competitiveness of our industry;
 - o further strengthening the excellence of our scientific institutions;
- 4) active interest in using topics related to space and space activities to inspire and motivate the younger generation to study technical and scientific subjects and pursue careers in space activities, as well as supporting such studies and employment;
- 5) an emphasis on raising awareness of the benefits of space activities in society and the potential for using satellite data and signals in other economic sectors, security and defence in the Czech Republic.

A prerequisite for fulfilling the Czech Republic's vision and the strategic objectives of NKP 2026+ is the maximum use of the support tools available to the Czech Republic – a basic overview and evaluation of these are provided in **Annex 4**.

At the same time, as in the National Space Plan 2020–2025, support must be managed – the basic principles of support for instruments that can be directly influenced are set out in **Annex 5**.

4. priority areas for intervention to further fulfil the Czech Republic's vision

4.1 Priority area No. 1 – Definition of strategic lines of development and creation of competence platforms

4.1.1 Description

In recent years, the Czech Republic has made significant progress in the field of space technologies and applications. However, in order to further strengthen this development and achieve systematic, sustainable and internationally competitive results, it is necessary to proceed with the targeted consolidation of professional capacities and investment support. This approach is reflected in the definition of so-called strategic development lines, which represent thematically defined areas with high innovative, technological and economic potential. These lines have been identified on the basis of the strengths of the Czech space industry and academia, as well as with regard to the main trends in European and global development.

Strategic development lines are not only a technical definition of thematic areas, but above all an expression of the Czech Republic's priorities in the field of space technologies and applications. Their aim is to direct efforts towards the integration of larger units (including entire satellites), strengthen the cooperation across the academic and industrial spheres, enhance competitiveness and promote the use of space system data and services across economic sectors, including defence, security and civil protection.

In order to support the development of these lines, competence platforms have been defined – structured coordination units designed to enable concentrated support, know-how sharing, joint technology development and the ability to act as an integrated partner in relation to ESA, EU and NATO programmes and activities, as well as national contractors and, where appropriate, the national and international environment in general.

At the same time, however, it should be emphasised that the existence of strategic development lines does not automatically mean limiting support for other promising initiatives that do not directly fall within these priorities. Their purpose is to create a backbone around which the entire Czech space ecosystem can further develop – from the perspective of science and research, technology and applications – and to strengthen its position within the European and global space ecosystem.

Thematic specialisation is therefore not a narrowing of ambitions, but rather a prerequisite for sustainable growth and strengthening of the Czech Republic's position in the European and global context. In the case of the development line for satellites up to 500 kg, it is also a matter of creating strategic capacities for the Czech Republic that are important not only from a commercial point of view, but also for the Czech Republic's defence capabilities and other state uses.

4.1.2 Sub-objectives

This priority area pursues the following objectives in particular:

- strengthening integration and testing activities in the Czech Republic with the aim of supplying end-to-end products and services, large space subsystems or entire systems, including satellites,
- strengthening cooperation within industry and academia,
- strengthening competitiveness vis-à-vis foreign partners by supporting innovation,
- strengthening scientific excellence and its use for the benefit of the Czech economy,
- exploiting synergies and providing comprehensive solutions to the European and global markets,

- increasing the adoption of space technologies (technology transfer) and applications (use of satellite data and services in various economic sectors and human activities),
- supporting the industrialisation of critical technologies,
- using space technologies and applications for the defence needs of the Czech Republic.

4.1.3 Measures

In order to achieve the set objectives in the area of strengthening the technological sophistication, innovation, economic contribution and international competitiveness of the Czech space sector, it is necessary to proceed with the targeted structuring of support and development of competences. The key tool for this structuring is the aforementioned definition of strategic development lines – thematically focused areas that reflect the technological strengths of the Czech Republic, the current and future needs of European programmes and global trends.

These development lines serve as a framework for the long-term, focused development of capabilities in areas with high added value, significant market potential and strategic importance – whether it be the development of end-to-end systems, advanced subsystems, scientific instruments, sensor solutions or data processing capabilities and services.

In order to implement these priorities systematically and effectively, competence platforms are proposed as measures to achieve them – expert and coordination structures bringing together industrial and academic actors in a given development line. These platforms will serve as national hubs of expertise, innovation and cooperation, with the aim of concentrating available capacities, promoting the sharing of know-how, jointly formulating technological directions and developing specific products and services.

Organisationally, the platforms will be semi-open in nature, with the possibility of linking up with the Ministry of Transport, the Minister of Transport's Coordination Council for Space Activities and other relevant public administration institutions. In terms of financing, the activities of the platforms will be supported by a combination of resources – in particular through contributions to mandatory activities and optional programmes of the ESA, the Framework Project for the implementation of support provided by the ESA to space-related activities in the Czech Republic, national programmes, EU instruments and also from the resources of the membership base itself, or others. However, membership in the platform does not automatically entitle members to any public resources – their use will be governed by the rules of the respective support instrument. The platforms will actively seek to attract private capital and partner investments.

The functioning of the competence platforms will be described in more detail in a document submitted for approval to the Coordination Council of the Minister of Transport for Space Activities.

The following competence platforms are defined as follows:

4.1.3.1 Competence platform for the construction of satellites weighing up to 500 kg

Over the last decade (2015–2025), the global space sector has seen a dramatic shift towards miniaturisation, modularity and greater flexibility of satellite platforms. Whereas large and expensive missions with satellites weighing several tonnes used to dominate, today satellites in the 100 to 500 kg class are increasingly being used, representing an optimal compromise between performance, payload capacity and cost. The platforms enable both independent missions and integration into larger constellations and are used in science, remote sensing, communications, navigation and security applications.

This brings a growing demand for proprietary medium-weight satellite platforms that can serve as the basis for commercial missions, technology demonstrators and government missions, including defence and security applications. The ESA, EU and NATO structures are

increasingly supporting the development of these capabilities within Europe, including support for the supply chain, testing capacities and technological sovereignty.

In accordance with the National Space Plan 2020–2025, preparations for so-called ambitious projects have begun in the Czech Republic. From among the projects submitted, AMBIC (Earth observation mission for state purposes) and QUVIK (space ultraviolet telescope) were selected. Both projects aim to combine the expertise of Czech industry and academia and enable the Czech Republic to enter the international market with its own platform of satellites weighing around 100 kg, capable of carrying various instruments and equipment (payload), and the associated ground segment for mission control. These projects should be completed in 2029, and the satellites should be launched into space immediately afterwards. In addition, there are other satellite initiatives in the Czech Republic, not only at the CubeSat level, but also satellites with their own platform.

These activities form the basis for further integration and development of the existing competencies and capacities of the Czech space industry and the academic integrated competence platform for the construction of satellites weighing up to 500 kg. The platform will bring together expertise across the sector and focus on the long-term development of the Czech Republic's capabilities in the design, construction, testing and operation of satellites that can be used for a wide range of applications – from Earth observation, through scientific and technological missions, to communication systems, including the development of related technologies, with the exception of those on which other competence platforms will work.

In addition to preparing its own commercial products, the platform will also focus on creating partnerships with European integrators and operators in order to ensure the involvement of Czech entities in international supply chains. Last but not least, it will be involved in supporting engineering education and the development of a new generation of experts capable of maintaining and further developing key competencies.

Focus of the platform:

- development and integration of modular satellite structures and platforms, initially in the 100 kg class and subsequently in the 500 kg class, adaptable to various types of missions (scientific, technological, Earth observation, telecommunications), including the supporting structure, thermal management and on-board infrastructure,
- preparation and verification of subsystems – communication, propulsion, navigation, Attitude and Orbit control system (AOCS) and others,
- deepening of expertise in the preparation of materials, metals, including their refinement, composite and ceramic materials, thin films and others,
- application of advanced engineering, submicron machining and refinement of mechanical components, additive manufacturing and material joining, preparation of static components as well as folding and pointing mechanisms, stabilisation systems and mechanical and thermal subsystems,
- development of electronics for critical mission components, development and integration of next-generation on-board computers and flight software using AI, including the introduction of advanced algorithms into satellite and on-board system control, and the integration of quantum technologies (communication, sensors, post-quantum encryption principles),
- building national testing infrastructure, e.g. for vibration and thermal vacuum testing, including low-temperature testing and electromagnetic compatibility (EMC) testing, and more.

The expected members of the platform are companies and research institutions.

4.1.3.2 Competence platform for scientific instruments

Scientific instruments for space missions represent the cutting edge of technological development and are often its most prestigious outputs. It is thanks to them that space missions bring new knowledge about the Solar System, Earth, the universe and the fundamental laws of nature. The success of scientific missions depends to a large extent on the quality and originality of scientific instruments capable of measuring, recording or analysing various physical, chemical and biological phenomena in extreme conditions.

Europe and the world have long invested in the development of advanced sensors, spectrometers, particle detectors, space observatories, remote sensing instruments and in-situ measurement devices. These technologies are increasingly linked to miniaturisation, low energy consumption, a high degree of autonomy and the combination of multiple measurement principles in a single system. The successful development and deployment of instruments in space also enhances a country's technological prestige, strengthens international cooperation and opens the door to participation in further missions.

For decades, the Czech academic sphere has been a very active player and a recognised partner in international scientific consortia and has been involved in the preparation of scientific instruments within the framework of the most important European scientific missions, particularly within the ESA. Czech researchers and engineers have participated in missions such as Solar Orbiter, BepiColombo, JUICE, ExoMars and FLEX, and they also regularly collaborate with NASA and other space agencies. Thanks to international agreements, Czech industry is also involved in the implementation of these projects.

In addition, the Czech academic sphere has established a network of cooperating scientific institutions that perceive it as an important partner. It is precisely the dynamics of multilateral and bilateral cooperation between scientific institutions at the European and global levels that offer the Czech Republic a number of opportunities that need to be properly seized and maximised for the further development of the Czech Republic.

Scientific institutions need strong partners in Czech industry who will be able to develop the necessary technologies and supply products for scientific instruments. This is particularly important for the development of bilateral and multilateral cooperation, as joint projects require work packages to be appropriately divided between the Czech Republic and one or more partner countries on the basis of mutual agreement. If the academic sphere has sufficient support in the Czech industrial base, this form of cooperation will not only significantly develop scientific excellence and the visibility of the Czech Republic in the world, but will also increase the share of Czech industry in the development of advanced technologies and enable the establishment or deepening of direct relations between Czech industry and foreign industrial players.

The competence platform for scientific instruments will enable this expertise to be further developed, systematically support new proposals, strengthen the application base and create a long-term sustainable framework for the Czech Republic's involvement in cutting-edge scientific space missions.

Focus of the platform:

- supporting the development of Czech industry's competencies in line with the needs of the Czech academic sphere, with a focus on the preparation of scientific instruments and experiments
- generating opportunities for the development of the Czech academic sphere and Czech industry within the framework of international scientific relations and related economic relations,
- identifying areas for developing cooperation between the Czech Republic and third countries at the government level (Government-to-Government), which will increase excellence, the position of Czech scientific institutions within scientific consortia (role

of "Principal Investigator") and the international reputation of the Czech academic sphere and the visibility of the Czech Republic in the world,

- identifying the unused capacity of scientific institutions and supporting an increase in their use in industrial research.
- cooperation in the preparation of scientific experiments to be carried out in space by a Czech astronaut or as part of other human spaceflight missions,

The expected members of the platform are companies and research institutions.

4.1.3.3 Competence platform for solar energy in space

Global and European trends clearly point to the fundamental role of solar energy in the further development of space solutions. The growing number of satellites, platforms and planned constellations is increasing the overall demand for efficient and weight-optimised energy sources in orbit. At the same time, rapid progress is being made in the development of flexible solar panels and new generations of battery and capacitor systems, which are the key to ensuring a stable and long-term sustainable energy supply not only for satellites but also for more energy-intensive space infrastructures. These include, for example, orbital data centres, computing nodes and service platforms. Solar energy sources will also be used in future missions with elements of permanent presence outside Earth's orbit, for example on the Moon or elsewhere in the Solar System.

These systems will require reliable, powerful and adaptable energy solutions. The creation of a competence platform in the Czech Republic will enable the systematic development and coordination of national expertise in this area, both in industrial production and research, as well as in applied development for specific space missions.

The Czech Republic has already built up significant expertise and capacity in the field of flexible solar panels, linking a number of companies and academic institutions in effective cooperation and a value chain. This expertise is world-class and has considerable development potential. Czech companies also have certain competencies in the preparation of fixed or foldable solar panels, which will continue to be used mainly in smaller or less energy-intensive missions.

The Czech Republic also has considerable industrial and research potential in energy storage and distribution technologies.

Focus of the platform:

- development and optimisation of the entire solar energy system in space, from solar panels and related structures, through cabling, connectors, battery and capacitor storage, to power supplies, in all cases with a focus on commercial use
- Completion and deployment of first-generation flexible solar panels in international cooperation.
- development and optimisation of technologies for deployable rigid and flexible solar panels adapted to specific platforms and the instrumentation and technical equipment they can carry,
- identification of commercially sustainable technologies whose integration into current flexible and rigid solar panel solutions will increase their technological independence and ensure their wide applicability (scalability, weight reduction, increased performance, etc.),
- focus on commercially promising solutions that will increase the complexity of the Czech Republic's competences in this area (foldable solar panels, energy storage systems and other related electrical and mechanical systems in space).

The expected members of the platform are companies and research institutions.

4.1.3.4 Competence platform for the development of launch facilities and in-orbit servicing of satellites

With rapid technological development and demand for data and satellite system services, there is growing demand for the manufacture of satellites, their launch into orbit and ensuring their sustainable operation. It is precisely the demand for cheap and frequent transport into space that is behind the launch of a number of projects to develop private launch vehicles. In fact, this is a revolutionary approach that began several years ago and continues to accelerate, especially with regard to transport to low orbit.

At the same time, there is growing strategic interest in Europe in strengthening Europe's autonomous access to space, reducing dependence on non-European launch services and supporting innovative models of launch and operation in orbit, including space tugs, robotic servicing and active orbital traffic management.

With the trend towards smaller satellites, which are less expensive to manufacture and launch, both small launch vehicles and devices capable of launching large numbers of small satellites in a single launch are becoming promising solutions. In the case of larger satellites, with higher production and launch costs, there are considerations about servicing satellites directly in orbit in order to extend their lifespan. A classic example would be refuelling.

Thanks to its strong engineering and technological base, the Czech Republic is in a favourable position to develop these capabilities and thus participate in this trend. The competence platform should enable coordinated development in the field of technology and component preparation and, in rare cases, entire systems for providing in-orbit services to other objects, as well as the preparation of technologies and components for launch vehicles.

Realistic and commercially viable technologies should be identified and developed within the competence platform. The aim is, among other things, to extend the applicability of Czech solutions to other satellites, launchers and launch vehicles in Europe and beyond, and to implement projects that meet these needs.

Focus of the platform:

- preparation of technologies, especially for micro and mini rockets,
- development of systems for the precise release and placement of satellites (e.g. deployment mechanisms, separation systems, dispensers, etc.) in orbit, with an emphasis on miniaturisation and scalability,
- development of technologies for orbital transport of satellites ("space tugs") and changing their orbit,
- development of service platforms for maintenance, refuelling, repairs and controlled deorbiting of satellites (robotic arms, docking systems, inspection technologies),
- simulation and testing of launch and manoeuvring dynamics (including software tools for control and autonomy),
- preparation of technologies for interoperability between different launch and service systems,
- support for the sustainability of space operations through active space debris removal, controlled deorbiting and a circular approach to the use of satellite components.

The expected members of the platform are companies and research institutions.

4.1.3.5 Competence platform for optical and laser systems

Optical systems are the backbone of all Earth observation satellites that collect data in the optical part of the spectrum. Along with the demand for data from these satellites, there is a growing demand for the development and production of increasingly innovative solutions for

entire telescopes, filters and individual optical components (aspherical components, lightweight mirrors, free-form optics, crystal optics, etc.).

Optical and laser technologies represent one of the most dynamically developing segments of the space sector, both in the field of scientific and exploration missions and in commercial, defence and security applications. The importance of these systems is growing rapidly due to the need for high-capacity and secure communication between satellites themselves, between satellites and Earth, and in the future between lunar infrastructure and orbital nodes, or even further into the Solar System. In parallel with this, the use of laser systems for precision measurement, navigation, remote sensing of the Earth, detection of objects in space and active defence technologies is developing.

The Czech Republic has a long history of strength in optical technologies and their use. Thanks to considerable effort and systematic state support, the Czech Republic has also built up unique laser expertise and infrastructure for basic and applied research. Both of these **areas share** part of their technological background, which is why we perceive them as largely interconnected in the field of space activities, although it is expected that cooperation within this platform will result in multiple product lines. The academic sphere and companies in the Czech Republic have considerable expertise, which offers significant potential for the Czech economy.

Focus of the platform:

- appropriate linking of current academic and industrial expertise with the aim of creating a robust value chain capable of working on the development, preparation, manufacture and testing of optical components and entire instruments and optical devices for commercial, civil, defence and scientific use
- development of components, technologies and products for space and ground systems,
- preparation of satellite optical and laser communication systems, including terminals for inter-satellite and satellite-ground communication,
- development of technologies for quantum communication and secure data transmission, including support for the European EuroQCI infrastructure and associated segments,
- development of optical systems for remote sensing of the Earth, in particular hyperspectral imaging, LIDAR and new concepts of active sensing,
- development of laser and optical systems for scientific missions and tracking of objects in orbit, for precise orientation, approach and autonomous operations in space (e.g. for in-orbit service platforms),
- development of deployable optical devices, optomechanics, active and adaptive optics, beam control systems, including miniaturisation.

The expected members of the platform are companies and research institutions.

4.1.3.6 Competence platform for processing data from remote sensing of the Earth

Earth Observation (EO) has become one of the pillars of modern decision-making in both the public and private sectors – from climate change monitoring and crisis management to agriculture, energy, infrastructure monitoring, natural resources and land development, and defence and security. With the growing demand for data for a wide variety of uses, the number of observation satellites is also growing, and along with it the variability and quantity of data provided. This is leading to rapid development of the application base and, consequently, a rapidly growing market.

We are entering a new era: the growing amount of available data, new types of sensors and the rapid development of machine learning (ML), AI and cloud processing methods are significantly increasing the possibilities for using Earth observation data. The main limitation

is gradually shifting from the availability (existence) of data as such to the ability to process, analyse, interpret and integrate it effectively into decision-making processes.

This brings along the rapid development in data processing and the preparation of end-to-end products and services. Given the growing volume and need for rapid availability of data (NRT) and products, on-board data processing using ML/AI is an important line of development. Data processing using ML/AI is also a dominant trend in cloud solutions in terrestrial segments. A significant trend is the fusion of Earth observation data with data from various sources that are entered into analyses and the preparation of automated systems for monitoring the status of phenomena of interest or for their prediction and modelling – digital twins.

A great opportunity for the development of applications is the ambitious Czech AMBIC satellite project, which after 2029 should provide high-resolution spatial data, primarily to government users.

However, awareness of the real possibilities and limitations of data use remains a key issue.

The Czech Republic has strong capacities in the field of software development, including ML/AI solutions, data processing and Earth observation, and their fusion with data from other sources and geoinformatics. However, these capacities are often fragmented. A competence platform would make it possible to create an expert base for the data infrastructure of the future, develop cutting-edge services with high added value, and participate more effectively in European programmes.

The competence platform should focus in particular on the following:

- implementing activities that will increase demand for applications based on Earth remote sensing data (raising awareness, education, application development, market stimulation, transfer of know-how, etc.);
- preparation of applications based on Earth observation data, including data fusion, and support for the development of integrated applications for wide use in the economy, for state authorities, including in climate and environmental services (monitoring of drought, air quality, forests and emissions), in crisis management systems (floods, fires, accidents, security monitoring) and in pilot projects for Smart Cities and regional development (urbanisation, transport, infrastructure), as well as dual-use technologies,
- development of advanced algorithms and AI tools for Earth observation data analysis, including processing of optical, radar and hyperspectral data,
- preparation of solutions for defence and security purposes and civil applications critical from a security perspective with the aim of maximising the potential of the AMBIC satellite or other satellite and non-orbital data sources,
- development of a data warehouse for the needs of the state and the private sector (e.g. the Sentinel cooperating ground segment) into a cloud solution with a robust application superstructure and digital twin elements,
- standardisation of data services and interoperability with European and global platforms (DIAS, DestinE, Copernicus Services, etc.),
- implementation of scientific and research projects in Earth observation with high scientific and application potential.

The expected members of the platform are companies and research institutions.

4.1.3.7 Competence platform for space security and the use of space for defence and security

In recent years, the security dimension of space has become one of the key priorities of European and global space policy. Space is no longer just the domain of civil and scientific activities, but is essential infrastructure for defence, crisis management, energy security,

strategic autonomy and society's resilience to new threats. In response to the growing dependence on data and services from satellite systems and the increase in the number of risky objects in orbit, in particular space debris, hybrid threats and geopolitical tensions, new programmes and initiatives focused on space security, the use of satellite data and services for dual use, and the protection of space infrastructure are emerging in the ESA, the EU and NATO.

These include, for example, Space Situational Awareness (SSA), orbital traffic monitoring and space debris tracking (SST), the government component of the planned IRIS² satellite megaconstellation, the GOVSATCOM system, and the newly planned satellite observation system for the Government Earth Observation Service (EOGS), among others. Given the growing number of satellite systems and their importance for society, the economy and defence, the importance of space debris and space weather monitoring and the ability to protect space infrastructure from them is also growing.

Secure space infrastructure is a prerequisite for the reliable provision of services. At the same time, it is necessary to ensure the uninterrupted use of services by users on Earth and in space, which is linked to ensuring cyber security, strengthening the resilience of space infrastructure, countermeasures against interference and data falsification, etc.

Dual-use technologies are a key tool for ensuring security and effective crisis response. In the field of remote sensing, it is necessary to develop technologies that enable the monitoring and protection of critical infrastructure and early warning of threats such as natural disasters or military threats. These will provide the necessary data to support decision-making processes in crisis and war situations and to ensure defence and security.

The platform should develop a strategic line of development for space security and a line of space utilisation for security and defence purposes.

Focus of the platform:

- ensuring the security of space infrastructure through projects and activities related to monitoring and removing space debris, monitoring space weather, etc.,
- protecting space infrastructure and ground and user segments from interference, cyber attacks and hybrid threats; i.e. security in the creation, processing, transfer, storage and use of satellite system data and services, preparation and production of secure receivers and terminals, GNSS data processing and protection against jamming and spoofing of signals, interference with satellite telecommunications, data falsification and alteration, software solutions for securing ground and user segment communications with satellites and for inter-satellite communications, including preventing hostile takeover of satellite communications, secure solutions for determining and transmitting precise time, etc.,
- support for the activities, cooperation and professional development of research organisations and innovative companies engaged in space security technologies,
- integration of solutions based on satellite navigation, satellite communications and Earth observation into defence and civil security systems, dual use of satellite data for defence, intelligence and security purposes – change detection, movement monitoring, crisis management, etc.,
- cooperation with European and Alliance structures (EU SST, GOVSATCOM, IRIS², NATO DIANA, etc.) and ensuring interoperable solutions, e.g. within the NATO Science and Technology Organisation (STO), which oversees scientific and technological research within NATO; at the Conference of National Armaments Directors (CNAD), in the NATO Industrial Advisory Group of member states (NATO – NIAG) and within the SPACENET network, in which NATO shares knowledge in the field of space activities
- ensuring the physical and cyber security of ground infrastructure;

- support for the development of threat warning systems (including environmental risks from space debris), development of Space Domain Awareness (SDA) capabilities,
- planetary defence,
- testing, validation and demonstration of security-oriented space technologies, including support for small experimental missions.

In this case, we anticipate the creation of several thematically focused branches within a single platform. The anticipated members of the platform are companies and research institutions.

4.1.3.8 Common principles

Regular meetings will be held with the individual competence platforms to discuss their needs, strategies and cooperation.

The individual competence platforms should cooperate with each other to the maximum extent possible with the aim of:

- maximising the benefits for the Czech economy and society in terms of the national project Czech Space Journey,
- ensuring coherence and continuous interaction with the Czech Republic's supporting space ecosystem,
- exploiting mutual synergies and creating comprehensive solutions for customers (One Stop Shop),
- maximising the use of dual-use technologies,
- actively exploring opportunities for technology transfer and initiating related projects with suitable partners,
- supporting education and human resource development in the fields of space engineering and system design,
- sharing knowledge and experience,
- creating partnerships with European integrators and operators in order to involve Czech companies in global supply chains.

The tools listed in **Annex 4** will be used to support the activities of the platforms. A key part of this measure is to secure funding for ESA programmes and activities and to manage and utilise these programmes in accordance with ESA rules and possibilities to support promising technologies and applications. The minimum level of funding required for ESA activities and programmes is set out in **Annex 6**.

4.1.5 Performance indicators

The sub-objectives under this priority area are considered fulfilled if:

- As part of the mid-term evaluation by the end of 2028, there will be at least three functioning competence platforms in the Czech Republic that largely meet the specified characteristics.
- By the end of 2032, there will be at least six functioning competence platforms in the Czech Republic that fully meet the specified characteristics.

A functioning competence platform will be considered to be a platform that has an organisational and management structure, at least five members and has implemented or is implementing at least five projects (2028) or eight projects (2032).

4.2 Priority area No. 2 – Support for promising technologies

4.2.1 Description

A number of promising technologies with significant market potential, where the Czech Republic could succeed in foreign markets, cannot currently be classified under the above-mentioned competence platforms. However, it would not be strategic or beneficial for the Czech economy if the Czech Republic did not support the development of these technologies and their application on the market. In the future, new competence platforms may emerge on the basis of these technologies, even if they are not listed in NKP 2026+. These promising technologies, which generally build on the current competencies of Czech companies and the academic sphere, include, for example, shielding technologies, space mining technologies, electric drives and control elements, deployment systems for large structures in space, and high-altitude platform systems (HAPS). These technologies have significant spillover effects beyond the space sector and can be applied in aviation, energy, materials engineering and the security industry. At the same time, they are highly relevant to European and international programmes, in particular ESA, Horizon Europe and the European Defence Fund (EDF). Attention will also be paid to the development of dual-use technologies.

4.2.2 Specific objectives

This priority area pursues the following specific objective in particular:

- the development of technologies and applications with significant market potential and their application in foreign markets.

4.2.3 Measures

The key measure is the financing of ESA programmes and activities and the management and use of these programmes in accordance with ESA rules and possibilities to support promising technologies and applications. The minimum level of financing required for ESA activities and programmes is set out in **Annex 6**.

4.2.4 Performance indicators

The sub-objectives under this priority area are considered fulfilled if:

- As part of the mid-term evaluation by the end of 2028, at least 20 projects to support such promising technologies are implemented in the Czech Republic.
- By the end of 2032, at least 40 projects supporting such promising technologies have been implemented in the Czech Republic as part of the final evaluation.

4.3 Priority area No. 3 – Strengthening the supporting space ecosystem in the Czech Republic and using space activities to modernise the Czech economy and develop society

4.3.1 Description

The successful and sustainable development of space activities is linked to the systematic development of a supporting space ecosystem, particularly in terms of raising awareness of the benefits of space activities, inspiring the younger generation, school and extracurricular education, internships, training and career preparation, technology incubation, support for technology transfer and the widespread use of space applications. These areas are central to the national project Česká cesta do vesmíru (Czech Space Journey), as their appropriate implementation can rapidly increase the Czech Republic's ability to maximise the potential that space activities represent for the economy and society.

The implementation of these measures depends on broad cooperation between various entities. By the beginning of July 2025, 140 leading representatives of major Czech

universities, secondary schools, the Czech Academy of Sciences and its institutes, companies, authorities and other entities had **already** signed a declaration of interest in participating in the implementation of the national project Czech Space Journey and fulfilling its objectives, as well as cooperating, to the best of their abilities, in the material, technical, administrative, organisational, and media support of the project and related activities. According to the declaration, these entities consider space activities to be of great importance for Czech society, the economy, science, innovation and education, and express their intention to take this into account in their activities. This community continues to grow.

The national project Czech Space Journey and cooperation with partners will be coordinated or directly managed at the level of the Coordination Council of the Minister of Transport for Space Activities, its committees and working groups, and within the Czech Space Team (see below).

4.3.2 Sub-objectives

This priority area pursues the following specific objectives in particular:

- raising awareness of the Czech Republic's achievements in the field of space activities and their importance for the modernisation of the Czech economy and the development of our society,
- using space activities to activate society towards joint efforts and solidarity and to strengthen national pride,
- motivating the younger generation to take an active approach, make an effort and cooperate, and to inspire them to study, in particular in the fields of science, technology, engineering and mathematics (STEM), which the Czech economy needs to increase,
- making the maximum use of the existing potential for developing human potential and capacities in the Czech Republic and create further opportunities,
- creating an interconnected educational ecosystem that uses the potential of space to systematically motivate pupils and students to study natural and technical fields and to prepare future experts for the space sector,
- ensuring stable support for educational, awareness-raising and popularisation activities in the field of space across regions and educational levels,
- exploiting the inspirational potential of the Czech astronaut's mission to the ISS to develop interest in space activities, science and innovation in society,
- strengthening links between educational institutions, industry and public administration in order to better prepare the younger generation for careers in high-tech fields,
- strengthening systemic activities such as technology incubation, support for technology transfer, and support for demand for solutions based on satellite services and data and related offerings,
- increasing capacity and raise the overall level of industry by further expanding the supply chain with new entities (while continuously improving the technological level of these entities) and applying new technologies/skills in practice.

4.3.3 Measures and performance indicators

4.3.3.1 Implementation of the mission of a Czech astronaut into space

The personality and role of an astronaut is directly linked to:

- Creating positive role models: As an ambassador for humanity, an astronaut embodies the values that people care about, and investing in their flight is therefore also an investment in these values. Being an astronaut is the dream job of many children, and a

real astronaut is a positive role model that they may want to emulate. It can be assumed that this inspiration will translate into increased interest in studying technical or scientific fields that are the key to the development of the Czech economy. The share of industry in the Czech Republic's GDP has always been one of the highest in Europe, but the number of students in STEM fields is low compared to other EU countries. Therefore, decisive measures are needed to reverse this trend. The project will achieve its goal if the inspiration is reflected in any secondary or higher education studies.

- The Czech Republic's position in the world (National Posture): The involvement of the Czech Republic and a Czech astronaut in activities on the International Space Station (ISS) raises our country's profile in the world and increases respect from other countries. This makes us part of a small club, which can also be used for cooperation in other areas and to build the Czech Republic's position and our soft power. An astronaut is also a tool of political and commercial diplomacy.
- Preparation and operation of experiments and technology demonstrators: These projects are typically very complex and are prepared in cooperation with scientists, industry and the non-space sector. Their objectives may be, for example, physical, biological, biotechnological, pharmaceutical, sociological, psychological or educational. In the case of a national mission, experiments and technology demonstrators will be implemented several years earlier than through the standard ESA process.
- Strengthening cooperation with other countries: Other countries may participate in the preparation of Czech experiments, which will open the door for the Czech Republic to cooperate on their experiments. Reciprocally, astronauts may operate experiments of partner countries or ESA experiments. This strengthens bilateral ties – economic and political.
- By raising awareness of the benefits of space activities and the significant achievements of the Czech Republic in modern history: This is an area with the highest added value. Astronauts are respected authorities who can more easily and credibly demonstrate the need to invest effort and financial resources in high-tech and, more generally, in areas that are otherwise difficult for the general public to grasp.
- Brand of the Czech Army: An astronaut-soldier will help build the image of the Czech Army as a modern and progressive defence force and will inspire people to join the Czech Army or active reserves.

The aim of this measure is to maximise the expected benefits associated with the personality and role of the astronaut through the systematic cooperation between the entities involved.

As for the experiments, technology demonstrators and other activities that a Czech astronaut could carry out on the ISS, the Ministry of Transport organised a conference on this topic in February 2024 in cooperation with the ESA and initiated a collection of ideas. The Ministry of Transport received 70 ideas for basic evaluation by ESA, which is comparable to the number received by Poland, a country almost four times larger than the Czech Republic, which has already sent its astronaut to the ISS. That is why, following a request from the Czech Republic, ESA issued a call for proposals for these experiments, technology demonstrators and other activities in September 2024. From the 25 proposals submitted, a set of 14 such experiments, technology demonstrators and other activities was selected.

The Czech government finally decided on the implementation of the Czech astronaut's mission to the ISS, using the Czech Republic's membership in the ESA, in its Resolution No. 365 of 21 May 2025, which was subsequently approved by the ESA member states in June 2025. The expected date for the mission to the ISS is the turn of 2027 and 2028. The national project Czech Space Journey aims to make the most of the opportunities that this mission presents for the development of Czech industry, science and society.

4.3.3.2 Building the future human potential of the Czech Republic

The future success of the Czech Republic in the field of space activities and the sustainability of current development in this area depend significantly on the training of new experts and workers who will work in the space industry and academia, or who will support them and the Czech Republic in general in public administration or other sectors. The development of the space industry, like other industries in the Czech Republic, is hampered by a shortage of human resources with the necessary education. This applies not only to higher education, but also to technical education in secondary schools and apprenticeships.

It is therefore essential to systematically develop "space" education across the entire education system. The topic of space serves as a powerful motivational and popularisation tool for interest in STEM fields and, at the same time, as a practical framework for developing the skills of future experts in the space sector and other high-tech sectors. Educational activities coordinated, for example, through the ESA ESERO (European Space Education Resource Office) Czech Republic, student associations and science centres are proving to be a highly effective tool for engaging pupils, students and teachers.

Particular emphasis will be placed on taking advantage of opportunities related to the preparation and flight of a Czech astronaut to the ISS, which will take place at the turn of 2027 and 2028. This event will be incorporated into the Czech education system as a powerful inspirational and educational moment, which will contribute to further strengthening the perception of space as a strategic and promising field for the younger generation.

Basic coordination in this area is currently taking place at the level of the Working Group for Education established within the Coordination Council of the Minister of Transport for Space Activities.

4.3.3.2.1 Incorporating the topic of space into the systemic support of school and extracurricular education at primary and secondary schools

Space science and related technologies are a key tool for motivating children and young people to study STEM subjects and prepare a new generation of experts who will actively contribute to building a high value-added economy. The mission of the Czech astronaut to the ISS represents a unique opportunity to motivate children and young people.

The ESA ESERO Czech Republic Education Office has been operating in the Czech Republic since 2015. Its main goal is to use the inspirational nature of space to increase the scientific and technical literacy of primary and secondary school pupils and motivate them to study and pursue careers in STEM. ESERO thus supports technically oriented education through the continuous training of primary and secondary school teachers, the preparation of suitable educational materials, the management, coordination and implementation of inspiring educational projects, etc. This office already has a network of active teachers and pupils. Its potential must now be maximised and actively and systematically linked to other educational and popularisation activities in the Czech Republic.

There is already at least one student association in the Czech Republic, consisting of dozens of pupils from various secondary schools, which is also very successful internationally. This association demonstrates the hidden potential of secondary school pupils, which needs to be further supported.

As part of the national project Czech Space Journey, the Ministry of Transport also implemented the first year of selection and training of young ambassadors of the Czech space programme, i.e. pupils aged 13 to 18 who underwent a demanding selection process testing their knowledge and mental, physical and communication skills and abilities. They then underwent training similar to that undergone by astronauts (in particular a survival camp, the ZeroG campaign and diving training). With the support of active headteachers and teachers, particularly from partner schools, these pupils will continue to inspire their peers to be active, to take an interest in science and technology, and to educate themselves. This

activity has succeeded in significantly raising awareness of space education and the opportunities it offers in the Czech Republic.

The aim of this measure is, in particular, through systematic cooperation between the Ministry of Transport, ESERO, active headteachers and teachers at primary and secondary schools, school founders, non-formal and informal education providers (e.g. science centres, observatories and planetariums, children's and youth centres, etc.), associations focused on working with gifted children, pupil and student associations, and active pupils and students:

- maximising the reach of ESERO activities,
- analysing good practice within the ESERO network and implementing new projects and programmes within the Czech Republic,
- with the involvement of the Ministry of Education, Youth and Sports, the National Pedagogical Institute and school founders, preparing the topic of the use (not only exploration) of outer space for introduction into the framework educational programmes of primary and secondary schools and putting it into practice,
- defining the needs for professional, testing and other material resources for school and extracurricular activities of pupils and students,
- with the involvement of state authorities and institutions, academia, industry and other entities, analysing the possibilities for meeting these needs and, if possible, fulfilling them,
- creating a comprehensive, interconnected and actionable educational ecosystem for space education,
- creating unique opportunities with a motivational and inspirational impact for gifted and motivated pupils, who will subsequently help to further disseminate and develop the Czech space ecosystem (e.g. regular Zero-G campaigns, which will become part of the Czech education system).

4.3.3.2.2 Introduction of new study programmes at universities and systematic support for the career preparation of young graduates

Although there are already several accredited study programmes in the field of space technologies and applications at colleges and universities in the Czech Republic, their number and specialisation still do not meet the needs of industry, academia and prospective students. The number of graduates is therefore still very low. However, in many cases, students have the opportunity to study at partner schools abroad or at the International Space University, where tuition fees apply.

On the other hand, student associations are being formed at universities, whose members come from various faculties and study programmes. These student associations and teams bring together students who, with the support of active teachers and often industry and other entities, fill the gaps in the current education system through their activities. These student teams consist of dozens of students currently working, for example, on the construction of cubesat satellites, the construction of autonomous rovers for extraterrestrial applications, or the construction and testing of student rockets.

At the same time, it is necessary to take advantage of the internship system offered in particular by the ESA and the EU. The Czech Republic has not yet established an ESA training framework for students and young graduates, although it has been discussed since its accession to the ESA and has created the framework conditions for it.

The aim of this measure is, in particular, through systematic cooperation with the Ministry of Transport, the Ministry of Education, Youth and Sports, leaders of colleges and universities, active teachers, student associations and active students:

- maximising the use of activities offered to the Czech Republic through its membership in ESA and the EU,

- initiating the creation of new study programmes or increasing the capacity of existing ones,
- defining the needs of parties in terms of professional, testing or other material resources for students' study and leisure activities,
- initiating the recognition of active membership in student associations as work in a facultative subject (recognition as a part of study requirements),
- with the involvement of state authorities and institutions, academia, industry and other entities, analysing the possibilities for meeting these needs and, if possible, fulfilling them,
- establishing a training framework for graduates and young professionals.
- initiating a support framework for student internships in companies,
- establishing a support system for inviting foreign experts to share their knowledge in fields where Czech educators do not yet have sufficient expertise (visiting professors).

4.3.3.3 Raising awareness of the benefits of space activities and their importance for the Czech Republic

Space activities are no longer the domain of just a few large countries, although many people still think so. Many people are still unaware that the Czech Republic is very successful in this field, with 150 companies and academic institutions operating in this area, and that this number is continuously growing. They are also unaware that they cannot do without space activities in their everyday lives. This lack of awareness is detrimental to space activities, their acceptance and their further development. It is therefore necessary to systematically raise awareness of space activities, their benefits and the Czech Republic's achievements in this field, in cooperation with state institutions, industry, academia, educational institutions and other partners. The awareness gained should also be used in the educational process at primary and secondary schools and further promoted through popularisation activities. This is also one of the objectives of the national project Czech Space Journey.

The main objectives of this measure are:

- making the maximum use of the partnership of the national project Czech Space Journey and systematically informing the public about the benefits of space activities and the achievements of the Czech Republic and popularising space activities in society,
- building an effective system for creating content to present the benefits of space activities and the Czech Republic's achievements in this area to the public,
- increasing the acceptance and support for space activities as a tool for modernising the Czech economy and developing society
- integrating the topic of space and space technologies into the formal education process at primary and secondary schools.

4.3.3.4 Creating opportunities for cooperation in the field of space activities

Space technologies are strategic technologies that have a direct impact on the development of a wide range of economic sectors and on ensuring security and defence capabilities. It is therefore not easy to establish a foothold in this area in the face of international competition and the interests of other countries, and concerted efforts and systematic cooperation between the state, industry and academia are therefore necessary. To this end, in addition to using tools to support the growth of the competences of companies and academia, it is necessary to use the state's capabilities to support international cooperation.

At the same time, it is necessary to organise industrial days, information days, networking events, seminars and workshops at the national level to promote awareness and cooperation between companies, between companies and academia or investors, or events that teach Czech entities how to properly write applications to the ESA or the EU.

The main objectives of this measure are:

- making effective and coordinated use of tools to support the international cooperation and exports, such as economic diplomacy projects (PROPED), Czech official participation, missions led by constitutional officials or civil servants, and other resources and opportunities to support exhibitions and exports, as well as the capacities of embassies and foreign representatives.
- formalising international relations at the level of international treaties or at least memoranda of cooperation and, on this basis, to systematically build partnerships at the state, industry and academic levels in cooperation with the other party
- supporting awareness and cooperation at the national level through industry days, information days, networking events, seminars and workshops.

4.3.3.5 Support for technology incubation and technology transfer

The CzechInvest agency operates the ESA BIC Czech Republic business incubator with offices in Prague and Brno. ESA BIC Czech Republic is a part of the ESA network, which includes several dozen incubators in ESA member and associate states. Currently, up to five start-ups are incubated annually in Prague and up to three start-ups in Brno. In July 2025, almost 70 start-ups were incubated or are currently undergoing incubation in the Czech Republic as part of this incubator. Thanks to the good practice gained during the implementation of the ESA BIC project in the Czech Republic, the CzechInvest agency has built an entire support system in the Technological Incubation project, consisting of business incubators and hubs supporting not only space activities, but also other areas such as mobility, AI, defence, healthcare and eco-innovation. The creation of the Space Hub and the increase in financial and professional support opportunities for incubated companies further enhanced the opportunities originally offered within the ESA BIC network. Supported companies working on solutions using, for example, satellite services and data can also take advantage of opportunities offered by incubators or hubs other than space-related ones. One of the important goals of the Technology Incubation project is to support technology transfer from academia to industry, which will also significantly help companies in the space sector.

The ESA Technology Broker project, implemented by the Technology Centre Prague, systematically supports the transfer of technology and knowledge between the space and non-space sectors. It identifies and creates new opportunities for the application of innovative space technologies across a wide range of industrial applications. It actively maps the needs of non-space industries for innovative solutions and specifically seeks suitable space technologies to meet them. It works closely with research institutions, technology associations and companies, thus helping to speed up the implementation of research and development results into practice. Through the ESA Spark Funding financial instrument, it directly supports selected technology transfer projects between the space and non-space sectors. At the same time, it monitors opportunities for participation in ESA tenders, innovation programmes, competitions and thematic calls, and provides this information to relevant entities in a targeted manner. Through these activities, the project contributes to increasing the competitiveness of Czech companies on the global market, both in the field of space technologies and in other industrial sectors.

The main objectives of this measure are:

- further increasing the number of incubated space start-ups within the entire Technology Incubation system,
- linking the activities of ESA BIC Czech Republic and Space Hub more visibly and systematically with the activities of regional innovation centres, and identifying and utilising regional resources,
- establishing or strengthening strategic partnerships with major companies and industry associations outside the space sector with the aim of using space technology to optimise

their activities or improve their products, while actively identifying and commercially exploiting demand for innovative technologies developed for non-space sectors that can be successfully adapted and used in space applications. including increasing investor interest in investing in space companies and the space sector in general,

- promoting successful examples of the use of space technologies in order to demonstrate the benefits of space activities for the civil and business sectors, stimulating interest in space innovation and increasing the number of active participants in space activities.

4.3.3.6 Increasing acceptance of applications and solutions using satellite services and data in the Czech environment

The use of satellite services and data is very broad, as shown, for example, in the current edition of the "GNSS and Earth Observation Market Report" prepared by EUSPA.¹⁷ There are already a considerable number of solutions that can be used in various economic sectors, in security, crisis management or our everyday activities, and thanks to which the intended goals can be achieved more efficiently, quickly or cheaply. Entities from various sectors and areas can certainly use foreign solutions, but it is more important for our economy to meet the needs of domestic customers with solutions developed by our companies. The state, as a key initial customer for innovation, can play a crucial role in supporting this approach, not only by actively seeking out and applying new solutions, but also by providing initial demand for innovative products and services, thereby supporting the domestic innovation ecosystem. It is precisely this approach and the use of support tools, such as the technological incubation in particular, that can activate an innovation chain that will satisfy the user requirements of customers from the Czech Republic and abroad, using the ideas of Czech students, young professionals and innovative companies. For these purposes, there are a number of tools available within the ESA, the EU and, in general, at the national level.

To promote the acceptance of space activities, stimulate the demand outside the field of space activities and initiate specific projects to meet this demand, the Czech Republic has joined the ESA Business Application Ambassador project and the associated network in other ESA member states. In 2024, this project underwent a significant expansion: its duration was extended by another three years (until 2027), its budget was increased, and its scope was also expanded to include direct support for the ESA InCubed+ programme. The activities now also include targeted mentoring and business coaching services for companies with the potential to use Earth observation data and services. The programme is now called ESA Commercialisation Ambassador.

Further support for these activities may be provided through the ESA Φ-lab (Phi-LAB) initiative.

The main objectives of this measure are:

- making the most of the opportunities offered by the ESA Commercialisation Ambassador project and the good practices gained in other ESA Member States,
- stimulating the demand from entities outside the space sector for solutions using satellite services and data, to play the role of a key early adopter for innovation, activating and supporting, through projects at national and European level, an innovation chain that will enable the Czech innovation environment to respond to user requirements of customers in the Czech Republic and abroad with the aim of satisfying them.

4.3.3.7 Sharing of testing infrastructure, laboratory equipment and purchases

Many companies and, in particular, the academic sphere in the Czech Republic have significant testing infrastructure, laboratory equipment and related expertise at their disposal.

¹⁷ https://www.euspa.europa.eu/sites/default/files/external/publications/euspa_market_report_2024.pdf

Testing infrastructure is expensive to acquire and operate, and Czech entities very often have to use very expensive foreign infrastructure, with the costs of testing then being reflected in the costs of technology development and the company's overall cash flow, which ultimately slows them down. Student associations and initiatives also face similar obstacles, as they often do not have the opportunity to sufficiently test or develop their solutions before participating and representing the Czech Republic in international competitions.

The most effective and optimal solution is to map existing testing infrastructure and laboratory equipment and related expertise, create an effectively functioning network of testing infrastructure and laboratory equipment, and concentrate the identified missing testing capacities and competences into a single entity, where all Czech entities could use them at acceptable prices. It is important to share existing testing infrastructure and laboratory equipment with the necessary expertise, provided that the operational and technical conditions and the owner's needs allow this.

The main objectives of this measure are:

- establishing an asset register of existing testing infrastructure and laboratory equipment and the associated expertise, including the conditions for their sharing,
- intensifying the cooperation between companies and the academic sphere in order to make the maximum use of existing testing infrastructure and laboratory equipment and creating a testing infrastructure network for the field of space technologies,
- identifying the needs of Czech industry and academia in terms of testing infrastructure and analysing the possibilities for meeting them and, if possible, fulfilling them,
- analysing whether joint purchases and sharing of surplus materials, components, etc. can be used to increase the efficiency of Czech space activities.

4.3.4 Performance indicators

The sub-objectives under this priority area are considered fulfilled if:

- in the medium-term evaluation by the end of 2028:
 - o **Re point 1)** The mission of a Czech astronaut to the ISS is successfully completed, including the implementation of scientific experiments, technological demonstrators and other activities prepared by the Czech academic sphere and industry, and at the same time a robust background is established for the use of these expected benefits associated with the personality and role of the astronaut, aimed at inspiring the younger generation to study STEM subjects and raising awareness of the benefits of space activities and the significant achievements of the Czech Republic.
 - o **Re point 2) a):**
 - The ESERO portfolio of activities is expanded by 25% compared to 2025,
 - The topic of space will be introduced into the framework educational programmes of primary and secondary schools,
 - At least 100 members will have passed through student clubs focused on space activities,
 - At least 30 primary and secondary schools will be actively involved in defining the needs of parties involved in school and extracurricular activities for pupils and students, and these needs will be at least partially met
 - At least one unique motivational opportunity with inspirational overlap will be held for gifted pupils, who will subsequently help with the further

dissemination and development of the Czech space ecosystem (e.g. the Zero-G campaign).

o **Re point 2) b):**

- At least one new study programme, field or specialisation in the field of space technologies or applications is created, or the capacity of existing ones will at least double.
- At least 250 members will have passed through student associations and young professional associations focused on space activities.
- At least 30 university teachers and 3 student associations are actively involved in defining the needs of students for study and leisure activities, and these needs are at least partially met.
- There is an ESA training framework for Czech students and young graduates with a capacity of at least 6 selected applicants per year.
- At least two universities recognise active membership in student associations as work in a facultative subject (recognition as part of study requirements).
- At least 3 foreign experts (visiting professors, industry experts, ESA, etc.) are involved in teaching or mentoring at Czech universities,
- At least 2 Czech universities have established a system for inviting and financing foreign lecturers specialising in space technology, applications or research,
- At least 5 experts from the Czech space industry regularly participate in teaching or supervising master's and bachelor's theses.

o **Re point 3):** The Advertising Value Equivalency (AVE) of Czech space activities for the period under review is at least CZK 3 billion.

o **Re point 4):**

- At least 8 trade missions, industry days or participations in foreign trade fairs focused on space activities are organized annually.
- At least two new international agreements on cooperation in the field of space activities are concluded or at least two new memoranda of cooperation are signed, or a functioning coordination system for mutual cooperation is created within the framework of at least two existing international agreements or memoranda of cooperation,
- The Czech Space Week festival of space activities and at least five other industry days, information days, networking events, seminars and workshops are organised annually to promote awareness and cooperation at the national level.

o **Re point 5):**

- The number of "space" start-ups incubated within ESA BIC Czech Republic and Technological Incubation is at least 12 per year,
- At least one new regional innovation centre has established cooperation with ESA BIC Czech Republic or Space Hub, and regional resources are used, albeit on a one-off basis, to support start-ups from the region.
- At least one partnership with a large system integrator from outside the space sector is established or intensified for the purpose of transferring technology from the space sector and vice versa;

- At least three events will be held to promote investor interest in investing in space activities, or we will actively participate in at least three such events;
- The space sector is involved in the National Innovation Hub (NIH) and, thanks to this cooperation, private resources are systematically used for space activities.
- At least four new technology transfer projects between the space and non-space sectors are identified and supported annually.
- At least one technological area of space projects with low involvement of Czech companies is identified annually, and targeted activities are implemented to strengthen this participation.
- o **Re point 6):**
 - The potential of individual economic sectors in the Czech Republic for the use of satellite services and data is continuously analysed and the most promising areas for their rapid adoption are identified.
 - The user requirements of current and potential Czech users of solutions utilising satellite services and data are continuously mapped, and their demand is linked to innovative companies that could respond to it.
 - At least three projects are implemented to support business relationships between Czech users and Czech suppliers of solutions using satellite services and data.
 - A robust application superstructure is being prepared for the satellite image data warehouse (e.g. the Sentinel cooperating ground segment).
- o **Re point 7):**
 - An asset register of relevant testing infrastructure and laboratory equipment, including the associated expertise, has been established and is being more effectively integrated into a national network of testing infrastructure in the Czech Republic, There are at least 5 good examples of the use of testing infrastructure and laboratory equipment and related expertise for purposes other than those of the owner,
 - The needs of the Czech industry and academia in terms of supplementing the missing testing infrastructure are identified and the possibilities for meeting them will be analysed,
 - The possibilities and potential for joint purchases and sharing of surplus materials, components, etc. will be analysed.
- As part of the final evaluation by the end of 2032:
 - o **Re point 1)** In addition to the continuous use of the personality and role of the astronaut to inspire the younger generation to study STEM subjects and raise awareness of the benefits of space activities and the significant achievements of the Czech Republic, at least two other benefits associated with the personality and role of the astronaut will be actively exploited.
 - o **Re point 2) a):**
 - The ESERO portfolio of activities has expanded by 50%.
 - The topic of space has been introduced into the framework educational programmes of primary and secondary schools in at least five cases.
 - At least 200 members have passed through student associations focused on space activities,

- At least 50 primary and secondary schools are actively involved in defining the needs of the facilities for school and extracurricular activities for pupils and students, and these needs are at least partially met,
- At least two unique motivational opportunities with inspirational overlap have been held for gifted pupils, who will subsequently help with the further dissemination and development of the Czech space ecosystem, and these activities will become a regular part of the Czech education system (e.g. the Zero-G campaign).
- o **Re point 2) b):**
 - At least 3 new study programmes, fields or specialisations for study in the field of space technologies or applications are created, or the capacity of existing ones at least triples,
 - At least 400 members will have passed through student associations and young professional associations focused on space activities,
 - At least 50 university teachers and 4 student associations will be actively taking part in defining the needs of the parties involved in student study and leisure activities, and these needs will be at least partially met,
 - The ESA training framework for students and young graduates has increased its capacity to at least 10 selected applicants per year,
 - At least 3 higher education institutions recognise active membership in student associations as work in a facultative subject (recognition as part of study requirements),
 - At least 5 foreign experts (visiting professors, industry experts, ESA, etc.) are involved in teaching or mentoring at Czech universities by the end of 2028,
 - At least 3 Czech universities have established a system for inviting and financing foreign lecturers specialising in space technology, applications or research,
 - At least 8 experts from the Czech space industry regularly participate in teaching or supervising master's and bachelor's theses.
- o **Re point 3):**
 - The Advertising Value Equivalency (AVE) of Czech space activities for the period under review will be at least CZK 5 billion.
- o **Re point 4):**
 - At least 10 trade missions, industry days or participations in foreign trade fairs focused on space activities are organized annually.
 - At least 4 new international agreements on cooperation in the field of space activities are concluded or at least 4 new memoranda of cooperation are signed, or a functioning coordination system for supporting mutual cooperation is created within the framework of at least 4 existing international agreements or memoranda of cooperation.
 - The Czech Space Week festival of space activities and at least 8 other industry days, information days, networking events, seminars and workshops are organised annually to promote awareness and cooperation at the national level.

o Re point 5):

- The number of start-ups incubated within the framework of technological incubation is at least 15 per year,
- At least 2 regional innovation centres are linked to ESA BIC or Space Hub, and regional resources are repeatedly used to support start-ups from the region,
- At least 5 events have been held to promote investor interest in investing in space activities, or we will actively participate in at least 5 such events,
- At least 2 ESA Technology Broker partnerships with industry/technology associations outside the space sector have been established or intensified for the purpose of technology transfer from/to the space sector,
- At least 5 new technology transfer projects between the space and non-space sectors are identified and supported annually,
- At least 2 technological areas of space projects with low involvement of Czech companies are identified annually and targeted activities are implemented to strengthen this participation.

o Re point 6):

- The potential of individual economic sectors in the Czech Republic for the use of satellite services and data is continuously analysed and the most promising ones for rapid adoption are identified,
- Furthermore, the user requirements of current and potential Czech users of solutions utilising satellite services and data are continuously mapped, and their demand is linked to innovative companies that could respond to it.
- At least 6 projects have been implemented to support business relationships between Czech users and Czech suppliers of solutions using satellite services and data.
- A robust application layer has been created on top of the satellite image data warehouse (e.g. the Sentinel cooperating ground segment).

o Re point 7):

- The asset register of relevant testing infrastructure and laboratory equipment, including the associated expertise, is updated on a continuous basis,
- There are at least 10 good examples of the use of testing infrastructure and laboratory equipment and related expertise for purposes other than those of the owner,
- The creation of at least one testing infrastructure or laboratory equipment within a joint testing centre is supported, which will complement the priority needs of Czech industry and academia (support will be provided on the principle of not creating competition with existing infrastructure, and the newly supported infrastructure will be integrated into the existing infrastructure network)

- At least one joint purchase and sharing of surplus materials, components, etc. has been implemented.

4.4 Priority area No. 4 – Institutionalisation of space activities in the Czech Republic

4.4.1 Description

The current management and coordination of space activities has long been reaching its functional limits, and the well-established support for the development of space activities is proving to be unsustainable in the long term and dependent on current political support. Despite the fact that ten times more entities have been involved in space activities over the last 15 years and the Czech Republic invests at least seven times more in this area, the core team at the Ministry of Transport, which is responsible for most space activities in the Czech Republic and coordinates the rest, consists of only a few individuals.

The Ministry of Transport, as the most active authority, whose powers are based primarily on government decisions, initiated the creation of the Czech Space Team, a team of active individuals employed by the Ministry of Transport and the CzechInvest agency, reinforced by systemic projects implemented in the Czech Republic thanks to the Czech Republic's membership in the ESA (ESA BIC business incubator, ESA Technology Broker, ESERO education office and ESA ambassador for satellite applications) and now the team of the state-owned company CENDIS dedicated to the implementation of the national project Czech Space Journey and the popularisation of space activities.

However, even this expanded team is currently unable to cover the entire spectrum of ESA and EU space activities in terms of capacity and expertise, especially those that have operational overlap and an impact on the security and defence capabilities of the state, and is only able to support the ever-accelerating development of Czech space activities and the development of the entire supporting space ecosystem with limited capacity, systematicity and sustainability.

4.4.2 Sub-objectives

This priority area pursues the following specific objectives in particular:

- changing the coordination of space activities to the management of space activities,
- transforming the Aviation Research and Testing Institute (VZLÚ) to utilise its potential for the development of space activities, aviation and the defence industry,
- establishing the Czech Space Agency.

4.4.3 Measures

In order to maximise the benefits of space activities for the economy and society, it is therefore necessary to start negotiations as soon as possible on a more robust state administration in the field of space activities and, following the example of other, even smaller states, to reopen the topic of establishing a national space agency. For these purposes, a suitable solution would be to **integrate the Czech Space Agency into the Ministry of Transport and initiate the transformation of the state-owned VZLÚ.**

VZLÚ can play a significant role in the development of space activities, as well as aviation and the defence industry, as its position and personnel and property resources can help to build it into a testing, integration and training centre, a technology park and a natural guarantor of international technological cooperation, and in the medium term, the Czech Space Agency.

As a parallel step, it is necessary to activate other relevant state authorities and institutions, better coordinate their activities, and replace the coordination of space activities with the management of space activities. To this end, it is necessary to consider and, if appropriate, propose that the Minister of Transport's Coordination Council for Space Activities be

transformed into the Government Council for Space Activities, as an independent advisory, coordinating and initiating body of the Czech Government.

At the same time, it is necessary to ensure sufficient human and financial resources to enable effective institutional support for space activities in the Czech Republic, both within the framework of the above-mentioned systemic steps (i.e. in particular the transformation of the VZLÚ and the creation of the Czech Space Agency) and in the meantime.

4.4.4 Performance indicators

The objectives of NKP 2026+ under this priority area are considered fulfilled if:

- As part of the mid-term evaluation by the end of 2028, the transformation of VZLÚ into a joint testing, integration and training centre, technology park and natural guarantor of international technological cooperation will be launched.
- As part of the mid-term evaluation by the end of 2028, sufficient human resources will be secured for institutional support of the Czech Republic's space activities, either by strengthening the existing team at the Ministry of Transport, securing capacities through VZLÚ or the Czech Space Agency, allocating personnel capacities for space activities within other authorities and institutions, securing external collaborators, etc.
- The Czech Space Agency will already be in existence by the time of the final evaluation at the end of 2032.

5. Evaluation of NKP 2026

An interim evaluation of the implementation of NKP 2026+ will take place in 2028 by evaluating the fulfilment of the indicators listed in Chapter 4. The final evaluation of the implementation of NKP 2026+ will take place in 2032 by evaluating the fulfilment indicators according to Chapter 4.

Annex No. 1 – Overview of space activity domains

1. Earth observation

Description of the domain

Earth observation (EO) involves the collection, analysis and use of data about the Earth through remote sensing technologies. This data is obtained primarily using optical and radar sensors. Satellite observations are the main source of information, but drones, new technologies using platforms in the upper atmosphere, and ground-based sensor networks are also playing an increasingly important role. The aim is to provide accurate and timely information on the state of land, atmosphere and seas for a wide range of uses in the public and private sectors.

Key European data sources include the Copernicus system (EU), which provides publicly available data with global coverage via Sentinel satellites, ESA satellites and EUMETSAT. In addition, new government Earth observation services (EOGS) are currently being developed, which will be supported by a completely new constellation of satellites.

The Galileo and EGNOS systems, which provide accurate positioning services for georeferencing Earth observation data, the new Destination Earth (DestinE) initiative focused on the digital twin of the Earth, and the DIAS cloud platforms, which provide access to and processing of large volumes of data, are also important parts of the European infrastructure.

With the growing demand for satellite data, the number of observation satellites and entire satellite constellations owned and operated by private entities is also growing. This represents significant opportunities for both the upstream industry and data processors and service creators.

The importance of Earth observation data is growing rapidly not only in the economy and security, but also in other sectors. Traditional users remain the environmental monitoring, including meteorology and climatology, but also the agriculture and food security (crop, water and soil monitoring), energy (renewable sources, infrastructure monitoring), urban planning and Smart Cities (spatial planning, transport), crisis management and humanitarian aid (natural disasters, humanitarian missions) and health and quality of life (air quality monitoring, heat islands), among others.

Trends

Although data show a shift towards cost-effective, scalable satellite constellations consisting of small satellites, large satellites for civil and defence purposes continue to drive the market.

Earth observation is undergoing rapid technological change. Thanks to new generations of satellites and entire constellations, the volume and resolution of data (spatial, temporal and often spectral) is growing. As a result, technologies for processing data directly in orbit using ML and AI are also developing rapidly. Another trend is the development of near-real-time services and the integration of Earth observation data with other sources (in-situ measurements, models, socio-economic data). Cloud platforms and new business models such as "data-as-a-service" are emerging.

Examples of use

- Security and crisis management support: disaster response, monitoring the course and impact of floods, fires, earthquakes or migration; border security, monitoring territory for defence and security purposes.
- Territorial development and mapping: monitoring the condition and development of settlements, documenting the condition of the territory, mapping land use and changes in the territory.
- Transport and infrastructure: monitoring the condition and development of infrastructure, sea ice and shipping.

- Agriculture and forestry: monitoring of vegetation, soil moisture and detection of crop stress, condition of forest stands.
- Environment, climate change, meteorology: long-term monitoring of climate indices, greenhouse gases, air quality, weather conditions and phenomena, changes in natural habitats, natural resource management, water quality.
- Economic indices: intensity of mining, agricultural production, movement of goods.

Business potential

The sector is becoming increasingly commercial and diversified in terms of the purpose, owners and operators of satellites. In addition to economic sectors, there is also a large increase in demand in the security sector.

The Earth observation market is growing dynamically and could exceed EUR 20 billion per year by 2030. Not only data providers but also developers of applications and services for end users play a key role. Commercial demand is growing in agriculture, insurance, energy, finance and infrastructure. Europe's advantage is the free availability of high-quality data from Copernicus, which creates space for innovation and new start-ups. However, commercial data with high spatial and temporal resolution is playing an increasingly important role where Copernicus is insufficient. This market is still relatively young and offers a number of opportunities!

Why participate

Involvement in Earth observation means access to data with global reach, the stable backing of European programmes (ESA, EU) and a rapidly developing innovation ecosystem. It offers the opportunity to participate in addressing global challenges such as climate change, cooperation in defence and security, food security and sustainable resource management. For businesses and research, it is an opportunity to create value from data and be part of new digital services with a social impact.

2. Satellite navigation

Domain description

Satellite navigation is a technology for determining position and time using signals transmitted from satellites orbiting the Earth. The basic systems are, for example, the American GPS, the European Galileo, the Russian GLONASS and the Chinese BeiDou. Satellite navigation is the basis of modern mobility, logistics, agriculture, telecommunications and crisis management.

Trends

Current trends are moving towards increased accuracy and reliability thanks to multi-GNSS receivers, the use of correction services (e.g. EGNOS in Europe) and combination with other technologies (e.g. inertial measurement, 5G, AI). There is a growing emphasis on the security and resilience of systems against interference and signal spoofing. New applications are emerging in autonomous transport, network synchronisation and smart agriculture. Precise Positioning Services (PPP-RTK) are also being developed, which improve localisation accuracy to the centimetre level.

- Low Earth Orbit Navigation (LEO-PNT) – increases accuracy and reduces signal latency; ESA is testing it in demonstration missions to strengthen the resilience of European navigation.
- Hybrid solutions – connecting GNSS with inertial and optical sensors or 5G terrestrial mobile networks to supplement navigation capabilities in areas with limited satellite signal reception.
- Security and resilience – emphasis on protection against jamming and spoofing, signal authentication and multi-frequency transmissions.

- Lunar navigation: The Moonlight project for navigation and telecommunications on the Moon.
- Miniaturisation of technologies and their integration into everyday devices and the IoT.
- Use of AI for processing navigation data and predicting user behaviour.
- Expansion of navigation use in the context of autonomous systems (cars, drones, ships).

Examples of use

- Transport: air (civil aviation, drones, etc.), land (driver applications, autonomous systems, etc.) and maritime transport, with applications in rail transport beginning to emerge.
- Logistics and shipment tracking: route optimisation, delivery prediction and goods security.
- Smart agriculture: precise sowing, fertilisation and harvesting based on accurate positioning.
- Critical infrastructure: time synchronisation of energy networks and public communication networks.
- Rescue operations and security: localisation of emergency callers and management of interventions.
- Mapping and geodesy: precise positioning.
- Time services: network synchronisation – banking, energy, telecommunications, terrestrial broadcasting, scientific experiments, etc.
- Defence: security of command and control systems and military weapon and information systems.

Business potential

The global GNSS market has significant growth potential – according to estimates, it will exceed EUR 500 billion in the next decade. The European Galileo system offers opportunities for services with higher accuracy and reliability, which strengthens sovereignty and economic independence. Satellite navigation brings the greatest added value in the areas of transport services, smart cities, telecommunications, Industry 4.0 and energy.

Why participate

Participation in the satellite navigation domain offers access to a highly innovative and rapidly growing market. For companies and research institutions, it represents an opportunity to collaborate on the development of applications, services and technologies with a European impact. Programmes such as Galileo and EGNOS are supported in the long term by the EU and ESA, thus ensuring stable investment. Involvement in this domain means an opportunity to influence future standards, create new market segments and contribute to Europe's technological autonomy.

3. Satellite telecommunications

Domain description

Satellite telecommunications encompasses a wide range of programmes focused on the development of innovative technologies, secure connectivity and strategic autonomy. A key pillar is the ARTES (Advanced Research in Telecommunications Systems) programme, which supports the development of advanced telecommunications technologies – from satellite platforms to applications for market validation of new solutions. The Civil Security from Space (CSS) programme links the capabilities of space infrastructure with the needs of security and civil authorities in crisis situations. The European IRIS² (Infrastructure for

Resilience, Interconnectivity and Security by Satellite) project is building a European multi-orbital constellation for secure connectivity for government and commercial users, combining LEO and MEO satellites with 5G and quantum cryptography support. The Moonlight lunar initiative aims to create a communications infrastructure for lunar missions. Together, these programmes strengthen European sovereignty, connect space and ground technologies, and respond to needs ranging from crisis management to space exploration.

Trends

- Ensuring extremely secure data transmission using quantum distribution of encryption keys.
- Hybrid networks – connecting terrestrial (5G/6G) and satellite networks for continuous high-speed connectivity anywhere on Earth.
- Small satellites and low-cost platforms – using CubeSats and mini-satellites for fast, inexpensive testing of new technologies and services.
- Secure government networks (e.g. IRIS²) – development of a European independent communication constellation for security and government purposes.
- Building lunar communication infrastructure (Moonlight).
- AI in data flow management – deployment of AI for autonomous control, traffic optimisation and efficient management of satellite networks.

Examples of use

- Eagle-1 – a satellite for quantum key distribution designed to demonstrate secure quantum communication between a satellite and ground stations in Europe.
- HydRON – an optical communication network testing data transmission between satellites and ground infrastructure.
- Sunrise – verification of low-orbit network architecture for providing broadband internet and digital services.
- QKD Sat – development of an experimental system for satellite quantum key distribution.
- Integration of satellites into terrestrial 5G/6G networks – ESA pilot projects with industry to ensure hybrid connectivity and seamless transition between networks.

Business potential

- Dynamic growth of the global connectivity market thanks to the development of LEO constellations and integration into 5G/6G networks.
- Opportunity to participate in pre-commercial, demonstration and innovation projects co-financed by ESA (e.g. under ARTES).
- Growing demand for cybersecurity solutions and encrypted communications for government and commercial satellite networks.
- Emergence of new business models and services in the downstream sector – for example in the areas of IoT, mobility, logistics and crisis management.

Why participate

Participation in ESA activities in the field of satellite telecommunications opens the way for companies to technologies with high innovation and commercial potential. Satellite communications are becoming a key component of global connectivity, security and digital sovereignty. Through programmes such as ARTES, ESA offers technical and financial support, access to partners and opportunities to test technologies in real-world conditions – an ideal starting point for companies that want to succeed in this field.

4. Space security

Domain description

Space Safety is a strategic domain linking science, technology, industry and security policy, with the aim of ensuring the safe and sustainable use of outer space. Within ESA, it is implemented through the Space Safety Programme (S2P, now entering its third operational period), **which focuses** on protecting life, infrastructure and the space environment from threats originating in space (Planetary Defence and Space Weather elements) and from threats created by human activity (Space Debris and ADRIOS elements – Active Debris Removal and In-Orbit Satellite Servicing).

The task of the Space Safety Programme is to detect, predict and mitigate these threats in a timely manner, develop new technologies/procedures/methods and, at the same time, support European industry and innovation.

Trends

- Increased interest in planetary defence – missions such as Hera (ESA) and Ramses (ESA + JAXA) demonstrate a growing emphasis on the ability to deflect potentially dangerous near-Earth objects.
- Space weather monitoring – the Vigil mission for early warning of solar storms to protect space and ground infrastructure, complementary small space weather monitoring missions, development of mathematical models and predictions (e.g. solar flares that can damage satellites and ground power grids), preparation of follow-up operational services.
- Active debris removal (ADRIOS) – development of technologies for capturing and removing non-functional satellites or preparation of missions to service satellites in orbit.
- Miniaturisation and nanosatellites – cheaper and more flexible solutions for monitoring and testing new technologies.
- Megaconstellations and Space Traffic Management – increasing orbital traffic (Starlink, OneWeb) brings new challenges in the field of orbital traffic safety and requires new solutions.

Examples of use

- Hera: mission monitoring NASA's DART impact on the asteroid Dimorphos – planetary defence test.
- Ramses: planned mission to the asteroid Apophis in 2029 – rapid response and asteroid exploration test.
- ClearSpace-1: the world's first mission to actively remove a piece of space debris (Vespa adapter).
- Vigil: mission for early warning of space weather from Lagrange point L5.
- DRACO: monitoring the destructive demise of objects in the atmosphere.
- Flyeye telescope: automated tracking of near-Earth objects (NEOs) in an extremely wide field of view.

Business potential

- Development of new technologies: robotic arms, capture systems, optical sensors, AI for navigation, small satellites and nanosatellites.
- Commercialisation of data and services: e.g. space weather prediction for aviation, energy and telecommunications, satellite in-orbit servicing, active space debris removal services, transition to a circular economy.
- Start-ups and spin-offs: new companies emerging from research and development in the field of space safety (e.g. Astroscale, ClearSpace).
- ESA projects: open calls for companies of all sizes – opportunity to obtain funding and access to ESA expertise.

Why participate

Participation in S2P P3 will ensure continuity for Czech entities in the implementation of high added-value projects (both scientific and technological) that have already been launched, and will open up new opportunities in the field of implementing new technological solutions (development of services and new missions, megaconstellations, STM, circular economy, etc.). According to the OECD, significant growth in the space security market is expected by 2030 (e.g., for satellite in-orbit servicing alone, average annual growth (CAGR) of 11.5% is estimated from 2023 to 2030.¹⁸)

5. Space transport

Domain description

The space transportation domain includes launch vehicles and ground infrastructure necessary for launching payload into space, as well as logistics systems in space and for returning payload from space to Earth. This domain covers a wide range of activities related to the development and operation of systems for transporting satellites and probes into space, including the preparation of these payloads prior to launch, the provision of transport services in orbit in the form of transfers from one orbit to another, refuelling and management of entire satellite fleets, and systems enabling re-entry into the atmosphere and landing on Earth. The domain also includes the construction and management of spaceports and test tracks for rocket engines.

Trends

- Reusable launch vehicles, which can dramatically reduce the cost of launching payload, continue to be the main trend.
- Launching huge constellations of satellites with high launch frequency.
- Competitive price pressure in the commercial payload launch sector, partly due to revenues from the institutional market.
- Achieving and maintaining absolute independence from non-European players and increasing the resilience of the sector, including security and defence payloads.
- Development of space logistics, such as refuelling, in-orbit servicing and assembly of satellites, and manufacturing in general.
- Management of large satellite fleets using AI.

Examples of use

- Establishing the capability to launch satellites and probes of all types and sizes using Ariane and Vega launchers and their upgraded versions.
- Development of new rockets with (currently) lower payload capacity through the Boost! and European Launcher Challenge (ELC) programmes.
- New engine (THRUST!).
- Reusable stages (BEST!).
- Tugs for transporting payload between different orbital paths (ASTRIS and PoC tug ISTV).
- Hub and fuel depot for in-orbit refuelling (ODYSSEY).

¹⁸ See On-Orbit Satellite Servicing Market (2023), <https://www.marketsandmarkets.com/Market-Reports/on-orbit-satellite-servicing-market-206789424.html>.

- Management of satellite fleet movements using AI, including for orbital data services and space debris removal (InSPoC-3 and InSPoC-4).
- Transport of payload from commercial space stations to Earth (LCRS).

Business potential

- Development of new technologies: avionics, materials, processes, production efficiency, reusability of rocket stages, new rocket engines and green fuels, robotic arms, capture systems, AI for large fleet management.
- Commercialisation: high launch cadence, democratisation of access to space, new business models such as payload aggregation, in-orbit refuelling and servicing, large fleet management and containerisation.
- New companies, start-ups and spin-offs: new companies in the space transportation domain (e.g. HyImpulse, HyPrSpace, Isar Aerospace, Latitude, Maia Space, Orbex, PLD Space, RFA, Sirius, Skyrora, The Exploration Company).
- ESA projects: open calls for companies of all sizes – opportunity to obtain funding and access to ESA expertise. Space transportation is a multi-billion pound market with enormous growth potential.

Why participate in the space transportation programme

Participation in space transport programmes will ensure continuity for Czech entities in the implementation of high added-value (scientific and, in particular, technological) projects that have already been launched and will open up new opportunities in the field of implementing new technological solutions. Europe is motivated to introduce new launch vehicles and maintain its own systems for accessing space. Countries are aware of a newly emerging operational domain beyond the launch of complex payloads into space, namely subsequent in-space operations/transport.

6. Robotic and human exploration

Description of the domain

Robotic and human exploration includes technological systems and missions focused on the study and use of destinations in low Earth orbit (LEO), on the Moon and its surroundings, and on Mars. These activities include the development of robotic probes, rovers and orbital stations, as well as the direct participation of astronauts in the exploration of these destinations and experiments in microgravity. The domain focuses on scientific research, technological innovation and preparation for long-term human stays outside Earth.

Trends

- The primary interest of states is in the polar regions of the Moon (some private companies are also involved), with the US and China dominating the race to the Moon in recent years.
- Countries are preparing a pair of lunar space stations in lunar orbit and subsequently building a station directly on the Moon's surface, which will require considerable transport capacity.
- The private sector is investing in the development of private space stations operated in LEO, which are to replace the ageing ISS after 2030, and in the case of SpaceX, also in extremely powerful launch vehicles for missions to Mars.
- Robotic exploration continues, which is significantly more cost-effective than human spacecraft missions.
- Large programmes typically involve cooperation between a number of countries, while at the same time a number of small missions are being developed and so-called

occasional missions are being used, where participation is in the role of a minority partner.

- Commercial activities no longer concern only ISS equipment and receiving station services, but are also being prepared for lunar activities (SpaceX's plans to colonise Mars are a specific chapter).
- Investments are being made in radioisotope generators and heaters, the possibilities of using ISRU resources in space are being explored, and the protection of astronauts from radiation in deep space and various aspects of long-term stays in space are being addressed.

Examples of use

- Both the European modules of the Gateway space station in lunar orbit and the Mars Sample Return mission series are in the implementation phase (in both cases, the position of the US is important).
- The Argonaut lunar landing module will be available for routine use in surface exploration and will also be offered to international partners.
- The LEO Cargo Return Service (LCRS) is being prepared as a means of exchange with space station operators for flight opportunities for European astronauts to these stations.

Business potential

- Development of new technologies: discoveries in materials engineering, biotechnology and pharmaceutical research utilising microgravity are expected in LEO.
- Commercialisation: operations around the Moon (but also further into the Solar System) will require navigation and telecommunications services, which are also expected to be provided commercially rather than by government agencies; the Moon offers opportunities for mining and exploiting resources such as water ice and helium-3.
- New companies, start-ups and spin-offs: the presence of astronauts beyond the Van Allen belts brings along the need to solve a whole range of technical problems related to life support systems and health protection, while other European companies are developing or already operating commercial services on the ISS or within the ground segment.

Why participate in the exploration programme

Participation in the European Exploration Envelope Programme (E3P) Terrae Novae robotic and human space exploration programme represents an opportunity to be part of one of the most ambitious fields of our time. Involvement in these activities enables the development of breakthrough technologies such as autonomous systems, materials resistant to extreme conditions, and more. Cooperation on projects exploring the Moon or Mars brings prestige and increases the Czech Republic's soft power, thereby opening up access to new markets and the opportunity to stand alongside global leaders in innovation, rather than behind them. Robotic and human exploration also supports sustainable development, improves our understanding of space and contributes to solving problems on Earth. Participation in the programme not only supports economic growth, but also contributes to building a better future for humanity. The national project Czech Space Journey, in which a Czech astronaut is preparing for a flight to the ISS, would largely lose its meaning without Czech participation in the E3P programme.

7. General space technologies

Domain description

The European Space Agency's programmes for the development of general space technologies (ESA), specifically the Technology Development Element (TDE) and the General Support Technology Programme (GSTP), focus on the development of technologies that are universal and usable in a wide range of space missions, i.e. they are not specific to one domain, but bring innovation across diverse areas from Earth observation to interplanetary exploration or launch vehicles. Dual-use technologies are of particular importance here.

Trends

- Both programmes are extremely broad in scope, so it makes no sense to describe trends across all domains of space activities below, but only transversal ones. However, in terms of the volume of projects implemented, a trend can be seen primarily in the areas of EEE components, Zero Debris and IOS, platform standardisation, advanced manufacturing, VLEO technologies, phased array antennas, advanced propulsion, industrialisation, and secondarily in optical and radar systems and radio frequency technologies, navigation, nuclear energy, cryogenic systems, cosmic radiation, materials science and ISRU.
- Dual-use technologies.
- ML and AI.
- Digitalisation and increased emphasis on cyber security.
- Quantum technologies.

Examples of use

- Discovery Element allows you to explore ideas at the lowest TRL and verify their applicability.
- The Preparation Element is used to carry out phase 0 studies for planned missions and to verify commercial potential.
- The Technology Development Element (TDE) is designed to advance technologies at low TRL in the early stages of a mission or even before the start of a mission as a so-called mission enabler.
- GSTP Element 1 Develop is designed for higher TRLs and allows ESA to address its needs through work plans, but also to respond to the needs of companies or states, either by including projects in work plans at their initiative or through the use of tools for technology de-risking or the development of so-called building blocks, which are critical parts of future systems.
- GSTP Element 2 Make is a bottom-up gateway through which companies can co-finance the refinement of their technology at a high TRL with a clear product vision.
- GSTP Element 3 Fly focuses on providing access to space for new technologies, services and applications by demonstrating and verifying them in a real space environment (IOD/IOV), which is essential for the successful launch of a space product/service on the market.

Business potential

- Development of new technologies: the programme allows technologies to be refined according to ESA requirements (fully funded) or company requirements (usually co-funded) before being launched on the market.
- Commercialisation: the programmes emphasise market applicability, with development culminating in qualification or even flight opportunities.
- New companies, start-ups and spin-offs: the programmes are suitable for emerging companies, and the ESA team is accustomed to helping such companies.

- ESA projects: the programme partly responds directly to ESA's needs and partly has a bottom-up character, which is mostly co-financed.
- Dual-use technologies can also be developed within the framework of EU, NATO and other instruments with a view to their deployment in defence.

Why participate in these programmes

Participation in the TDE and GSTP programmes represents a unique opportunity to get involved in the development of technologies that have the potential to change the future of the space industry in a short period of time. These programmes support innovations that can be used not only in space missions but also on Earth, contributing to technological progress and economic growth.

Cooperation with ESA provides prestige and access to a global network of experts and institutions. In addition, it opens the door to new business opportunities, from the development of specialised equipment to the commercialisation of data and technologies.

The programme is extremely flexible and allows for the implementation of activities that, for example, could not be pushed through in some programme councils against the will of other countries that protect their companies through voting.

8. Scientific programme

Domain description

ESA's scientific programmes include astronomical and astrophysical missions, as well as robotic exploration of the Solar System (planets, comets and other cosmic objects). Their aim is to expand our knowledge of the universe, its origin, composition and dynamics. The selection of missions to be undertaken is done autonomously by the scientific community, albeit within the limits set by ESA (the executive and member states).

Trends

- Calls for proposals respond to current scientific issues and ensure the highest possible relevance of missions, which is why the last two major ESA missions have focused on the study of gravitational waves and the icy moons of gas giants.
- Inflation and the limited willingness of member states to increase the budget of the ESA Science Programme at several recent ESA Councils at ministerial level have caused a significant internal debt, which has resulted in the cancellation of the M6 mission. If this trend continues, there will be a long period during which it will not be possible to launch a new mission and no missions will be launched, which will seriously damage the ESA's reputation as a first-class agency.
- The US administration has presented an austerity proposal in NASA's draft budget for scientific missions.
- The trend in recent years has been to use ML and AI to process existing data, which is leading to new scientific discoveries.

Examples of use

- The Rosetta mission, which explored comet 67P/Churyumov-Gerasimenko, achieved a number of world firsts and enabled many technological innovations.
- The Gaia mission has created a detailed catalogue of billions of stars and other objects in our galaxy, contributing to the study of its dynamics and evolution. In terms of scientific output, it has become the most successful space mission in terms of the number of articles published per year, surpassing even the Hubble Telescope.
- Exploratory robotic missions to the Solar System, such as Solar Orbiter to study the Sun, BepiColombo to study Mercury, JUICE to study Jupiter's moons, and the Euclid robotic mission to study dark energy and dark matter, are all unique in their focus.

- Equally important are upcoming missions such as PLATO to study Earth-like exoplanets, Ariel to study exoplanetary atmospheres, Comet Interceptor to conduct detailed exploration of long-period comets or interstellar objects, and the EnVision mission to study Venus.

Business potential

- Development of new technologies: the technologies used are often at the very limits of human capabilities and, in the long term, find their way into products and services.
- Commercialisation: ESA scientific programme missions do not usually have a short-term return on investment in terms of the marketability of the instruments and methods developed.
- New companies, start-ups and spin-offs: the programme is not particularly suitable for start-ups, as the TRL requirements demand established companies that already have experience.
- ESA projects: the programme can be used to test flight hardware/software, which can help participating companies establish themselves on the market, and it makes sense to support such participation (unless it involves the repeated production of the same type of hardware/software).

Why participate in this programme

Participation in ESA Science Programmes is automatic and the level of funding is derived from the GDP of the Member States. It offers the scientific community a unique opportunity to participate in world-class research. It thus brings prestige and increases the soft power of the Czech Republic, thereby providing access to new markets and the opportunity to stand alongside global leaders in innovation, rather than behind them.

ESA missions have excellent scientific returns. For missions in cooperation with NASA, European scientists are relatively more successful than Americans in competitions for observation time, so the cost-benefit ratio is excellent. Within the ESA, Czech scientists are very successful in using data from scientific missions – in terms of the ratio of first-author scientific publications using ESA mission data to national financial contributions, the Czech Republic ranks fourth among ESA member states.

9. Space education

Description of the domain

The space education domain focuses on the systematic use of space as a tool to motivate pupils and students to study STEM subjects. Space as an educational and cultural phenomenon fascinates across generations and offers strong inspirational potential for the younger generation. This domain therefore links the formal education system with non-formal and informal education activities and supports educational organisations, schools, science centres, student associations and other relevant entities.

The national project Czech Space Journey integrates educational and communication activities across all age groups. A key event will be the preparation of Czech astronaut's flight to the ISS at the turn of 2027 and 2028, which will be used as another educational and inspirational catalyst for the Czech education system.

Trends

- The introduction of space topics into school curricula and the creation of facultative subjects focusing on space in secondary schools.
- Involvement of schools and pupils in European ESA Education projects (Astro Pi, Moon Camp, CanSat, Climate Detectives, Mission X) coordinated by ESERO offices and national projects such as the Czech Rocket Challenge.

- Development of projects such as the Zero-G campaign for selected students and teachers.
- Creation of specialised schools and fields of study, e.g. the first secondary school in the Czech Republic focusing on space and other fields of study at universities.
- Strengthening the role of teachers, science centres and student associations.
- Active cooperation with industry and recognised student activities in the academic sphere.

Examples of use

- Teaching STEM subjects through space examples and phenomena.
- Student projects with real-world applications, e.g. rocket, satellite or autonomous rover launches, microcomputer programming on the ISS or the use of satellite images.
- Working with talented young people, e.g. selecting young ambassadors as part of the Zero-G campaign or motivating the most active students to win awards as part of Space Hero.
- Training for teachers.
- Involvement of science centres and popularisation events in school education.

Business potential

- Support for the creation of new educational services, educational start-ups and digital content (e.g. virtual reality or AI in class).
- Development of partnerships with companies and industry – internships, mentoring, experts in class.
- Increasing the skills and readiness of the future workforce in the space sector.

Why participate in this programme

Space education offers not only inspiration, but also a direct opportunity to prepare Czech students for a future in which the space sector will be one of the important components of the economy. The active participation of schools, institutions and companies in this domain is the way to educate top experts who are in high demand across all fields, not just in space. It is also an important aspect for the popularisation and education of science and technology across Czech society.

Appendix No. 2: Institutional anchoring of space activities in the Czech Republic

Ministry of Transport	Overall coordination of the Czech government's space activities; responsibility for domestic regulatory and support activities, including the preparation and implementation of the NKP; overall responsibility for membership in the ESA; responsibility for EU space policy and EU space systems (Copernicus is a shared competence with the Ministry of the Environment), including the interface with EUSPA; responsibility for EU framework programmes for space research and innovation; interface for standardisation in space activities, contact point for international cooperation in space activities; coordination of downstream development, cooperation with the Ministry of Foreign Affairs within the UN Committee on the Peaceful Uses of Outer Space (COPUOS), responsibility for membership in its Scientific and Technical Subcommittee and cooperation with the Ministry of Foreign Affairs in its Legal Subcommittee, and others.
Ministry of Education, Youth and Sports	Overall responsibility for education and research and development, including international cooperation; cooperation with the Ministry of Transport on ESA membership, overall responsibility for coordinating EU framework programmes for research and innovation; responsibility for supporting large research infrastructures and the Czech Republic's membership in international organisations in the field of research and development established under international law (e.g. ESO and CERN).
Ministry of Industry and Trade	Overall responsibility for state industrial and trade policy and for supporting entrepreneurship and industry; responsibility for electronic communications, membership in ITU, ITSO and EUTELSAT IGO. Supporting organisations: Agency for the Support of Entrepreneurship and Investment (CzechInvest) and Czech Trade Promotion Agency (CzechTrade).
Ministry of the Environment	Responsibility for membership in the GEO Group and EUMETSAT, responsibility for the development of sectors in related fields of environmental protection; joint responsibility for the Copernicus programme. Supporting organisation: Czech Hydrometeorological Institute (ČHMÚ).
MFA	Responsibility for Czech foreign policy and international law; overall responsibility for membership in COPUOS, including responsibility for membership in the COPUOS Legal Subcommittee; diplomatic assistance and support.
MO	Responsibility for the defence of the Czech Republic; control over the armed forces of the Czech Republic; responsibility for managing defence research and development; responsibility for the Czech Republic's membership in the European Defence Agency (EDA) and NATO; responsibility for developing the use of satellite data and services in the field of defence. The Satellite Centre of the Czech Republic (SATCEN ČR) operates within the Ministry of Defence as part of Military Intelligence, which is the national element of image intelligence and, within the Ministry of Defence, the manager for the development of ISR (Intelligence, Surveillance, and Reconnaissance) capabilities in the SPACE operational domain and the development of national capabilities in the field of space exploration. To fulfil these tasks, autonomy is required in the areas of development,

	procurement of new technologies and building a complete chain of space systems.
Ministry of the Interior	Coordination of the use of satellite data and services in the field of internal affairs, including the Czech Police, the Fire and Rescue Service and the Office for Foreign Relations and Information, responsibility for managing security research and development.
Government Office	Coordination of European policies, seat of the Executive Secretariat of the Council for Research, Development and Innovation, and coordination of science, research and innovation.
NÚKIB	Guarantee and regulation of cyber and information security and national contact point for the publicly regulated service of the Galileo system (PRS) and Govsatcom, security accreditation of EU space systems and activities.
ČÚZK	Responsibility for the operation of the Czech public network of permanent GNSS stations (CZEPOS), which provides data from GNSS and other related services, responsibility for national reference systems and connection to European and global implementations.
ČTÚ	Responsibility for radio spectrum management, including issues related to the registration of satellite networks with the International Telecommunication Union (ITU), radiocommunications sector. The CTU is the body responsible for monitoring the radio spectrum and exercising state control over electronic communications, including resolving radio frequency interference in all frequency bands, including satellite frequencies.

Annex No. 3: Capacities and capabilities of the Czech Republic in the field of space activities

Current Czech capabilities and capacities could be utilised in the upstream, midstream and downstream areas of the space industry to reflect existing or emerging market opportunities. Further support and development of the existing ecosystem, which already has expertise and a solid background in space activities, would also strengthen the reuse of products across related markets. This would increase overall revenues and secure additional resources for future research and development.

1. Upstream

Many technologies, products and services have a purely general purpose, which means that they can be used in a number of space domains (as well as for non-space applications).

Design and manufacture of flight hardware

Key competencies in this area include, for example:

- design and manufacture of mechanical parts or entire systems;
- structural health monitoring (SHM);
- equipment for materials science and technology in space;
- electronic, electrical and EMC system design;
- manufacture of reliable electronic equipment in clean rooms for space missions;
- development of digital circuits and single-chip computers;
- use of wireless sensors during flight;
- instruments and equipment for crystallochemistry, the study of crystal growth and melt solidification processes, crystal growth for technical applications
- optics, including X-ray optics, acousto-optic tunable filters, cameras for hyperspectral imaging, electro-optics, adaptive optics, surface treatment of free-form optical components, thin films, polarizers in the infrared and THz range, laser applications, precision mechanics, etc.;
- inertial sensors for use in space applications;
- nuclear engineering applications in space;
- development and manufacture of instruments and equipment according to specific requirements and various space applications, including mechanics, optics and electronics, including automated and manual assembly of printed circuit boards, manufacture of pressure and temperature sensors, trace moisture sensors, design and manufacture of special connectors and cable harnesses, use of COTS components suitable for the space environment.

Mechanical systems for space applications

The Czech space industry has a long history in the field of mechanical systems for space applications. A good example of its current capabilities is the supply of mechanisms for deploying solar panels for the new generation of Iridium satellites. Other areas currently under development include positioning mechanisms for antennas, nozzles and various structural elements.

It is recommended to leverage experience in the design, testing and manufacture of mechanical systems for both ESA and commercial projects.

Key competencies in this area include, for example:

- design, elasticity and strength calculations, thermal calculations and flow analyses; fatigue life and fracture mechanics assessment;
- design and optimisation of highly loaded elements;

- numerical calculations involving complex multiphysical effects;
- temperature analyses and subsystem designs for space applications;
- measurement of thermal emissivity, absorptivity and thermal conductivity at low temperatures;
- strength assessment of components for the space industry;
- aerodynamics, aeroelasticity, acoustics;
- climatic and mechanical testing of components, parts and materials, and durability testing;
- additive manufacturing (3D printing);
- production of composites and bonded sandwich structures, very high strength epoxy adhesives, epoxy resins for laminating, drawn composite profiles and sandwich panels, e.g. for radiation shielding;
- custom design, development and commercialisation of hi-tech polymer and nanocomposite materials with special properties;
- custom production of thin films for electronic and optical applications, production of thin-film components by magnetron sputtering, ion beam etching and UV photolithography;
- production and supply of qualified mechanical parts, assembled modules and subsystems, e.g. mechanical subsystems for solar panels;
- design, development and integration of opto-mechanical and opto-electronic subsystems for optical and X-ray telescopes (costs) of satellites.

Electrical power supply and control systems for space applications

Specific areas where these are particularly important:

- power management, including conversion and distribution (e.g. power processing unit, power control and distribution unit, advanced monitoring functions such as electrostatic discharge monitoring and prevention);
- electrical control (e.g. electric motors, position actuators – reaction wheels, force gyroscopes, flow control units, electric pressure regulators and thrust vector control systems, and other actuators and mechanisms);
- energy storage systems, including energy accumulation and generation (e.g. battery systems including battery management, innovative energy storage concepts and, where applicable, capacitors and supercapacitors);
- thermal management (e.g. cryogenic cooling, heating, heat exchangers)
- systems for generating electricity using solar panels (both fixed and flexible).

However, this is a highly competitive area with several well-established European players.

Software

In summary, competencies in this area include, for example:

- on-board software:
 - complete software packages (developed through a complete development cycle from requirements definition through architectural design, detailed design, implementation, delivery and acceptance phases);
 - initialisation, application and control software, and software critical to mission fulfilment;
 - on-board software for controlling satellites/probes and their subsystems, including instruments, now also using AI;

- ground segment software for ESA ground stations, such as satellite control systems, mission control systems (MCS) and EGSE (e.g. for ESTEC, ESTRACK, etc.). Software for ground infrastructure, such as antenna robotisation, control system development and tracking software;
- development of software for remote sensing and navigation service infrastructure.

Simulation and testing

In summary, competencies in this area (existing mainly in aviation) include, for example:

- strength and thermal calculations and flow analyses;
- fatigue life and fracture mechanics assessment;
- verification of highly stressed components and their optimisation;
- numerical calculations involving complex multiphysical effects;
- temperature analyses and subsystem designs for space applications;
- strength assessment of components for the space industry;
- testing of climatic and mechanical resistance of components, parts and materials, testing of aerodynamic and acoustic properties, aeroelasticity and service life;
- couple load analyses (analyses of the connection between the rocket carrier and the payload)
- environmental testing in a thermal vacuum chamber, outgassing measurements, atomic oxygen, UV radiation, rheology, simulation of the effects of cosmic radiation;
- precise coordinate measurement of dimensions;
- optical microscopy, ultrasonic, thermographic and X-ray non-destructive testing, including robotic industrial CT;
- high-resolution X-ray imaging and computed tomography;
- design and manufacture of EGSE, SCOE and unit testers, testing of semiconductor components and assembled printed circuit boards;
- central control systems (CCS)
- EMC laboratories, testing of cable harnesses and electronics, including passive components;
- optical microscopy, atomic force microscopy, scanning electron microscope, confocal microscope, X-ray optical test bench, vacuum test bench, X-ray optics characterisation, FTIR, NMR;
- high voltage load tests for ion engines;
- design and preparation of radiation tests for electronics;
- ISO8/ISO7/ISO5 clean rooms

On-board systems

The next generation of on-board systems platforms is expected to integrate European technologies that are independent of technologies subject to US export restrictions. The new generation of on-board platforms covers five main areas in which the Czech space industry also has capabilities:

- hardware platform including:
 - on-board computers and platforms for control, data processing, guidance and navigation equipment, payload processing;
 - modules based on modern encapsulation technologies such as system-on-chip, multi-chip modules, system-on-package and system-in-package;
 - modules extensively integrating multiple multi-core and many-core chips;

- AOCS;
- software platform including:
 - reference software architectures that enable software reusability across different space missions and across the space and aviation industries;
 - mechanisms to ensure reliable separation of functions through temporal and spatial separation of spacecraft and/or aircraft memory spaces.
 - positioning and control algorithms
- network interfaces/data buses, including payload and platform buses that reflect the growing demand for high-speed interfaces, time-triggered Ethernet (TTE) networks.
- modules ensuring the reliability of on-board data systems, such as:
 - system reference architectures;
 - external device interfaces;
 - network interface cards;
 - Integrated development toolkits to accelerate development and the verification and validation cycle, including tools for concurrent software and hardware design and to support the entire development cycle.
- integrated testing facilities enabling application testing in laboratory conditions, and thus in the early stages of the development cycle.

According to studies that have already been conducted, some of the key determining characteristics are:

- increased performance;
- reduction in size, weight and power consumption (SWaP);
- implementation of functional services linked to on-board communication;
- streamlining of interfaces;
- new architectures for low-level and application software;
- greater modularity and support for multiple devices simultaneously;
- high data line throughput and increased memory capacity.

In addition, there are a number of technologies, products and services that are specific to the particular domain of space activities (and sometimes have non-space applications).

Laser technologies

The Czech Republic has historical experience in the development of various laser devices for space applications. The Czech academic sphere is highly regarded by the ESA in this regard, particularly in the areas of laser communication, laser measurement and tracking (LIDARs) and in research into laser-matter interactions, which are used for plasma propulsion, material analysis in space, and laboratory astrochemistry and astrophysics. These activities are further supported by centres of excellence in research and development in the field of laser technologies and their applications (HiLASE Centre, PALS and eli-ERIC). For this reason, the long-term goals of research organisations involved in laser systems have expanded significantly into the field of space in recent years. Laser technologies are also used in instrumental analysis for in situ exploration using rovers and landers.

Based on its existing know-how, critical knowledge and access to state-of-the-art laser equipment for research and development, the Czech Republic has unique capabilities to develop new laser instruments for revolutionary areas of space technology. These capacities and capabilities should be further developed so that they can be used in:

- space exploration and analysis, with an emphasis on raw material resources
- monitoring, controlling and recycling space debris;

- long-term interplanetary and interstellar travel.

Specific technologies include, in particular:

- material processing using laser technologies, such as the treatment and machining of special surfaces and materials that can also be used in space environments;
- laser sources, which are the basic building blocks of technologies such as LIDARs, LIBS systems for material analysis, or systems for additive manufacturing in space;
- laser sensor systems, especially in connection with orbital or extraterrestrial stations;
- laser systems for manipulating space objects, including functional satellites or space debris;
- complex laser analytical instruments (LIBS, LAMS).

Earth observation

The Czech Republic has a developing and technologically competent ecosystem in the field of Earth observation in the upstream segment. A number of industrial and research institutions are involved in the preparation and delivery of satellite subsystems, optical and radar sensors, mechanical structures, thermal and power systems, as well as software for satellite control and on-board data processing.

In the academic sphere, institutions focusing on sensor preparation, calibration and validation, satellite measurement simulation, optics and photonics, AI for on-board data processing, and new Earth observation mission concepts are particularly prominent. Between 2022 and 2024, preparations were made for the 12U cubesat SATurnin-1 for the needs of the Ministry of Defence. In the same year, the AMBIC mission was selected for implementation. This is a 100 kg class satellite that will provide data for government use and for services provided by industry.

Another important facility is the Flying Laboratory of Imaging Systems (FLIS), used to collect aerial hyperspectral data and laser scanning data for research and application projects in the field of environmental monitoring. It is also used to calibrate and validate existing and newly developed satellite sensors.

- proposal, design, preparation, and integration of entire Earth observation missions (currently mainly in the form of multi-unit CubeSats, with a 100+ kg class mission also in preparation);
- development, design and manufacture of high-tech optical systems, including active and adaptive optics, aspheric and free-form optics, related precision mechanics and new materials with special properties (e.g. crystal growth, thin-film optics, etc.);
- development of hyperspectral and thermal systems for observing atmospheric phenomena and the Earth's surface;
- microaccelerometers for SWARM satellites for precise measurement of motion caused by non-gravitational influences on the satellite's orbit;
- cryogenic equipment for cooling payloads on Earth observation satellites (used, for example, on MTG);
- software for processing satellite data in orbit (on-board data processing), including the use of AI;
- development of high-altitude platforms (HAPS) for Earth observation;
- qualified production of cryostats (MTG, Copernicus CO2M)
- SCOE, EGSE for Earth observation satellites/missions;
- other capacities are listed in the areas of laser technologies, flight hardware, on-board systems, simulation and testing, and others.

Multi-constellation GNSS

The Czech Republic has highly specialised expertise in the following areas:

- precise time and clock measurement, which complements the field of GNSS. These professional skills are important for the on-board control of atomic clocks or for the distribution of precise time via optical satellite networks.
- scientific use of GNSS, specifically in the field of researching atmospheric influences on the propagation of electromagnetic waves, including the GNSS part of the spectrum.
- space geodesy and precise determination of satellite orbits.
- Satellite orientation and trajectory control, where Czech industry focuses on the development of AOCS system components such as gyroscopes and MEMS-based inertial sensors.
- Development of software-defined GNSS receivers, processing of SBAS system data and monitoring of GNSS signal quality.

Satellite communications

Czech industry has considerable experience in:

- the development of satellite communication terminals for civil and military aviation, including unmanned aerial vehicles (UAVs),
- communication terminals and associated products such as power amplifiers, data links and security gateways, which are the basic products of Czech industry's telecommunications technology development, focusing on security-critical data and voice communications for air traffic control,
- secure quantum optical communication, where the academic community has theoretical knowledge that helps develop unbreakable quantum cryptographic techniques, laser transmitters and photon receivers, and sensor heads. In addition to the above-mentioned telecommunications products, long-term academic interest has focused on the modelled propagation of electromagnetic fields through the atmosphere.
- The academic sphere and industry have know-how in the areas of quantum cryptographic key distribution (QKD), including Quantum Trusted Node,
- space and ground hardware for telecommunications satellites, which, however, have nothing to do with the field of telecommunications itself (supercapacitors, solar panel deployment/unfolding mechanisms, antenna pointing mechanisms, fuel tanks and other components).

Launch vehicles and propulsion systems

Current capabilities are based on existing local industrial capacities, capabilities and cooperation across the industrial sector and the research and development sector (universities, research institutions). The industry already benefits from synergies between individual sectors (space, aviation, automotive), which leads to long-term benefits for the national economy. The use of technologies and suppliers that have not yet been involved in the traditional space industry is a way to achieve this goal.

Czech industry is involved in the production and integration of Ariane 6 booster engines, critical components of turbo pumps for rocket engines, and the development, production and integration of small satellite launch equipment, control and two other types of valves, and control electronics for Vega launch vehicles. Components for a new rocket engine with a deep throttle valve for Vega E are being developed in the Czech Republic. Furthermore, the production of Ariane 6 booster engines has been established here and the production of the first parts is already underway. The launch of Ariane 6 start-up activities is planned. Czech industry also supplied key components for the Ariane 6 launch pad, in particular the flame deflector installed in the trenches under the launch pad and the electrically powered mobile platforms for the mobile gantry crane. Furthermore, Czech industry projects are underway to

develop critical on-board software for processing Ariane 6 telemetry and subsystems for the Ariane 6 ground segment at the French space agency CNES.

Another possible area of Czech interest is small launch vehicles (micro-launchers), in particular sounding rockets, which ESA has not yet focused on, with the exception of the FLPP programme and future space exploration missions.

The industry is currently developing technologies in the following promising areas:

- mechanisms and composite and metal structures;
- satellite installation and launch systems
- separation systems for small satellites;
- low-impact release mechanisms;
- monomers and polymeric materials (coatings, adhesives, casting resins);
- synthesis and customised surface treatments using nanoparticles;
- nanocomposites and hybrid composites;
- thermal insulation materials;
- multifunctional anti-corrosion coatings;
- use of wireless sensors during flight;
- structural systems for monitoring the condition of structures;
- computational mechanics;
- system-level design, aerodynamics, aerothermodynamics, acoustics;
- properties of the aerodynamic cover of the payload;
- insulation systems and comfort damping for payload protection;
- high-performance valves and control electronics;
- electrically powered pumps for rocket propellants and multi-phase ammonia-based cooling systems;
- high-performance valves for cryogenic rocket engines and their control electronics;
- a loosely related area is high-altitude platforms (HAPS) and their payloads, particularly for Earth observation and telecommunications;
- new metallic materials for launch vehicle structures;

Space Situational Awareness (SSA)

Czech industry and academia are actively involved in SSA activities, both within the framework of the ESA Space Security Programme (where the Czech Republic's most significant contribution is its involvement in complex missions such as HERA, VIGIL, Clearspace-1, RAMSES, etc.), as well as in other initiatives related to SSA issues (mostly involving the sharing of data from the observation and monitoring of SSA phenomena or the provision of relevant scientific expertise, e.g. through the EU SST project or complementary activities carried out under Horizon Europe).

Space Weather (SWE):

- provision of SWE services (solar activity forecasts, real-time monitoring of ionospheric phenomena, daily geomagnetic forecasts, radiation dosimetry);
- use and application of SWE sensors (imaging of the Sun in white light and H-Alpha channel, observation of solar radio radiation, ionospheric monitoring, geomagnetic observations, spectrometry);
- development of SWE applications (detection and monitoring of ionospheric disturbances, research in the field of magnetosphere, geomagnetic disturbance forecasts, dosimetry applications for manned space missions);

- development, testing and calibration of SWE sensors, e.g. based on TimePix, for precise measurement of cosmic radiation in orbit (radiation effects on satellites, radiation dosimetry for human spaceflights);
- studies and modelling for the SWE field;
- processing of SWE data.

Space Surveillance & Tracking (SST):

- SST debris monitoring and cataloguing;
- processing of SST data and development of software applications;
- technology for combining SST sensors;
- development and qualification of SST sensors (optical and laser technologies).

Czech industry and academia are active in the optical observation of space debris and the processing of related data. Regular observations are carried out for the purpose of cataloguing new space debris, but also for the subsequent refinement of existing data. Effective cooperation has been established between active SST observers and data processing experts, and SST observations are carried out according to defined schedules. The data obtained is then forwarded to the ESA Expert Centre for further analysis.

Czech industry and academia continue to collaborate on control and process software for SST telescopes (particularly within the scope of the ESA network, e.g. Test-bed telescopes in Spain and Chile).

Near Earth Objects (NEO)

- observation and characterisation of NEOs;
- activities related to mitigating the consequences of possible NEO threats (including monitoring fireballs);
- advanced spectroscopic technologies for NEOs;
- research and development in the field of special optics, optoelectronic systems and optical measurement methods, robotisation and remote control of telescopes;
- development of software for NEO telescopes (assignment and scheduling of NEO observations, long-term archiving and analysis of NEO data).

Other capabilities of the Czech academic sphere related to NEOs include autonomy analysis and on-board software development, planetary geology research, spectroscopy, optical navigation, NEO internal composition analysis, NEO structural analysis, data processing and autonomous navigation algorithms.

As in the case of test-bed telescopes, which are usable for both SST and NEO applications, Czech entities have successfully participated in the implementation of a unique Fly-Eye telescope with an extremely wide field of view for planetary defence purposes. The first of these telescopes is currently undergoing testing (2025, final location in Monte Mufara, Italy), and similar involvement by Czech entities is also expected in the deployment of the second Fly-Eye telescope (to be located in the southern hemisphere).

Space science and space research

A specific upstream area is on-board scientific instruments. The direct participation of Czech research institutions and their industrial partners includes:

- a dual Langmuir probe (DSLP) and a thermal plasma measurement unit (TPMU) for the Proba-2 satellite;
- low-frequency wave analyser and power supply for radio and plasma wave measurement instruments on the JUICE probe;
- compact personal dosimeters for real-time radiation research and monitoring in NASA living quarters on the ISS;

- radiation detectors for the Gateway stations for the ESA experiments IDA (Internal Dosimetry Array, radiation effects, astronaut radiation dosimetry) and ERSA (European Radiation System Array, cosmic radiation research, space weather);
- particle detector for environmental research aboard the Moon Orbiter probe (Intuitive Machines);
- wide-angle directional Compton gamma camera for the THOR astrophysical experiment aboard Space Rider;
- Timepix-based focusing X-ray telescopes aboard VZLUSAT-1 and VZLUSAT-2
- X-ray scintillation detector using enriched garnet single crystals;
- experiments to evaluate the short- and long-term effects of radiation on algae and cyanobacteria;
- a single-photon laser detector for the ELT instrument comparing the mutual deviation of atomic clocks on the ISS and on Earth using laser pulses;
- acoustic-optical infrared filter with fast tuning based on a calomel single crystal;
- power supplies with distribution units;
- development and design of optics for scientific instruments;
- modules for instruments for measuring and analysing radio and plasma waves;
- sensitive electronics for scientific instruments of the ATHENA mission (so-called Row Addressing and Synchronisation for the X-IFU instrument and galvanic isolation modules for WFI) and scientific data simulations to determine the required parameters for the X-ray detector on the ATHENA satellite;
- magnetic divertor for the ATHENA mission;
- secondary mirrors for the Ariel space telescope;
- electronic systems for the VenSpec-H spectral analyser for the EnVision mission;
- switching unit for the optical bench for the LISA mission (known as the Fibre Switch Unit Actuator), including control electronics;
- application of high-power lasers to support space missions;
- development of analysers based on laser-induced breakdown spectroscopy (LIBS) and analytical systems based on laser ablation, miniaturisation of these systems for rovers and landers;
- high-resolution mass spectrometry as an extension of the French CosmOrbitrap consortium for future exploration missions and development of proprietary analysers based on miniature high-resolution mass spectrometers;
- development and support of laboratory astrochemistry and astrophysics to support space missions;
- waveform analyser and power supply for the radio and plasma wave measurement instrument on the Solar Orbiter probe;
- dust impact analysers and digital units on two probes of the Comet Interceptor mission;
- a data processing unit for the Vigil mission;
- electronics and sensors for the low-frequency electromagnetic wave analyser on the landing platform of the ExoMars probe;
- experimental study of composite materials with low thermal conductivity at low temperatures and high strength for ATHENA under an ESA contract;
- verification of the thermal radiation properties of the solar white coating for JUICE and ATHENA;
- thermal radiation properties of surfaces for the MTG and ARIEL missions;

- absorption of thermal radiation by a surface contaminated with a lunar regolith simulant for ESA/ESTEC.

The scope and focus of national contributions to these scientific instruments or parts thereof are usually negotiated by the academic community directly involved in the relevant international scientific consortia. Technical implementations are then carried out in close cooperation with national industrial partners, who often take the lead in development and production.

2. Midstream

Midstream includes components and technologies to support the use of space missions. From this perspective, it often bridges the gap between upstream and downstream. Midstream **mainly concerns** preliminary data processing, storage, archiving and distribution. It also includes all infrastructure related to the operation of the space segment, i.e. uplink and downlink stations, communication networks, etc.

The Czech Republic is to find the following capacities in midstream:

- building mission operations centres, uplink and downlink communication antennas and related infrastructure;
- building and operating data centres and archives, computing and dissemination platforms for Earth observation data and other data from space systems;
- growing capacity in large-volume data processing, cloud computing, development of AI as a tool for EO data processing;
- development of the Internet of Things (IoT) network, which could be used for EO data calibration and validation;
- construction and operation of networks of permanent GNSS reference stations (excluding the manufacture of GNSS receivers/antennas);
- development of software for long-term real-time monitoring of GNSS performance for all constellations, showing their mutual development trends.

3. Downstream

Downstream is defined as industrial activities that use space infrastructure and data obtained from space systems to provide tools and services to end users. The following basic prerequisites are important for success in downstream: a) excellent expertise in the field of software b) very close cooperation with potential customers, not only in terms of precisely defining customer requirements for the outputs of a given application or service, but also in terms of costs and possible inputs from these customers. However, before the technology becomes a commodity, in-depth or detailed knowledge of the space systems and instruments whose data are used in the service or application is essential. Before the use of satellite navigation became a commodity, the pioneers in the use of GNSS services were companies with in-depth knowledge of this technology, including the space segment (upstream). As a result, they not only mastered this technology, but also gained a dominant position in the satellite navigation applications and services market.

Targeting downstream development within the EU is much more difficult than within the ESA. In comparison, the ESA offers more than a level of magnitude higher resources for the development of applications and services related to Galileo and Copernicus within its programmes.

There are a significant number of companies in the Czech Republic with technological potential for development in the field of space activities, whether upstream or downstream. However, as already mentioned, upstream is limited by the amount of the Czech Republic's contribution to the ESA, and therefore any significant growth in this area leads to an increase in these contributions.

Although this limitation does not affect the downstream sector as much, given the existence of established European players who entered the market earlier (before the Czech Republic became a member of the ESA), it is much more difficult for them to gain a foothold.

As part of its programmes, the ESA fully funds preparatory activities in the downstream sector and co-finances demonstration phases. Support for the development of downstream applications for defence purposes is also offered by the EDF and EDA as part of their own instruments.

Earth observation

Capacities and capabilities in the Czech Republic in downstream Earth observation:

- Processing of Earth observation data – multispectral, hyperspectral, thermal and SAR data. Development of new products based on Earth observation data (including integrated applications), e.g. monitoring of terrain and infrastructure movements, SAR, multispectral and hyperspectral data for applications in the field of the environment, agriculture, including food security, forestry, land use and land cover, natural resource use, natural disaster monitoring, transport, infrastructure and land use monitoring, atmospheric monitoring and modelling, air pollution, greenery health, land surface temperature and overheating, etc.;
- use of laser scanning data, product development;
- integration of Earth observation data-based information into GIS and customer systems, services for midstream and end users;
- ML and AI for Earth observation data processing; blockchain-based services/technologies for EO;
- spectroscopy, spectrometry, radar interferometry, gravimetry (especially academic entities);
- calibration and validation of raw Earth observation data;
- development of algorithms for data processing;
- processing of data from scientific Earth observation missions, e.g. GOCE, SMOS, SWARM and others.

Navigation, satellite communications and integrated applications

A number of companies are developing applications that use GNSS as the primary source of position, navigation and time. Examples can be found in many areas of the national economy;

- traditional areas of transport and logistics;
- fleet management;
- intelligent transport systems;
- e-Call;
- unmanned aerial vehicles;
- environmental protection;
- construction;
- precision agriculture and forestry;
- person tracking and health monitoring
- sport
- geo-marketing
- media and entertainment.

A newly emerging application domain in the Czech Republic is autonomous mobility, particularly in the area of automated and connected vehicles. Although GNSS positioning is only one piece of the complex puzzle of automated driving, it is a very important one. The system time provided by the GNSS system is widely used in the Czech Republic by banks, electricity networks and telecommunications operators to synchronise their networks. This situation is unlikely to change, but solutions integrating various sources of accurate time (multi-constellation GNSS receivers, Loran) are expected. Many of the above applications are critical to the national economy, the general stability of the state and the safety of citizens. Therefore, great attention must be paid to ensuring that these applications are properly secured, robust and resistant to both intentional and unintentional interference. Another new application integrating GNSS with Earth or sky observation and satellite telecommunications is the domain of HAPS platforms. Czech industry is a pioneer in this field with a vision of a number of very interesting applications.

As far as satellite telecommunications applications as such are concerned, the market in the Czech Republic is very small due to the generally very good coverage by terrestrial and mobile networks. The only exception is satellite television, a service traditionally used by households in remote areas that are not connected to cable television or terrestrial internet. Overall, GNSS and integrated applications are a very promising area in which many potential developers and users of applications coexist, even though they are still unaware of all the possibilities offered by space systems.

Annex 4: Overview of the main support tools available to the Czech Republic for the development of space activities

A support tool for space activities in the Czech Republic is the national project Czech Space Journey, which was presented to the **government on 19 June 2024**. The aim of the national project is to contribute significantly to the transformation of the Czech economy into an economy based on high value-added activities through space activities. To achieve its objectives, the national project combines the following instruments in an appropriate manner:

Czech Republic's membership in ESA

The Czech Republic's membership in ESA and ESA activities and programmes are by far the most important tools for the comprehensive development of Czech industry and academia.

The ESA is an intergovernmental organisation whose purpose is to ensure and promote cooperation between European states in the field of space research and technology for exclusively peaceful purposes and their space applications with the intention of using them for scientific purposes and for functional space application systems.

The Czech Republic can thus take full advantage of the opportunities offered by:

- 1) **Mandatory ESA activities**, which include the agency's core activities, such as studies on future projects, technological research, joint technical investments, information systems and training programmes, and which are organised mainly through the Science Programme, the Discovery Programme, the preparation and development of technologies and the technical and operational infrastructure of ESA.
- 2) **Optional ESA programmes** covering space domains such as Earth observation, satellite navigation, satellite communications, launchers, manned spaceflight, microgravity, exploration, technology development, etc., including the development of space applications.

Traditionally, more than three-quarters of Member States' contributions to the ESA budget are allocated to optional programmes. It is precisely these optional programmes that help Member States build their industrial capacities and capabilities so that they are able to carry out mandatory activities and remain competitive on a global scale. Overall, 90-95% of the ESA budget is used to conclude contracts with industry. ESA's industrial policy is therefore a key tool for motivating Member States to invest in ESA programmes. This motivation is driven by what is known as industrial return or geographical return. In order to monitor and control geographical return, ESA maps the geographical distribution of all contracts among its Member States, as well as their technical value. From these statistical data, a return coefficient is derived for each Member State as the ratio between the actual and ideal weighted value of contracts.

The emphasis on geographical return is a unique feature of the ESA, which motivates member states to finance its activities. Geographical return is particularly important for the Czech Republic, as it guarantees that Czech contributions to the ESA will return to the Czech Republic, even though Czech industry may in some cases be less competitive than the rest of Europe.

- 3) A specific agreement to support the Czech space ecosystem in the form of a **"Framework Project for the Implementation of ESA Support for Space Activities in the Czech Republic"** was activated in 2017 following a decision by the government and approval by ESA member states.

The Framework Project implements activities aimed at capacity building and raising the level of the space industry through the adoption of new technologies and procedures. The emphasis is mainly on the industrial sphere, because this sphere (unlike the academic sphere) is fully involved in production programmes in the Czech Republic and at the international level. The motivation behind the project is to prepare companies for integration

into supply chains that require a higher level of project documentation, quality management, process workflows, automation of production processes, etc. Since 2022, ambitious projects have been implemented beyond the scope of the above activities in accordance with NKP 2020+. Ambitious projects pursue a number of objectives, in particular giving Czech industry the opportunity to acquire or develop integration capabilities, increase its competitiveness vis-à-vis foreign partners, and strengthen effective cooperation with the academic sphere through mutual complementarity and the creation of a value chain. Unlike other projects, ambitious projects are aimed at independent space flight under the direction of Czech actors, either as independent missions or as a significant and clearly autonomous element of a larger international mission. Currently, the AMBIC satellite project to meet the needs of state users and the QUVIK science-focused project are being implemented this way.

From 2024, and in particular thanks to the Czech government's decision of 2025, this instrument will be used to implement the national project Czech Journey into Space, in terms of education, raising awareness of the importance of space activities and, in particular, the mission of a Czech astronaut into space and the preparation of experiments to be carried out.

The considerable potential of this instrument lies in the possibility of implementing activities at the government-to-government level, particularly with countries outside the ESA and the EU, which aim to achieve common scientific goals through effective cooperation between the academic and industrial spheres of both parties.

The Framework Programme implements projects that cannot be effectively implemented within the framework of ESA's mandatory activities and optional programmes. Nor can they be implemented through support programmes available in the Czech Republic, for example because, given their specific focus on space activities, there is no expert base in the Czech Republic that could competently evaluate and monitor the projects and provide expert consultation and guidance.

4) A specific case is **ESA system projects** financed from the above-mentioned instruments, which have become institutionalised over time at the level of the individual participating Member States, including the Czech Republic, and have created robust international networks for the exchange of know-how and experience. In the Czech Republic, these are:

- a) The ESA BIC Czech Republic business incubator in Prague and Brno, which has incubated approximately 70 start-ups to date;
- b) ESA Commercialisation Ambassador, which aims to develop the use of satellite services and data in various economic sectors and everyday life;
- c) The ESA ESERO Education Office, which aims to use the inspirational nature of space to increase the scientific and technical literacy of primary and secondary school pupils and motivate them to study and pursue careers in science, technology, engineering and mathematics.
- d) ESA Technology Broker, which helps transfer technology from space activities to other areas and vice versa.

5) **Other instruments** financed from the above-mentioned ESA instruments, which, through Czech entities or directly, help to build a robust space ecosystem in the Czech Republic, such as the Czech Training Scheme, ESA EO Training Academy, ESA Academy, etc.

Czech Republic's membership in the EU

The EU also has instruments that can be used for the development of space activities. The focus of some instruments, such as structural and cohesion funds, is linked to the priorities of the respective country, and their use to support space activities is random.

The following are relevant instruments:

1) Horizon Europe

More concentrated support for space activities is linked to the EU's framework programmes for research and innovation, now Horizon Europe for the period 2021–2027.

Space activities are covered by Cluster 4, 'Digital, Industry and Space', which aims to strengthen Europe's independent, secure and competitive access to space and exploit its potential for the benefit of European society and the economy. The emphasis is not only on technological autonomy and innovation, but also on maximising the use of data and services from satellite systems offered by European satellite programmes – primarily Copernicus, Galileo and EGNOS – and on preparing applications for new services from these systems and the GOVSATCOM and IRIS² systems.

This part of the programme supports the development of new space technologies and systems, including satellite platforms, small launch vehicle technologies, ground segments, etc. It also focuses on supporting small and medium-sized enterprises and start-ups in the preparation of innovative solutions, particularly in applications. In addition to technological development, security is an important issue, both in terms of protecting European capabilities in orbit (e.g. through space debris monitoring and space traffic management systems) and in terms of ensuring secure access to data and services from satellite systems. Horizon Europe's 'space' section also focuses on supporting access to data and system interoperability.

The European Commission emphasises international cooperation – whether with European partners such as ESA or EUMETSAT, or with actors outside Europe – and the creation of common standards and regulatory frameworks that will enable the effective use of space activities on a global scale.

Projects funded by Horizon Europe can take the form of research and development activities, demonstration missions, testing of new technologies, but also the development of specific applications for the public and private sectors. The emphasis is on synergies with other EU policy areas, such as digital technologies, AI, green transformation and defence.

2) CASSINI

CASSINI is a European Commission programme aimed at supporting entrepreneurship, innovation and investment in space technologies and services. Its aim is to strengthen the European space ecosystem, in particular by supporting start-ups and small and medium-sized enterprises, and enabling them to transform the technological potential of European space programmes – such as Copernicus, Galileo and EGNOS – into functional, competitive and sustainable business solutions.

The programme was created as a part of a broader EU strategy to support the New Space economy and is a key tool for connecting the space sector with digital technologies, finance, industry and public administration. It is the first comprehensive European initiative to combine financial instruments, incubation, mentoring, competitions and access to data and infrastructure with the aim of creating a favourable environment for the growth of space companies and the development of innovative solutions based on data from satellite systems and space technologies.

The CASSINI programme is based on several pillars. The first is the CASSINI Business Accelerator, which offers selected companies intensive support in business development, customer access, technical advice and financing. It also includes CASSINI Prizes and Hackathons, which support innovation through themed competitions – for example, in the areas of climate services, security, mobility, and land management. Another important part is CASSINI Matchmaking, which helps companies establish contacts with investors, large companies, and the public sector.

One of the key elements of the programme is the CASSINI Seed and Growth Funding Facility, an investment tool created in cooperation with the European Investment Fund. This

tool enables early-stage and growth financing for European space start-ups through private funds, with the EU acting as an investor and providing de-risking. The aim is to strengthen access to risk capital in the space sector, and support the emergence of European high-tech companies in this sector.

CASSINI is open to actors from across the EU and associated countries and complements other European instruments such as Horizon Europe, the EU Space Programme and ESA initiatives. Its key added value is its ability to bridge the gap between the technical potential of the Europeanspace programme and its concrete impact on everyday life, whether in navigation, crisis management, agriculture, urban planning or environmental monitoring.

3) EU space programme

In terms of upstream activities, these instruments, as practice shows, unlike ESA activities, are not a very effective tool for systematically building the Czech Republic's space capabilities and capacities and for supporting the Czech space ecosystem. Given the high level of interest, their use is rather random and, without combination with other tools, i.e. ESA activities or programmes or other national or international programmes, they do not enable the systematic development of our space ecosystem or its strategic direction.

The European Commission is also the manager of the EU Space Programme, which is a set of activities related to the preparation and operation of space infrastructures such as the Galileo and EGNOS satellite navigation systems, the Copernicus Earth observation system, and the Govsatcom and IRIS satellite communication systems. Work on related programmes usually begins at ESA in combination with its optional programmes, but in later stages it involves EU public procurement. Given the institutional framework for space activities in Europe, it is clear that the Czech Republic's financial participation in ESA's optional programmes is key to its involvement in the development of EU space infrastructure (see above), as it is thanks to this that Czech industry and academia are involved in the formation of industrial consortia, which subsequently obtain EU public contracts and thus also EU funds that the European Commission invests in space activities.

This approach should also be applied to other EU ambitions, whether it be low Earth orbit satellite navigation (LEO PNT), the EOGS intelligence satellite network, or space weather protection (SWE) as part of the Space Domain Awareness initiative. It is clear that with greater emphasis on EU security and defence capabilities and further convergence of space and defence activities, EU investment in space activities will grow, and Czech industry and academia must be able to access these joint investments.

As far as the downstream sector is concerned, it is clear that the aforementioned space infrastructures are opening up unprecedented opportunities for the use of satellite data and services in virtually all economic sectors and everyday life. The European Commission and EUSPA have the tools to support the use of satellite data, services and new solutions in various economic sectors. On the other hand, the advantage of EU activities is the more effective integration of space activities with individual sectoral policies that fall within the remit of various Directorates-General of the European Commission or EU agencies, especially where regulatory barriers need to be overcome in order to deploy new solutions.

Although the EU Space Programme, Horizon Europe and Cassini are undoubtedly important for supporting EU space activities and their use by Czech entities, they cannot be fully utilised for the systematic development and strategic direction of the Czech space ecosystem.

4) Cooperation in the development of defence capabilities

In 2023, the European Commission and the European External Action Service (EEAS) issued a joint communication to the European Parliament and the Council entitled "EU Space Strategy for Security and Defence." Among other things, the new strategy focuses on measures to strengthen the resilience of the space sector, protect European space

infrastructure and take defence interests into account in the further development of EU satellite systems.

The European Defence Agency (EDA) supports cooperation between Member States in the field of defence capabilities, research and technology, coordinates joint projects, harmonises requirements and seeks savings through sharing and joint development, and plays a role in the implementation of Permanent Structured Cooperation (PESCO). Cooperation in the development of defence capabilities in the space sector is mainly addressed by the EDA Defence in Space Forum, in which the Czech Republic participates. The development of space technologies and products also takes place within the EDA Captech groups, which include Czech representatives from both the public and private sectors.

Specific space industry projects are addressed within the European Defence Fund (EDF). The EDF is a financial instrument established by the European Commission to support research and development of defence technologies and systems. Its aim is to reduce the fragmentation of the European defence industry and increase its competitiveness.

NATO

Following the adoption of NATO's Overarching Space Policy (2019), NATO established space as a new operational domain and subsequently included space technologies among the categories of emerging and disruptive technologies (EDT) in 2021. NATO is strengthening its innovation cooperation with the civil and defence industries, start-ups, and scientific and research institutions. In the field of scientific cooperation, space technologies are addressed by the Science and Technology Organisation (STO), and cooperation with industrial partners is developing within the Conference of National Armaments Directors (CNAD), which will implement the newly adopted NATO Commercial Space Strategy. This strategy aims to strengthen cooperation with the private sector and partners in the field of space and contribute to capability development. The NATO Industrial Advisory Group (NIAG) has established SPACENET, a group of over 300 companies, including several dozen Czech entities, which serves as a forum for communication and the exchange of recommendations between NATO, academia and industry.

The NATO DIANA defence accelerator and the NATO Innovation Fund were established with the aim of supporting innovation potential in the space industry (and beyond).

Other international instruments

In addition to the membership in the ESA and the EU, the Czech Republic's membership in the following organisations is also important for promoting common strategic goals and the direction of space activities in Europe and around the world:

- in the United Nations (UN), where regulatory issues affecting global access to space activities are addressed within the Committee on the Peaceful Uses of Outer Space and its subcommittees. Although the committee's broad and diverse membership base makes it difficult to adopt new binding international rules, the committee and its subcommittees provide an important platform for leading representatives of space activities from around the world to meet and exchange information on space activities. At the same time, gradual steps are being taken to prepare and adopt at least recommendations for sustainable access to outer space and to discuss issues of resource use in space and planetary defence.
- In the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), where the Czech Republic, together with other countries, provides continuous long-term satellite observations of weather and climate, processing, archiving and distribution of its data, images and products obtained to the national meteorological services of member and cooperating states in Europe, as well as to other users around the world. The close cooperation between EUMETSAT and ESA

is also significant, with functional prototypes of each new series of meteorological satellites being developed within ESA programmes based on EUMETSAT specifications, and serial production of individual prototypes being carried out by ESA on behalf of EUMETSAT. Thanks to its participation in ESA programmes, Czech industry is involved in the formation of industrial consortia and thus also has access to EUMETSAT funds (the direct return on investment in ESA is between 4 and 5).

- in other organisations such as ESO, CEN/CENELEC, GEO, EUROCONTROL, WMO, IMO, ICAO, CERN, IMSO, ITU, ITSO and EUTELSAT IGO, which are directly or indirectly related to space activities.

The Czech Republic's active involvement in the platform created around the United States' Artemis Accords initiative for cooperation on the exploration and use of the Moon and other celestial bodies, including mining, also has considerable potential. This involvement not only strengthens transatlantic ties, but also engages the Czech Republic in dynamic cooperation between the participants of the Artemis Accords, opening up new opportunities for the Czech space industry, science and research.

However, the Czech Republic is not yet taking full advantage of other opportunities and should consider them for involvement and participation in the coming period:

- The European Space Policy Institute (ESPI), which is an important and respected player in the field of space policy-making in Europe and a partner of global space think tanks.
- The International Astronautical Federation (IAF), which is the most important platform bringing together space agencies, industry associations, research institutions and other major players in the field of space activities, and which facilitates formal and informal communication between them through its activities.

National instruments

Currently, there is no specific instrument for supporting space activities at the national level, but some instruments have the potential to contribute to the development of space activities, especially in combination with the Czech Republic's membership in the ESA or the EU. These include, in particular, the opportunities offered by the research and development programmes of the Technology Agency of the Czech Republic (TA CR) or the Ministry of Industry and Trade (MIT).

As regards the research and development programmes of the TA CR and other providers, the most significant step was the support for the establishment and operation of the National Competence Centre for Aviation and Space, which aims to strengthen cooperation between the research, academic and private sectors and to create suitable conditions for the commercialisation of research results and their use for the needs of society. These objectives are in line with those of the national space plan. For this tool to be used effectively, coordination is needed, particularly with activities carried out at ESA level.

The second important tool is the MIT's "Country for the Future" research and development programme, through which the CzechInvest agency implements a technology incubation programme. The ESA BIC business incubator served as a model for setting up this programme. The field of space activities is now one of the areas of technological incubation, and thanks to this programme, the possibilities for incubating space start-ups and participating in the development of a robust space ecosystem in the Czech Republic have been strengthened within the "Space Hub". At the same time, the Technology Incubation programme has opened up the possibility of using sister incubators or hubs for the incubation of start-ups using satellite data and services, e.g. in the areas of mobility, AI or the circular economy.

The use of other, generally cross-cutting or subject-specific research and development programmes of the TA CR and other providers to support space activities is otherwise rather random, although more regular than in the past. In the field of space technologies, the expertise of the ESA is often still needed to achieve results, and the international environment of the ESA better ensures the involvement of our entities in international supply chains and the commercialisation of results and their practical application. However, TA ČR programmes have already supported several projects by established space companies aimed at developing specific space components or independent CubeSat satellite solutions. These activities have given Czech companies a competitive advantage for follow-up projects within ESA or on the institutional or purely commercial market.

Defence research by the Ministry of Defence, which has already supported the development of the SATurnin-1 satellite for imaging the Earth's surface, could become an important tool for supporting space activities for defence purposes. Within the framework of TA ČR, a new research programme called PRODEF has been established for the development of the defence industry, in particular to support its involvement in international supply chains and consortia and to strengthen its technological level.

In the downstream sector, programmes run by TA ČR and other providers support a number of projects that develop solutions using satellite data and services. The ESA Business Application Ambassador is now working to identify these projects, connect supply and demand, and provide further support for their development.

Other instruments, such as EU operational programmes, can also be used directly or indirectly to support space activities in the Czech Republic.

Annex No. 5 – Principles of project support

The principles for supporting projects financed from instruments that can be directly influenced include:

1) Keeping pace with market trends and needs

The Czech Republic should not support the development of industrial capacities and capabilities that have very little chance of success on the European or global market. When assessing whether or not to grant support to a project proposal, great emphasis should be placed on alignment with technological and market trends, gaining competitive advantages and focusing on market gaps. The Czech Republic should also support scientific research for planned missions and the development of scientific instruments for space science missions in order to enable Czech academic teams to promote their own projects, which will demonstrate their scientific excellence worldwide.

2) Be innovative

There is growing demand for innovative products and new space systems. This trend should be seen as an opportunity for Czech industry to reap significant benefits from its participation in space activities. Long-term success can only be achieved by leveraging newly acquired capabilities, which will require their consolidation into economically sustainable products. This will help the entire Czech space industry to further strengthen its excellent international reputation and occupy markets with high added value potential. It will also help it not only to create but also to maintain intellectual capital.

3) Be disruptive

Disruptiveness and innovation cannot be planned or enforced, but industry, academia and individuals can be motivated and encouraged to think disruptively and come up with disruptive solutions. In the field of space activities, there is considerable scope for entirely new concepts and approaches that can have a rapid and significant impact on existing technologies. On the other hand, the more projects focus on process and technology innovation or new concepts and approaches, the more revolutionary they are, and the riskier they can be. These projects must therefore remain realistic and feasible.

4) Being excellent

In line with European research conditions, the Czech Republic strives to strengthen and expand the excellence of its scientific base and to consolidate the overall research environment so that its research and innovation system is more competitive on a European and global scale. National and international cooperation should be a means to achieve this goal.

5) Create, protect and exploit intellectual property rights

Given that the Czech Republic faces serious shortcomings in the use of intellectual property rights (IPR), great emphasis should be placed on this area. For the further development of space activities in the Czech Republic, it is therefore very important that all resources be used to exploit all possible means of ensuring the protection of IPR.

6) Increase cooperation between academia and industry while respecting their natural roles

The natural missions of academia and industry should be exploited to maximise economic benefits for society, including in terms of return on public investment, and to ensure economic sustainability. Both communities are very important and interdependent in the space sector, as in other economic sectors. The roles of industry and academia can also be demonstrated using technology readiness levels (TRL). Within the triple or quadruple helix concept, it is also important to promote cooperation between academia and industry with government, users, the public sector and interest groups, which naturally connect all three poles of the innovation ecosystem and promote change and progress in cooperation between them.

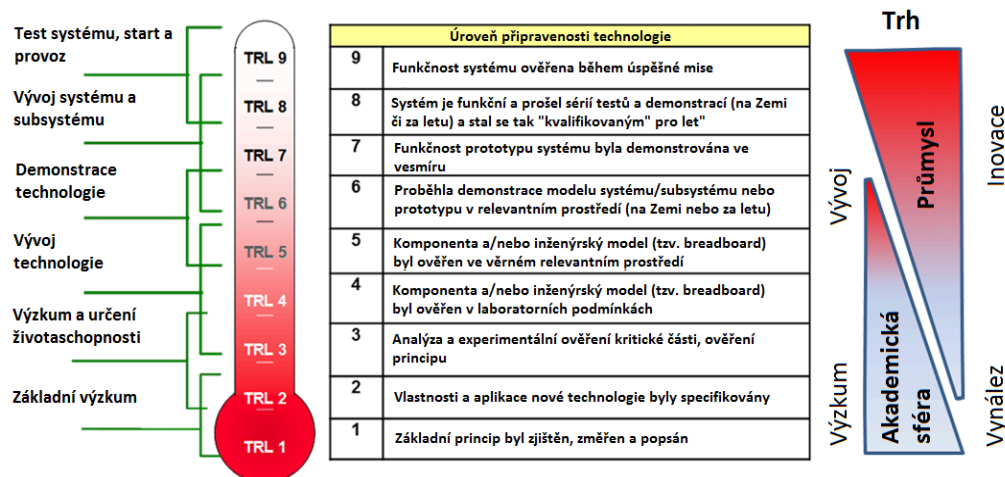


Figure 1: TRL levels in the context of the roles of academia and industry. Source: ESA

7) Creating synergies between companies and between SMEs and large industry

The economic ecosystem in the Czech Republic can be further stabilised not only by establishing a high level of cooperation between industry and academia, but also by ensuring a high level of cooperation between the companies themselves, which complement the individual value chains. It is necessary to create an interconnected value chain between SMEs and large industry.

8) Maximising return on investment

One of the main requirements for ensuring return on investment is the need to preserve and further utilise the intellectual capital created in the Czech Republic. At the same time, there needs to be balanced participation between industry and academia and utilisation of their natural roles. If, in certain special cases, academia were able to develop technologies up to TRL 6 or higher, there would be a problem with the return on investment for the development of such technologies. In an industrial environment, it is easier to develop a product that can subsequently be commercially exploited. Market requirements are taken into account during its development, and these requirements influence the design and production of the product. In order for Czech entities to actively participate in the development of new technologies and their final implementation or use, it is necessary for them to participate in relevant projects from the early stages, when the directions of research and goals for further development are defined.

9) Increase the share of private investment

Due to the high risk involved, ESA finances most of its technological activities 100%. Where space activities become more commercial, industry is increasingly able to take on some of the risks and co-finance the necessary activities. ESA is adapting its programmes accordingly. Gradually, with the creation of a more robust space industry base in the Czech Republic, the share of public investment in market-oriented activities must be reduced. Otherwise, the space industry could become dependent on public funding and the healthy development of this sector in the Czech Republic could be distorted. However, the co-financing system must be balanced so that it can continue to motivate industry to take risks in technologically demanding projects.

10) Stimulate and accelerate the transfer of technology and knowledge

To maximise the return on investment, the Czech Republic focuses on creating an environment for the transfer of knowledge gained through space activities, including the results of research, technology development and services, to other areas. The Czech Republic also focuses on creating an environment for the transfer of knowledge from other sectors to the space sector.

11) Increase the Czech Republic's autonomy in the field of space activities

Thanks to the growing capabilities of the Czech space industry, the Czech Republic is already moving towards creating its own satellite systems, particularly to fulfil its security and defence interests, and where it makes the most economic or other strategic sense, it can take gradual steps to further reduce its dependence on foreign supplies.

Annex 6: Indicative breakdown of the minimum level of funding for ESA programmes and activities

Amounts are given in CZK million*

Domain	2026	2027	2028	2029	2030	2031	2032
Mandatory ESA activities (indicative, depends on the ratio of the Czech Republic's GDP to the GDP of all ESA member states)**	400	400	400	400	400	400	400
TOTAL (Mandatory ESA activities)	400	400	400	400	400	400	400
Earth observation (Future EO, Copernicus Space Component, InCubed, ERS, etc.)	230	230	230	230	230	230	230
Satellite telecommunications (ARTES programme with elements for secure and quantum communications, technology development, etc.)	230	230	230	230	230	230	230
Satellite navigation (NAVISP, FutureNAV, LEO-PNT, etc.)	20	20	20	20	20	20	20
Technology (especially GSTP)	50	50	50	50	50	50	50
Space transport (launch vehicles) (ARIANE 6, Launcher challenge, FLPP, VEGA, IOSHEX, etc.)	230	230	230	230	230	230	230
Commercialisation	110	110	110	110	110	110	110
Space Safety (Compet Element, Space Weather Element, ADRIOS, LEO Evolution platform, etc.)***	120	120	120	120	120	120	120
Manned flights and robotic exploration (E3P)	60	60	60	60	60	60	60
Scientific instruments and other (especially PRODEX programme)***	100	100	100	100	100	100	100
European Resilience from Space and related activities	320	320	320	320	320	320	320
TOTAL (Optional ESA programmes)****	1470	1470	1470	1470	1470	1470	1470
Framework project for the implementation of support provided by ESA to the Czech Republic in the field of space activities	500	500	500	500	500	500	500
Mission of Czech astronaut to the ISS*****	800	800	0	0	0	0	0

TOTAL (Framework project for the implementation of support provided by ESA to the Czech Republic in the field of space activities)	1,300	1,300	500	500	50	500	500
TOTAL	3,170	3,170	2,370	2,370	2,370	2,370	2,370

* Note: The actual amount of the reimbursement in CZK will depend on the current CZK/EUR exchange rate, as the ESA budget and member contributions are set in EUR.

** Note: Mandatory ESA activities are covered by the Ministry of Education, Youth and Sports budget. When implementing NKP 2026+, the Ministry of Education, Youth and Sports will proceed in 2026 in accordance with the budgetary framework set out for Chapter 333 in the Czech Republic's state budget expenditure on research, development and innovation for 2026, its medium-term outlook for 2027 and 2028 and its long-term outlook until 2032, and the internal structure of the allocation of institutional support funds for the Czech Republic's international cooperation in research and development. The starting point for compiling these budgetary frameworks was the assumption that budgetary resources for the Czech Republic's membership in the ESA would be allocated in the amount of CZK 400 million per year. As regards the implementation of NKP 2026+ by the Ministry of Education, Youth and Sports in subsequent years (i.e. 2026+), the Ministry will always proceed in accordance with the possibilities of budget chapter 333 as set out in the approved expenditure of the Czech Republic's state budget for research, development and innovation. The increase in budgetary resources for the Czech Republic's membership in the ESA beyond the annual amount of CZK 450 million will take place while respecting the internal structure of the allocation of institutional support funds for the Czech Republic's international cooperation in research and development, so that the increase in budgetary resources for the Czech Republic's membership in ESA does not have a negative impact on the Czech Republic's participation in other activities, initiatives and programmes of international cooperation in research and development.

*** Note: These optional ESA programmes will be financed by the Ministry of Transport and the Ministry of Education, Youth and Sports according to their focus.

**** Note: The amounts shown represent the minimum level of funding for contributions to ESA optional programmes in 2026–2028, i.e. the proposed amount of contributions to the ESA Council at ministerial level in 2025. It can be assumed that, following the growth in the capacities of Czech industry and academia, opportunities will open up for the Czech Republic after 2028 and subsequently after 2031 to participate in even more demanding and complex activities and thus acquire the capabilities necessary for successful penetration of markets in the field of space activities, which will be reflected in the draft mandates of the Czech Republic for the ESA Council at ministerial level, which will be submitted to the government for approval. These opportunities, to which the Czech Republic will have to respond, may also arise on an ongoing basis.

***** Note: The costs of the Framework Project for the implementation of support provided by ESA to the Czech Republic in the field of space activities include the costs of the Czech astronaut's mission to the ISS, whereby, according to the Czech Government's resolution of 21 May 2025 No. 365, the Czech Republic's contribution in the total amount of CZK 1,600 million must be paid in 2026 and 2027.

Annex No. 7: List of abbreviations

Abbreviation	Full name / explanation
ADRIOS	Active Debris Removal/In-Orbit Servicing – ESA programme
AI	artificial intelligence
AMBIC	AMBIC – technology demonstrator for Czech satellites for Earth observation and secure communications
AOCS	attitude and orbit control system
ARTES	Advanced Research in Telecommunications Systems – ESA programme
ASTRIS	Advanced Space Transportation Research and Innovative Systems – module for the Ariane 6 rocket
ATHENA	Advanced Telescope for High Energy Astrophysics – ESA's planned X-ray telescope
AVE	Advertising Value Equivalency
BeiDou	BeiDou – Chinese satellite navigation system
BepiColombo	Joint ESA and JAXA mission to Mercury
BEST!	Business Experiment Support Tool
BIC	Business Incubation Centre
CAGR	compound annual growth rate
CENDIS	state-owned enterprise for transport digitisation (under the Ministry of Transport)
CERN	European Organisation for Nuclear Research
ClearSpace	initiative to remove space debris
CM	Crew Module
CNAD	Conference of National Armaments Directors
COPUOS	United Nations Committee on the Peaceful Uses of Outer Space
CosmOrbitrap	Mass spectrometer for the Rosalind Franklin mission
COTS	Commercial Off-The-Shelf – commercially available product
CSS	Civil Security from Space – ESA programme
CT	Computed tomography
CubeSat	standard small satellite measuring 10 x 10 x 10 cm
DART	Double Asteroid Redirection Test – NASA mission testing the possibility of deflecting an asteroid
DestinE	Destination Earth – European initiative for a digital twin of Earth
DIANA	Defence Innovation Accelerator for the North Atlantic – NATO defence innovation accelerator
DIAS	Data and Information Access Service – service for accessing Copernicus data
DRACO	Demonstration Rocket for Agile Cislunar Operations – nuclear-powered rocket engine programme
DSLPL	Dual Segmented Langmuir Probe – plasma sensor
E3P	European Exploration Envelope Programme – ESA programme
EDA	European Defence Agency
EDF	European Defence Fund
EDT	Emerging and disruptive technologies
EEAS	European External Action Service

EEE	Electrical, Electronic and Electromechanical components
EGNOS	European Geostationary Navigation Overlay Service
EGSE	Electrical Ground Support Equipment
ELC	European Launcher Challenge – ESA tender and programme for the development of a new generation of commercial launchers
ELT	Extremely Large Telescope
EMC	Electromagnetic compatibility
EnVision	EnVision – ESA's future mission to explore Venus
EO	Earth observation
EOGS	Earth Observation Ground Segment
ERIC	European Research Infrastructure Consortium
ERSA	European Radiation System Array – European network of radiation measurement instruments on the Gateway space station
ESA	European Space Agency
ESERO	European Space Education Resource Office
ESO	European Southern Observatory
ESTEC	European Space Research and Technology Centre
ESTRACK	European Space Tracking
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EuroQCI	European Quantum Communication Infrastructure
EUSPA	European Union Agency for the Space Programme
EUTELSAT	European Telecommunications Satellite Organisation
ExoMars	Exobiology on Mars – ESA programme
FLEX	Fluorescence Explorer – satellite for measuring vegetation fluorescence
FLPP	Future Launchers Preparatory Programme – ESA programme
FSS	Fixed Satellite Service
FTIR	Fourier Transform Infrared Spectroscopy
GCE	GNSS Centre of Excellence
GEO	Intergovernmental Group on Earth Observations
GIS	Geographic Information System
GLONASS	Globalnaya Navigatsionnaya Sputnikovaya Sistema – Russian satellite navigation system
GNSS	Global navigation satellite systems
GOCE	Gravity Field and Steady-State Ocean Circulation Explorer – ESA satellite for measuring the gravitational field
GOVSATCOM	Government Satellite Communications – EU government communications satellite programme
GPS	Global Positioning System – American global navigation satellite system
GSTP	General Support Technology Programme – ESA programme
HAPS	High-Altitude Pseudo-Satellite – unmanned vehicle in the stratosphere
HDP	gross domestic product
HiLASE	High average power pulsed laser system

HydRON	High Throughput Optical Network – ESA programme
HyImpulse	HyImpulse – German start-up developing hybrid rockets
HyPrSpace	HyPrSpace – French start-up developing hybrid rocket engines
IDA	Internal Dosimetry Array
IFU	Integral Field Unit
IGO	Intergovernmental Organisation
InCubed	Investing in Industrial Innovation – ESA programme for financing innovation in remote sensing of Earth
InSPoC	In-orbit Servicing, Assembly and Manufacturing Space Operations Centre
IOD	In-Orbit Demonstration
IOS	In-Orbit Servicing
IoT	Internet of Things
IOV	In-Orbit Validation
IPR	Intellectual property rights
IRIS2	Infrastructure for Resilience, Interconnectivity and Security by Satellite – EU secure satellite communications programme
ISO5	ISO 5 clean rooms
ISO7	ISO 7 clean rooms
ISO8	ISO 8 clean rooms according to ISO 14644
ISR	Intelligence, Surveillance, and Reconnaissance
ISRU	In-Situ Resource Utilisation
ISS	International Space Station
ISTV	In-space transportation vehicle
ITRE	European Parliament Committee on Industry, Research and Energy
ITSO	International Telecommunications Satellite Organisation
ITU	International Telecommunication Union
JAXA	Japan Aerospace Exploration Agency
JUICE	Jupiter Icy Moons Explorer – ESA mission
LAMS	Laser Ablation Molecular Spectroscopy
LCRS	transport of cargo from commercial space stations to Earth
LEO	Low Earth Orbit
LIBS	Laser-Induced Breakdown Spectroscopy
LIDAR	Light Detection and Ranging
LIDARs	laser distance measurement (plural)
LISA	Laser Interferometer Space Antenna – space gravity observatory
MCS	Mission Control System
MEMS	Micro-Electro-Mechanical Systems
MEO	Medium Earth Orbit
ML	machine learning
MO	Ministry of Defence
MPO	Ministry of Industry and Trade
MSS	Mobile Satellite Service

MŠMT	Ministry of Education, Youth and Sports
MV	Ministry of the Interior
MFA	Ministry of Foreign Affairs
MŽP	Ministry of the Environment
NASA	National Aeronautics and Space Administration (USA)
NATO	North Atlantic Treaty Organisation
NEO	Near-Earth Object
NIAG	NATO Industrial Advisory Group
NIH	National Innovation Hub
NKP	National Space Plan
NMR	Nuclear Magnetic Resonance
NRT	near real time
NÚKIB	National Office for Cyber and Information Security
ODYSSEY	name for a hub and fuel depot for in-orbit refuelling
OECD	Organisation for Economic Co-operation and Development
OneWeb	OneWeb – a private company building a satellite telecommunications constellation
PALS	Prague Asterix Laser System
PESCO	Permanent Structured Cooperation
PLD	PLD Space – Spanish company developing small launch vehicles
PNT	Positioning, Navigation and Timing
PoC	Proof of Concept
PPP	Public–Private Partnership
PROPED	Economic diplomacy support projects
PRS	Public Regulated Service – part of the Galileo satellite system
QKD	Quantum Key Distribution
QUVIK	Ultraviolet telescope for observing kilonovae
RFA	Rocket Factory Augsburg – German company developing small rockets
RIU	external device interface units
RTK	Real-Time Kinematic – a method for precise GNSS positioning
RVVI	Government Council for Research, Development and Innovation
S2P	Space Safety Programme – optional ESA programme
SAR	synthetic aperture radar
SATCEN ČR	Satellite Centre of the Czech Republic
EU SatCen	EU Satellite Centre
SBAS	Satellite-Based Augmentation System
SCOE	Special Check-Out Equipment
SDT	Science Definition Team
SHM	Structural Health Monitoring
SIA	Satellite Industry Association
SME	Small and Medium-sized Enterprise
SMOS	Soil Moisture and Ocean Salinity – ESA satellite
SpaceX	SpaceX – American company developing rockets and satellites
SDA	Space Domain Awareness

SSA	Space Situational Awareness – monitoring the situation in outer space
SST	Space Surveillance & Tracking - monitoring space debris
STEM	science, technology, engineering and mathematics
STIX	Spectrometer Telescope for Imaging X-rays
STM	Space Traffic Management in orbit (Earth)
STO	Science and Technology Organisation
SWaP	Size, Weight and Power
SWARM	ESA satellite constellation for measuring the Earth's magnetic field
SWE	Space Weather
TARANIS	Tool for the Analysis of Radiations from Lightning and Sprites – French mission
TDE	Technology Development Element in the ESA programme
THOR	Transient High-Energy Observations of the Radio and X-ray Universe – experiment on Space Rider
THRUST!	Technologies for High-thrust Re-Usable Space Transportation – name of a part of the FLPP programme
THz	terahertz frequencies
TimePix	Timepix – a particle detection chip developed at CERN
TPMU	Telemetry Processing and Monitoring Unit
TRL	Technology Readiness Level
TTB	Trunk Test Buffer (used in telecommunications)
TTE	Time to Event
TVC	Thrust Vector Control
UAV	Unmanned Aerial Vehicle
USA	United States of America
UV	ultraviolet radiation
VenSpec	Venus Spectrometer – spectrometer for the Venus mission
VLEO	Very Low Earth Orbit
VZLÚ	Research and Test Flight Institute, Inc.
VZLUSAT	VZLUSAT – Czech satellite developed by the Research and Test Flight Institute
WFI	Wide Field Imager